PART SIX – ATTACHMENTS

Attachments

P707 Embassy Security Guard, BEQ and Ops Facility

Marine Corps Base, Quantico, Virginia

FY16

eProject #: N40080-16-1354717
PWB#: 2014150
Category Codes: 72125, 61010, 14345, 17125

RFP, 5 May 2016

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Part 3 contains the project description, functional and performance requirements, scope items, and expected quality levels that exceed Part 4. Part 4 identifies design criteria, verification requirements, and performance and quality requirements of products. See "Order of Precedence" paragraph in Part 2 for relationships between all parts of this RFP.

MCB QUANTICO EROSION AND SEDIMENT CONTROL, STORM WATER POLLUTION PREVENTION AND LOW IMPACT DEVELOPMENT APPLICATION AND DESIGN GUIDANCE

(PROVIDED DIGITALLY)

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Erosion & Sediment Control, Storm Water Pollution Prevention and Low Impact Development (LID) on MCB Quantico

Application & Design Guidance

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Guide To Requirements For Land Disturbances On MCB Quantico:

This guidance package is designed to help direct and assist applicants through the entire process for Land Disturbances on MCB Quantico. The following information will help the applicant determine what permit fees are required as well as what plans (i.e. Erosion & Sediment Control [E&SC] and/or Storm Water Pollution Prevention Plan [SWP3]) are required. In addition to what is required, there are many diagrams and visual aids to help in the design of your plans. In the very back is a Supplementary Forms section that contains all application forms talked about in this guide, as well as the applicable checklists that are used by NREA to review application submissions. The checklists can be used as a guide to ensure all components of your application are included prior to submittal to NREA. This will help to ensure a faster and smoother application process for you.
The first step in the land disturbance process is to determine how much land area will be disturbed during your project. To determine which application fees apply, and if a E&SC and/or SWP3 plan will be required, please use the following guidelines:

IF <2500 SQ FT (232 SQ.M., 0.057 ACRES):

No required permit, however applicable state and federal erosion and sediment control regulations still apply.

PROJECTS ≥ 2500 SQ FT:

THE FOLLOWING ARE REQUIRED FOR ALL PROJECTS ≥ 2500 SQ FT UNLESS OTHERWISE SPECIFIED:

Storm Water Construction Permit for DCR (Original Check and Signatures to be submitted through NREA)
Storm Water Pollution Prevention Plan (narrative and plans)
Erosion and Sediment Control (narrative and plans)
NREA Online Storm Water Construction Training
Onsite Responsible Land Disturber (Virginia State Certified)

a) Sites ≥2500 sq ft (232 sq.m., 0.057 acres) and within 100 feet from open water or drainage lines:

If the site is ≥2500 square feet and lies within a **resource protection area** (RPA), or an area determined by NREA to be in a sensitive area, the following is required:
This applies to all applicable size site locations East of I-95 and may include sensitive areas West of I-95 as determined by NREA at time of project review. Sensitive areas are designated as:

1. Tidal wetlands;
2. Nontidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies with perennial flow;
3. Tidal shores;
4. Such other lands considered by the local government to meet the provisions of this section and to be necessary to protect the quality of the state waters; (ex: county delineated RPAs) and
5. A buffer area not less than 100 feet in width located adjacent to and landward of the components listed above, and along both sides of any water body with perennial flow." (9VAC 10-20-10 et seq.).

b) For sites ≥10,000 square feet but <1 acre:

Located anywhere on Base, and more than 100ft from open water, sensitive areas, or drainage lines, the following is required:
Note: Erosion and Sediment Control (narrative and plans)- Short Form applies

c) If ≥ 43,560 sq.ft. (4,047 sq.m., 1.00 acre):

All other sites on installation

DCR Application Fees: **$200 (sites <1 acre but greater than 2500sq ft)**
$300 (1 acre but less than 5 acres)
$500 (5 acres and over)

Steps For Obtaining A Construction VPDES General Permit For Storm Water Discharges:

After you have determined your application fees and your requirements for E&SC/SWP3 you should refer to the following sequence:

It is recommended that all required submittals be provided to NREA AT LEAST 45 DAYS from anticipated date of the proposed land disturbing activity.

STEP ONE:

The following materials need to be obtained (you can find and print this information at http://www.dcr.virginia.gov/soil_and_water/vsmp.shtml or via the NREA Water Programs website at **http://www.quantico.usmc.mil/activities/display.aspx?PID=1786&Section=NREA**, there are also hard copies of this information located in the back of this pamphlet)

- VSMP general permit application form for construction activities:
- General permit notice of termination (NOT) for storm water discharges from construction activities
- Permit application fee form

STEP TWO:

Develop an Erosion and Sediment Control (E&SC) Plan *and* a Storm Water Pollution Prevention Plan (SWP3) for the project site. There is a generic SWP3 Plan that you can use (just fill in the highlighted areas with all pertinent information and attach the maps) located on the NREA Water Programs website and in the back of this pamphlet. The SWP3 and E&SC plans must be reviewed and approved by NREA prior to any land disturbance activities.

STEP THREE:

Provide NREA with a name of the Responsible Land Disturber (RLD) for the construction site. The RLD must fall under one of the following criteria to be acceptable:

- He/she must have a state RLD certificate (see http://www.dcr.state.va.us/sw/es_rld.htm for more information.), **OR**:
- Must be a certified P.E. in the state of Virginia, **OR**
- Must be enrolled in the state Erosion and Sediment Control Certification Program (see http://www.dcr.state.va.us/sw/estr&crt.htm for more info) or have obtained a state certificate through this program.

NEW TRAINING REQUIREMENT: At a minimum, all contractor RLD's are required to complete the online module of Storm Water Training at the following site:
http://nreabweb.emainc.com/MCBQ_SW_Training/SWPP%20Training/index.asp

STEP FOUR:

Provide a Storm Water Management Plan (SWMP) for review and approval.

STEP FIVE:

Fully fill out the permit registration statement and permit application fee forms.

STEP SIX:

Provide the original permit application fee form, the original check (made out to "Treasurer of Virginia") and the original registration statement to the Environmental Compliance Section, NREA Branch, who will review the forms, prepare the transmittal letter and submit the package to the Department of Conservation and Recreation (DCR).

NO LAND DISTURBING ACTIVITY CAN BEGIN UNTIL THE PERMIT HAS BEEN ISSUED BY DCR OR AFTER 15 BUSINESS DAYS FROM THE POSTMARK DATE WHEN NREA SUBMITS YOUR PERMIT TO DCR, WHICHEVER OCCURS FIRST.

STEP SEVEN:

When total stabilization of the site has occurred, NREA will provide the contractor a close-out memo. Once this memo has been received, the contractor is to fill out the Notice Of Termination (NOT) for the project and send it to the Virginia DCR. A copy of the NOT must be sent to NREA. If you have any questions about filling out these forms, please call NREA at (703) 432-0528.

Energy Independence And Security Act:

In December 2007, Congress enacted Energy Independence and Security Act (EISA). Section 438 of that legislation establishes strict storm water runoff requirements for Federal development and redevelopment projects. The provision reads as follows:

"Storm water runoff requirements for federal development projects**.** The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow."

INTENT OF SECTION 438 OF EISA:

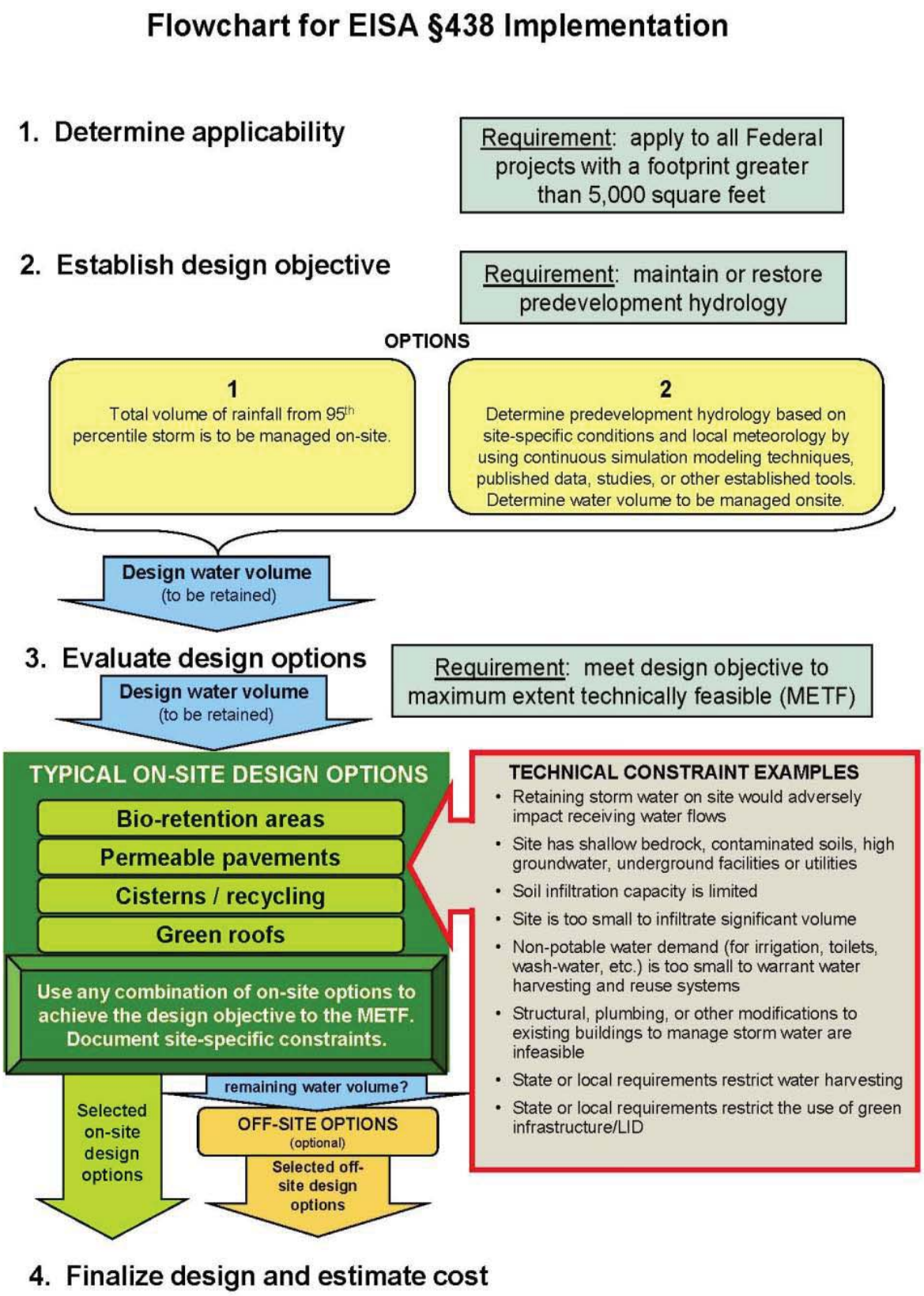
The intent of Section 438 of EISA is to require federal agencies to develop and redevelop facilities in a manner that reduces storm water runoff and pollutants in order to protect or restore the waters of the U.S. A new way of thinking about storm water has evolved, and new approaches have been developed to eliminate or reduce the amount of water and pollutants that run off a site and ultimately discharged into adjacent water bodies. The new approach has a fundamental notion to employ systems and practices that use or mimic natural processes to 1) infiltrate and recharge, 2) evapotranspire, and/or 3) harvest and reuse precipitation near to where it falls to earth.

COMPLIANCE WITH SECTION 438:

Compliance with Section 438 requires that storm water management measures are implemented to the maximum extent technically feasible (METF) to maintain or restore the pre-development hydrology conditions, specifically with respect to temperature, rate, volume, and duration of flow. To meet these performance requirements, storm water control practices that are effective in reducing the volume of storm water discharge must be used. To meet the intent of the statute, the Federal facility must use all known, available and reasonable methods of storm water retention, and/or reuse to prevent the offsite discharge of storm water runoff.

Navy policy, dated 20 December 2010, Engineering and Construction Bulletin, Issue No. 2011-01, states that all new construction projects costing over Seven Hundred Fifty Thousand Dollars ($750,000.00) and/or disturbing 5,000 sq. ft. or more shall comply with EISA. The 2010 Navy Policy further states that Low Impact Development (LID) shall be used in these same projects. LID is to be tracked and reported as to the Navy's progress on storm water management.

IMPLEMENTATION OF SECTION 438:



Low Impact Development (LID), What Is It And Do I Need It In My Project:

LOW IMPACT DEVELOPMENT (LID):

According to the Under Secretary of Defense memorandum dated January 19, 2010, Low Impact Development (LID) is to be utilized to the "most practicable extent possible" beginning FY2011. This offers a new innovative approach to urban storm water management. LID uniformly or strategically integrates storm water controls throughout the urban landscape. It does not rely on the conventional end-of-pipe or in-the–pipe structural methods. The primary goal of LID is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff.
The Department of Navy policy sets a goal of no net increase in storm water volume and sediment or nutrient loading from all construction sites.

WHAT IS LID:

LID is a storm water management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives and fulfill environmental regulatory requirements. LID employs a variety of natural and engineered features that reduce the rate of runoff, filter out pollutants, and facilitate the infiltration of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve the quality of receiving surface waters and stabilize the flow rates of nearby streams. LID incorporates a set of overall site design strategies as well as highly localized, small-scale, decentralized source control techniques known as Integrated Management Practices (IMPs). IMPs may be integrated into buildings, infrastructure, or landscape design. Rather than collecting runoff in piped or channelized networks and controlling the flow downstream in a large storm water management facility, LID takes a decentralized approach that disperses flows and manages runoff closer to where it originates. Because LID embraces a variety of useful techniques for controlling runoff, designs can be customized according to local regulatory and resource protection requirements, as well as site constraints. Figures located in Appendix D provide illustrations of key elements in LID. New projects, redevelopment projects, and capital improvement projects can all be viewed as candidates for implementation of LID.

LID employs a variety of different techniques. The following is a list of basic IMPs that are available.

- Bioretention: Vegetated depressions that collect runoff and facilitate its infiltration into the ground.
- Dry Wells: Gravel-or stoned-filled pits that are located to catch water from roof downspouts or paved areas.
- Filter Strips: Bands of dense vegetation planted immediately downstream of a runoff source designed to filter runoff before entering a receiving structure or water body.
- Grassed Swales: Shallow channels lined with grass and used to convey and store runoff.
- Infiltration Trenches: Trenches filled with porous media such as bioretention material, sand, or aggregate that collect runoff and infiltrate it into the ground.
- Inlet Pollution Removal Devices: Small storm water treatment systems that are installed below grade at the edge of paved areas and trap or filter pollutants in runoff before it enters the storm drain.
- Permeable Pavement: Asphalt or concrete rendered porous by the aggregate structure.
- Permeable Pavers: Manufactured paving stones containing spaces where water can penetrate into the porous media placed underneath.
- Rain Barrels and Cisterns: Containers of various sizes that store the runoff delivered through building downspouts. Rain barrels are generally smaller structures, located above ground. Cisterns are larger, are often buried underground, and may be connected to the building's plumbing or irrigation system.

- Soil Amendments: Minerals and organic material added to soil to increase its capacity for absorbing moisture and sustaining vegetation.
- Tree Box Filters: Curbside containers placed below grade, covered with a grate, filled with filter media and planted with a tree in the center.
- Vegetated Buffers: Natural or man-made vegetated areas adjacent to a water body, providing erosion control, filtering capability, and habitat.
- Vegetated Roofs: Impermeable roof membranes overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundation.

WILL NREA REQUIRE LID FOR MY PROJECT:

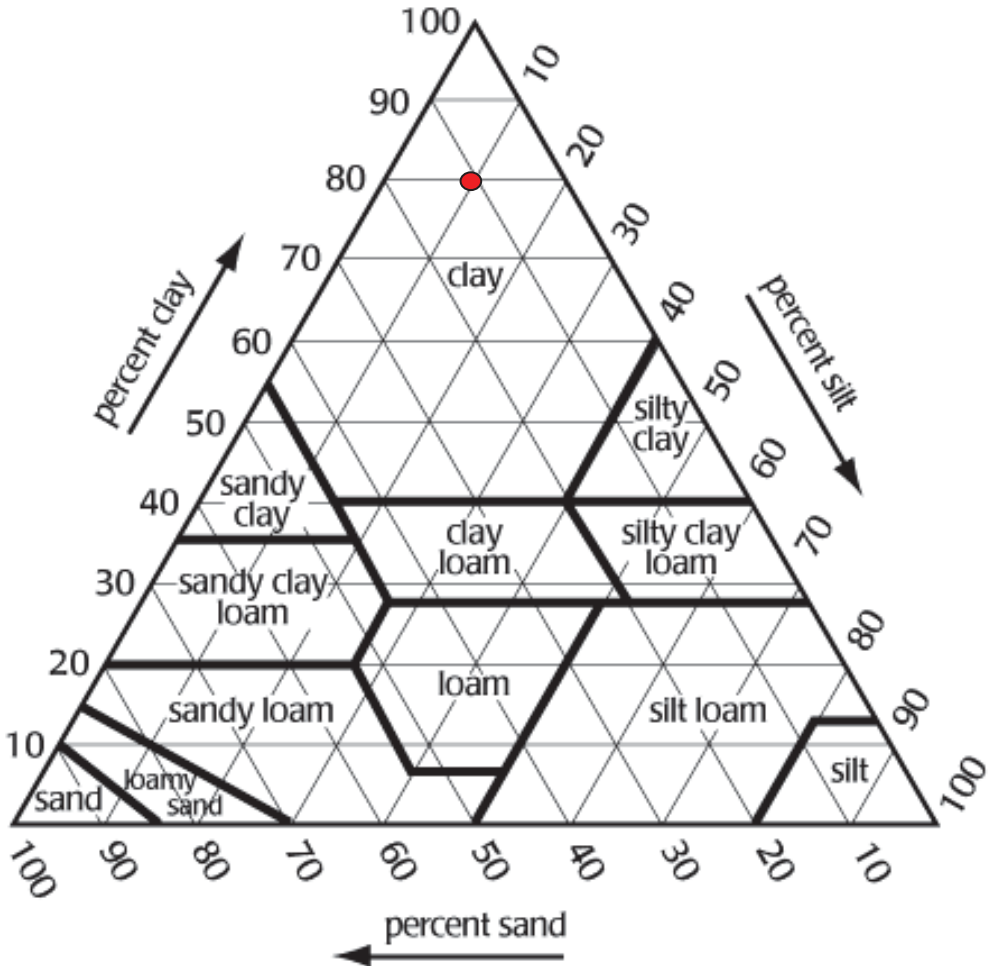
MCB Quantico began reviewing construction plans for adherence to the UFC in 2009 and will require LID integration into each land disturbing project with a Storm Water Management element in FY2011 and beyond. When designing your SWP3 plans, remember, Department of Navy (DON) policy states that all new and/or major construction projects beginning in FY2011 shall incorporate Low Impact Development (LID) features in the design. With this in mind, included is a simple guide with step-by-step instructions to help you in the process of determining where to start when designing LID devices for your project, including which devices may be most effective in different situations. The diagram below shows the most important aspects of LID that you should keep in mind when designing your LID features.

Determining What LID Features Are Best Suited For Your Project Site:

The following 4-step process will assist the designer/developer in identifying the LID practices best suited for their site.

STEP ONE:

Determine what type of soil, in general, your site consists of (i.e. sand, clay, etc.). You can use the Texture Triangle below to determine the general percentages of sand, silt, and clay on your site. For example, if it is determined that you have a heavy Clay texture on your site, you can look at the texture triangle and see that a heavy Clay (red dot on texture triangle) is approximately 80% Clay, 10% Sand and 10% Silt.



STEP TWO:

Once you have a general idea of the soil makeup, use the Soils and Particle Size Conversion Cheat below to determine the size of particle you are dealing with.

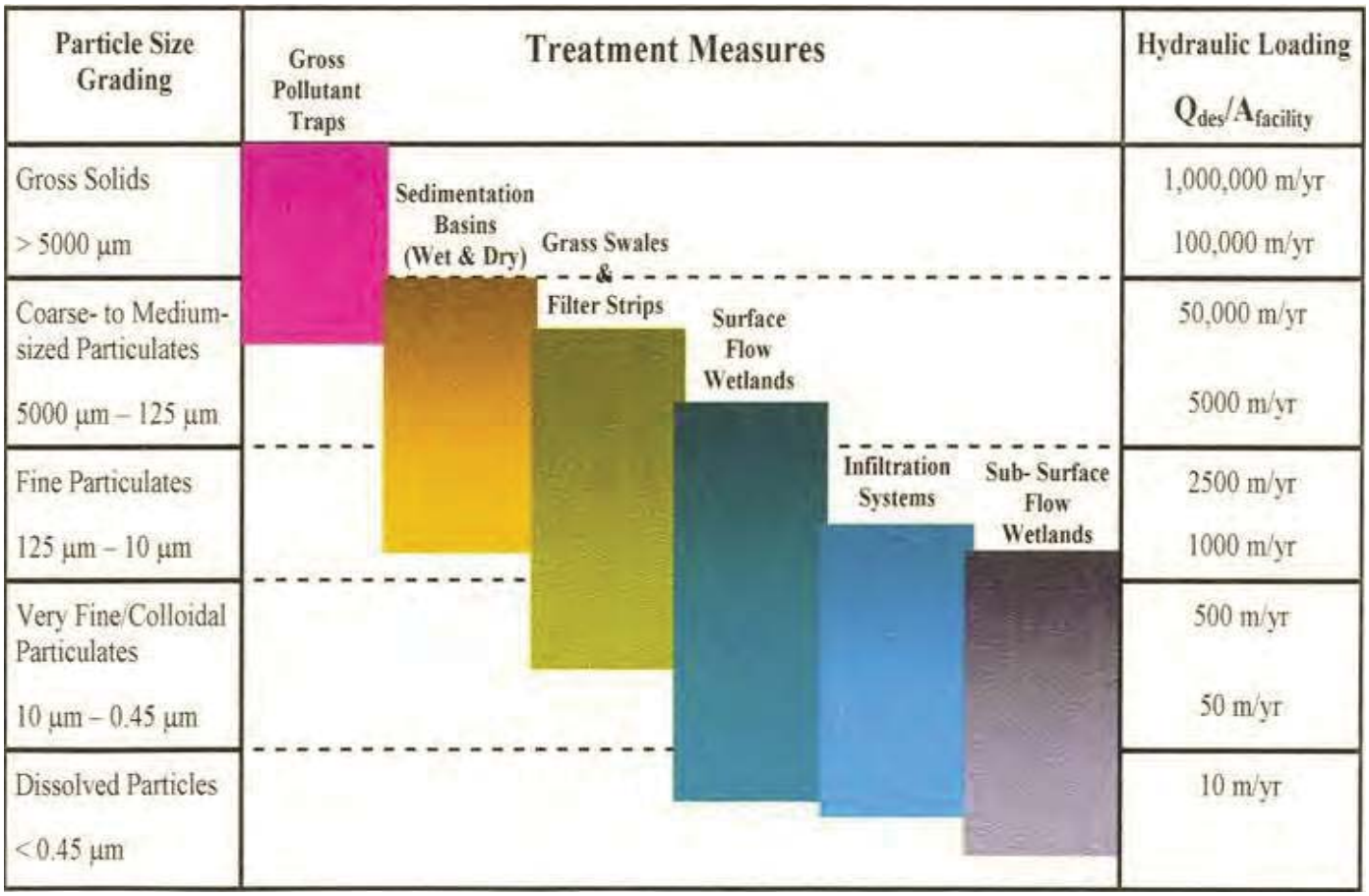
Soils and Particle Size Conversion Cheat Sheet		
Particle	**Diameter**	**Conversion**
clay	less than 0.002 mm	less than 2 µm
silt	0.002 mm - 0.05 mm	2µm - 50 µm
sand	0.05 mm - 2.00 mm	50 µm - 2000 µm
fine pebbles	2.00 mm - 5.00 mm	2000 µm - 5000 µm
medium pebbles	5.00mm - 20.00 mm	5000 µm - 20000 µm
coarse pebbles	20.00 mm - 75.00 mm	20000 µm - 75000µm

Looking at the chart, a general Clay material consists of particles 0.002 mm or less than 2 µm.

STEP THREE:

With this knowledge, you can refer to Removal Effectiveness of LID Features Chart (see below) to determine which type of LID feature(s) would work best on your site.

Removal Effectiveness of LID Features Chart



Using this chart, you can figure that on your site, the most effective LID Features would be some sort of Surface Flow Wetland, Infiltration System, and/or a Sub-surface Flow Wetland.

STEP FOUR:

You can then refer to the following charts (Functions of LID Features and LID Uses and Other Info.) to determine if the LID feature you have selected will accomplish your goal(s) for the site.

Functions of LID Features

Feature	Effect or Function				
	SlowerRunoff	Infiltration	Retention	Detention	WaterQualityControl
Soil Amendments		X			
Bioretention		X	X	X	X
Dry Wells		X	X		X
Filter Strips	X				X
Vegetated Buffers	X				X
Grassed Swales	X				X
Infiltration Trenches		X			X
Inlet Devices					X
Rain Barrels			X		
Cisterns			X		
Tree Box Filters					X
Vegetated Roofs	X			X	X
Permeable Pavers		X			X
Permeable Pavement	X	X			X

LID Uses and Other Information

LID Feature	Appropriate Uses	Estimated Cost	Maint. Issues	Corrective Actions
Soil Amendments	- increase soil's infiltration capacity - help reduce runoff from the site - soils become more effective at maintaining water quality	Increased upfront costs, may be partially offset by reductions in the required volume of stormwater ponds and other detention or retention practices	- may be inspected as part of the E&SC plan, usually at completion. -routine soil infiltration rate analysis of amended soils in potential problem areas is recommended.	- extensive mechanical aeration and/or disking of organic amendments to depth of several inches and site restabilization
Bioretention	Median Strips Parking lot islands Swales	$107 and $430 per square meter ($10 and $40 per square foot)	biannual evaluation of the trees and shrubs, subsequent removal of any dead/diseased vegetation	replace dead vegetation, soil pH regulation, erosion repair, mulch replenishment, unclogging the underdrain, and repairing overflow structures
Dry Wells	Small impervious areas Runoff from driveways Runoff from downspouts	Site Specific (i.e. cost of excavation, price of gravel, depth of well)	Clear debris from inlet, drain, gutter that could clog downspout.	Clogging of gravel over long period of time if extensive loading fine grained sediment is present
Filter Strips	Treating runoff from roads and highways Roof Downspouts Very small parking lots or pervious surfaces Fringe of stream buffers Pretreatment for structural purposes	Approximately 30¢ per square foot for seed or 70¢ per square foot for sod	Mowing, irrigation, and weeding. Inspection of filter strips at least twice annually for erosion or damage to vegetation and additional inspection after periods of heavy runoff.	The need for litter removal should be determined through periodic inspection, but litter should always be removed prior to mowing

LID Feature	Appropriate Uses	Estimated Cost	Maint. Issues	Corrective Actions
Vegetated Buffers	Along creeks, streams, rivers and other waterways	- Forest buffer costs range between $218 and $729 per acre to plant and maintain. - Grass buffers costs between $168 to $400 per acre to plant and maintain	Inspect annually, and after heavy rain events for evidence of sediment deposition, erosion, and flow channel development.	Self maintaning if sized and constructed properly
Grassed Swales	manage runoff from drainage areas that are less than 10 acres in size, with slopes no greater than 5 percent.	approximately $0.50 per square foot (includes design costs)	periodic mowing, weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages.	Remove cuttings from the channel; Accumulated sediment removed to avoid concentrated flows; The grass should be thick and reseeded as necessary.
Infiltration Trenches	used in conjunction with another stormwater management device, such as a detention pond pretreated with other devices such as grit chambers, water quality inlets, sediment traps, swales, and vegetated filter strips	site and design specific	Prevent clogging; A thorough annual inspection should include monitoring of the observation well to confirm that the trench is draining properly	Remove stone and sediment that has clogged the system
Inlet Devices (Hydrodynamic Separators)	Areas with limited land availability	Capital costs can range from $2,300 to $40,000 per precast unit	Inspections can be scheduled according to observed rates of sediment accumulation, remove sediment by pump or vac truck	Removal or replacement of failed device

LID Feature	Appropriate Uses	Estimated Cost	Maint. Issues	Corrective Actions
Rain Barrels	Stores rooftop runoff from downspouts in barrels for later re-use	approx. $120/barrel	minimal maintenance; inspect screens for clogging	repair/replace sceens as needed; replace barrel as needed
Cisterns	Stores rooftop runoff from downspouts in larger volumes than barrels in underground tanks for later re-use	vary by size	minimal maintenance; inspect screens for clogging	repair/replace sceens as needed; replace tank as needed
Tree Box Filters	Satisfy regulatory requirements for new development	site and design specific	Regular Removal of trash	Plants may be replaced because they have overgrown the filter or because of environmental stress
	protect and restore streams			
	retrofit existing urban areas		Watering of plants during severe drought	
	protect reservoir watersheds			
Vegetated Roofs	help control nitrogen pollution in stormwater runoff	avg between $161-$215/sq m ($15-$20/sq ft)	minimal maintenance; tend to plants and shrubs as normal	Repair localized problems
Permeable Pavers	Used in place of conventional asphalt or concrete	$54-$108/sq m ($5.00-$10.00/sq ft.); may eliminate need for underground stormwater systems	sweeping, vacuuming or low pressure washing, adding aggregate as needed. DO NOT PLOW	Replace individual blocks as needed
Permeable Pavement	Used in place of conventional asphalt or concrete	Permeable Asphalt - $5-$11/sq m ($0.50 to $1.00 per square foot	sweeping, vacuuming or low pressure washing, adding aggregate as needed.	With Proper maintenance, no additional actions needed other than normal wear & tear repairs.
		Permeable Concrete - $22-$70/sq m($2.00-$6.50/sq ft.)		

LID Definitions And Diagrams:

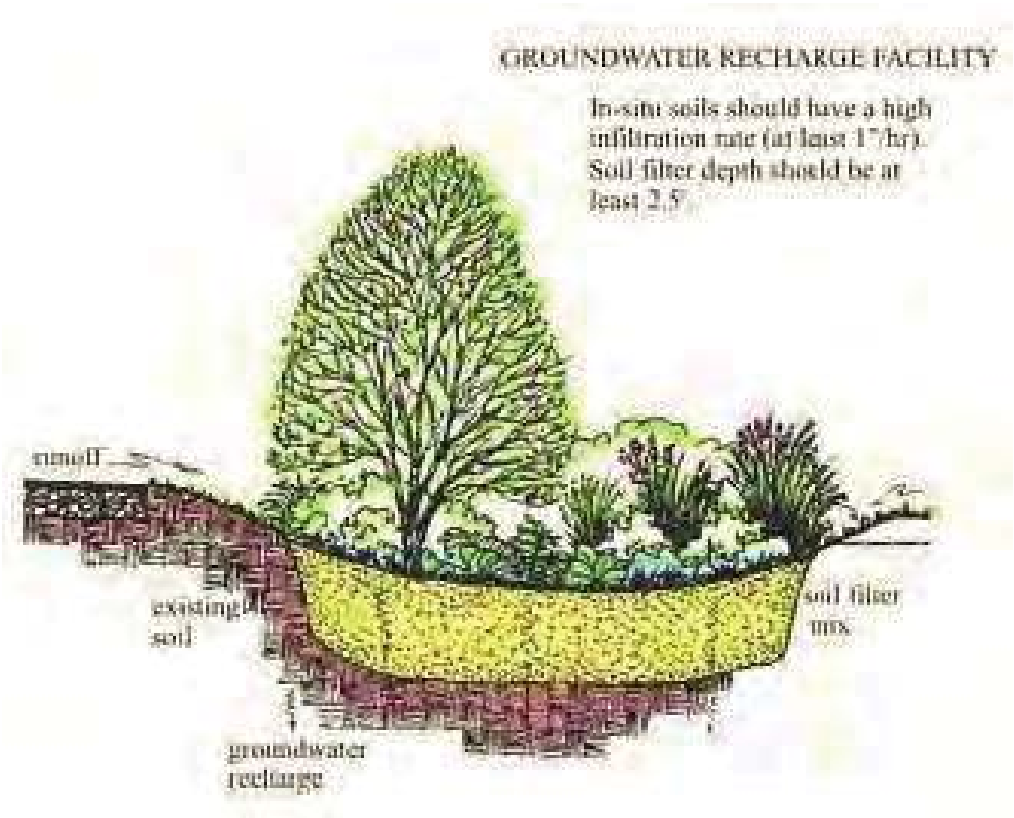
For additional reference and visual aide, see below for definitions of the basic LID features and diagrams to illustrate the basic concept/design of each feature. Remember, the following diagrams are not the only way possible to design the features. The guide is designed to be a tool to illustrate the feature, not be the design guide.

SOIL AMENDMENTS:

Soil amendments, which include both soil conditioners and fertilizers, make the soil more suitable for the growth of plants and increase water retention capabilities. The use of soil amendments is conditional on their compatibility with existing vegetation, particularly native plants.

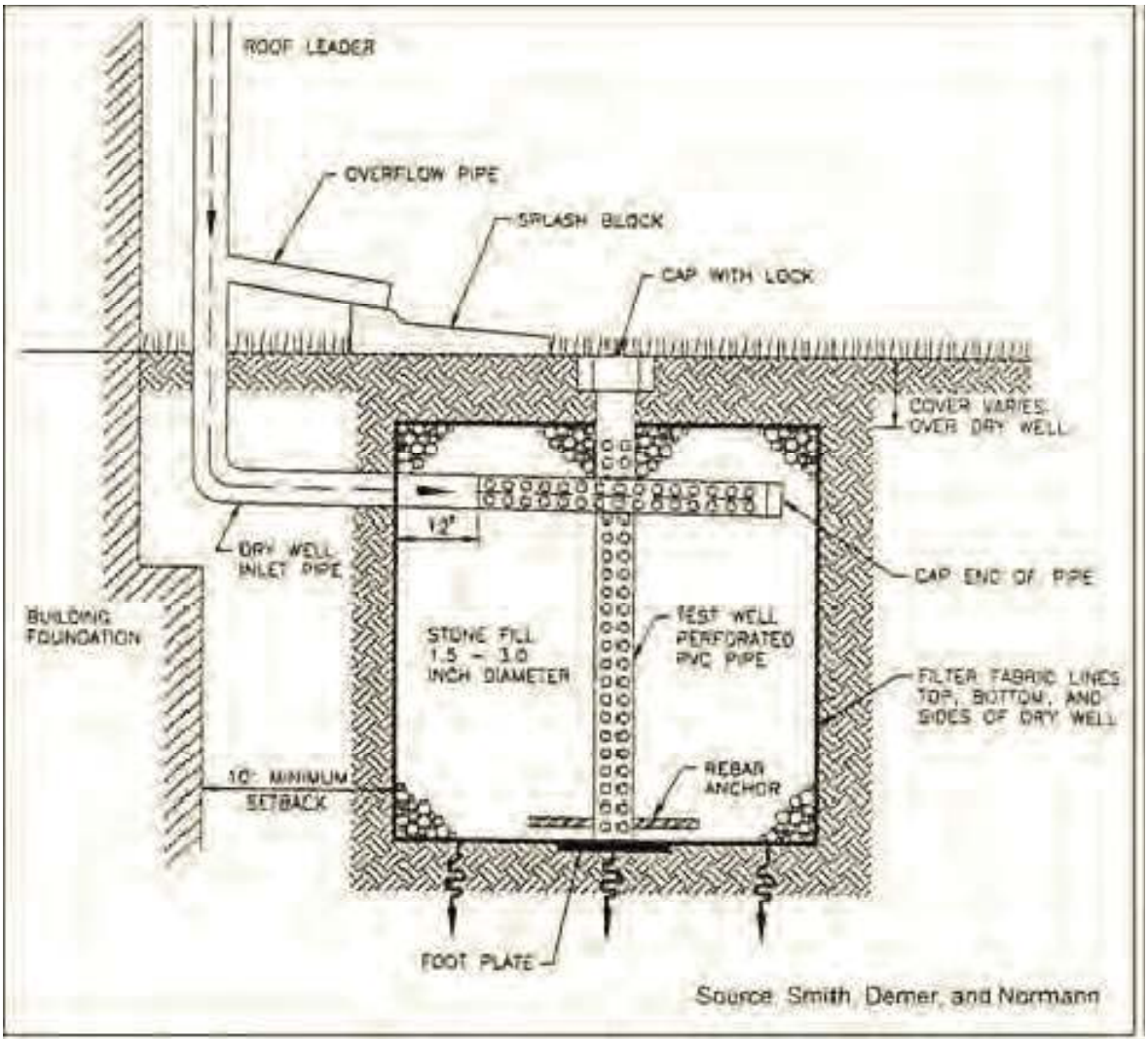
BIORENTION:

Bioretention areas typically have porous backfill under the vegetated surface, and an under drain that encourages infiltration and water quality filtering while avoiding extended ponding.



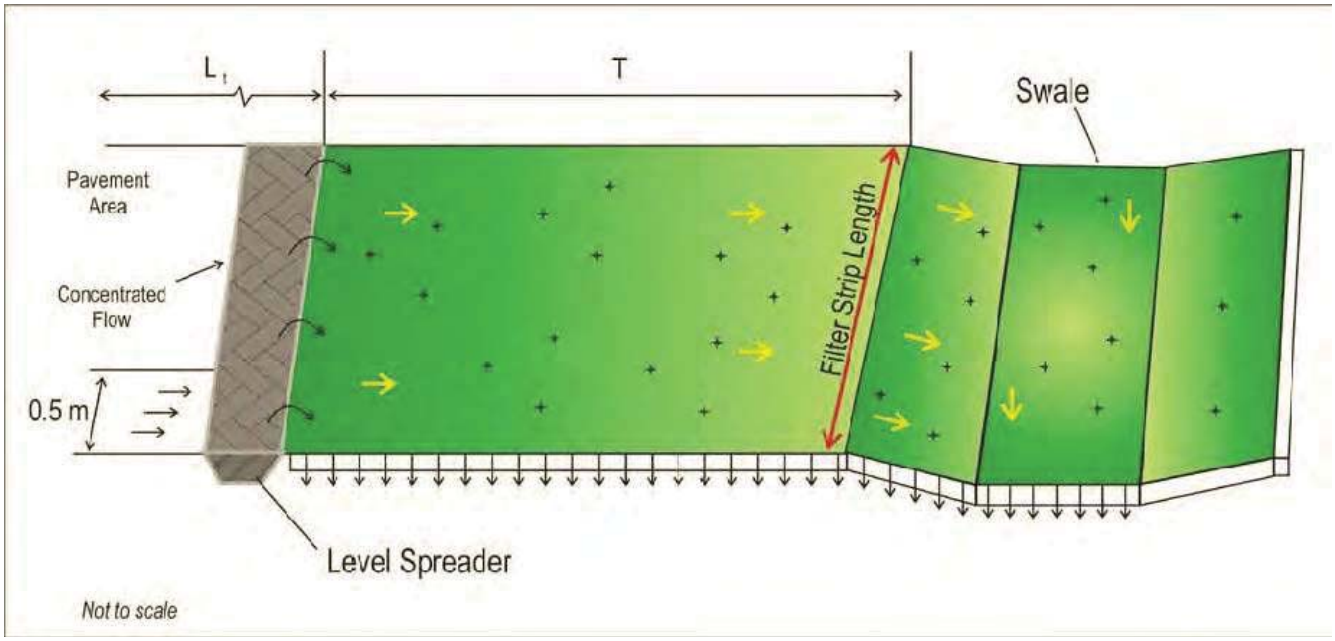
DRY WELLS:

A dry well typically consists of a pit filled with aggregate such as gravel or stone and is located to catch water from roof downspouts or paved areas.



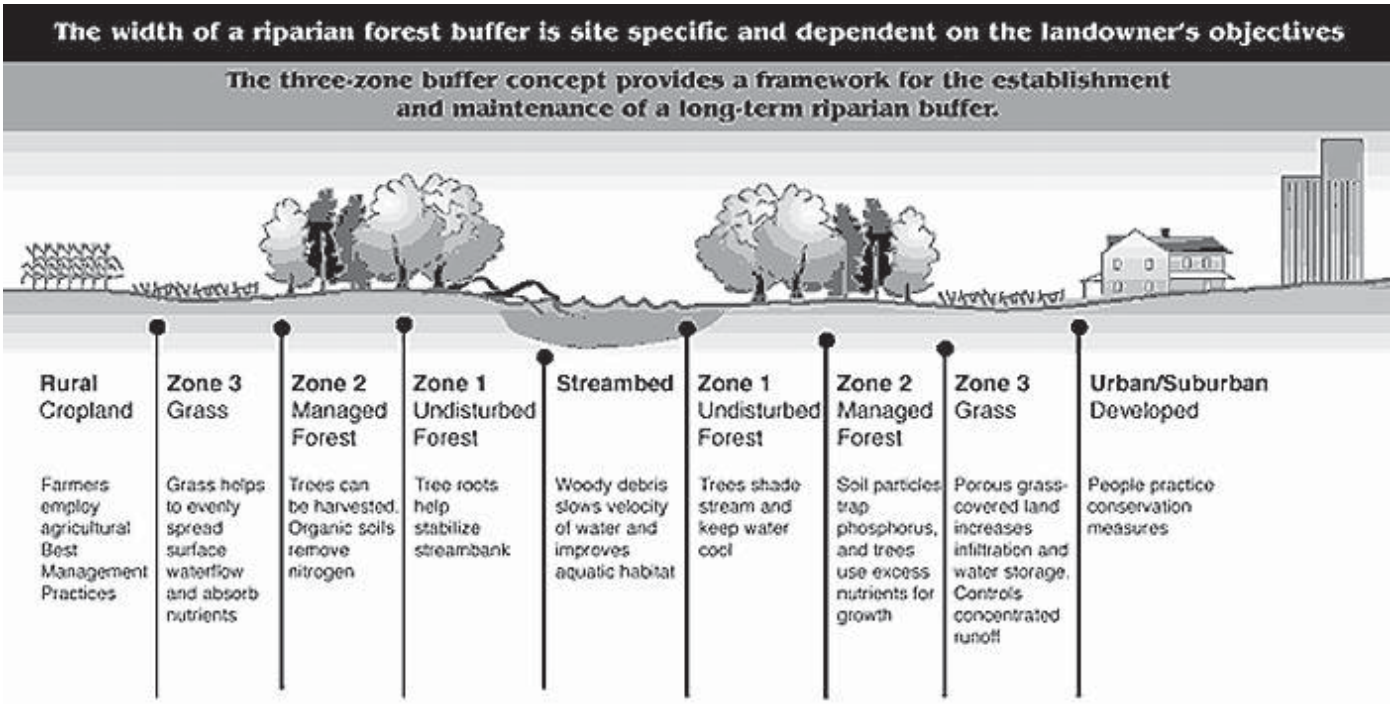
FILTER STRIPS:

Are bands of dense vegetation planted downstream of a runoff source.



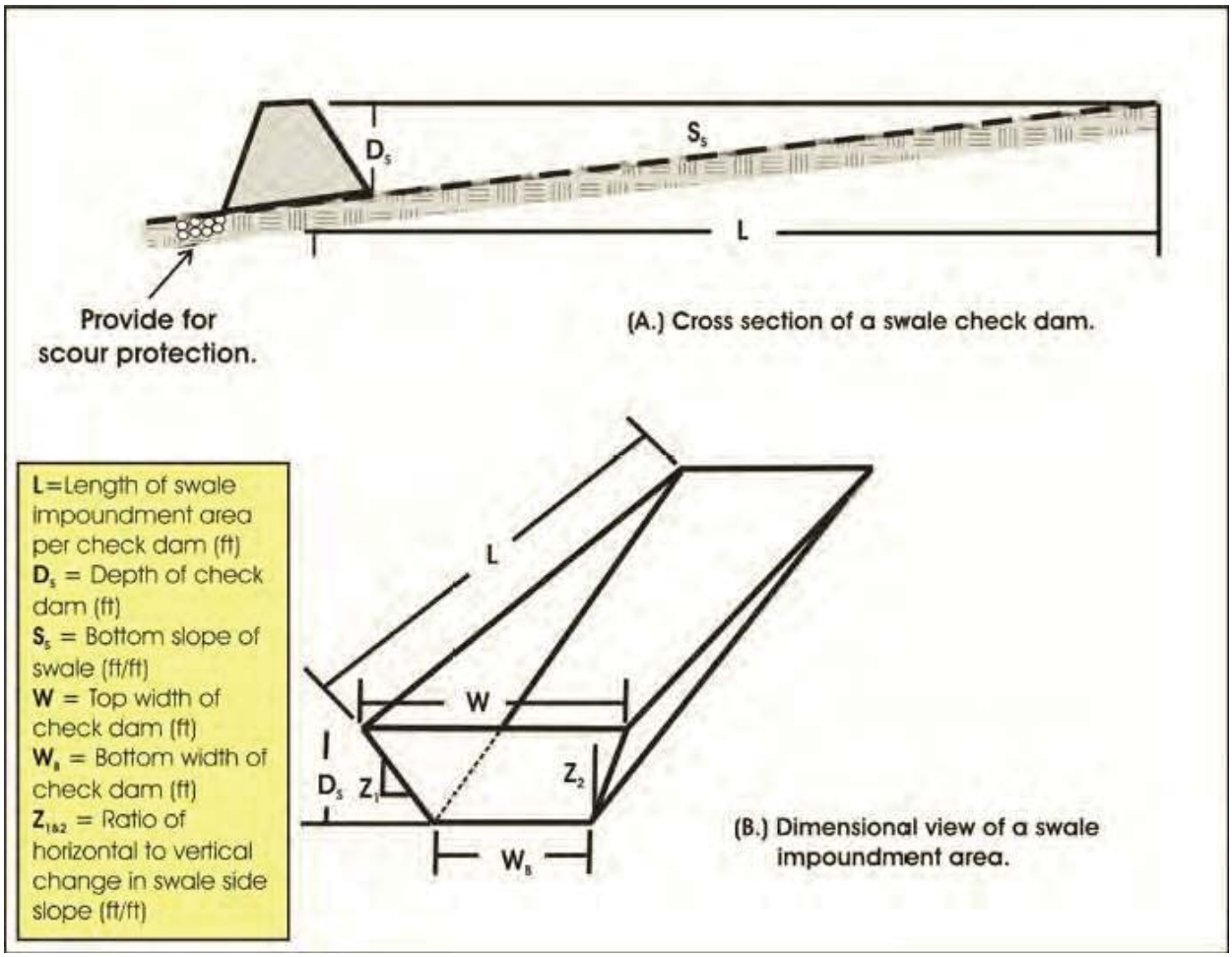
VEGETATED BUFFERS:

Vegetated buffers trap and filter sediments, nutrients, and chemicals from surface runoff and shallow groundwater.



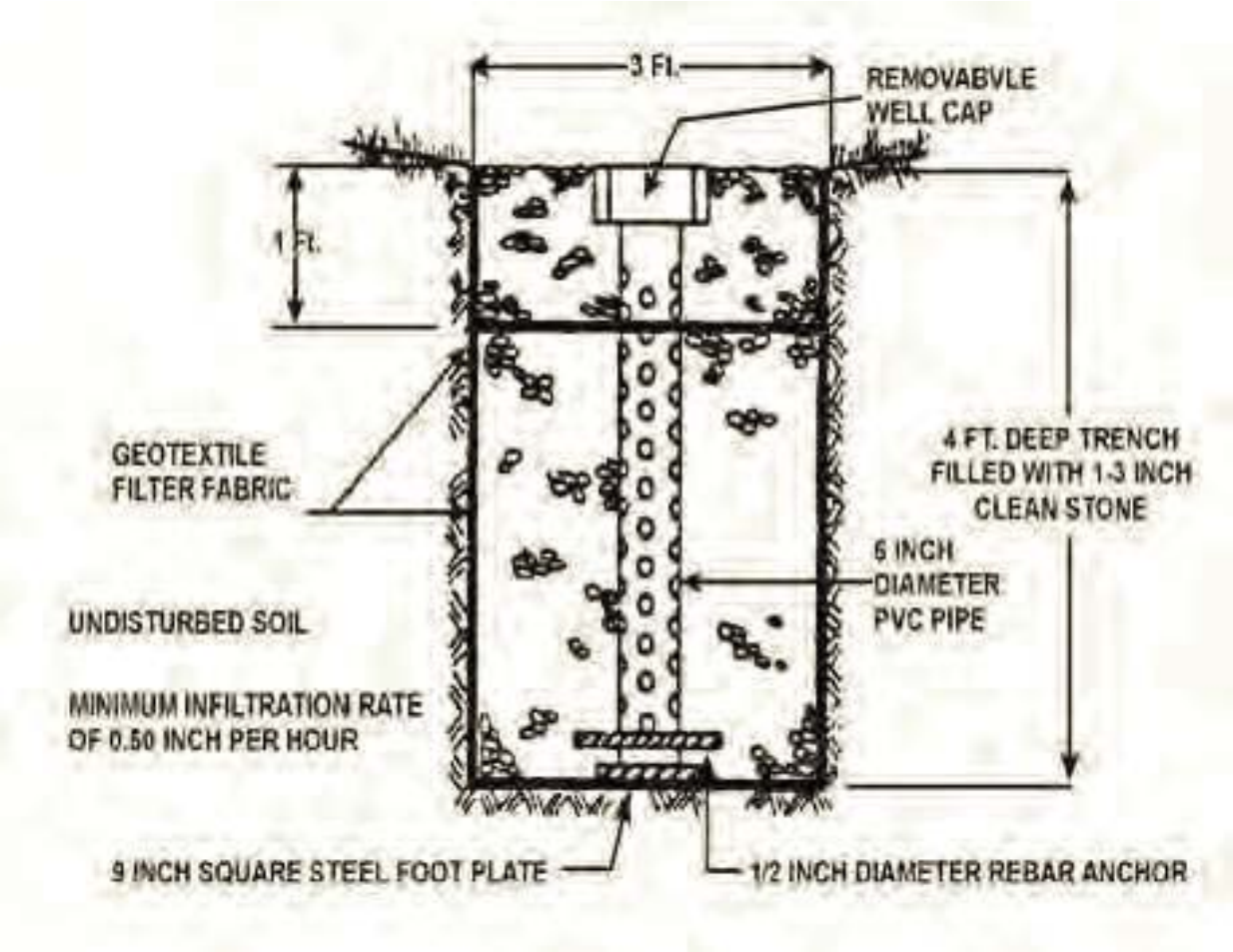
GRASSED SWALES:

Are shallow grass-covered hydraulic conveyances that help to slow runoff and facilitate infiltration.



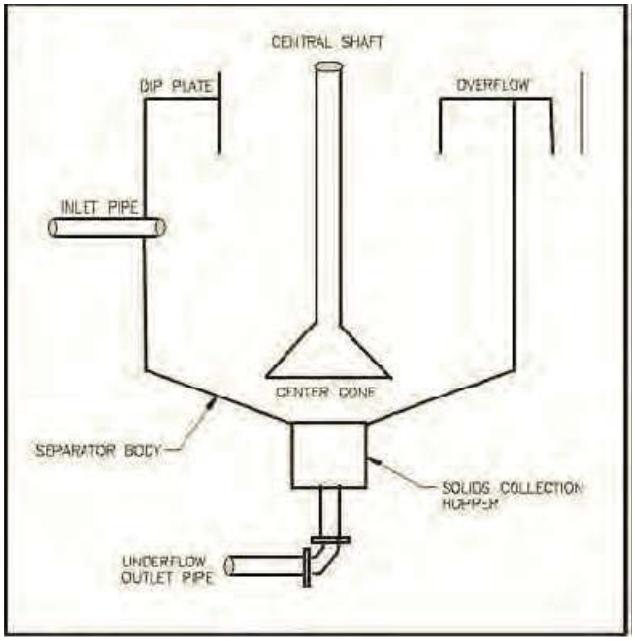
INFILTRATION TRENCHES:

Infiltration trenches are trenches that have been back-filled with stone. These trenches collect runoff during a storm event and release it into the soil by infiltration.



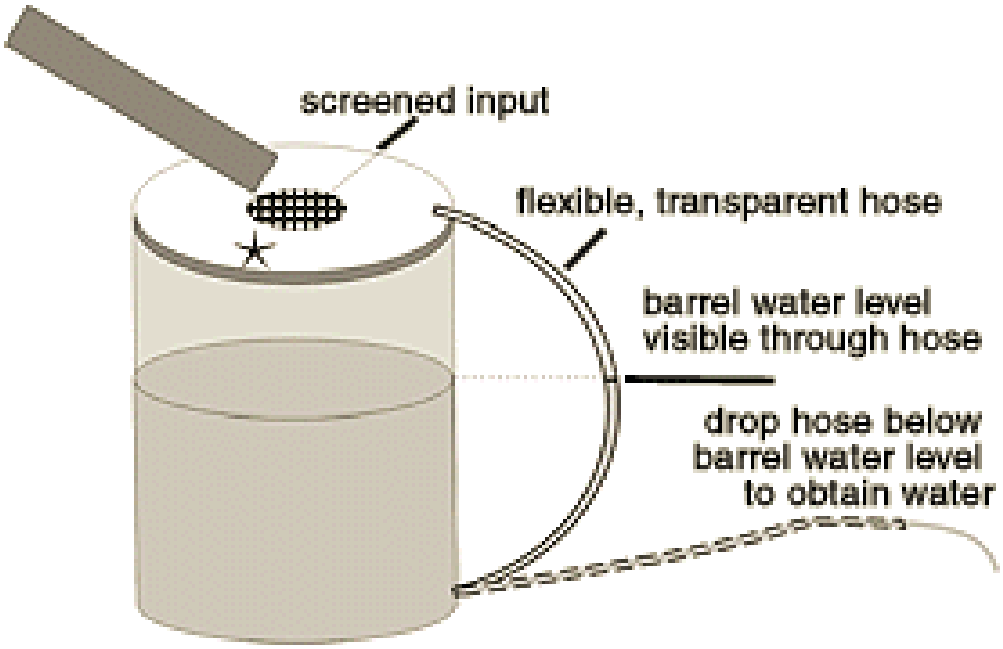
INLET DEVICES (A.K.A. HYDRODYNAMIC SEPARATORS):

Inlet devices are flow through structures with a settling or separation unit to remove sediments and other stormwater pollutants.



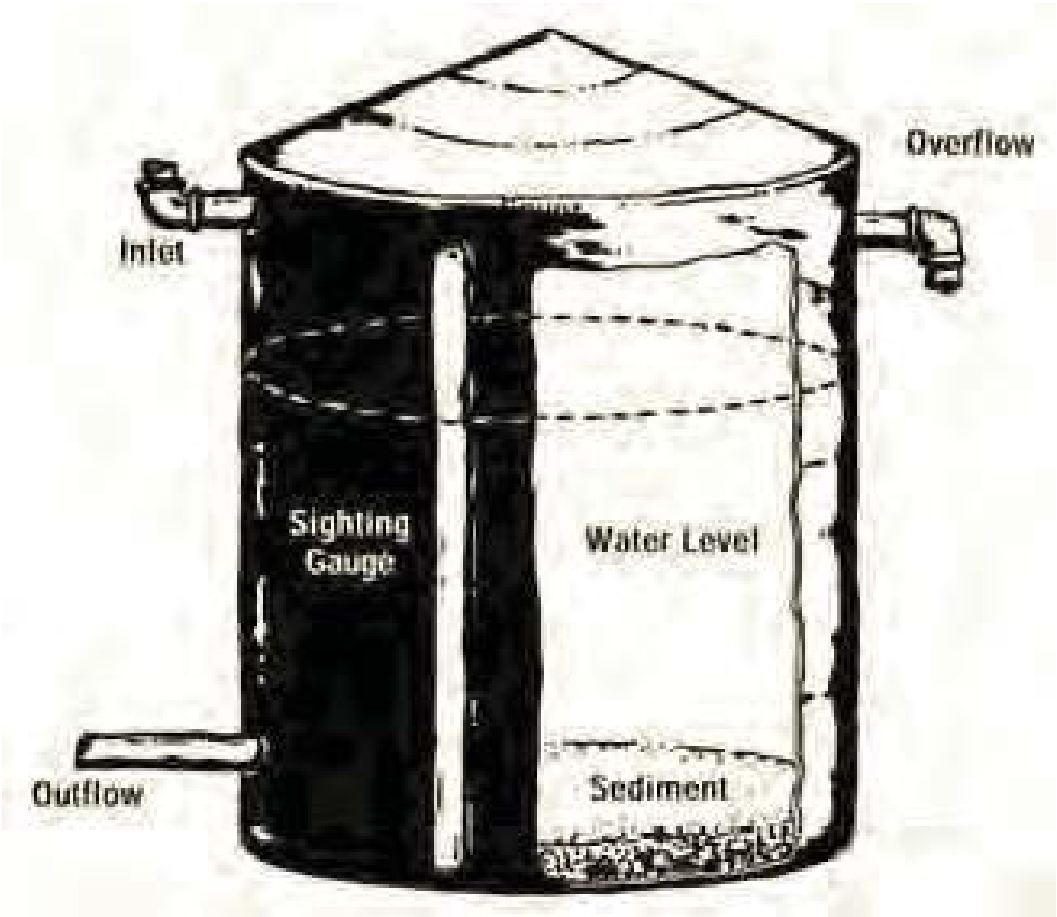
RAIN BARRELS:

Rain barrels are placed outside of a building at roof downspouts to store rooftop runoff for later reuse in lawn and garden watering.



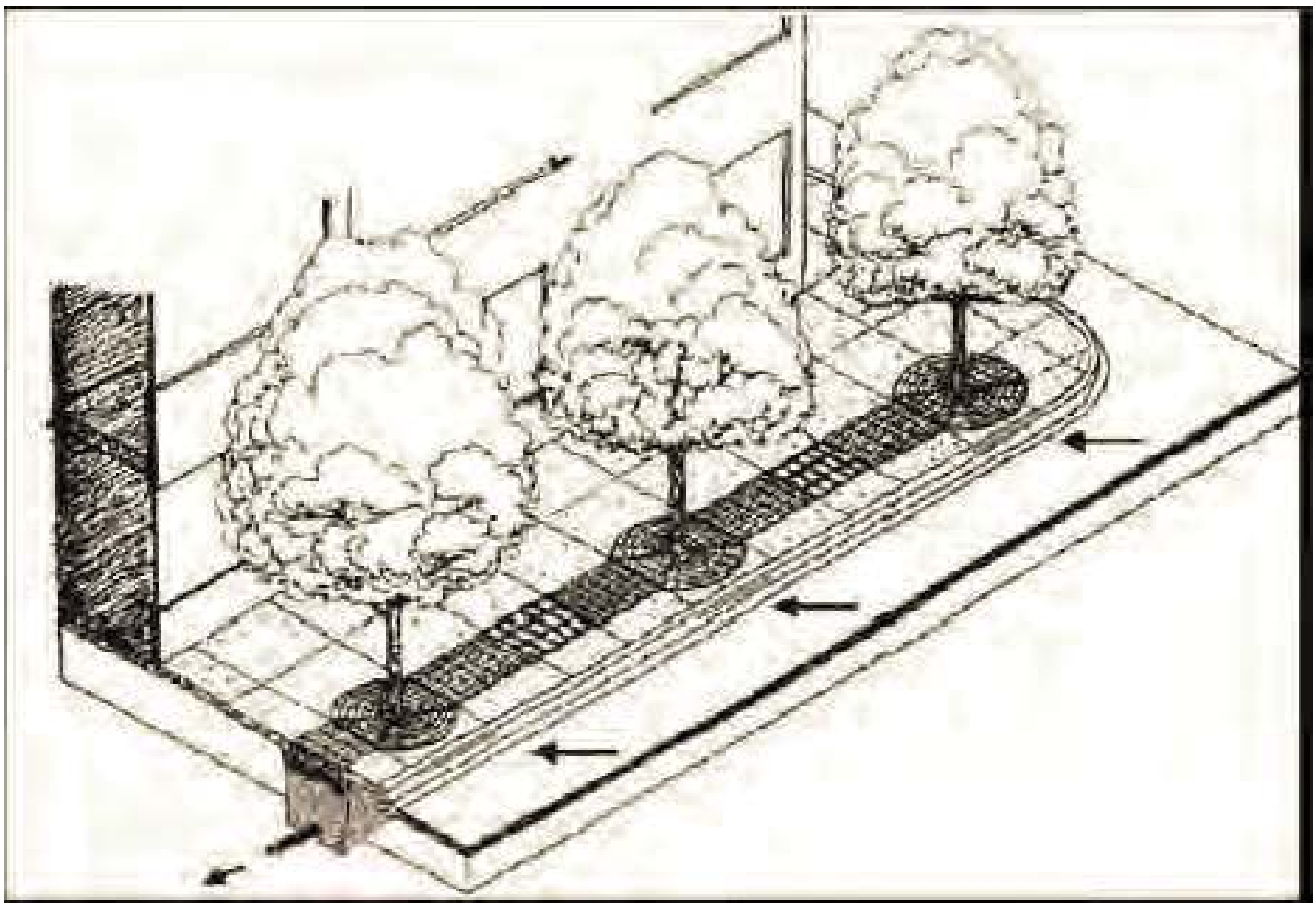
CISTERNS:

Also collect rooftop runoff but store the water in significantly larger volumes in manufactured tanks or built underground storage areas. Both cisterns and rain barrels can be implemented without the use of pumping devices, instead relying on gravity flow.



TREE BOX FILTERS:

Tree box filters are in-ground containers typically containing street trees in urban areas. These filters can be very effective at controlling runoff water quality, especially when numerous units are distributed throughout a site. Runoff is directed to the tree box, where it is filtered by vegetation and soil before entering a catch basin.

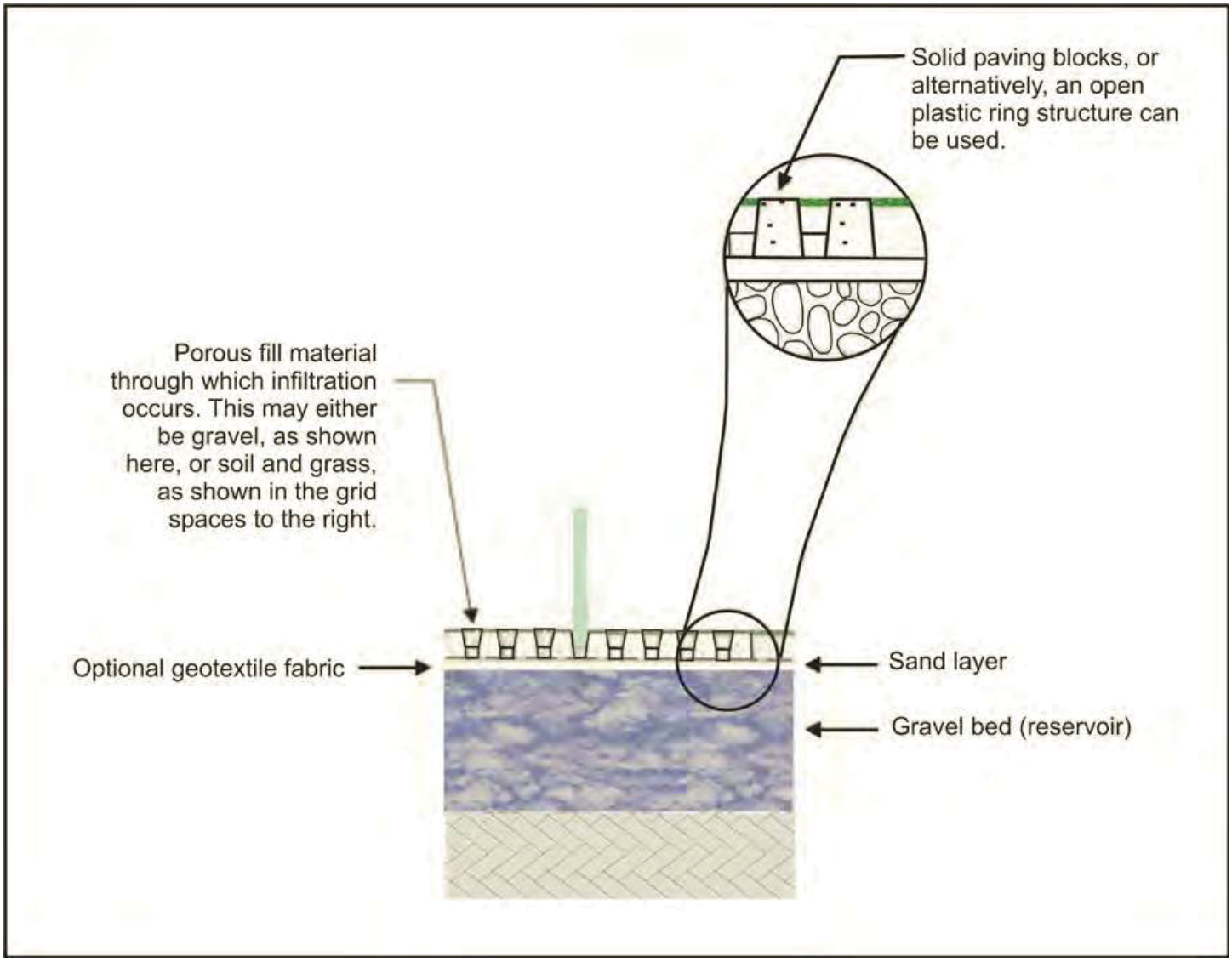


VEGETATED ROOFS:

Vegetated roofs, also known as green roofs, ecoroofs or nature roofs, are structural components that help to mitigate the effects of urbanization on water quality by filtering, absorbing or detaining rainfall.

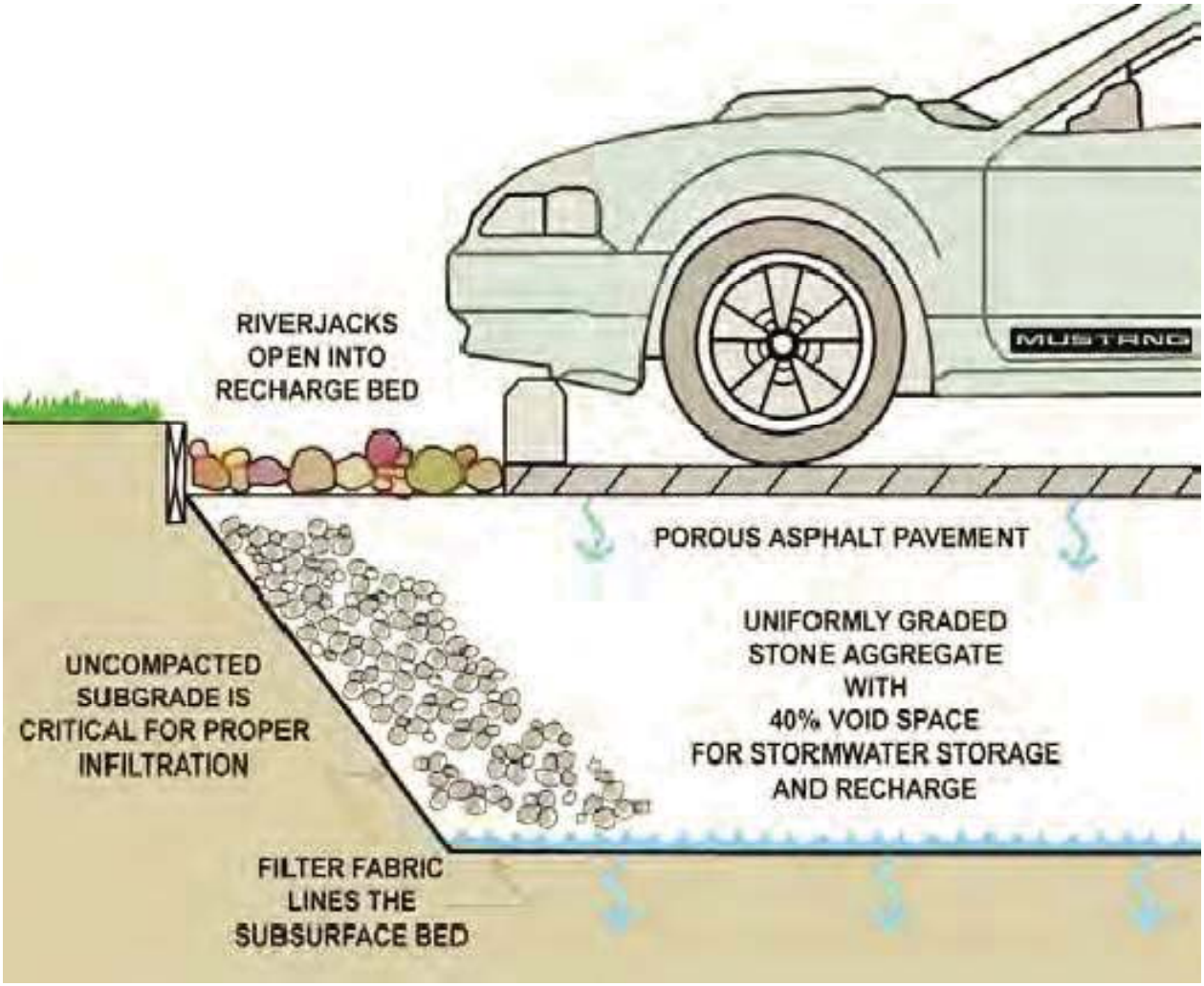
PERMEABLE PAVERS:

Permeable pavers allow water to seep through regularly interspersed void areas in order to reduce runoff and associated pollutants.



PERMEABLE PAVEMENT:

Can be either asphalt or concrete. As with permeable pavers, water is allowed to pass through voids and infiltrate into the underlying soil. Permeable pavement lacks most of the fine material found in conventional pavements, allowing water to flow through voids in the aggregate. (By contrast, paver blocks themselves are not necessarily permeable; infiltration occurs in the gaps between the blocks.) A layer of clean, uniformly graded gravel lies beneath the pavement, and geotextile separates this stone bed from the soil below. Runoff from the paved surface and adjacent impervious areas slowly passes through the gravel layer, which also may serve as a storage area. Permeable pavement has the same structural properties as conventional pavement. Environmental benefits are similar to other IMPs: reduction of runoff volume and rate, pollutant filtering, flow dispersion, and groundwater recharge. In addition, permeable pavements reduce the footprint of a site's impervious area.



Additional References:

For further understanding and a few additional resources, you can visit the websites listed below:

EPA – NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM:

The following website, http://cfpub.epa.gov/npdes/home.cfm?program_id=6 will take to you the EPA website for their National Pollutant Discharge Elimination System (NPDES), storm water program. You can find basic information about storm water here as well as informational guides on LID and even ones that help you design a SWPPP. You can find templates, examples, etc. on this site.

LID DESIGN GUIDANCE:

http://www.epa.gov/owow/NPS/lid/

- Here you will find design strategies, help with hydrologic analysis, and the LID Development manual (UFC 3-270-10) which was created by the Department of Defense, and it provides guidance on integrating LID into your designs.

SWPPP DESIGN GUIDANCE:

http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

- Here you will find resources such as guidance on developing a SWPPP. You can view examples and templates as well as webcasts to walk you through creating an effective SWPPP

DCR – RUNOFF REDUCTION METHOD:

The Runoff Reduction Method is an innovative system for storm water design. The Runoff Reduction Method focuses on determining a BMPs' capacity for pollutant removal as well as to reduce the overall volume of runoff . The following website, http://www.dcr.virginia.gov/lr2f.shtml will take to you to the DCR Runoff Reduction Method. Here you will find several spreadsheets and guides to help you in your design process.

There are two spreadsheets, one for new development and one for redevelopment projects. There are also instructional documents, including spreadsheet instructions, a process flow chart, a document regarding assigning land cover values, and BMP design tables for use in applying the spreadsheet(s).

Supplementary Documents:

The following pages contain Supplementary Documents mentioned throughout this guidance packet. You will find the Permit Application Fee Form which outlines the application fee amounts for specified permits.
Second, you will find the General Permit Application Form that is needed to apply for your storm water permit. This form needs to be filled out completely as well, along with the Permit Application Fee Form, and both signed originals need to be forwarded to NREA along with your original check, with proper fees, made out to Treasurer of Virginia. NREA will forward your forms and check along with our cover letter to DCR.
After the General Permit Application Form you will find the Notice of Termination Form. You will need this form when your construction project is complete and you have achieved Final Stabilization. Remember, NREA defines Final Stabilization as 90% coverage with 2 – 3" cuttings, or when sodded or mulched completely.

If needed, and applicable, the E&SC Plan Short Form has been included as well. An example of a concise form for calculations has been provided. This is a simplified form that allows the designer to compile all calculations and present them in one easy to read document that can be inserted into the design proposal.

In addition the needed forms, you will also find three checklists; E&SC Plan Review Checklist, SWPPP Plan Review Checklist, and the LID Plan Review Checklist. These are the same checklists NREA uses to review all plan submissions. Prior to submitting your plans, use the checklist to see if you have covered all points that NREA will be looking for in your plans. Utilizing the checklists should help to speed your application and review process by helping to eliminate unwanted and unnecessary plan changes.

Department of Conservation & Recreation
CONSERVING VIRGINIAS NATURAL & RECREATIONAL RESOURCES

DEPARTMENT OF CONSERVATION AND RECREATION PERMIT FEE FORM

Instructions:
Applicants for an individual Virginia Stormwater Management Program (VSMP) Permit are required to pay permit application fees. Fees are also required for registration coverage under General Permits. Fees must be paid when applications for permit issuance or modification are submitted. Applications will be considered incomplete if the proper fee is not paid and will not be processed until the fee is received.

The permit fee schedule is included with this form. Fees for permit issuance, reissuance, modification and maintenance are included. Once you have determined the fee for the type of application you are submitting, complete this form. The original copy of the form and your check or money order payable to "Treasurer of Virginia" should be mailed to:

Department of Conservation and Recreation
Division of Finance, Accounts Payable
203 Governor Street, 4th Floor
Richmond, Virginia 23219

A copy of the form and a copy of your check or money order should accompany the permit registration statement (application). You should retain a copy for your records. Please direct any questions regarding this form or fee payment to SWMESquestions@dcr.virginia.gov.

Construction Activity Operator:

Name:_____ FIN: _____

Mailing Address:_____

City:_____ State:_____ Zip:_____ Phone:_____

Daytime Phone Number: (_____) _____ - _____

Name and Location of Construction Activity:

Name:_____

Town, City, or County:_____

Type of VSMP Permit (from Fee Schedule):

_____ MS4 Individual Permit _____ MS4 General Permit

_____ Construction Individual Permit _____ Construction General Permit

Type of Action: _____ New Issuance _____ Reissuance

_____ Modification _____ Maintenance

Amount of Fee Submitted (from Fee Schedule): _____

Existing Permit Number (if applicable): _____

FOR DCR USE ONLY

Date: _____ DC #: _____

(DCR 199-145) (03/09)

Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

Virginia Stormwater Management Program (VSMP) Permit Fee Schedule

A. VSMP Individual Permits. Applications for issuance of new individual VSMP permits, and for permittee initiated major modifications that occur (and become effective) before the stated permit expiration date. [NOTE: Individual VSMP permittees pay an Annual Permit Maintenance Fee instead of a reapplication fee. The permittee is billed separately by DCR for the Annual Permit Maintenance Fee.]

TYPE OF VSMP PERMIT	ISSUANCE	MODIFICATION
Municipal Stormwater / MS4 Individual (Large and Medium)	$21,300	$10,650
Municipal Stormwater / MS4 Individual (Small)	$2,000	$1,000
Construction Stormwater Individual	$0	$0

B. Registration Statements for VSMP MS4 General Permit Coverage. The fee for filing a permit application (registration statement) for coverage under a VSMP MS4 stormwater general permit issued by the permit issuing authority is as follows:

TYPE OF VSMP PERMIT	ISSUANCE
Municipal Stormwater / MS4 General Permit (Small)	$600

C. Registration Statements for VSMP Construction General Permit Coverage. The fee for filing a permit application (registration statement) for coverage under a VSMP Construction stormwater general permit issued by the permit issuing authority is as follows:

TYPE OF VSMP PERMIT	ISSUANCE
Construction General / Stormwater Management - Phase I Land Clearing ("Large" Construction Activity - Sites or common plans of development or sale equal to or greater than 5 acres)	$500
Construction General / Stormwater Management - Phase II Land Clearing ("Small" Construction Activity - Sites or common plans of development or sale equal to or greater than 1 acre and less than 5 Acres)	$300
Construction General / Stormwater Management - 2,500 square feet of land disturbance and less than 1 acre in designated Chesapeake Bay Preservations Area and not part of a common plan of development or sale.	$0

D. Permit Maintenance Fees. The annual permit maintenance fees apply to each VSMP permit identified below, including expired permits that have been administratively continued.

TYPE OF PERMIT	MAINTENANCE
VSMP Municipal Stormwater / MS4 Individual (Large and Medium)	$3,800
VSMP Municipal Stormwater / MS4 Individual (Small)	$400
VSMP General / Stormwater Management - Phase I Land Clearing ("Large" Construction Activity - Sites or common plans of development equal to or greater than 5 acres)	$0
VSMP General / Stormwater Management - Phase II Land Clearing ("Small" Construction Activity - Sites or common plans of development equal to or greater than 1 acre and less than 5 Acres)	$0

(DCR 199-145) (03/09)

Department of Conservation & Recreation
CONSERVING VIRGINIAS NATURAL & RECREATIONAL RESOURCES

VSMP General Permit for Discharges of Stormwater from Construction Activities (VAR10)

Registration Statement

(Please Type or Print All Information)

1. **Construction Activity Operator** *(The permit will be issued to this operator, and the Certification in Item #13 must be signed by the appropriate person associated with this operator [see the instructions])*

   Name:_____

   Mailing Address:_____

   City:_____ State:_____ Zip:_____ Phone:_____

2. **(Must be included for renewals of coverage only) Existing Permit Coverage #:**_____

3. **Location of Construction Activity**

   Name:_____

   Address:_____

   Town, City, County:_____ State:_____ Zip:_____

   Decimal degrees to the nearest 15 seconds : Latitude _____ Longitude _____

   Location of all Offsite Support Activities to be Covered Under the Permit

   Name:_____

   Address:_____

   Town, City, or County:_____ State:_____ Zip:_____

   If street address unavailable: Latitude _____ Longitude _____

4. **Status of Activity:** Federal ❑ State ❑ Public ❑ Private ❑ (Check one only)

5. **The Nature of the Construction Activity** (e.g., commercial, industrial, residential, agricultural, oil and gas, etc.)**:**

   _____

6. **Name of the Receiving Water(s):** _____

   Hydrologic Unit Code (HUC): _____

   (Receiving waters identified as impaired on the 305(b)/303(d) Water Quality Assessment Integrated Report or for which a TMDL WLA has been established for stormwater discharges from a construction site shall be noted in an attached list.)

7. **If the discharge is through a Municipal Separate Storm Sewer System (MS4), the name of the municipal operator of the storm sewer:**_____

8. **Estimated Project Start Date (mm/dd/yyyy):** _____ **Estimated Project Completion Date (mm/dd/yyyy)**: _____

9. **Total Land Area of Development** (to the nearest one-tenth acre)**:** _____

   Estimated Area to be Disturbed (to the nearest one-tenth acre)**:** _____

10. **Is the area to be disturbed by the construction activity part of a larger common plan of development or sale?** Yes❑ No❑

11. **Are nutrient offsets intended to be acquired for this activity?** Yes❑ No❑ Under consideration❑

12. **A stormwater pollution prevention plan (SWPPP) must be prepared in accordance with the requirements of the General VSMP Permit for Discharges of Stormwater from Construction Activities <u>prior to</u> submitting this Registration Statement. By signing this Registration Statement the operator is certifying that the SWPPP has been prepared.**

13. **Certification:** "I certify under penalty of law that I have read and understand this Registration Statement and that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations."

    Print Name: _____ Title: _____

    Signature:_____ Date:_____

(Please sign in INK. The person signing this form must be authorized to sign on behalf the operator identified in Item #1 above.)

Mail to: Department of Conservation and Recreation, Stormwater Permitting, 203 Governor Street, Suite 206 Richmond, VA 23219

INSTRUCTIONS for FORM DCR 199-146

VSMP General Permit Registration Statement - Construction Activity Stormwater Discharges

General

A Registration Statement must be submitted to the Department of Conservation and Recreation to register for coverage under the General VSMP Permit for Stormwater Discharges from Construction Activities.

Section 1 Construction Activity Operator Information

"Operator" means the owner or operator of any facility or activity subject to the VSMP permit regulation. In the context of stormwater associated with a large or small construction activity, operator means any person associated with a construction project that meets either of the following two criteria: (i) the person has direct operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications or (ii) the person has day-to-day operational control of those activities at a project that are necessary to ensure compliance with a stormwater pollution prevention plan for the site or other permit conditions (i.e., they are authorized to direct workers at a site to carry out activities required by the stormwater pollution prevention plan or comply with other permit conditions).

The entities who are considered operators will commonly consist of the owner or developer of a project (the party with control of project specifications) and the general contractor (the party with day to day operational control of the activities at the project site which are necessary to ensure compliance with the permit). Contractors and subcontractors who are under the general supervision of the general contractor are not considered operators and would not need to submit a registration statement. Give the legal name of the operator, do not use a colloquial name. Enter the complete address and phone number of the operator. **The permit will be issued to this operator.**

Section 2 Existing Permit Coverage Number

For reapplications only, indicate the existing permit coverage number for the project. This section does not need to be completed for initial applications for coverage for new projects.

Section 3 Location of Construction Activity Information

Enter the activity's official name and complete street address, including town, city or county, state and ZIP code.

If the site lacks a street address, enter the town, city or county and the latitude and longitude in degrees to the nearest 15 seconds of the approximate center of the site (example 37° 30' 15" N 77° 20' 15" W).

Location of Offsite Support Activities

This permit also authorize stormwater discharges from support activities (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas) located on-site or off-site provided that: (a) The support activity is directly related to the construction site that is required to have VSMP permit coverage for discharges of stormwater associated with construction activity; (b) The support activity is not a commercial operation serving multiple unrelated construction projects by different operators, and does not operate beyond the completion of the construction activity at the last construction project it supports; and (c) Appropriate control measures are identified in a stormwater pollution prevention plan and implemented to address the discharges from the support activity areas.

Provide the information required for each off-site support activity seeking coverage. If an off-site support activity is going to be covered by this permit the total land area of the off-site support activity and area to be disturbed by the off-site support activity need to be included in the Estimated Area to be Disturbed (Section 8).

Section 4 Status of Activity

Indicate the appropriate status (Federal, State, Public, or Private) of the activity.

Section 5 Nature of the Construction Project

Indicate the nature of the construction project (commercial, residential, agricultural, oil and gas, etc). This list is not all inclusive.

Section 6 Name of Receiving Water(s)

Enter the name of the receiving water(s) for all stormwater discharge(s), including any stormwater discharges from off-site support activities to be covered under the permit. Receiving waters identified as impaired on the 305(b)/303(d) Water Quality Assessment Integrated Report or for which a Total Maximum Daily Load (TMDL) Waste Load Allocation (WLA) has been established for stormwater discharges from a construction site shall be noted.

Hydrologic Unit Code (HUC) is a watershed unit established in the most recent version of Virginia's 6th order national watershed boundary dataset.

Section 7 Name of MS4 Operator

If the stormwater is discharged through a municipal separate storm sewer system (MS4), enter the name of the operator of the MS4. The name of the MS4 operator is usually the Town, City, County, Institute or Federal facility where the construction activity is located.

Section 8 Estimated Project Start Date

Enter the date (Month/Day/Year) the projected is expected to start.

Estimated Project Completion Date

Enter the date (Month/Day/Year) the project is expected to be complete.

Section 9 Total Land Area of the Development

Enter the total area (to the nearest one tenth acre) of the development (meaning the total acreage of the larger common plan of development or sale). Include the total acreage of any offsite support activities to be covered under the permit.

Estimated Area to be Disturbed

Enter an estimate of the total number of acres (to the nearest one tenth acre) to be disturbed. Include in the Estimated Area to be Disturbed the area of disturbance that will occur at off-site support activities to be covered under the permit.

Section 10 Larger Common Plan of Development or Sale

Indicate if the area to be disturbed by the construction activity is part of a larger common plan of development or sale. Larger common plan of development or sale defines a contiguous are where separate and distinct construction may be taking place at different times on different schedules. Plan is broadly defined as any announcement or documentation, including a sign, public notice or hearing, sales pitch, advertisement, drawing, permit application, zoning request, etc., or physical demarcation such as boundary signs, lot stake, and surveyor markings indicating that construction activities may occur.

Section 11 Nutrient Offsets

Indicate if nutrient offsets are intended to be acquired in accordance with §10.1-603.8:1 of the Code of Virginia. If the acquisition of offsets is being considered but is not certain, select "under consideration."

Section 12 A stormwater pollution prevention plan (SWPPP) must be prepared in accordance with the requirements of the General VSMP Permit for Discharges of Stormwater from Construction Activities prior to submitting this Registration Statement. By signing this Registration Statement the operator is certifying that the SWPPP has been prepared.

Section 13 Certification

The operator identified in Section 1 of this Registration Statement is responsible for certifying and submitting this Registration Statement. Please sign the form in INK. State statutes provide for severe penalties for submitting false information. State regulations require this Registration Statement to be signed as follows:

For a corporation: by a responsible corporate officer. For the purpose of this part, a responsible corporate officer means: (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy-making or decision-making functions for the corporation; or (ii) the manager of one or more manufacturing, production, or operating facilities, provided the manager is authorized to make management decisions that govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long-term compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

For a partnership or sole proprietorship: by a general partner or the proprietor, respectively.

For a municipality, state, federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this part, a principal executive officer of a public agency includes: (i) the chief executive officer of the agency or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency.

The Department of Conservation and Recreation reserves the right to request additional information not directly addressed by the Registration Statement if, in its discretion, a facility or operation poses a potential impact on water quality.

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

VSMP General Permit Notice of Termination - Construction Activity Stormwater Discharges (VAR10)

(Please Type or Print All Information)

1. **Construction Activity Operator:**

   Name:_____

   Mailing Address:_____

   City:_____ State:_____ Zip:_____ Phone:_____

2. **Name and Location of Construction Activity** (As listed on registration statement)**:**

   Name:_____

   Address: _____

   City, Town or County:_____ State:_____ Zip:_____

   If street address unavailable: Latitude _____ Longitude _____

3. **VSMP Stormwater General Permit Number:** _____

4. **The Reason for Terminating Coverage Under the General Permit** (The construction activity operator may only submit a Notice of Termination after one or more of the conditions below have been met)**:**
   - ❑ **Necessary post-construction control measures included in the SWPPP for the site are in place and functioning effectively and final stabilization has been achieved on all portions of the site for which the operator is responsible;**
   - ❑ **Another operator has assumed control over all areas of the site that have not been finally stabilized and obtained coverage for the ongoing discharge;**
   - ❑ **Coverage under an alternative VPDES or VSMP permit has been obtained; or**
   - ❑ **For residential construction only, temporary stabilization has been completed and the residence has been transferred to the homeowner.**

The Notice of Termination must be submitted within 30 days of one of the above conditions being met. Authorization to discharge terminates at midnight on the date that the Notice of Termination is submitted.

5. **Permanent Control measures Installed:** Attach a list of permanent control measures (both structural and non-structural) that will be installed at the construction site. For each BMP, include the following information: (a) Type of control measure installed and the date that it became functional as a permanent control measure; (b) Geographic location (county or city and Hydrologic Unit Code) (latitude and longitude may additionally be included if available); (c) Waterbody the control measures discharge into; and, (d) Number of acres that will be treated (to the nearest one-tenth of an acre). If no permanent control measures were installed please check this box ❑
6. **Participation in a Regional Stormwater Management Plan:** Where applicable, attach the following information related to participation in a regional stormwater management plan: (a) type of regional facility or facilities to which the site contributes; (b) geographic location of any regional facility to which the site contributes (county or city and Hydrologic Unit Code); (c) geographic location of the site (county or city and Hydrologic Unit Code) (latitude and longitude may additionally be included if available); and (d) number of acres treated by a regional facility.
7. **Nutrient Offsets:** Where applicable, attach the following information related to nutrient offsets that were acquired in accordance with §10.1-603.8:1 of the Code of Virginia: (a) name of the broker from which offsets were acquired; (b) geographic location (county or city and Hydrologic Unit Code) of the broker's offset generating facility; (c) number of nutrient offsets acquired (lbs. per acre per year); and (d) nutrient reductions achieved on site (lbs. per acre per year).
8. **Certification:**
   "I certify under penalty of law that I have read and understand this notice of termination and that this document and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations."

   Print Name: _____ Title: _____

   Signature:_____ Date:_____

(Please sign in INK. The person signing this form must be authorized to sign on behalf the operator identified in Item #1 above.)

Mail to: Department of Conservation and Recreation
Stormwater Permitting
203 Governor Street, Suite 206
Richmond, VA 23219

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

INSTRUCTIONS for FORM DCR 199-147

VSMP General Permit Notice of Termination - Construction Activity Stormwater Discharges

General

A VSMP General Permit Notice of Termination must be submitted when an operator no longer wishes to be covered under the VSMP General Permit for Stormwater Discharges from Construction Activities.

Mail to: Department of Conservation and Recreation
Stormwater Permitting
203 Governor Street, Suite 206
Richmond, VA 23219

Section 1 Activity Operator Information

Give the legal name of the person, firm, public organization, or any other entity that was issued the general permit for the site described in this Notice of Termination. Do not use a colloquial name. Enter the complete address and phone number of the operator.

Section 2 Activity Location Information

Enter the activity's official name and complete street address, including city, state and ZIP code. If the activity or site lacks a street address, indicate the latitude and longitude to the nearest 15 seconds of the approximate center of the site.

Section 3 Permit Information

Enter the existing VSMP Stormwater General Permit number assigned to the activity or site identified in Section 1 that the operator wishes to be terminated.

Section 4 Reason for Termination

Check the appropriate statement indicating the reason for submitting this Notice of Termination. The Notice of Termination may only be submitted after one or more of the following conditions have been met:

1. Necessary post-construction control measures included in the SWPPP for the site are in place and functioning and final stabilization has been achieved on all portions of the site for which the operator is responsible;
2. Another operator has assumed control over all areas of the site that have not been finally stabilized;
3. Coverage under an alternative VPDES or VSMP permit has been obtained; or
4. For residential construction only, temporary stabilization has been completed and the residence has been transferred to the homeowner.

The Notice of Termination must be submitted within 30 days of one of the above conditions being met. Authorization to discharge terminates at midnight on the date that the Notice of Termination is submitted.

Section 5 Permanent Control Measures Installed

Attach a list of the permanent control measures (both structural and non-structural) that will be installed at the construction site. For each control measure, include the following information:

(a) Type of control measure installed
(b) Geographic location (county or city and Hydrologic Unit Code)
(c) Waterbody the control measure discharge into
(d) Number of acres that will be treated (to the nearest one-tenth of an acre)

Check the box if no permanent control measures were installed.

Section 6 Participation in a Regional Stormwater Management Plan

Where applicable, attach the following information related to participation in a regional stormwater management plan: (a) type of regional facility or facilities to which the site contributes; (b) geographic location of any regional facility to which the site contributes (county or city and Hydrologic Unit Code); (c) geographic location of the site (county or city and Hydrologic Unit Code) (latitude and longitude may additionally be included if available); and (d) number of acres treated by a regional facility.

Section 7 Nutrient Offsets

Where applicable, attach the following information related to nutrient offsets that were acquired in accordance with §10.1-603.8:1 of the Code of Virginia: (a) name of the broker from which offsets were acquired; (b) geographic location (county or city and Hydrologic Unit Code) of the broker's offset generating facility; (c) number of nutrient offsets acquired (lbs. per acre per year); and (d) nutrient reductions achieved on site (lbs. per acre per year).

Section 8 Certification

State statutes provide for severe penalties for submitting false information on this Notice of Termination.

State regulations require this Notice of Termination to be signed as follows:

For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (2) the manager of one or more manufacturing, production, or operating facilities provided the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures

For a partnership or sole proprietorship: by a general partner or the proprietor; or

For a municipality, state, Federal, or other public facility: by either a principal executive officer or ranking elected official.

The Department of Conservation and Recreation reserves the right to request additional information not directly addressed by the registration statement if, in its discretion, a facility or operation poses a potential impact on water quality.

Erosion and Sediment Control Plan for Projects with Land Disturbance Less Than 1 Acre

Project: _____

Project Manager: _____

Responsible Land Disturber: _____

Land Area to be Disturbed _____ (acres or square feet)

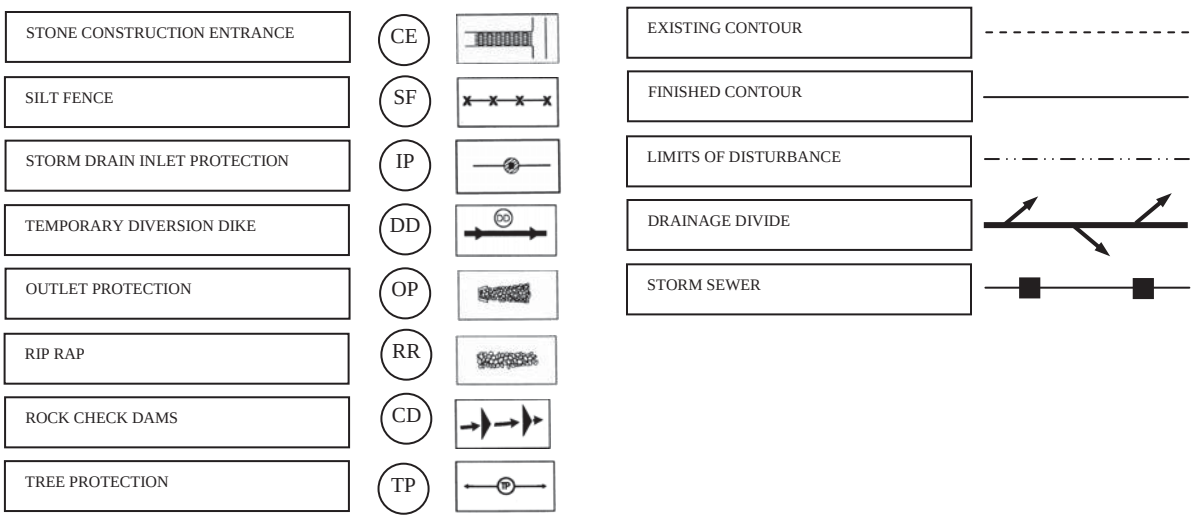
The following information is required:

1. Describe the nature, purpose, and scope of land disturbing activity
2. List all E&SC practices that will be required during all land-disturbing activities provided on the next two pages. Responsible Land Disturber should sign the acknowledgement.
3. Provide a Site Map with description of E&SC practices.

Map must include the following:

- Indicate North
- Indicate all areas that are to be cleared and graded.
- Show all improvements such as buildings, parking lots, access roads, utility construction, etc.
- Show the locations of all erosion and sediment controls and stormwater management practices used on the site.
- Show existing and final contour lines and drainage divides.

Recommended Plan Symbols:



4. Describe any off-site land-disturbing activities that will occur (including borrow sites, stockpiles, etc.)
5. Provide a schedule of regular inspections and repair of erosion and sediment control structures. Identify all post-construction maintenance requirements and responsible party for effecting all actions.
6. Use Fax Cover provided and Fax information to the Environmental Compliance Section, NREA Branch.

Erosion and Sediment Control Notes:

1. Permanent or temporary soil stabilization shall be applied to denuded areas within seven days after final grade is reached on any portion of the site.

2. Temporary soil stabilization shall be applied within seven days to denuded areas that may not be at final grade but will remain dormant for longer than 30 days.

3. Permanent stabilization shall be applied to areas that are to be left dormant for more than one year.

4. During construction of the project, soil stockpiles and borrow areas shall be stabilized or protected with sediment trapping measures.

5. The applicant is responsible for the temporary protection and permanent stabilization of all soil stockpiles on site as well as borrow areas and soil intentionally transported from the project site.

6. A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized.

7. Permanent vegetation shall not be considered established until a ground cover is achieved that, is uniform, mature enough to survive and will inhibit erosion.

8. All measures intended to trap sediment shall be constructed as a first step in any land-disturbing activity and shall be made functional before upslope land disturbance takes place.

9. Stabilization measures shall be applied to earthen structures such as dams, dikes and diversions immediately after installation.

10. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion.

11. Slopes that are found to be eroding excessively within one year of permanent stabilization shall be provided with additional slope stabilizing measures until the problem is corrected.

12. Concentrated runoff shall not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

13. Whenever water seeps from a slope face, adequate drainage or other protection shall be provided.

14. All storm sewer inlets that are made operable during construction shall be protected so that sediment-laden water cannot enter the conveyance system without first being filtered or otherwise treated to remove sediment.

15. Before newly constructed stormwater conveyance channels or pipes are made operational, adequate outlet protection and any required temporary or permanent channel lining shall be installed in both the conveyance channel and receiving channel.

16. Underground utility lines shall be installed in accordance with the following standards in addition to other applicable criteria:
    a. No more than 500 linear feet of trench may be opened at one time.
    b. Excavated material shall be placed on the uphill side of trenches.
    c. Material used for backfilling trenches shall be properly compacted in order to minimize erosion and promote stabilization.
    d. Restabilization shall be accomplished in accordance with the current edition of the VESCH.
    e. Applicable safety regulations shall be complied with.

17. Where construction vehicle access routes intersect paved or public roads, provisions shall be made to minimize the transport of sediment by vehicular tracking onto the paved surface.

18. Where sediment is transported onto a paved or public road surface, the road surface shall be cleaned thoroughly at the end of each day.

19. Sediment shall be removed from the roads by shoveling or sweeping and transported to a sediment control disposal area. Street washing shall be allowed only after sediment is removed in this manner.

20. All temporary erosion and sediment control measures shall be removed within 30 days after final site stabilization or after the temporary measures are no longer needed, unless otherwise authorized by the local program authority.

21. Trapped sediment and the disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion and sedimentation.

22. Properties and waterways downstream from development sites shall be protected from sediment deposition, erosion and damage due to increases in volume, velocity and peak flow rate of stormwater runoff. Concentrated stormwater runoff leaving a development site shall be discharged directly into an adequate natural or man-made receiving channel, pipe or storm sewer system.

23. Increased volumes of sheet flows that may cause erosion or sedimentation on adjacent property shall be diverted to a stable outlet, adequate channel, pipe or pipe system, or to a detention facility.

24. All measures used to protect properties and waterways shall be employed in a manner which minimizes impacts on the physical, chemical and biological integrity of rivers, streams and other waters of the state.

25. All Land Disturbing Activities aboard MCB Quantico will be conducted in accordance with the current edition of the Virginia Erosion and Sediment Control Law and Regulations (VESCLR) and the Virginia Erosion and Sediment Control Handbook, 1992 Edition (VESCH). A copy of the handbook and the approved E&SC Plan will be kept on-site at all times.

This Plan is not applicable to projects with the following characteristics:

1. Project requires a sediment trap or basin.
2. Work will be performed in live watercourses.
3. Work will be performed in any areas that could potentially be characterized as wetlands.
4. Project will involve de-watering operations.
5. Project will increase peak flows rates of stormwater runoff, add additional impervious area, or create new drainage channels.
6. Existing conditions at the project site have inadequate stormwater management measures.

Responsible Land Disturber's Acknowledgement:

Signature	**(Date)**
Print Name	
Title	

Facsimile Transmittal

EROSION AND SEDIMENT CONTROL PLAN

MARINE CORPS BASE, QUANTICO, VIRGINIA

FROM: Company: _____

POC: _____

Phone: _____

Fax: _____

E-mail: _____

TO: Water Program, Environmental Compliance Section, NREA Branch (G-5)

Phone: (703) 784-4030

Fax: (703) 784-4953

SUBJ: **EROSION AND SEDIMENT CONTROL PLAN**

PAGES TRANSMITTED: [ ]

Notes:

The Contractor should include in their E&SC and their SWPPP submittal the following type of information. This format is recommended for ease of reference.

	Pre-Construction	Post-Construction	LID Device #1	LID Device #2	LID Device #3	Location within Plans/Specs
Drainage Area A						
Drainage Area B						
Drainage Area C						

LID Practices and BMP's	Drainage Area Location	Volume Required	CFS Required	Actual Volume/CFS	Location within Plans/ Specs
Soil Amendments					
Bioretention					
Dry Wells					
Filter Strips					
Vegetated Buffers					
Grassed Swales					
Infiltration Trenches					
Inlet Devices					
Rain Barrels					
Cisterns					
Tree Box Filters					
Vegetated Roofs					
Permeable Pavers					
Permeable Pavement					

NATURAL RESOURCES & ENVIRONMENTAL AFFAIRS BRANCH
MCB QUANTICO, VIRGINIA

CHECKLIST FOR EROSION & SEDIMENTATION CONTROL (E&SC) PLAN REVIEW FOR MCB QUANTICO CONSTRUCTION PROJECTS

Construction Project Name: _____ Review Date/Time: _____

Reviewer: _____Nikki Bennett_____ Title:__Water Program Manager__

A. PROJECT NARRATIVE REQUIREMENTS

	YES	NO	N/A
1. **Project Description:**			
a. Nature and purpose of land disturbance described?	☐	☐	☐
b. Land area (in acres) to be disturbed specified in the narrative?	☐	☐	☐
2. **Existing Site Conditions:** Description of existing topography, drainage, and vegetation provided?	☐	☐	☐
3. **Adjacent Areas:** Description of neighboring areas which might be affected by the land disturbance provided?		☐ ☐	☐
4. **Off-Site Areas:** Description of any off-site land disturbing activities (borrow pit, waste, surplus, etc.) provided?	☐	☐	☐
5. **Soils:** Brief description of the soils on the site giving such information as soil name, mapping unit, erodibility, permeability, depth, texture and soil structure provided?	☐	☐	☐
6. **Critical Areas:** Description of areas on the site that are potential erosion problems (steep slopes, channels, underground springs) provided?	☐	☐	☐
7. **Erosion and Sedimentation Control Measures:**			
a. Current edition of the VA E&SC Law and Regulations, and the Va E&SC Handbook cited?	☐	☐	☐
b. Enumerated description of methods which will be used to control E&SC on the site provided?	☐	☐	☐
c. Cited the maintenance and use of current VESCHB & approved E&SC plan at job site?	☐	☐	☐
8. **Permanent Stabilization:** Brief description, including specifications, of how the site will be stabilized provided?	☐	☐	☐
9. **Stormwater Runoff Considerations:**			
a. Increase of peak runoff resulting from site development determined?		☐ ☐	☐
b. Flooding or downstream channel degradation as a result of runoff increase determined?	☐	☐	☐
c. Description of strategy used to control stormwater runoff provided?	☐	☐	☐
10. **Calculations:**			
a. Calculations for pre- and post-development runoff provided?	☐	☐	☐
b. Detailed calculations for the design of temp sediment basins, perm storm detention basins, diversions, channels, etc. provided?	☐	☐	☐
11. **Maintenance:** A plan or schedule of regular inspections and repair of E&SC devices described?	☐	☐	☐

B. SITE PLAN REQUIREMENTS

	YES	NO	N/A
1. **Vicinity Map:**			
a. Is a small map showing the site location in relation to surrounding area included in the drawings?	☐	☐	☐
b. Land area (in acres) to be disturbed included in the drawings?	☐	☐	☐
2. **North Arrow:** Is North arrow shown on all pages of E&SC drawings?	☐	☐	☐
3. **Limits of Clearing and Grading:** Are areas to be cleared and/or graded marked?	☐	☐	☐
4. **Existing Contours:**			
a. Existing contours on site shown?	☐	☐	☐
b. Existing contours at offsite areas which will affected by the land disturbance shown?	☐	☐	☐

B. SITE PLAN REQUIREMENTS (Continued)

	YES	NO	N/A
5. **Final Contours:**			
a. Changes to the existing contours shown?	☐	☐	☐
b. Final drainage patterns shown?	☐	☐	☐
6. **Existing Vegetation:** Existing tree lines, grassed areas, or unique vegetation shown?	☐	☐	☐
7. **Soils:** Boundaries of soil types shown?	☐	☐	☐
8. **Existing Drainage Patterns:**			
a. Drainage divides and respective direction of flow shown?	☐	☐	☐
b. Area (in acres) of each drainage divide shown?	☐	☐	☐
9. **Critical Erosion Areas:** Per Chapter 6 of VESCH, are potentially serious erosion areas shown?	☐	☐	☐
10. **Site Development:** Are all site developments such as buildings, parking lots, access roads, utility construction, storm sewer system, final drainage, etc. shown?	☐	☐	☐
11. **Location of Practices:** Locations of E&SC and stormwater management practices used on site shown?	☐	☐	☐
12. **Off-site Areas:**			
a. Any off-site land disturbing activities identified?	☐	☐	☐
b. Adequate E&SC measures, protection, or stabilization shown?	☐	☐	☐
13. **Detail Drawings:** All detail drawings of E&SC devices not referenced to the VESCH explained and/or illustrated?	☐	☐	☐
14. **Minimum Standard Requirements (Per 4VAC50-30-40)**			
MS-1 Has temp or perm stabilization of denuded areas been addressed in the narrative? Seeded? Yes / No Mulched? Yes / No Graveled? Yes / No	☐	☐	☐
MS-2 Has stabilization of soil stockpiles been addressed with seeding and/or sediment trapping devices?	☐	☐	☐
MS-3 Has maintenance of permanent stabilization been addressed?	☐	☐	☐
MS-4 Will all sediment trapping devices be constructed and functional as first step in LDA?	☐	☐	☐
MS-5 For perimeter sediment trapping devices, has stabilization of earthen structures been addressed?	☐	☐	☐
MS-6 Are adequate sediment traps and/or basins required where needed?	☐	☐	☐
MS-7 Has stabilization of cut and fill slopes been adequately addressed?	☐	☐	☐
MS-8 Are paved flumes, channels, or slope drains required where necessary?	☐	☐	☐
MS-9 Has adequate stabilization or protection of surface roughening, outlets, etc. been addressed?	☐	☐	☐
MS-10 Has adequate protection of all operational storm sewer inlets been addressed?	☐	☐	☐
MS-11 Are channel lining or outlet protection adequate for stormwater conveyance channels?	☐	☐	☐
MS-12 Are in-stream construction measures adequately addressed to minimize channel damage?	☐	☐	☐
MS-13 Are temporary stream crossings of non-erodible materials planned for installation where applicable?	☐	☐	☐
MS-15 Has restabilization of areas subject to in-stream construction been adequately addressed?	☐	☐	☐
MS-16 Is stabilization of utility trenches adequately addressed?	☐	☐	☐
MS-17 Is the transport of soil and mud onto public roadways adequately addressed with applicable measures?	☐	☐	☐
MS-18 Has removal of all temp control devices been addressed?	☐	☐	☐
Has maintenance of all control devices been addressed?	☐	☐	☐
MS-19 Are properties and waterways downstream adequately protected from erosion and sediment deposition due to increases in peak runoff?	☐	☐	☐

C. CONCLUSION: ☐ **E&SC Plan Approved** ☐ **E&SC Plan Disapproved**

D. GENERAL JUSTIFICATION/S:

☐ The E&SC Plan does not meet the 19 Minimum Standards of the VESCH.

☐ Verbiage in the E&SC Narrative is either inadequate or insufficient, or both.

☐ Details of E&SC measures on construction drawings (Site Plan) is either inadequate or insufficient, or both.

☐ Other (comment/s shown below)

E. COMMENTS:

_____
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_____
_____
_____
_____
_____
_____

Reviewer's Signature:_____
Email:_____
Phone:_____

Total Area Disturbed: _____

Construction Start Date: _____

Contractor Information: _____
(Address, Phone, etc.) _____
_____
_____
_____

Contractor POC: _____
Email:_____
Phone: _____

MCBQ ROICC POC: _____
Email:_____
Phone: _____

MCBQ PWB POC: _____
Email:_____
Phone: _____

Storm Water Pollution Prevention Plan Checklist

Site:_____ **Inspected by:**_____

SITE DESCRIPTION	YES	NO	N/A
1. Description of the nature of the construction activity			
2. A description of the intended sequence of major activities which disturb soils for major portions of the site (e.g. grubbing, excavation, grading, utilities and infrastructure installation)			
3. Estimates of the total area of the site and the total area of the site that is expected to be disturbed by excavation, grading, or other activities including offsite borrow and fill areas covered by the plan			
4. An estimate of the runoff coefficient of the site prior to construction and after construction activities are completed			
5. Existing data describing the soil or the quality of any discharge from the site			
6. A description of existing vegetation at the site			
7. A description of any other potential pollution sources, such as vehicle fueling, storage of fertilizers or chemicals, sanitary waste facilities, etc.			
8. The name of the receiving water(s) and the ultimate receiving water(s), and areal extent of wetland acreage at the site			
9. A site map indicating:			
a. drainage patterns and approximate slopes or contours anticipated after major grading activities			
b. areas of soil disturbance and areas of the site which will not be disturbed			
c. the location of major structural and nonstructural controls identified in the plan			
d. the location of areas where stabilization practices are expected to occur including the types of vegetative cover			
e. surface waters (including wetlands)			
f. locations where storm water is discharged to a surface water with an outline of the drainage area for each discharge point			
g. existing and planned paved areas and buildings			
h. locations of permanent storm water management practices to be used to control pollutants in storm water after construction activities have been completed			
i. locations of offsite mate Hal, waste, borrow or equipment storage areas covered by the plan			
j. locations of other potential pollution sources as described in 7. above			
10. The location and description of any discharge associated with industrial activity other than construction, including storm water discharges from dedicated asphalt plants and dedicated concrete plants, which is covered by this permit			
CONTROLS	**YES**	**NO**	**N/A**
For ***each*** specific major activity, the plan will address the following:			
1. Erosion and Sediment controls for each site			
a. The plan must address how offsite accumulations of sediment must be removed, at a frequency sufficient to minimize offsite impacts, if sediment escapes the construction site,			
b. Statement saying that if periodic inspections or other information indicates a control has been used inappropriately, or incorrectly, the permittee must replace or modify the control for site situations			
c. Statement saying that sediment must be removed from sediment traps or			

Storm Water Pollution Prevention Plan Checklist

Site:_____ **Inspected by:**_____

sedimentation ponds when design capacity has been reduced by 50%.			
d. Statement saying that litter, construction debris, and construction chemicals exposed to storm water shall be prevented from becoming a pollutant source for storm water discharges (e.g., screening outfalls, picked up daily).			
e. Offsite material storage areas (also including overburden and stockpiles of dirt, borrow areas, etc.) where storm water discharges are authodzed by this permit are considered a part of the project and shall be addressed in the plan			
2. Stabilization Practices			
a. Description of interim and permanent stabilization practices			
b. Site-specific scheduling of the implementation of the practices			
c. Site plans should ensure that existing vegetation is preserved where attainable and that disturbed portions of the site are stabilized			
d. A record of the dates when major grading activities occur, when construction activities temporarily or permanently cease on a portion of the site, and when stabilization measures are initiated shall be maintained and included in the plan			
3. Structural Practices			
a. The plan shall include a description of structural practices to divert flows from exposed soils, store flows or otherwise limit runoff and the discharge of pollutants from exposed areas of the site to the degree attainable			
b. area with 3 or more acres at one time, a temporary (or permanent) sediment basin providing 3,618 cubic feet of storage per acre drained, or equivalent control measures, shall be provided where attainable until final stabilization of the site			
c. For drainage locations serving less than 3 acres, smaller sediment basins or sediment traps should be used. At a minimum, silt fences, vegetative buffer strips or equivalent sediment controls are required for all downslope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual site conditions) of the construction area unless a sediment basin providing storage for 3,618 cubic feet of storage per acre drained is provided			
STORM WATER MANAGEMENT	**YES**	**NO**	**N/A**
1. A description of measures that will be installed during the construction process to control pollutants in storm water discharges that will occur ***after*** construction operations have been completed			
OTHER CONTROLS	**YES**	**NO**	**N/A**
1. Statement saying that no solid materials, including building materials, garbage, and debris shall be discharged to surface waters of the State, except as authorized by a **CWA Section 404 permit**			
2. Sediment removed from the roads each day			
3. The plan shall ensure and demonstrate compliance with applicable State or local waste disposal, sanitary sewer or septic system regulations			
4, Description of construction and waste materials expected to be stored onsite with updates as appropriate			
5. Description of controls to reduce pollutants from these materials including storage practices to minimize exposure of the materials to storm water, and spill prevention and response			
6. Description of pollutant sources from areas other than the permitted construction			

Storm Water Pollution Prevention Plan Checklist

Site:_____ **Inspected by:**_____

activity (including storm water discharges from dedicated asphalt plants and dedicated concrete plants) that contribute to the permitted discharge			
7. Except for flows from fire fighting activities, sources of nonstorm water that are combined with storm water discharges from the construction site must be identified in the plan. The plan shall identify and ensure the implementation of appropriate pollution prevention measures for the nonstorm water component(s) of the discharge			
MAINTENANCE	**YES**	**NO**	**N/A**
1. Description and schedule of procedures to maintain in good and effective operating conditions vegetation, erosion and sediment control measures and other protective measures during construction identified in the site plan			
2. If site inspections required by Part II.D.4. identify BMPs that are not operating effectively, maintenance shall be performed before the next anticipated storm event, or as necessary to maintain the continued effectiveness of storm water controls			
INSPECTIONS	**YES**	**NO**	**N/A**
1. Inspections shall be conducted at least once every fourteen calendar days and within 48 hours of the end of a storm event that is 0.5 inches or greater			
2. Inspection reports shall include:			
a. name(s) and qualifications of personnel making the inspection, and the date(s) of the inspection			
b. major observations relating to the implementation of the SWPP plan			
c. the location(s) of discharges of sediment or other pollutants from the site			
d. location(s) of BMPs that need to be maintained			
e. location(s) of BMPs that failed to operate as designed or proved inadequate for a particular location			
f. location(s) where additional BMPs are needed that did not exist at the time of inspection			
g. incidents of noncompliance			
h. Where a report does not identify any incidents of noncompliance, the report shall contain a certification that the facility is in compliance with the storm water pollution prevention plan and this permit			
i. Signature			

NATURAL RESOURCES & ENVIRONMENTAL AFFAIRS BRANCH

MCB QUANTICO, VIRGINIA

CHECKLIST FOR LID (Low Impact Development) PLAN REVIEW

FOR MCB QUANTICO CONSTRUCTION PROJECTS

Construction Project Name: Review Date/Time:

Reviewer: **Steve Clark** Title: **Water Programs Manager** Approved? YES ☐ NO ☐

	Yes	No	N/A
1. Do the LID features designed reduce the hydrologic impact of development and maintain or restore the sites hydrologic and hydraulic function?	☐	☐	☐
2. LID site design strategies (check all that apply):			
a. Grading to encourage sheet flow and lengthen flow paths	☐	☐	☐
b. Maintaining natural drainage divides to keep flow paths dispersed	☐	☐	☐
c. Disconnecting impervious areas such as pavement and roofs from the storm drain network, allowing runoff to be conveyed over pervious areas instead	☐	☐	☐
d. Preserving the naturally vegetated areas and soil types that slow runoff, filter out pollutants, and facilitate infiltration	☐	☐	☐
e. Directing runoff into or across vegetated areas to help filter runoff and encourage recharge	☐	☐	☐
f. Providing small-scale distributed features/devices that help meet regulatory and resource objectives	☐	☐	☐
g. Treating pollutant loads where they are generated, or prevent their generation	☐	☐	☐
3. Are the LID features designed site applicable (i.e. size of drainage area, available storage, land use, soil type, slope, vegetative cover, etc.)?	☐	☐	☐
4. Are pre-construction and post-construction calculations and data included in design	☐	☐	☐

5. Estimated Cost for LID features in design $_____

Individual Design Components:

1.	Does the LID design provide for the conservation of natural areas	☐	☐	☐
2.	Does the LID design provide minimization of development impacts	☐	☐	☐
3.	Does the LID design control the watershed timing and runoff patterns	☐	☐	☐
4.	Does the LID design use Integrated Management Practices (IMPs)	☐	☐	☐
5.	Does the LID design provide for pollution prevention	☐	☐	☐
6.	Does the LID design provide for O&M procedures for each LID practice in the site plan	☐	☐	☐

LID Features Used In Design (check all that apply):

a.	Soil Amendments	☐	qty. _____	h.	Inlet Devices	☐	qty. _____
b.	Bioretention	☐	qty. _____	i.	Rain Barrels	☐	qty. _____
c.	Dry Wells	☐	qty. _____	j.	Cisterns	☐	qty. _____
d.	Filter Strips	☐	qty. _____	k.	Tree Box Filters	☐	qty. _____
e.	Vegetated Buffer	☐	qty. _____	l.	Vegetated Roofs	☐	qty. _____
f.	Grassed Swales	☐	qty. _____	m.	Permeable Pavers	☐	qty. _____
g.	Infiltration Trenches	☐	qty. _____	n.	Permeable Pavement	☐	qty. _____

MCB QUANTICO ENVIRONMENTAL COMPLIANCE AND PROTECTION STANDARD OPERATIONS PROCEDURES (PROVIDED DIGITALLY)

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Environmental Compliance and Protection Standard Operating Procedures

Marine Corps Base, Quantico

Prepared by:
Environmental Management System Section
Natural Resources and Environmental Affairs Branch

AUGUST 2013 VERSION: 1.0

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Approval

This ECPSOP meets requirements established within MCO P5090.2A, Environmental Compliance and Protection Manual, and the MCBO 5090.2D, Environmental Program Management.

_____ Date:_7 April 2014___

Col David W. Maxwell
Base Commander
Marine Corps Base, Quantico, Virginia

Distribution: A

Copy To: GF, MCBQ
NREA, MCBQ
Files

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Record of Changes

Log completed change actions as indicated.

Change Number	Date of Change	Summary of Revision	Signature of Editor

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APPENDICES

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List of Acronyms

ACHP	Advisory Council on Historic Preservation
ACM	Asbestos Containing Material
AC/S	Assistant Chief of Staff
AICUZ	Air Installation Compatible Use Zone
AL	Action Level
APM	Asbestos Program Manager
APZ	Accident Potential Zone
ARPA	Archaeological Resources Protection Act
AST	Aboveground Storage Tank
AUL	Authorized Use List
BMP	Best Management Practice
BOSS	Base Operations Support Service
BUMEDINST	Bureau of Medicine Instruction
CAA	Clean Air Act
C&D	Construction and Demolition Debris
CE	Categorical Exclusion
CECOS	Civil Engineer Corps Officers School
CETEP	Comprehensive Environmental Training and Education Program
CFR	Code of Federal Regulations
CG/CO	Commanding General/Commanding Officer
CLE	Conservation Law Enforcement
CMC	Commandant of the Marine Corps
CMC (LF)	Commandant of the Marine Corps, Facilities and Services Division
CRM	Cultural Resources Manager
CWA	Clean Water Act
CWAA	Clean Water Act Amendments of 1987
DLA	Defense Logistics Agency
DMM	Discarded Military Munitions
DMR	Discharge Monitoring Report
DoD	Department of Defense
DoDEA	Department of Defense Education Activity
DoDI	Department of Defense Instruction
DoN	Department of the Navy
DUERS	Defense Utility and Energy Reporting System
E^2MS	Environmental and Energy Management Systems
EA	Environmental Assessment
EC	Environmental Coordinator
ECE	Environmental Compliance Evaluation
ECO	Energy Conservation Officer
ECPSOP	Environmental Compliance and Protection Standard Operating Procedure
EIRB	Environmental Impact Review Board
EIS	Environmental Impact Statement
EMS	Environmental Management System
EO	Executive Order
EOD	Explosive Ordinance Disposal
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act

ESACC	Expended Small Arms Cartridge Casings
FFA	Federal Facilities Agreement
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FMS	Facilities Maintenance Section
FONSI	Finding of No Significant Impact
FWA	Fish, Wildlife, and Agronomy
FY	Fiscal Year
GIS	Geographic Information Systems
HAZCOM	Hazard Communication
HAZMINCEN	Hazardous Material Minimization Center
HAZWOPER	Hazardous Waste Operations and Emergency Response
HM	Hazardous Material
HMMP	Hazardous Material Management Program
HMMS	Hazardous Material Management System
HQMC	Headquarters Marine Corps
HS	Hazardous Substance
HW	Hazardous Waste
HWC	Hazardous Waste Coordinator
HWMP	Hazardous Waste Management Program
IC	Incident Commander
ICRMP	Integrated Cultural Resources Management Plan
ICS	Incident Command System
IH	Industrial Hygienist
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
IPMC	Integrated Pest Management Coordinator
IRP	Installation and Restoration Program
ISMP	Integrated Spill Management Plan
LBP	Lead-Based Paint
LCM	Lead Containing Materials
Ldn	Day-Night Average Sound Level
LPM	Lead Program Manager
LQG	Large Quantity Generator
LSP	Lead Safety Program
MARCORSYSCOM	Marine Corps Systems Command
MC	Military Constituents
MCAF	Marine Corps Air Facility
MCBO	Marine Corps Base Order
MCBQ	Marine Corps Base, Quantico
MCO	Marine Corps Order
MEC	Munitions and Explosives of Concern
MOA	Memorandum of Agreement
MOM	Measure of Merit
MRA	Munitions Response Area
MRP	Munitions Response Program
MRS	Munitions Response Site
NAGPRA	Native American Graves Protection and Repatriation Act
NAVFAC	Naval Facilities Engineering Command
NAVRAMP	Navy Radon Assessment and Mitigation Program

NAVMC	Navy Marine Corps
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Agency
NHC	Naval Health Clinic
NHPA	National Historic Preservation Act
NMMC	National Museum of the Marine Corps
NOI	Notice of Intent
NOPRS	Navy Online Pesticide Reporting System
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NREA	Natural Resources and Environmental Affairs
NRHP	National Register of Historic Places
ODS	Ozone Depleting Substance
OPMAN	Operations Management Division
OPNAVINST	Office of the Chief of Naval Operations Instruction
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
P2ADS	Pollution Prevention Annual Data Summary
PA	Preliminary Assessment
PA	Programmatic Agreement
PCB	Polychlorinated Biphenyl
PCO	Property Control Office
POL	Petroleum, Oil, and Lubricants
PPE	Personal Protective Equipment
PPV	Public Private Venture
PWB	Public Works Branch
QPMT	Quantico Projects Managers Team
QRP	Qualified Recycling Program
RACM	Regulated Asbestos Containing Material
RCRA	Resource Conservation and Recovery Act of 1976
REIA	Request for Environmental Impact Analysis
ROD	Record of Decision
ROICC	Regional Officer in Charge of Construction
SAP	Satellite Accumulation Point
SARA	Superfund Amendments Reauthorization Act
SDS	Safety Data Sheets
SES	Senior Executive Service
SHPO	State Historic Preservation Officer
SI	Site Investigation
SOP	Standard Operating Procedure
SPR	Spill Prevention and Response
SOW	Scope of Work
STEP	Status Tracker for Environmental Programs
STP	Sewage Treatment Plant
SWMAP	Storm Water Management Action Plan
SWP	Small Whorled Pogonia
T&E	Threatened & Endangered
TSCA	Toxic Control Substances Act of 1976

UCS	Unified Command Structure
USACE	United States Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USMC	United States Marine Corps
UST	Underground Storage Tank
UXO	Unexploded Ordnance
VAC	Virginia Administrative Code
VAPCL	Virginia Air Pollution Control Law
VDEQ	Virginia Department of Environmental Quality
VPDES	Virginia Pollution Discharge Elimination System
WEBCASS	Web Compliance Assessment and Sustainment System

CHAPTER 1

Introduction

1. Purpose

a. Per Marine Corps Order (MCO) 5090.2A, Marine Corps installations are required to establish an Environmental Compliance and Protection Standard Operating Procedure (ECPSOP) document to identify all applicable organizational and environmental policies, procedures, roles and responsibilities.

b. Per Marine Corps Base Order (MCBO) 5090.2D, Marine Corps Base Quantico's (MCBQ) Environmental Management System (EMS) Manual provides the framework associated with the implementation and operation of the EMS aboard MCBQ, including the development and implementation of the ECPSOP.

c. The purpose of this ECPSOP is to provide the operational controls for all environmental media at MCBQ in compliance with MCO 5090.2A; and as applicable, to provide references to Environmental Media Program Management Plans (Program Plans) or other MCBOs.

d. Specific EMS-related administrative procedures are provided in the MCBQ Management Coordination Plan (MCP), as described in Chapter 21 of this ECPSOP.

2. Policy and Objectives

a. Policy. The ECPSOP is designed to support the Base Commander's Environmental Policy in a manner that demonstrates a firm commitment to:

(1) Improving Quantico's environment in a manner that enhances Quantico's value as a premier support and training facility;

(2) Complying with all applicable environmental laws, regulations, and policies in order to sustain our capacity to train and to support our Marines, Sailors, Civilian Marines, and their families;

(3) Reducing energy and water consumption through conservation and efficiency to meet federal energy and water reduction mandates and reduce utility costs;

(4) Preventing pollution and spills, while minimizing the use of hazardous materials, reducing waste sources, and ensuring a safer and cleaner environment. If spills do occur, immediately report and clean them properly;

(5) Minimizing soil erosion, fire hazards, and other threats to our cultural and natural resources.

b. Objectives. The ECPSOP provides information concerning operational controls for MCBQ's EMS, organized by environmental media, and provides guidance for Installation programs that:

(1) Protect human health and the environment.

(2) Comply with all applicable regulations, policies, and orders.

3. Requirements and Scope

a. General Requirements

(1) United States Marine Corps (USMC) units and personnel regularly conduct activities during day-to-day operations and training that may impact human health and the environment. To govern these actions, Headquarters Marine Corps (HQMC) has issued MCO P5090.2A, Environmental Compliance and Protection Manual.

(2) Section 2226 of MCO P5090.2A states that "Installation commanders will publish an environmental compliance and protection standard operating procedures (ECPSOP) document." MCBQ, also referred to as "the Base," has prepared this document to satisfy the requirements of the ECPSOP required by MCO 5090.2A.

(3) MCBQ has developed Environment Management Programs that are structured around federal, Commonwealth of Virginia (hereafter referred to as Virginia or state), Department of Defense (DoD), and HQMC regulatory requirements. The Natural Resources and Environmental Affairs (NREA) Branch has primary responsibility and oversight for the majority of environmental programs at MCBQ; however, as noted in this ECPSOP, specific chapters call out responsible parties for each program/media area. Requirements under each program have a corresponding written plan or instruction which are maintained by program managers, reviewed annually, and updated as required.

b. Scope

(1) This document is directed towards all Marines, Sailors, families, civilians and contractors who work and/or live within the fence line of the Base.

(2) The ECPSOP is implemented under the direction of the Commander, MCBQ and carries the Commander's authority for implementing the programs described herein.

4. Overview

a. The ECPSOP is organized into several chapters, which reflect those elements required by MCO P5090.2A and the International Organization for Standardization (ISO) 14001 standard applicable to EMS programs. Chapter 1 provides an overview of the ECPSOP and Chapters 2 through 30 describe each environmental program in the following format:

(1) Requirements.

(2) Practices.

(3) Definitions.

(4) Program Overview.

(5) Program Roles and Responsibilities.

(6) Training Requirements.

(7) Communications.

(8) Practice Control.

(9) Emergencies.

(10) Records Control.

(11) Sampling, Monitoring, Measuring, and Reporting Requirements.

(12) Pertinent Documents.

b. The NREA Branch, GF Installation and Environment Division, manages the environmental compliance and conformance programs at MCBQ. NREA is composed of five sections, the functions and duties of which are described in paragraphs 5.a.(1) through 5.a.(5).

c. At MCBQ, the Safety Division manages the Lead-based Paint (LBP) and the Asbestos Programs. The Naval Health Clinic (NHC) Quantico is responsible for managing the Medical and Infectious Waste Management Program. Radon Monitoring and Abatement is a multidisciplinary effort that includes Public Works Branch (PWB), GF Installation and Environment Division, NREA Branch, NHC Quantico, Safety Division, Department of Defense Education Activity (DoDEA), and Lincoln Military Housing. Energy and water conservation as well as potable water management are managed through the PWB. All of the aforementioned programs are included in this ECPSOP.

5. Roles, Responsibilities, and Resources. The responsibility for managing and implementing the majority of MCBQ's environmental

programs falls under the NREA Branch; however, several programs are managed by the PWB, Safety Division, and NHC Quantico, as summarized in **Figure 1**, Environmental Program Responsibilities. All environmental programs aboard MCBQ shall be managed in the most effective and efficient way within approved resources, program cost, performance, and schedule.

a. NREA Branch, GF, Installation and Environment Division. This branch manages and coordinates the implementation of natural resources and environmental programs for MCBQ. The goals of the NREA Branch include: management and conservation of natural and cultural resources; protection of natural resources from environmental harm; and reduction and proper management of hazardous materials and hazardous wastes [including implementation of a pollution prevention (P2) Program]. Above all, the NREA Branch ensures compliance with, and enforcement of, federal, state, DoD, and USMC environmental laws, regulations, orders, and mandates.

(1) Administrative Section. Administrative staff is comprised of the Branch Head, the Deputy, and the administrative assistant. Branch leadership provides oversight and direction for the other NREA sections, as well as budgetary support, communication with GF and higher, and other services as needed. The Administrative Section:

(a) Develops and tracks the NREA budget for MCBQ and coordinates the budget with HQMC.

(b) Tracks all executed budget data into the Status Tracker for Environmental Programs (STEP) for use by HQMC.

(c) Provides administrative support and services to the NREA.

(2) Environmental Compliance Section. This section provides daily coordination, oversight, and management of the environmental compliance programs (e.g., Storage Tank Management Program, Hazardous Waste Program, Air Program, etc.) in accordance with MCO P5090.2A. Refer to subsequent chapters for a discussion of each environmental media program.

(3) Environmental Auditing Section. This section is responsible for implementing an annual MCBQ self-evaluation program at "every permitted site and source, every process which generates a waste or may be considered a potential source, and every command/unit and tenant" at MCBQ, in accordance with MCO 5090.2A. In cooperation with the Environmental Planning Section, the information attained by this section during the annual MCBQ self-evaluation program is incorporated into year-end conformance assessments [Internal Environmental Compliance Evaluations (ECEs)] and triennial HQMC External (Benchmark) ECEs, as discussed in greater detail in Chapters 14 and 21 of this ECPSOP.

(4) Environmental Planning Section. This section consists of the Environmental Management System (EMS) Coordinator, the Pollution Prevention/Sustainability Program, the National Environmental Policy Act (NEPA) Coordination Program, Cultural Resources Management Program, Noise Management Program, Comprehensive Environmental Training and Education Program (CETEP), and the Installation Restoration Program. Specific coordinator and program specific requirements and procedures are discussed in the corresponding, subsequent chapters.

(5) Natural Resources Section. This section is comprised of the Conservation Law Enforcement Program (CLEP), Forest Resources Management Program, and the Fish, Wildlife, and Agronomy (FWA) Program. Specific program requirements and procedures are discussed in the corresponding, subsequent chapters.

b. Safety Division. MCBQ Safety Division is responsible for implementing and oversight of the Base's Asbestos Awareness Program and LBP Prevention Program.

c. NHC Quantico. The NHC Quantico manages the Base's Medical and Infectious Waste Program.

d. PWB, GF Installation and Environment Division. PWB manages the Base's potable water infrastructure and ensures water is available to personnel for activities such as drinking, bathing, cleaning, and fire response. The PWB is also responsible for implementing energy and water conservation measures at MCBQ.

e. Host and Tenant Command Environmental Coordinators (ECs). ECs are personnel that are responsible for environmental awareness at the command level. ECs also maintain and manage environmental procedures at their respective commands. As stated in MCBO 5090.2D, refer to the MCBQ Management Coordination Plan (MCP) for a description of EC duties and requirements.

6. Document and Record Control

a. In accordance with MCO P5090.2A, each installation and unit shall prepare and maintain desktop procedures for each environmental billet. This requirement applies, but is not limited to all of the responsible parties listed in paragraph 5. These desktop procedures shall be in place to maintain continuity of daily operations and to ensure continued environmental compliance in the event of personnel turnover. In addition to desktop procedures, MCO P5090.2A requires environmental billets to maintain turnover folders. Turnover folders must contain information specific to the billet that will ensure program continuity. Pertinent information to be included:

(1) The billet title; supervisor's title; title of any subordinate personnel.

(2) A description of the billet and a list of essential tasks and/or practices associated with the billet and required training.

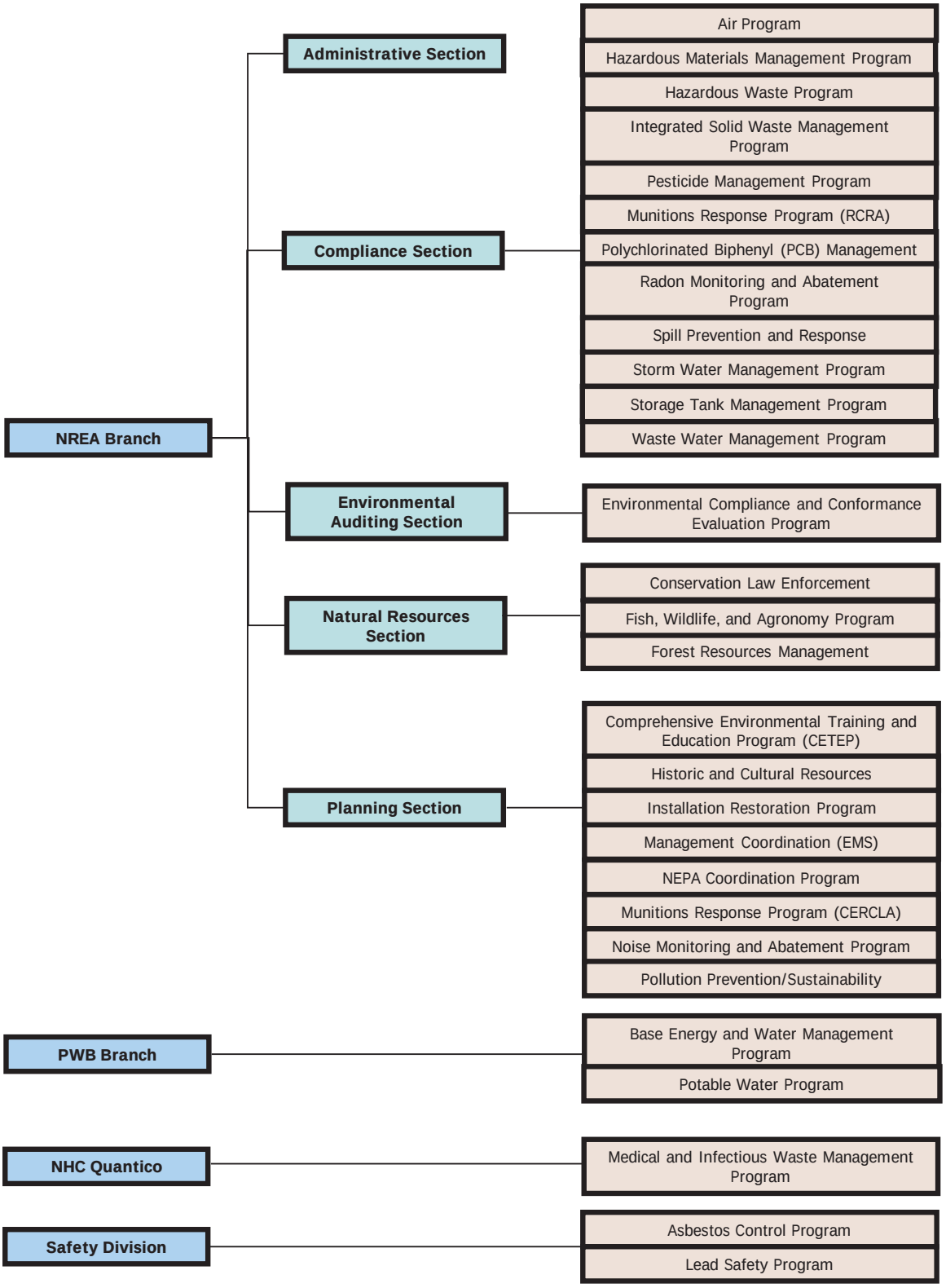
(3) List of applicable environmental laws and regulations related to the specific billet.

(4) A list of required reports, due dates, and records; a listing of required environmental compliance permits.

(5) For more information, a full listing of elements required in turnover folders are described in Appendix B-2, Section B of MCO P5090.2A.

b. Program-specific documents (e.g., program plans and permits) and record control processes are described in the subsequent chapters of this ECPSOP, as applicable.

Figure 1: Environmental Program Responsibilities



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Chapter 2

Air Program

1. Requirements. In 1970, The Clean Air Act (CAA) was established to develop comprehensive federal and state standards for mobile and stationary emission sources. The CAA also established the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, the National Emission Standards for Hazardous Air Pollutants (NESHAP), and other programs governing emission estimates and reduction plans. The most recent major amendment to the CAA was in 1990. The Virginia State Air Pollution Control Board (SAPCB) governs state requirements and implements state-delegated functions of the CAA. The federal and state standards exist to protect human health and prevent deterioration of the environment from unnecessary air pollutants. The MCBQ Air Program exists to implement the compliance and reporting requirements of the CAA and SAPCB.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Criteria pollutants. Commonly found air pollutants (ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxides, and lead).

b. Mobile emission source. Emission generating source(s) that move around (e.g., cars, buses, aircraft).

c. Ozone depleting substance (ODS). Materials, when released freely, facilitate the degradation of the Earth’s ozone layer.

d. Stationary emission source. Emission generating source(s) that are permanently stationed (e.g., stationary generators, boilers, engine test stands, paint booths).

4. Program Overview

a. Air emission sources on MCBQ include internal combustion units (e.g., emergency generators, fire pumps, and natural gas compressors), external combustion units (e.g., boilers, space heaters, and water heaters), other stationary sources, and mobile sources. In addition, MCBQ operates heating, ventilating, and air conditioning (HVAC) systems and motor vehicles that contain refrigerant gasses classified as ODS. Many of the emissions sources on MCBQ are regulated by the Federal New Source Performance Standards (NSPS) and the NESHAP rules.

b. All emission sources that existed prior to 2010 and are not operated by select tenant organizations (Marine Corps Community Services, DoDEA, and the Defense Commissary Agency) are regulated under a New Source Review (NSR) Permit dated 10 January 2010 (as amended 15 February 2012). In addition, MCBQ operates under a Reasonably Available Control Technology (RACT) permit dated 2 June 2000 and a Title V Permit dated 3 September 2003. Although the Title V Permit expired in 2008, the SAPCB considers the permit to remain in effect until a renewal is issued.

c. The types of primary emission sources common at MCBQ are listed below:

(1) External Combustion Units. All boilers, water heaters, and space heaters installed prior to the date of the Base's NSR Permit are subject to fuel throughput limitations and fuel quality standards. Oil-fired units may be subject to more stringent NESHAP requirements or air permit limitations. Refer to the air permits and NESHAP Subpart JJJJJJ for more information.

(2) Diesel/Natural Gas/Propane Engine Generators. All generators installed prior to the date of the Base's NSR Permit are subject to operating limitations and fuel quality standards. All engines are subject to NSPS and/or NESHAP requirements. Specific units may be subject to more stringent requirements, such as air pollution control equipment. Refer to the air permits, NSPS Subpart IIII and JJJJ, and NESHAP Subpart ZZZZ for more information.

(3) ODS. ODS are utilized for both mission critical and non-mission critical applications. ODS containing items are commonly referred to as "white goods" and include things such as refrigerators and water coolers. White goods must be turned into Defense Logistics Agency (DLA) Disposition Services for proper disposal. Purposefully venting an ODS is strictly prohibited.

(4) Motor Vehicles. Most non-tactical government vehicles must have an emissions test every two years to ensure factory installed emission control equipment is functional. Certain overweight, antique, or alternative fuel vehicles may be exempt from emissions testing requirements. Typically, emissions testing is coordinated through the Fleet Manager. Personal vehicles are also required to comply with localized Virginia air emissions testing requirements by virtue of MCBQ's location within a designated nonattainment area for certain NAAQS.

(5) Solvent Tanks. All cold cleaning machines (remote reservoir and immersion tanks) must be operated according to permit requirements (e.g., covered when not in use and appropriate/visible signage).

(6) Fuel Dispensing/Vehicle Refueling. Equipment designed to reduce the escape of gasoline vapors to the atmosphere must be installed, used, and inspected daily to ensure functionality.

5. Program Roles and Responsibilities

a. The Air Program Manager (APM) shall:

(1) Coordinate, organize, implement, and track the Base-wide effort to maintain compliance with the federal and state air pollution control regulations and associated permits.

(2) The APM acts as a liaison between MCBQ and the regulatory agencies delegated the authority to implement the CAA.

b. The Head of the Facilities Maintenance Section (FMS) and activity or tenant command EC shall:

(1) Ensure operations personnel are properly trained to perform their duties and are completing their duties. Duties controlled by the Head of FMS and EC include, among others, generator maintenance, handing or transporting ODS, and documentation and recordkeeping.

(2) Record use of ODS materials and generator run-times, in spreadsheet form, and provide monthly reports to the APM.

(3) Provide data, as required, to the APM.

c. All personnel under the authority of the Commander (active duty, civil servants, and contractors) must attend environmental awareness training commensurate to the responsibilities of their job (e.g., personnel handling ODS materials should attend training for ODS materials and must be certified if working as a technician servicing ODS-containing equipment).

6. Training Requirements

a. The APM is required to receive hazard communication (HAZCOM) training and visible emissions evaluator certification (EPA Method 9).

b. The APM shall provide informal training for data collection and reporting personnel on an as needed basis. The APM will also provide site-specific training for all certified personnel working with ODS and all personnel at the fuel dispensing/vehicle refueling facilities that employ Stage I and Stage II vapor recovery systems (i.e., the gas station and government fueling station).

c. All personnel at the Camp Barrett Heat Plant, and any personnel working with generators at Buildings 2134, 3255, 2033,

27410, 3098, 2133, 2132, 27310, and 27414 must receive formal operations and maintenance training.

7. Communications. The NREA Branch APM acts as the liaison for general correspondence between MCBQ and the regulatory agencies delegated the authority to implement the CAA. All new emission sources require the approval of the APM as part of the NEPA process. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The APM uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this chapter, practices performed at MCBQ that are associated with the Air Program are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The APM reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. All new construction utilizes non-ODS refrigerants, as verified through APM review of construction specifications during the NEPA Process (see Chapter 23). In accordance with MCO P5090.2A (CH 1-2), MCBQ tracks: ODS system leak rates; equipment replacement; supply management; and recycling and reclamation of Class 1 and Class 2 ODSs by implementing paragraphs 5.b.(2), 10.a, and 11.c of this chapter.

c. All other operational controls are documented through MCBQ's Title V Air Permit and New Source Review Permit, and other regulatory requirements and mandates referenced in paragraph 12 of this chapter.

9. Emergencies

a. MCBO 6240.2A. A Standby Emissions Reduction Plan is attached to MCBO 6240.2A and specifies the only emergency response situation associated with the Air Program. The Standby Emissions Reduction Plan identifies specific measures to be taken to reduce air pollution emissions from particular facilities in the event that the accumulation of air pollutants reaches a level that could cause significant harm to public health. The Virginia Department of Environmental Quality, Air Regional Office (VDEQ-AIR) determines when these situations arise and notifies MCBQ in the event of an air pollution episode. Should the VDEQ-AIR declare an air pollution episode, the Director, Installation and Environment Division (GF),

initiates action to implement the emission reductions corresponding to the air pollution episode stage declared. The Commander ultimately retains the inherent authority to determine what operations are essential to the Base's mission and personnel.

b. No other practices performed at MCBQ could have potential emergency situations associated with the Air Program. Such events would be handled through other NREA Programs (e.g., Spill Prevention and Response, Storage Tank Management Program, etc.).

10. Records Control

a. Air Program Manager maintains air compliance records via Excel spreadsheet, on available NREA Branch electronic media (i.e. SharePoint and/or Share Drive). A separate ODS equipment database is also maintained by NREA Branch. This database documents all ODS containing equipment, ODS recycling/recovery equipment, and ODS gas cylinders on deck at MCBQ.

b. Personnel must maintain records of all their formal training at their work location/facility.

c. Extensive recordkeeping requirements are included in the conditions of MCBQ's permits. Refer to MCBQ's Title V permit and NSR permit for explicit recordkeeping requirements for each type of emissions source.

11. Sampling, Monitoring, Measuring and Reporting Requirements

a. Most non-tactical government vehicles must have an emissions test every two years to ensure factory installed emission control equipment is functional. Certain overweight, antique, or alternative fuel vehicles may be exempt from emissions testing requirements. Typically, emissions testing is coordinated through the Fleet Manager. An annual report is required to demonstrate the compliance status of the Base.

b. All personal vehicles must also be tested in accordance with Virginia local emissions testing requirements. The ARP is responsible for coordinating the confirmation of those tests with the vehicle registration office on MCBQ, and maintaining records of compliance.

b. The Base is classified as a major source and therefore subject to the monitoring and reporting requirements of Title V of the CAA and the associated permits.

c. ODS are monitored and reported to the APM on a continual basis. HQMC has a reporting requirement for an installation's annual usage of ODS. Personnel authorized to use ODS shall report quantities stored as well as quantities used. Personnel shall also provide

copies of any applicable authorization letters and training records to the APM.

d. Solvent cleaning tanks are required to have quarterly inspections.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO 6240.2A, Air Pollution Episode, Standby Emission Reduction Plan and Open Air Burning Policy, dated 16 July 2010.

(2) MCBQ New Source Review Permit, issued 8 January 2010 and amended 15 February 2012.

(3) MCBQ Virginia Title V Operating Permit, issued 3 September 2003.

b. Reference Documents

(1) 42 USC 85, Air Pollution Prevention and Control, (Clean Air Act of 1970 and subsequent amendments [e.g., 1990]).

(2) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 6 – Air Quality Management, dated W/CH 1-2.

(3) MCBul 5090, Policy Pertaining to ODS, 1-November-1993.

(4) OPNAVISNT 5090.1C, Environmental Readiness Program Manual, Chapter 7 – Clean Air Ashore, dated May 17, 2010.

(5) VAC 5 *et seq.*, Commonwealth Air Pollution Control Board, (Virginia Administrative Code of 1996 and subsequent amendments).

Chapter 3

Hazardous Materials Management Program

1. Requirements. It is USMC policy that commands / installations / activities shall control and manage Hazardous Materials (HM) using methods that minimize the types and quantities of HM procured, stored, distributed, and used to accomplish mission requirements. Compliance with this P2 requirement is critical to USMC efforts to reduce unnecessary risks and costs from excess or expired HM inventories; protect the environment from HM releases; enhance the safety of our military and civilian workforce; and ultimately enhance readiness. The federal laws mandating the management of HM include the Emergency Planning and Community Right-to-Know Act (EPCRA), the Hazard Communication Standard, the Superfund Amendments and Reauthorization Act (SARA), and the P2 Act. These laws require DoD installations to provide data to federal, state, and local agencies on the types and quantities of HM stored, used, and disposed of by those installations.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Authorized use list (AUL). List of approved HM necessary to support the mission requirements of the command, facility, or activity.

b. Cradle-to-grave. Full life accountability for HM and Hazardous Waste (HW), i.e., tracking from purchase to final use and disposal.

c. HM. Material that, because of its quantity, concentration, or physical or chemical characteristics, may pose a real hazard to human health or the environment.

d. Hazardous Material Management System (HMMS)/Hazardous Substance Management System (HSMS). Software developed to track HM and/or HW from pre-acquisition, receipt, labeling, and storage through usage.

4. Program Overview

a. To effectively manage HM and HW located aboard MCBQ from "cradle-to-grave," a Hazardous Materials Management Program (HMMP) has been implemented. The HMMP establishes P2 measures to eliminate/minimize environmental costs, minimize procurement of HM, and reduce the generation of pollution from operations, through the tracking HM procurment, store, use, and disposed of by MCBQ.

b. This process has recently been improved through the use of the electronic tracking system, HMMS. This system will reduce the amount of HM procured and used, reduce the amount of subsequent HW generated by up-front HM control in procurement, and minimize environmental impacts.

5. Program Roles and Responsibilities. Refer to MCBO 6280.4 for program roles and responsibilities for Commanding Generals, Commanding Officers and Division Directors, GF Division, Safety Division, ROICC, PWB, NREA Branch, Security Battalion and Fire Prevention and Protection Branch.

6. Training Requirements. The following training requirements exist for personnel who are involved in the management or handling of HM as part of their regular job duties:

a. Hazardous Communication Training

b. General Awareness/Familiarization Training

c. Function-Specific Training

d. Safety Training

e. Emergency Response Training

f. Security Awareness Training

g. Occupational Safety and Health Administration (OSHA) and EPA Training (Refer to the CETEP Manual for great detail)

7. Communications. The NREA Branch, HM Program Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies delegated the authority to implement EPCRA, Hazard Communication Standard, SARA, or P2. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The HM Program Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the HM Program are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The HM Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. In-depth practice controls are provided in MCBO 6280.4 and are available electronically for downloading through the MCBQ website (http://www.quantico.usmc.mil/directives.aspx?Command=MCBQ).

c. All other HM Program operational controls, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Practices performed at MCBQ that could result in potential emergency situations associated with the HM Program are managed through the Base's Integrated Spill Management Plan (ISMP) by the Spill Prevention and Response Program (refer to Chapter 10).

10. Records Control

a. All HM records are maintained electronically through HMMS/HSMS, the automated information management system for tracking hazardous substances. HMMS/HSMS is a powerful software tool used for HM tracking, and providing data for compliance reporting. The data records are maintained on a standalone server, backed up weekly.

b. Host and tenant command ECs must ensure that they or their shop and work center personnel provide a HM Usage Report to the HMMS Manager on a monthly basis.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. As mentioned under Records Control of this chapter, ECs must ensure that a HM Usage Report is provided to the HMMS Manager on a monthly basis. To complete this report, they or their staff must perform an inventory of all HM they possess.

b. Data relating to HM usage is transmitted, as needed, to the APM, personnel preparing the Base's EPCRA report, and other Program Managers. As described above, this data is required for reporting to various regulatory agencies.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO 6280.4, Hazardous Materials Management Program.

(2) MCBO P5100.1C, MCBQ Safety and Occupational Health Program.

(3) MCBO P11320.1, Fire Protection/Prevention Program.

b. Reference Documents

(1) 14 USC 11001, *et seq.,* Emergency Planning and Community Right-to-Know Act.

(2) 42 USC 133, *et seq.,* Pollution Prevention Act of 1990.

(3) 29 CFR 1900.1200, Hazard Communication.

(4) 49 CFR 173.2, Hazardous material classes and index to hazard class definitions.

(5) EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management.

(6) Marine Corps Bulletin, Marine Corps Policy for the Reuse of Hazardous Materials.

(7) Marine Corps Bulletin, Marine Corps Policy for Installation Hazardous Material Authorized Use Lists.

(8) Marine Corps Bulletin, Marine Corps Policy for the Submission of Installation Material Safety Data Sheets (MSDSs) to the Hazardous Materials Information Resource System (HMIRS)

(9) MCO 4450.12A, Storage and Handling of Hazardous Materials.

(10) MCO P5090.2A, Environmental Protection and Compliance Manual, Chapter 15 – Pollution Prevention.

(11) National Fire Protection Association Standards.

Chapter 4

Hazardous Waste Program

1. Requirements. MCBQ is a large quantity generator (LQG) of hazardous waste (HW). Many practices that are common to MCBQ generate different types of hazardous waste streams. These waste streams are classified, managed, and disposed of per meeting one or more of four characteristics that determines if a waste is hazardous for proper disposal. The characteristics are ignitability, corrosivity, reactivity, and toxicity. Generator knowledge and laboratory analysis is used when determining these factors. The Hazardous Waste Program was developed and implemented to, but not limited to, following and implementing the "cradle to the grave" concept in tracking of hazardous wastes from the generator (e.g., producer of a hazardous waste steam) through ultimate disposal. This includes managing, tracking, and enforcing environmental compliance with all local, state, and federal environmental laws in accordance with MCO P5090.2A, Chapter 9, and Quantico's Hazardous Waste Management Plan (HWMP), which establishes procedures to achieve and maintain regulatory compliance with the RCRA, Title 40, Code of Federal Regulation (CFR), Protection of Environment; Title 49 CFR, Transportation; and Virginia Administrative Code, 9 VAC 20-60-10 et seq.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this Hazardous Waste (HW) Program. A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Environmental Coordinator (EC). Personnel appointed as the command point of contact for matters involving all environmental issues or concerns to include management of HW and Universal Waste (UW) sites/operations in compliance with all federal, state, and local environmental laws.

b. Less than (<) 90-day Accumulation Site. Area designated at or near a waste-generation point where waste is stored before being shipped off-site for disposal. Full containers of HW removed from Satellite Accumulation Areas (SAAs) may be relocated here.

c. Hazardous Waste. Liquids, solids, gases, or sludge's that may pose a threat to human health and the environment.

d. Hazardous Waste Site Manager (HWSM). Personnel designated as responsible for managing hazardous waste sites (<90-day, SAA, and/or UW) at the organization level (also referred to as a practice owner through EMS).

d. Large Quantity Generator (LQG). A facility that creates 2,200 pounds (lbs) or more of HW or more than 2.2 lbs of acute HW per calendar month.

e. Acute HW. Any waste listed under 40 CFR 261.31 through 261.33(d) with a hazard code of H. These include USEPA Hazardous waste numbers: F020, F021, F022, F023, F026, and F027 and the P listed wastes (40 CFR 261.31 through 261.33).

f. Manifest. Document that captures, tracks, and records off-site shipment information and ultimate disposal of HW.

g. Satellite Accumulation Area (SAA). Area designated at or near a waste-generation point that may not accumulate more than 55 gallons of hazardous waste or one quart of acute hazardous waste.

h. Universal Waste. A category of waste that is not designated as HW, but is widely generated and must be prevented from unrestricted release into the environment (e.g., batteries, pesticides, mercury-containing equipment, and bulbs/lamps).

4. Program Overview

a. The MCBQ HWMP provides guidance to all personnel on the accumulation, storage, management, transportation, and disposal of HW(s) generated during normal daily operations and special activities (e.g., construction or renovation projects). The HW Program accomplishes its goals through an effective combination of compliance inspections, assistance visits, and training for responsible parties.

b. The Installation is categorized as a LQG and is composed of five < 90-day Storage Sites, 10 SAAs, and 13 UW Sites. NREA provides a waste pick up service to remove waste from all generating commands/units and tenant organizations for final disposal by off-site authorized transport contracted services. The three types of accumulation/storage sites have varying requirements which are described below:

(1) < 90-day storage sites require containers to be properly labeled, in good condition, compatible with waste being stored, kept closed when not in use, and have adequate isle space. The facility must have fire, spill, and eye wash working equipment to include a communication or alarm system that is available. < 90 day sites are authorized to store multiple waste streams and amounts and must be inspected weekly. Waste shall be removed/picked up from unit sites within 10 days by NREA HW/UW pickup service and transported to the NREA < 90 site, located at the HW Warehouse, which acts as a consolidated pick-up/drop-off location for removal from the Base.

(2) SAAs have the same container requirements as the < 90 day sites, but are only authorized to store waste in quantities not to exceed 55 gallons or one quart of acute HW in total. Containers are to

be labeled with the container's contents and the accumulation start date. When the container is full it must be moved to a < 90-day storage site within three days.

(3) UW Sites are set aside for the accumulation and storage of UW (e.g., batteries, lamps, pesticides, and mercury containing equipment). Waste(s) shall be stored in containers that are compatible with the waste being stored and must be structurally sound. Containers are opened only when adding or removing waste and appropriately labeled with the container's contents and accumulation start date. UW should not be stored more than 180 days.

c. Personnel who manage hazardous waste sites (e.g., < 90-day and SAAs) are not authorized to transport HW containers throughout the base. NREA HW Program employees are the only authorized personnel to pick up and transport HW from accumulation and storage areas for final delivery and disposal. If a command/unit or tenant organization has a full container of HW, they must contact NREA to schedule a HW pick-up.

d. There are specific provisions regarding the off-base transport and ultimate disposal of HW generated at MCBQ. First, waste must be characterized using an approved method (e.g., generator knowledge, sample laboratory testing, etc.). Second, the waste must be transported by a certified HW handler with a properly completed manifest form. At least three days prior to shipment, HW Program personnel shall be provided a manifest, waste profile sheet, land disposal restriction (LDR) sheet, and all other waste characterization/analysis documents for review. Only trained authorized HW Program employees may sign HW manifest to be shipped/transported off-site. Personnel responsible for coordinating off-site shipment must provide the NREA HW Program with a copy of the signed manifest from the Treatment/Storage/Disposal Facility (TSDF) within 30 days of off-site shipment. A Manifest Standard Operating Procedure (SOP) is provided in the HWMP.

e. HW sites must have appropriate spill control equipment (absorbent pads, secondary containment, dry sweep, etc.) located at or near HW accumulation points. If a spill or discharge occurs, immediately notify the MCBQ Fire Department (911) and HW Program personnel (784-4030). Sites should be equipped with a contingency plan which addresses local HW personnel and necessary immediate actions. The contingency plan should also contain a site diagram with HW location(s) and evacuation routes. The EC, HW Site Managers (HWSM), and HW Handlers (HWH) and all other personnel as necessary, shall be trained and knowledgeable in the procedures contained within the contingency plan.

5. Program Roles and Responsibilities. All program roles and responsibilities of the Commanding Officers/Supervisors of Marine Corps Commands/Units and Tenants, NREA Environmental Compliance (via the HW Program Manager), ECs, are listed in the HWMP.

6. Training Requirements. Training for personnel involved in the management of HW sites is divided into three categories: Initial Training, Refresher Training, and On-The-Job Training.

a. Initial Training

(1) RCRA HW training (24-hour) – 90-day sites.

(2) SAAs.

(3) UW Training.

(4) HW Program personnel - RCRA Training (24-hour), Department of Transportation HM Transport (Manifests) Training, and OSHA Limited Site Worker Training (24-hour).

b. Refresher Training

(1) RCRA HW Refresher (8-hour) - 90-day sites.

(2) SAA Refresher.

(3) UW Training Refresher.

(4) HW Program personnel - RCRA Training Refresher, Department of Transportation HM Transport (Manifests) Training Refresher (every 3 years), and OSHA Limited Site Worker Training Refresher (8-hour).

c. On-the-job training relating to the duties of all HW management personnel must be approved and documented by the EC Supervisor, HW Program Manager, and MCBQ CETEP Coordinator.

7. Communications. The NREA Branch, HW Program Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies as further described in the MCBQ HWMP. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The HW Program Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the HW Program are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be “significant” based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ’s EMS

to mitigate the risk of impact(s). The HW Program Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Thorough operational controls are provided within MCBQ's HWMP.

c. All other HW Program operational controls, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Practices performed at MCBQ that could result in potential emergency situations associated with the HW Program are managed through the Base's Integrated Spill Management Plan (ISMP), Core Plan, and by the Spill Prevention and Response Program (refer to Chapter 10). For further guidance, refer to the MCBQ ISMP and MCBQ HWMP.

10. Records Control. Generally, HW regulations require that records (e.g., inspection logs/checklists, spill reports, and training records) are maintained for at least three years. The HW Program also maintains records for the following items: deficiency notices (i.e., notice of violations), corrective action reports, HW inventories, waste turn-in forms, HW characterization, and HW off-site shipping manifest and disposal logs. Paper and electronic records are maintained in the Environmental Compliance Section, NREA Branch office. For additional guidance concerning MCBQ HW Program records, please refer to the MCBQ HWMP.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. The HW Program is responsible for profiling unidentified waste prior to disposal. Furthermore, all HW must be quantified and reported in accordance with all federal and state regulations as specified in the MCBQ HWMP.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBQ Hazardous Waste Management Plan.

(2) MCBO 5280.1B, Handling, Transfer, and Disposal of Hazardous Materials and Hazardous Waste.

(3) Standard Operating Procedure for Management of Hazardous Waste.

(4) EPA ID Number VA1170024722.

b. Reference Documents

(1) 42 USC 6901 *et seq.*, Resource Conservation and Recovery Act.

(2) 49 USC 5101 *et seq.*, Hazardous Materials Transportation Act.

(3) 40 CFR 260 *et seq.*, Hazardous Waste Management.

(4) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 9 – Hazardous Waste Management.

Chapter 5

Integrated Solid Waste Management

1. Requirements. MCBQ has implemented an Integrated Solid Waste Management Program (ISWMP) to manage solid waste disposal and reduce waste streams in accordance with the requirements established in: 40 CFR Parts 239 through 259; Virginia Administrative Code, 9 VAC 20-60-10 et seq.; MCO P5090.2A, Chapter 17, and other associated federal regulations, orders, and mandates. The ISWM Program also incorporates the Qualified Recycling Program (QRP) in accordance with: DoDI 4715.4, Pollution Prevention; Office of the Under Secretary of Defense (OUSD) Memorandum of 24 Apr 2003, Qualified Recycling Program Guidance; OUSD Memorandum of February 1, 2008, DoD Integrated (Non-Hazardous) Solid Waste Management Policy and associated federal regulations, orders, and mandates.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through the ISWMP. A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Integrated Solid Waste Management (ISWM). A comprehensive approach to managing non-hazardous solid waste that encompasses waste prevention, diversion, composting, and other methods of disposal. Through ISWM, the U.S. Department of Defense (DoD) components seek to determine the most cost effective, energy-efficient, and least-polluting means to manage installation or facility solid waste streams.

b. Qualified Recycling Program (QRP). An organized recycling program that requires diversion or recovery of recyclable materials from the non-hazardous solid waste stream. QRP proceeds are distributed in accordance with 10 U.S.C. 2577, Disposal of Recyclable Materials.

c. QRP Committee. A committee established by the Commander, Marine Corps Base Quantico (MCBQ) for the purpose of prioritizing projects and activities to be funded from net recycling proceeds. The committee recommends priorities for the disbursement of revenues to the Commander.

d. Recycling. A series of activities, including collection, separation, and processing, by which products or other materials are recovered from the solid waste stream for use in the form of raw materials in the manufacture of new products other than fuel for producing heat or power by combustion.

e. Diversion (Solid Waste). An activity to remove solid waste from landfill disposal or incineration that includes: reuse, donation, recycling, and composting/mulching. Diversion activities must be in accordance with all applicable DoD, DoD Components, federal, state, and local requirements. Waste to energy recovery is not considered diversion for the solid waste diversion goal; although it is applicable to the energy reduction goals of EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management.

f. Source Reduction. Effecting changes in the design, manufacturing, purchase, or use of materials or products (including packaging) in order to reduce the amount or toxicity before they are discarded.

4. Program Overview

a. Non-hazardous solid waste streams at MCBQ are grouped into one of four areas:

(1) Residential. Residential waste from housing units consisting of food packaging materials, beverage containers, boxes, plastic/aluminum wrapping materials and miscellaneous paper/plastic waste products.

(2) Administrative. Waste from office and administrative areas consisting of mixed paper, printer cartridges, beverage containers, and cardboard.

(3) Industrial. Waste from support activities such as vehicle/equipment maintenance facilities and warehouse facilities.

(4) Construction and Demolition Debris. Waste from construction, demolition, or renovation projects.

b. Waste minimization, diversion, and reduction are conducted according to the category/area described above. Specific methods are discussed below:

(1) Residential recycling is managed by Lincoln Military Housing. Solid waste from these housing facilities is collected by a contractor and disposed of in off-base landfills.

(2) Traditional recycling services for approximately 70 buildings are currently provided by a NAVFAC Washington Contract. As a result of a successful single stream recycling (SSR) pilot conducted at the MCBQ Headquarters and at the NREA Branch, SSR is being implemented at 12 buildings as part of a phased approach to Base-wide implementation of SSR.

(3) Waste streams at industrial facilities are managed using several methods. The Marine Corps Exchange and Defense Commissary

Agency (DeCA), Quantico has implemented their own cardboard and plastic recycling programs. Sewage sludge from the waste water treatment plant is transported to the King George County Landfill, and is currently being mixed with other materials for use as alternative daily cover. Expended small arms cartridge casings (ESACC) are turned in to the Property Control Office (PCO) MCB-2 Transfer Site by generating activities. The PCO deforms the ESACC and sells it directly for the QRP. Efforts are underway to begin consignment sales of ESACC with Defense Logistics Agency Disposition Services (DLADS). Refer to MCBQ's Solid Waste Management Plan for a more detailed discussion on how nonhazardous solid waste is managed.

(4) Construction and demolition debris (C&D) is typically removed from MCBQ by the contractor who creates the waste. Generators of C&D are required to submit a Construction Waste Management Report to the ISWM Program Manager.

(5) The Base's ISWMP is achieved through the implementation of the MCBQ ISWMP Plan, which provides procedures for managing all non-hazardous wastes generated at MCBQ.

5. Program Roles and Responsibilities

a. The Commander is responsible for implementing ISWM for the purpose of achieving DoD solid waste diversion goals. The DoD ISWM hierarchy of approaches and technologies for managing solid waste to maximize resource conservation and protect the environment is, from highest to lowest: source reduction, reuse, donation, recycling, composting/mulching, incineration for volume reduction with energy recovery, other forms of volume reduction, and landfilling. Since recycling is one of the waste diversion methods employed at MCBQ, the Commander must implement source separation for recycling and develop a single authorized QRP, if cost-effective. QRP management personnel shall be designated in writing. The Commander may establish a QRP Committee.

b. The ISWM Program Manager is responsible for:

(1) Managing the ISWMP in accordance with all applicable laws, regulations, requirements, and guidance. Develop ISWMP goals for MCBQ. This includes close coordination with MCBQ's EMS staff as well as applicable tenants, commands, and organizations within the fence line.

(2) Recommending performance work statements that include provisions for contractors, including construction and demolition contractors, to conform to ISWMP requirements (i.e., collect and report information required in waste diversion reports).

(3) Develop and maintain an ISWMP Plan that will act as a guidance document for how solid waste will be managed. Pertinent

information will include financial, technical, and environmental operating factors.

(4) Maintain records, submit metrics, and provide reporting data to required personnel/organizations. Acquire necessary training for individuals working in the ISWMP.

(5) Serve as an advisor to the QRP Committee.

(6) Develop an annual QRP Business Plan that outlines the operation of the QRP as part of MCBQ's ISWMP strategy. The Business Plan can also function as MCBQ's commodity feasibility study. Conduct commodity feasibility studies.

(7) Identify and document facilities that participate in the recycling program. Identify what recycling method works best for participating facilities, be it: recycling bins, collection buildings, scheduled recycling pick-ups, etc. Establish collection guidelines at different areas of MCBQ (e.g., office, industrial, retail, and housing areas) and source separation criteria.

(8) Provide awareness training to individuals participating in the QRP. Acquire necessary training for individuals working in the QRP.

(9) Oversee QRP and Recycling Center operations, management, recordkeeping, and general accountability in accordance with Section 17104(5) of MCO P5090.2A.

(10) Maintain oversight for sales of recyclable materials and ensure that excluded materials are not sold in compliance with 32 CFR 172.

c. Contracting Officer Representatives at MCBQ are responsible for inserting language into Request for Proposals and Scope of Work (SOWs) that require contractors to adhere to the requirements of MCBQ's ISWMP. This includes that Construction Waste Management Reports are submitted to the ISWMP Manager, making solid waste data required as part of the contract SOW, and requirements to meet or exceed DoD solid waste diversion goals.

d. Tenant activities and other organizations not under the direct command of MCBQ are responsible for participating in the ISWMP and the QRP and providing required data to the ISWMP Manager.

e. The DeCA, Quantico and Marine Corps Exchange are responsible for reporting ISWMP data to the ISWMP Manager for annual reporting purposes.

6. Training Requirements

a. Collection personnel are required to have awareness training on collection/handling of spent munitions (e.g., used cartridge casings) and recyclable HM (e.g., lead-acid batteries).

b. The ISWM Program Manager must have Ammunition Explosives and Dangerous Articles training to ensure incorrect materials are not inadvertently sold to vendors.

c. QRP personnel must also have a mandatory training program that describes, at a minimum, applicable regulations and laws; identification of items that can be processed through the QRP; and identification of items that cannot be processed through the QRP.

d. The ISWMP Manager is also responsible for financial accounting, records management, and the QRP. Recommended formal educational programs are: The U.S. Army Corps of Engineers online course, QRP/Ordnance and Explosives Recognition and Safety, Control Number 844, and the Air Force Institute of Technology resident course, WENV 160 QRP Management.

e. All training records must be maintained at MCBQ by the personnel who received the training. Copies shall be provided to their organization's EC.

7. Communications. The ISWMP Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The ISWMP Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination and ISWMP Plans for greater detail concerning ISWMP communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this chapter, practices performed at MCBQ that are associated with the ISWMP are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The ISWMP Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. All other ISWMP operational controls are documented through MCBQ's ISWMP Plan and other regulatory requirements and mandates referenced in paragraph 12 of this chapter.

9. Emergencies. No practices performed at MCBQ could have potential emergency situations associated with the ISWMP. Such events would be handled through other NREA Programs (e.g., Spill Prevention and Response, Storage Tank Management , etc.).

10. Records Control

a. The following records are required for MCBQ's QRP:

(1) Sales records of qualified scrap by direct sales and sales through DLADS.

(2) Expense records for operating and overhead costs.

(3) Records of incomes and expenditures.

(4) Records of cost avoidance.

(5) Records of profit distributions.

b. For MCBQ's ISWM Program, records are maintained in order to identify the amount of solid waste diverted from landfills and solid waste transported to landfills. These records may be located in multiple locations, including the P2ADS report filed by the NREA Branch, Environmental Compliance Section as well as any records related to sale/reuse of brass and items turned into DLADS.

c. Refer to the ISWMP Plan for greater detail concerning procedures to meet ISWMP record keeping requirements.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Non-hazardous solid waste data is entered into a U.S. Navy website. The website used at the time this ECPSOP was prepared is Environmental Portal (EPRPortal): https://eprportal.cnic.navy.mil.

b. The NAVFAC Engineering Service Center sends out the Solid Waste Annual Data Call with instruction contained in the EPRPortal Solid Waste Module User Guide. The ISWMP Manager is responsible for submitting MCBQ's nonhazardous solid waste data.

12. Pertinent Documents

a. Operational Control Documents. Solid Waste Management Plan, MCBQ, Virginia, December 2009.

b. Reference Documents

(1) EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management, of January 24, 2007.

(2) EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance, of October 5, 2009.

(3) 10 USC 2577, Disposal of Recyclable Materials, of January 7, 2011.

(4) 42 USC 13101 & 13102, Pollution Prevention Act of 1990, of November 5, 1990.

(5) 32 CFR 172, Disposition of Proceeds from DoD Sales of Surplus Personal Property, July 1, 2009.

(6) DoDI 4715.4, Pollution Prevention, June 1996.

(7) OUSD(E) Memorandum of 24 Apr 2003, Qualified Recycling Program Guidance.

(8) OUSD(I&E) Memorandum of February 1, 2008, DoD Integrated (Non-Hazardous) Solid Waste Management Policy.

(9) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 3 – Funding Environmental Compliance, May 2009.

(10) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 15 – Pollution Prevention, May 2009.

(11) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 17 – Solid Waste Management and Resource Recovery, May 2009.

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Chapter 6

Pesticide Management Program

1. Requirements. Federal and state regulations, require proper storage and handling of pesticides per Title 40 CFR 150 -189 and 2 VAC 20-40-10 et seq., respectively. Proper procedures and certifications are also mandated for personnel conducting pest management operations. MCBQ is a large installation with improved and unimproved lands, developed building and family housing areas, and includes a golf course and other recreational facilities. Pests on MCBQ may be animal or plant in nature and can occur inside or outside of buildings. The Pest Management Program exists to ensure mission operational capability for the Installation. This includes training areas and ranges, buildings, turf, and food services and storage.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through the Integrated Pest Management (IPM) Program. A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Algicides. An agent used to destroy or inhibit the growth of algae.

b. Avicides. An agent used to kill or repel birds.

c. Fungicides. An agent used to destroy or inhibit growth of fungi.

d. Herbicides. An agent used to destroy or inhibit plant growth.

e. Insecticides. An agent used to destroy insects.

f. Integrated Pest Management (IPM). A planned program, incorporating continuous monitoring, education, recordkeeping, and communication to prevent pests and disease vectors from causing unacceptable damage to operations, people, property, material, or the environment. IPM uses targeted, sustainable, (effective, economical, and environmentally sound) methods, including education, habitat modification, biological control, genetic control, cultural control, mechanical control, physical control, regulatory control, and where necessary, the judicious use of least-hazardous pesticides.

g. Larvicides. Insecticide that is specifically targeted against the larval life stage of an insect.

h. Pest. Unwanted organisms (e.g., fungi, rodents, birds) that cause adverse impacts to the mission of MCBQ and affect the health and well-being of humans and protected species.

i. Pesticide. Any substance or combinations of substances used to mitigate and control pests (i.e., unwanted plant/animal species) that are labeled for use by the EPA.

4. Program Overview. The MCBQ IPM Program is applicable to all activities and tenant commands within the boundary of MCBQ. The program governs all aspects of pest management, including application of algicides, avicides, fungicides, herbicides, insecticides and larvicides, as well as other IPM techniques that do not require the use of pesticides for control of pests. Primarily, control of pest species is accomplished through contracted services. There are some facilities that are approved to apply their own pest control substances (e.g., Medal of Honor Golf Course, NREA Branch, the Crossroads Inn, and the Commissary). For greater detail concerning the IPMP, please refer to the MCBQ IPM Plan (IPMP).

5. Program Roles and Responsibilities

a. The Commander has primary responsibility for implementing a comprehensive pest management program for the Installation. The Commander will be accountable for installation-level responsibilities and has delegated authority to the Hazardous Materials Management Program (HMMP) Manager, NREA Branch for implementing the Installation’s Pest Management Plan.

b. The NREA Branch Head is responsible for:

(1) Overall management and implementation of the MCBQ Pest Management Program.

(2) Appointing a Base Integrated Pesticide Management Coordinator (IPMC); this role is currently held by the HMMP Manager, NREA Branch.

c. The IPMC acts as the single point of contact for pest management issues on MCBQ, as further specified in the MCBQ IPMP.

d. PWB is responsible for:

(1) Contract administration in order to implement the MCBQ Pest Management Program.

(2) Scheduling contracted pest management services.

(3) Providing oversight and inspection of contractor pesticide application operations.

e. Pesticide applicators must fully comply with label requirements in all phases of pesticide application, including storing, mixing, application, disposal and use of all safety precautions and personal protective equipment.

f. Contractors performing pesticide application or other operations must provide the IPMC with copies of certification(s) appropriate with the materials/methods being used.

6. Training Requirements

a. Applicable personnel described under 40 CFR 171.1 include those responsible for storage, mixing, and application of restricted-use pesticides. These personnel shall receive training in accordance with 40 CFR 171.4(a), (b), and (c), including comprehension of material labeling. Trained personnel must demonstrate their knowledge of safe pest control and pesticide application.

b. Facility Support Contract Section personnel, who will inspect contractor pesticide application operations, must complete Contract Surveillance Representative Training. There are two phases to this training: Quality Assurance Evaluator Training and Pest Control Quality Assurance Training; both are conducted periodically by NAVFAC Atlantic. It is recommended that these personnel also complete a Pest Management Correspondence Course, which may be obtained through the Navy Public Works Training Center or NAVFAC Atlantic.

c. Personnel whose primary responsibility is the application of pest management tools (i.e., pesticide applicators) must undergo comprehensive training which includes two years of on-the-job training, correspondence courses, and training in basic pest control technology. Refer to the IPMP for more information on training requirements for Certified Pesticide Applicators. Initial certification is available through courses offered by the Navy Disease Vector Ecology and Control Center two times a year; refresher training is required every three years thereafter.

7. Communications. The NREA Branch, IPMC acts as the liaison for general correspondence between MCBQ and the regulatory agencies as further described in the MCBQ IPMP. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The IPMC uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this chapter, practices performed at MCBQ that are associated with the IPMP are listed in Table A-1, Appendix A. Of those practices, a standardized risk

ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The IPMC reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For detailed IPM procedures, refer to the MCBQ IPMP. All other IPM operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. No practices performed at MCBQ could have potential emergency situations associated with the IPMP. Such events would be handled through other NREA Programs (e.g., Spill Prevention and Response, Storage Tank Management, etc.).

10. Records Control

a. DoD installations are required to maintain complete daily records of pesticide applications and non-chemical pest management operations using DD Form 1532-1 or the computer-generated equivalent. These records shall account for all shop operations and shall provide a historical record of pest management operations and pesticide applications for each building, structure, or outdoor site.

b. These records are maintained by the originating command and Installation IPMC. Records must be maintained permanently, but can be archived after two years.

c. Logs of specific pesticide applications must be maintained and made available to the Virginia Department of Agriculture and Consumer Services upon request.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Records pertaining to pest surveillance, pesticide applications and all non-chemical pest control operations are required to be reported in the electronic Navy Online Pesticide Reporting System (NOPRS). All contractors, tenant commands, and Base personnel must report pest management operations in this system.

(1) Records should be input into the system on a daily basis as soon as treatments are completed, to ensure that application information is not lost.

(2) In instances where pesticide applications are very minimal and computer access to NOPRS unavailable, the Base IPMC can input records, provided that all required application information is provided in hard copy format. Hard copy forms for reporting pesticide applications can be obtained by contacting the IPMC.

(3) For MCBQ pest management shops that have not yet been provided access to NOPRS, hard copies must be completed, maintained and submitted monthly to the IPMC, who shall provide copies to NAVFAC Atlantic.

(4) Pest management records reported in NOPRS do not need to be sent to NAVFAC Atlantic, Applied Biology, since they have access to these records.

b. The IPMC shall monitor reported applications in the NOPRS system to ensure that they are submitted correctly and timely.

C. The IPMC shall ensure that all personnel applying pesticides on MCBQ are provided access to report pest management records in the NOPRS system.

12. Pertinent Documents

a. Operational Control Documents. MCBQ Integrated Pest Management Plan.

b. Reference Documents

(1) 7 USC 136, *et seq.*, Federal Insecticide, Fungicide, and Rodenticide Act.

(2) 7 USC 2801, *et seq.*, Federal Noxious Weed Act.

(3) 15 USC 2601, *et seq.*, Toxic Substances Control Act (TSCA).

(4) 40 CFR 150-189, Federal Insecticide, Fungicide, and Rodenticide Act/Pesticide Programs.

(5) 2 VAC 20, *et seq.*, Pesticide Control Board.

(6) DoDI 4150.7, Department of Defense Pest Management Program.

(7) OPNAVINST 6250.4, Pest Management Programs.

(8) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 14 – Pesticide Pollution Prevention and Appendix F – Integrated Pest Management Plans.

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Chapter 7

Munitions Response Program (RCRA)

1. Requirements. In 1992, the Federal Facility Compliance Act was signed into law. This law required the U.S. Environmental Protection Agency (EPA), in consultation with DoD and the States, to publish regulations that identify when conventional and chemical military munitions become hazardous waste and subject to Subtitle C of RCRA, and that provide for the safe storage and transportation of such waste. These regulations, entitled the Military Munitions Rule (MR) (62 FR 6621, February 12, 1997), that define when military munitions become waste and how these waste military munitions (WMM) will be managed, became effective at the federal level on August 12, 1997. Any WMM from an active range shall be managed in accordance with the DoD Policy to Implement the EPA's Military Munitions Rule of July 1998. Furthermore, if munitions are classified as a waste there are additional state requirements VHWMR under 9 VAC-20-60 that must also be implemented as described in the MCBQ HWMP.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this RCRA Munitions Response Program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Discarded Military Munitions (DMM). Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. Does not apply to UXO or military munitions planned for future use or disposal or military munitions that have been properly disposed.

b. Military Constituents (MCs). Any material(s) originating from unexploded ordnance (UXO), DMM, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

c. Munitions and Explosives of Concern (MEC). Military munitions that are classified as UXO, DMM, or MCs present in high enough concentrations to pose an explosive hazard.

d. Unexploded Ordnance (UXO). Military munitions that: have been primed, fused, armed, or otherwise prepared for action; have been fired, dropped, launched, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and remain unexploded either by malfunction, design, or any other cause.

4. Program Overview. This program addresses DMM, MC, MEC, and/or UXO that have been classified as a hazardous waste by MCBQ Explosive Ordinance Disposal (EOD) and are associated with activities of an

active range. Any DMM, MC, MEC, and/or UXO associated with activities at closed ranges are managed by the Munitions Response Program (MRP) through the CERCLA process, as described in Chapter 22.

5. Program Roles and Responsibilities

a. MCBQ EOD is required to:

(1) Maintain an archive of munitions response activities.

(2) When dispatched EOD assumes the situation requires an immediate response unless they are advised otherwise, from an explosive safety standpoint. Upon evaluation of an explosives or munitions emergency, the EOD emergency response specialists may determine that:

(a) An immediate response is required. In this situation, the MR's immediate response exemption from RCRA applies.

(b) An immediate response is not required, but the situation poses an imminent and substantial risk to human health or the environment. In this situation the MR's immediate response exemption from RCRA may not apply. The responder should consult with the MCBQ NREA Branch.

(c) An emergency response is not required. In these situations, continued support by the EOD emergency response specialists may not be required and the item may not be a WMM. The munitions should be:

1. Evaluated further for return to the active inventory.

2. Handled through the Designated Disposition Authority (DDA) disposition process (see Chapter 6 of the DoD Policy to Implement the EPA's Military Munitions Rule), if applicable.

3. Processed through the host installation environmental office for WMM disposal, if applicable.

(3) Requirements for RCRA Compliance. EPA's objectives in clarifying the applicability of RCRA to emergency responses were to remove regulatory impediments to emergency responses and promote the safe and prompt management of emergencies that involved explosives and munitions. RCRA rules exempt emergency responses from permit requirements in two ways. The distinctions between the two are based on the emergency response specialist's determination as to the action required to control or eliminate the actual or potential threat to human health, public safety, or property. These distinctions are:

(a) Immediate Responses (Level 1):

1. DoD policy is that only EOD and Technical Escort Unit (TEU) personnel conduct Level 1 responses.

2. EPA established exemptions from RCRA generator, transporter, and permitting (to include emergency permits) requirements during the "immediate response" to an explosives or munitions emergency. This exemption allows emergency response specialists to take whatever action is necessary to control or eliminate the immediate threat. Such actions include the movement (transport) of an item to a safer location for defusing, detonation, or the performance of render-safe procedures. The EOD emergency response specialist is the only authority that can determine when a Level 1 response is terminated.

3. EPA guidance as to what constitutes an immediate response (Level 1) is limited. DoD's position is that these include responses to situations where military munitions that are not properly secured or under DoD control potentially threaten human health, the environment, or property. DoD’s intent is that EOD personnel will use established procedures and good judgment to determine whether a situation requires a Level 1 response.

4. Reasonable Delays. When extenuating circumstances (e.g., adverse weather, nightfall, safety, etc.) delay actions necessary to terminate an explosives or munitions emergency, the response may be delayed until the necessary action can be completed. EOD personnel must ensure the explosives or munitions are in a safe and secure environment. If time permits or as agreed upon in a Memoranda of Understanding (MOU), the EOD will consult with the NREA Branch, which will consult with the appropriate federal, state, or local environmental agency regarding permitting requirements.

5. Once the EOD determines the Level 1 response is over, remaining WMM, if any, must be managed in compliance with RCRA regulations or an emergency permit. In these situations, EOD support may no longer be required or the EOD personnel may be performing operations outside of their emergency response mission.

6. Prior coordination with local authorities and regulators, regulator familiarization training, use of an MOU (Appendix B), and establishment of ground rules for such responses will minimize controversies arising during or after emergency responses.

(b) Imminent and Substantial Endangerment Responses (Level 2):

1. EPA did not fully exempt from RCRA regulation those situations that do not require an "immediate response" but that pose an "imminent and substantial endangerment to human health and the environment." EOD personnel must determine whether the response action can be delayed without compromising safety or increasing the risk long enough to obtain an emergency permit. When the response action can be delayed, the EOD personnel should consult with NREA Branch, which will consult with the appropriate State and Federal regulatory authorities.

2. When EOD support is not required during a Level 2 response, qualified personnel such as quality assurance specialists (ammuniton surveillance) (QASAS), weapons officers, ammunition handlers, and trained and certified DoD contractors may conduct Level 2 responses on DoD installations, or as directed.

3. In Level 2 responses, EPA or the state may issue a temporary emergency permit that allows a response that is not in compliance with normal RCRA requirements.

a. When requesting an emergency permit, the following information, as a minimum, should be provided: 1.) Type of military munitions (hazardous waste) involved, to the extent known; 2.) manner and location of proposed disposal, treatment, or storage; and 3.) the manner in which the military munitions (waste) will be transported to another site, if required.

b. Environmental agencies normally issue such permits telephonically. The regulator is responsible for providing a written emergency permit within five days. The requesting installation is required to have the written permit as part of its emergency response records. To ensure appropriate documentation, the installation should submit a written follow-up to its telephonic emergency permit request and include this request in its records.

c. Procedures for obtaining emergency permits should be included in all MOU's with the regulating authority.

d. When a response involving non-military munitions or explosives requires an emergency permit, the civilian authority requesting EOD support is responsible for requesting the permit.

(4) Provide explosives safety oversight, respond to EOD calls, review explosive mishap reports and EOD incident reports.

(5) Provide verification that final response actions were completed in accordance with approved safety documentation.

b. NREA Branch, Hazardous Waste Program Manager.

(1) Responsible for maintaining and reporting records of MCBQ EOD declaring and disposing of any DMM, MC, MEC, and/or UXO as a hazardous waste.

(2) Responsible for coordinating with VA DEQ if an Emergency Permit is required for disposal of DMM, MC, MEC, and/or UXO as a hazardous waste.

6. Training Requirements. All personnel involved in the handling of WMM receive training in all applicable aspects of RCRA regulation, the requirements of both the MR and State regulations, and all applicable DoD guidance. These training requirements are further specified in the DoD Policy to Implement the EPA's Military Munitions Rule, dated 1 July 1998.

7. Communication

a. MCBQ EOD personnel are responsible for providing the NREA Branch, HWMP Manager all records of DMM, MC, MEC, and/or UXO that are disposed of as hazardous waste.

b. The NREA Branch, HWMP Manager is responsible for coordinating with VA DEQ if an Emergency Permit is required for disposal of DMM, MC, MEC, and/or UXO as a hazardous waste. For further information concerning communication with environmental regulatory agencies concerning this topic, refer to the MCBQ HWMP.

c. The NREA Branch, HWMP Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the MRP (RCRA) are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The NREA Branch, HWMP Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For detailed Munitions Response Program (RCRA) Procedures, refer to the MCBQ HWMP and DoD Policy to Implement the EPA's Military Munitions Rule, dated 1 July 1998.

c. All other Munitions Response Program (RCRA) operational controls, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Emergency procedures concerning DMM, MC, MEC, and/or UXO are provided in chapter nine of the DoD Policy to Implement the EPA's Military Munitions Rule, dated 1 July 1998. For emergency procedures concerning hazardous materials or waste, refer to the MCBQ ISMP.

10. Records Control

a. Range Control Office maintains all records of operational range use and military munitions expenditures. Required information also includes any UXO clearance operations as well as coordinates of all known, or suspected, UXO areas must also be maintained.

b. EOD maintains call sheets for all emergency responses (UXO and non-UXO). These records must be maintained indefinitely.

c. The NREA Branch, HWMP Manager maintains records and manifests for all DMM, MC, MEC, and/or UXO disposed of as a hazardous waste.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Prior to any in-ground remediation of munitions, an Explosives Safety Submission must be provided to and authorized by Marine Corps Systems Command (MARCORSYSCOM).

b. Following completion of remediation activities, an after action report must be submitted to MARCORSYSCOM for endorsement.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBQ HWMP Plan, 2013.

(2) MCBQ ISMP, 2009.

b. Reference Documents

(1) 9 VAC 20-60 *et seq.*, Virginia Hazardous Waste Management Regulations.

(2) 40 CFR 266, Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Systems – Subpart M, Military Munitions.

(3) 42 USC 6901, *et seq.*, Resource Conservation and Recovery Act.

(4) DoD Policy to Implement the EPA's Military Munitions Rule, dated 1 July 1998.

(5) Navy Environmental Restoration Program Manual.

(6) OPNAVINST 5090.1C, Navy Environmental and Natural Resources Program Manual, Chapter 29 - Munitions Response.

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Chapter 8

Polychlorinated Biphenyl (PCB) Management

1. Requirements. PCBs are a persistent organic pollutant with known toxic properties. They are present in dielectric fluids which are used in several types of electrical and mechanical equipment. The EPA has banned the general use of PCBs unless otherwise stated in 40 CFR 761.30. Federal laws exist to prevent unwarranted exposure to PCB-containing materials and also govern disposal of such PCB-containing materials located within the Installation's boundary. These laws and regulations include: 15 USC 2601 *et seq.*, the Toxic Substances Control Act (TSCA) of 1976; 42 USC 6901 *et seq.*, RCRA; 42 USC 9601 *et seq.*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended; and 40 CFR 761 *et seq.*, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions. Chapter 19 – Polychlorinated Biphenyls Management, of MCO P5090.2A establishes the Marine Corps policy and responsibilities for compliance with regulatory requirements for managing PCBs. MCBQ's PCB Management Program exists to protect personnel and the environment during use, handling, storage, and disposal of PCBs and PCB-containing equipment.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this PCB Management Program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Light Ballast. A component of a fluorescent light fixture used for starting and regulating electric current.

b. Polychlorinated biphenyl (PCB). Anthropogenic organic chemicals formerly used in a variety of industrial applications due to their low reactive nature.

c. PCB Container. Any package, can, bottle, bag, barrel, drum, tank, or other device that contains PCB's or PCB articles and whose surface(s) have been in direct contact with PCB's.

d. PCP Equipment. Any manufactured item, other than a PCB container, or a PCB article container which contains a PCB article or other PCB equipment. This includes microwave ovens, electronic equipment, and fluorescent light ballasts and fixtures.

e. PCB Transformer. Any transformer that contains 500 parts per million (ppm) or greater of PCBs.

4. Program Overview

a. The USMC has enacted a policy where "all future procurement of transformers or any other equipment containing dielectric or hydraulic fluid must be accompanied by a manufacturer's certification that the equipment contains no detectable PCBs or that equipment contains less than two (2) parts per million (ppm) at the time of shipment. Affix labels to such newly procured transformers and equipment that they are non-PCB containing equipment."

b. Reinstallation of PCB-containing items is prohibited. These items must be permanently removed from the Base and disposed according to proper guidelines.

c. Existing PCB-containing items, and any new ones discovered, must be registered with the MCBQ Fire Department and any off-base fire department(s) that may respond in the event of an emergency.

d. Items which contain PCBs must be marked or labeled in accordance with 40 CFR 761.40. This includes:

(1) A disclaimer that the labeled piece of equipment contains PCBs and requires special handling in accordance with the EPA, and

(2) The phone numbers for the United States Coast Guard (USCG) National Response Center ([800] 424.8802) and any applicable local contacts (e.g., PCB Program Manager).

e. Light ballasts manufactured up to 1979 may contain PCBs. The EPA banned production of PCB-containing light ballasts after 1979. When determining if your light ballast contains PCB materials, remember to check for the label "No PCBs." If a ballast is located that predates 1979, and is not labeled, contact the NREA Branch at (703) 784-4030. A good rule of thumb is to assume all non-labeled ballasts contain PCB's.

5. Program Roles and Responsibilities

a. The Commander is responsible for implementing a PCB Management Program. These duties have been delegated to the NREA Branch, GF Installation and Environment Division

b. The NREA Branch is responsible for ensuring there are no active PCB containers, equipment, or transformers. Active PCB containers, equipment, or transformers are accurately catalogued, tracked, and if necessary, removed. Periodically, the NREA Branch may conduct a survey for PCB-containing items. If PCB items are generated, stored, treated, or disposed, the NREA Branch must prepare and submit a report of these items to the Naval Facilities Engineering Service Center, pertinent Naval Facilities Engineering Command (NAVFAC) Field Division/Activity, and Commandant of the Marine Corps, Facilities and Services Division (CMC (LF)).

c. Installation and contractor personnel who are working aboard MCBQ should:

(1) Report unlabeled equipment to the NREA Branch that is suspected of containing PCBs.

(2) Notify emergency personnel of a suspected PCB spill.

(3) Notify the NREA Branch of any suspected PCB-containing light ballasts. Turn in PCB-containing materials at designated sites.

6. Training Requirements. General environmental awareness training (to include discharge reporting) is required for anyone who manages or interacts with PCB-containing items. Personnel who oversee the PCB Management Program must also have hazardous material and hazardous waste training (refer to Chapters 3 and 4). Personnel must also be adequately trained so that they can accurately mark inventory, and inspect PCB-containing items.

7. Communications. The NREA Branch, PCB Program Manager (also the HM Program Manager at the time this document was prepared) acts as the liaison for general correspondence between MCBQ and the regulatory agencies. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The PCB Program Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the program's communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this chapter, practices performed at MCBQ that are associated with the PCB Program are listed in Table A-1, Appendix A. Of those practices, the EMS Coordinator, as described in Chapter 21 performs a standardized risk ranking procedure. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The PCB Program Manager reviews all Draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. All other PCB Program operational controls, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Practices performed at MCBQ that could result in potential emergency situations associated with the PCB Program are managed through the Base's Integrated Spill Management Plan (ISMP) by the Spill Prevention and Response Program (refer to Chapter 10).

10. Records Control

a. Any inspection, maintenance action, or repair to PCB-containing equipment (in use or storage) must be maintained for three years after the piece of equipment has been disposed of.

b. If the Installation maintains at least 45 kilograms (99.4 pounds) of PCB's; one or more PCB transformer; or 50 or more PCB capacitors, annual records (including signed manifests and disposal records) and an annual log of PCB waste disposal (completed prior to July 1 for the previous year) must be maintained. These records must be maintained for three years after the Installation has been certified PCB-free.

(1) The written document log must contain the following information:

(a) Name, address, and EPA identification number of the facility and the calendar year covered by the annual document log.

(b) Manifest number of every manifest generated by the facility during the calendar year.

(c) Total number by specific type of PCB articles, PCB article containers, PCB containers, PCB transformers, and any PCB's and PCB items in PCB containers.

(d) Total weight in kilograms of PCB's in PCB article containers and PCB transformers, total weight in kilograms of contents of PCB containers, PCB article containers, and total weight of Large High Voltage Capacitors or Large Low Voltage Capacitors PCB capacitors remaining in service at the facility at the end of the calendar year.

c. A phone log (or other form of verification) for each telephone call to confirm receipt of PCB's transported by an independent transporter.

d. Training records of all personnel involved in managing PCB-containing items must be kept on hand. These records are located in the NREA Branch office.

e. Records are maintained by the Environmental Compliance Section, NREA Branch. Paper records are stored in Compliance Section file cabinets while electronic records are stored on the NREA Branch file server.

f. MCBQ has been certified as PCB-free for over five years at the time this document was prepared. However, procedures are discussed in this chapter to ensure mitigation steps are understood should an unaccounted PCB source be discovered.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Immediately notify the PCB Program Manager if a leak is observed from a piece of equipment that is suspected of containing PCB-materials.

b. A One Year Exception Report must be submitted to the EPA Regional Administrator if one of the following conditions is met:

(1) The generator has not received a certificate of disposal within 13 months from the date of removal from service.

(2) The generator receives a certificate of disposal for a disposal date more than 1 year after the date of removal from service.

12. Pertinent Documents

a. Operational Control Documents. There are no additional operational control documents in place at MCBQ because MCBQ has been certified as "PCB free".

b. Reference Documents

(1) 15 USC 2601 *et seq.*, The Toxic Substances Control Act (TSCA) of 1976.

(2) 42 USC 6901 *et seq.*, The Resource Conservation and Recovery Act (RCRA) of 1976.

(3) 42 USC 9601 *et seq.*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended.

(4) CFR 761 *et seq.*, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

(5) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 19 – Polychlorinated Biphenyls Management.

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Chapter 9

Radon Monitoring and Abatement

1. Requirements. As uranium that is situated in soil and rock decays, it releases colorless and odorless radon gas into the environment, which can migrate into buildings through cracks or holes in the foundations. Radon can be found in all types of structures (e.g., schools, homes, offices, warehouses). Exposure to high levels of radon has been linked to cancer, but fortunately, this risk is easily mitigated through radon reduction systems or incorporating radon-resistant construction methods. The requirement for radon testing and monitoring in federal government buildings was promulgated under TSCA. As part of the DoN, the USMC has implemented the Navy Radon Assessment and Mitigation Program (NAVRAMP).

2. Practices. Potential and actual environmental impacts from practices performed at MCBQ are mitigated through this Radon Monitoring and Abatement Program. A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Building. Housing and non-housing structure.

b. Gap Testing. Method to account for the difference between previous inventory of tested structures and current inventory of structures.

c. Modified Structure. A building significantly altered by either changing the original number or type of windows, doors, ground slabs, walls, or otherwise making modifications in any manner to significantly change the air exchange or flow within the building.

d. NAVRAMP. United States Navy’s (USN’s) tool to identify, mitigate, and prevent radon build-up in DoN and USMC buildings.

e. Occupied Buildings. A building with continuous human presence for more than 4 hours per day.

f. Radon. Radon is a commonly occurring radioactive, noble gas, formed during the decay of uranium.

g. Radon Mitigation System. Techniques employed to prevent radon from entering a building or reduce radon levels inside a building.

4. Program Overview

a. MCBQ’s Radon Monitoring and Abatement Program is implemented as a joint effort between the following Installation activities:

(1) PWB, GF Installation and Environment Division;

(2) NREA Branch, GF Installation and Environment Division;

(3) NHC Quantico;

(4) Safety Division;

(5) Department of Defense Education Activity (DoDEA), and;

(6) Lincoln Military Housing - Public Private Venture (PPV).

b. These activities work together to ensure all occupied structures aboard MCBQ have radon levels below the action level of 4 picocuries per liter of air (4 pCi/L). MCBQ activities, with the exception of Lincoln Military Housing - PPV, utilize the NAVRAMP as their guidance for radon prevention and mitigation.

c. The NAVRAMP is applicable to all occupied buildings aboard MCBQ and requires radon testing for all newly constructed buildings, as well as buildings that have undergone significant renovations and can be considered "modified structures." As previously discussed, Lincoln Military Housing - PPV is exempt from jurisdiction of the NAVRAMP; however, the Lincoln Military Housing - PPV has conducted radon testing of all housing structures and mitigated any high concentrations below the action level. Lincoln Military Housing – PPV conducts annual radon testing and provides all residents with a Radon Disclosure and a copy of the U.S. Environmental Protection Agency's (EPA's) *A Citizen's Guide to Radon*. In addition, any resident who suspects radon infiltration within their home can contact Lincoln Military Housing - PPV and request testing be conducted.

5. Program Roles and Responsibilities. There are several Installation activities that function within the Radon Monitoring and Abatement Program. Their responsibilities are described as follows:

a. The Commander is responsible for ensuring a Radon Monitoring and Abatement Program exists. The Commander has delegated operational control of the Program to several Installation activities.

b. Lincoln Military Housing - PPV.

(1) Performs annual monitoring of all installed radon mitigation systems;

(2) Performs radon testing, as requested, for housing tenants;

(3) Forwards testing data to NHC Quantico, and;

(4) Maintains testing results/records, records of methods of radon mitigation, and locations of active mitigation.

c. Safety Division Representative(s).

(1) Reviews requests for proposals and associated contracts issued for new construction or renovations to ensure correct safety language is incorporated, and;

(2) Ensures that contractors performing radon-related tasks have obtained appropriate training.

d. PWB, GF Installation and Environment Division

(1) Conducts radon testing, mitigation, and monitoring (if applicable) for all USMC-owned buildings aboard MCBQ;

(2) Ensures requirements are inserted in contract documents, for new construction or renovations, which requires builder to conduct radon testing once construction is complete;

(3) Conducts gap testing of facilities which have been constructed or undergone significant renovations since MCBQ's original radon assessment, and;

(4) Provides testing and monitoring results to NHC Quantico.

e. NHC Quantico's Industrial Hygienists

(1) Receipt of radon testing/monitoring results;

(2) Interpretation of test results (i.e., determining which structures/areas must mitigate radon concentrations), and;

(3) Forward all testing/monitoring records to the NREA Branch;

f. NREA Branch, GF Installation and Environment Division, Radon Monitoring and Abatement Program

(1) Receipt and storage, with the exception of Lincoln Military Housing - PPV, of all radon testing, mitigation, and monitoring data;

(2) Verify that radon management is accurately addressed in future NEPA documentation, and;

(3) Perform site investigations to ensure regular monitoring or mitigation are being conducted at required buildings.

6. Training Requirements

a. Contractor personnel involved with the installation of radon-resistant materials and general radon abatement are responsible for training their own personnel.

b. Other personnel should be provided with general awareness training.

7. Communications

a. The NREA Branch, Radon Monitoring and Abatement Program Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The Radon Program Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the program's communication procedures.

b. Required radon testing after the completion of renovation or new construction projects is relayed to the project proponents through the NEPA process. Project proponents are required to acknowledge the requirement by countersigning the final NEPA decision document. Additionally, Requests for Proposals (RFPs) and Scopes of Work (SOWs) are reviewed for pertinent radon testing language. The NEPA mitigation program ensures that the testing is performed in accordance with OPNAVINST 5090.1B CH-1 through post-NEPA review checks.

8. Practice Control

a. As mentioned in paragraph 2 of this chapter, practices performed at MCBQ that are associated with the Radon Monitoring and Abatement Program are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Radon Program Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For further information concerning the NAVRAMP, refer to NAVINST 5090.1C, Environmental and Natural Resources Program Manual.

c. All other Radon Program operational controls, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. No potential emergency situations are anticipated with this program. If radon concentrations exceed the EPA action level of 4 pCi/L, interim steps, such as ventilating the building (open windows and doors) on a regular basis, should be taken to mitigate until a radon abatement system is installed. Contact the Radon Monitoring and Abatement Program Manager at (703) 784 - 4953 or the NHC IH at (703) 784-1674 for additional guidance concerning the

frequency and period a building should be ventilated. Ventilation needs will vary based up the season, concentration of radon, and size and energy efficiency of a building.

10. Records Control

a. Lincoln Military Housing - PPV maintains records of all radon testing, monitoring, and types of mitigation employed for housing areas. They also maintain records describing methods of abatement used during construction or renovation.

b. All other radon testing, monitoring, and abatement/mitigation records are maintained with the NREA Branch. Currently, all records exist in paper files. If records are generated, they are added to the paper file. Electronic files may be used in the future to track areas/buildings where active mitigation measures are employed.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. Radon sampling is required at all newly constructed occupied buildings or modified structures. Continued monitoring and testing is required in structures that have been deemed to contain high levels of radon gas. All radon testing and monitoring, outside of Lincoln Military Housing - PPV, shall be reported to NHC Quantico and the NREA Branch.

12. Pertinent Documents

a. Operational Control Documents. NAVINST 5090.1C, Environmental and Natural Resources Program Manual.

b. Reference Documents

(1) 15 USC 53, Subchapter III, Indoor Radon Abatement.

(2) 40 CFR 195, Radon Proficiency Programs.

(3) Code of Virginia 22.1-138, Minimum Standards for Public School Buildings.

(4) NAVINST 5090.1C, Environmental and Natural Resources Program Manual.

(5) MCO P5090.2A, Environmental Compliance and Protection Manual.

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Chapter 10

Spill Prevention and Response Program

1. Requirements. Marine Corps Base, Quantico uses petroleum, oil, and lubricants (POL) as well as certain hazardous materials (HM) for operational purposes. These substances could result in the generation of hazardous waste (HW). Federal (40 CFR 112) and state (9 VAC 25-91-170, et seq.) regulations require facilities that utilize these materials to maintain and/or implement spill prevention, control, countermeasures and spill response procedures. Therefore, MCBQ must comply with emergency notification and response procedures prescribed in RCRA, CERCLA, and EPCRA.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this Spill Prevention and Response (SPR) Program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Discharge. The accidental or intentional spilling, leaking, pumping, pouring, emitting, emptying, or dumping of POLs, HM, and/or HW into or on any land or water.

b. Incident Commander (IC). The IC is responsible for directing spill response efforts until the event is over or responsibility has been transferred to a higher authority (i.e., the Base Commander).

c. Incident Command System (ICS). A standard incident management organization, with five functional areas, for management of all major incidents: command, operations, planning, logistics, and finance/administration.

d. Regional/Area Contingency Plan. A plan developed for coordinated response and clean-up of a “worst-case” discharge of hazmat(s).

e. Reportable spill. A spill greater than or equal to 25 gallons, the reportable quantity (RQ), or impacts state waters.

f. Threshold Quantity. Level of a spilled hazardous material that is federally required to be reported to the National Response Center.

g. Unified Command Structure (UCS). A large-scale ICS used when regional coordination is required.

4. Program Overview

a. MCBQ complies with the aforementioned regulations through the implementation of a comprehensive SPR Program through MCBQ's Integrated Spill Management Plan (ISMP). The MCBQ ISMP is designed in accordance with the National Response Team's Integrated Contingency Plan Guidance. The objective of this Plan is to describe response protocols to assist in providing coordinated response capability in the event of a release or spill that poses a threat to human health or the environment. The MCBQ ISMP describes the structure and mechanisms for conducting efficient, coordinated, and effective actions that minimize adverse impacts from discharges of POLs and other hazardous substances.

b. The MCBQ ISMP and SPR Program have also been developed to ensure compliance and seamless coordination with the EPA Region 3 Regional Contingency Plan and the USCG Sector Baltimore Area Contingency Plan.

c. MCBQ utilizes the ICS for typical emergency response operations. The IC manages initial emergency response and directs on-scene operations during spills. All initial emergency response and clean-up actions are performed by Facility Response Team personnel. Emergency responsibilities are assigned as part of work requirements and are outlined in the individual's position description. Personnel assigned to emergency response positions are stationed at MCBQ and are required to immediately report to the IC upon notification.

d. The Facility Response Team is primarily composed of members of the MCBQ Fire Department; however, due to manning requirements, first responders may not always comprise the Facility Response Team. Once a situation is under control, the first responders may transfer control of clean-up and recovery to properly trained personnel from MCBQ Fire Department and NREA Branch.

e. In the event of large-scale spills, the Installation may not be able to respond with the appropriate amount of personnel or materials. In situations such as this, the Base Commander assumes a position in the UCS in which he can coordinate resources with federal, regional, and state response organizations.

f. The ICS/UCS command structure is designed to be flexible, allowing MCBQ to tailor the size of this structure to meet the incident needs. Using ICS/ UCS will also enable MCBQ to participate in a seamless unified command with other government agencies when necessary.

5. Program Responsibilities. A full listing of responsibilities is provided in the MCBQ ISMP. A summary is provided as follows:

a. Any person aboard MCBQ who causes or discovers a release of POL or other hazmat has a responsibility to report the release to

proper Base authorities in accordance with Section II, Core Plan, of the MCBQ ISMP (also known as "Emergency Notification and Response Procedures"). If the material can be immediately controlled/contained without endangering human safety, shop personnel should respond with spill control materials to mitigate the release, in accordance with unit level response plans, and then follow published Emergency Notification and Response Procedures in the ISMP to seek further instruction. The ISMP, Spill Reporting Form shall be submitted to the ISMP Program Manager, NREA Branch (784-4030) within 24 hours of the spill. If the release cannot be safely controlled, shop personnel should evacuate the area and immediately contact the MCBQ Fire Department (911).

b. The Duty Fire and Emergency Services Chief is the designated IC, unless relieved by higher authority (i.e., the Base Commander), and will also act as the On-Scene Commander (OSC). The OCS is in charge of the Facility Response Team and remains on-scene until spill response actions are concluded.

c. The Commander of MCBQ is the Area IC in the event of a catastrophic spill or discharge. The Area IC will coordinate with other response agencies/organizations to control an emergency at MCBQ. The Area IC remains in the command post or emergency operations center.

d. The Facility Response Team responds to discharges of POLs, HMs, or HWs within MCBQ. The Facility Response Team also performs spill containment/control and recovery operations when needed.

e. The major responsibilities of the SPR Response Program Manager, NREA Branch include ensuring the MCBQ ISMP is updated whenever there is a major facility change and/or every five years. The SPR Program Manager also performs liaison functions with and required notifications to federal and state regulators, incidental to a release of POL, HM, or HW to the environment.

6. Training Requirements

a. Training required in support of the MCBQ SPR Program is comprehensive and varies widely depending on the material handled and response role. There is also training directed at both the facility level and individual level.

b. Individual-level training shall correspond to a person's level of involvement with POLs, HMs, and HWs. Training can include courses on general spill prevention and response, storm water pollution prevention, and on-the-job training. Responders and members of the Base Spill Response Team should have received the 40 hour Hazardous Waste Operator (HAZWOPER) course training in accordance with 29 CFR 1920.120.

c. Position-specific training may be required for some billets that have a large role in spill and emergency response. These personnel must review the MCBQ ISMP and contact their management, and the CETEP coordinator to determine what specific training is required.

7. Communications. The SPR Program Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies as further described in the MCBQ ISMP. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The SPR Program Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning EMS communication procedures. Refer to the MCBQ ISMP for greater detail in communication procedures concerning the MCBQ Spill Prevention and Response Program.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the MCBQ SPR Program are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The MCBQ SPR Program Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For further information concerning spill prevention and response procedures, please refer to the MCBQ ISMP.

c. All other SPR Program operational controls, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Refer to the MCBQ ISMP for emergency response procedures for a release of POLs, HMs and/or HWs to the environment.

10. Records Control. SPR Program Manager, NREA Branch maintains files on all spills of POLs, HMs, and HWs that occur aboard MCBQ. Records are maintained in accordance with applicable federal and state regulations. Individual units must maintain a record of submitted spill reporting forms in their Environmental Management Operating File. These records must be maintained on-site for five years.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. In accordance with Section II, Core Plan, of the MCBQ ISMP (also known as "Emergency Notification and Response Procedures"). If the spill can be immediately controlled/contained without endangering human safety,

shop personnel should respond with spill control materials to mitigate the release. All spills of POLs ,HMs, and HWs must be reported to the SPR Manager. A phone call is sufficient to report the discharge, but it must be followed by submitting a copy of the ISMP, Spill Reporting Form to the SRP Program Manager within 24 hours of the spill. The Spill Reporting Form is available from NREA and is provided in Section II of MCBQ ISMP. Further reporting may be required and is dependent on the severity of a spill:

a. Within 24 hours, the SPR Program Manager shall notify the VDEQ of any spill that meets or exceeds regulatory requirements for a reportable spill quantity. Within seven days following a reportable spill, the Commander or designated representative submit a written report to the VDEQ describing the circumstances, effects, notifications, response, and mitigation efforts of the incident.

b. A Post Incident Investigation/Discharge Review must be prepared following a reportable spill. Information concerning required elements can be found in the MCBQ ISMP or by contacting the SPR Program Manager, NREA Branch.

12. Pertinent Documents

a. Operational Control Documents. MCBQ ISMP.

b. Reference Documents

(1) 42 USC 9601, *et seq.*, The Comprehensive Environmental Response, Compensation, and Liability Act.

(2) 42 USC 9601, *et seq.*, The Resource Conservation and Recovery Act.

(3) 42 USC 11004-11049, The Emergency Planning and Community Right-to-Know Act.

(4) 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

(5) 40 CFR 112, Oil Pollution Prevention.

(6) 9 VAC 25-91-170, *et seq.*, Commonwealth of Virginia Oil Discharge Contingency Plan.

(7) DoDI 6055.06, DoD Fire and Emergency Service.

(8) National Fire Protection Agency (NFPA) Standard 471, Recommended Practices for Responding to Hazardous Materials Incidents.

(9) NFPA Standard 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents.

(10) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 7 - Emergency Planning and Response.

Chapter 11

Storm Water Management Program

1. Requirements. Storm water discharges have been identified by the EPA as a significant contributor of pollutants to federal and state waterways. Various laws have been enacted to address this issue, most notably the Clean Water Act Amendments (CWAA) of 1987. The CWAA established the National Pollutant Discharge Elimination System (NPDES). The Federal Government has delegated authority for the NPDES to the VDEQ, who then issues permits based on the type of permit required. The MCBQ Comprehensive Storm Water Management Action Plan (SWMAP) identifies and addresses the installation protocol as required by federal and state storm water pollution prevention laws to ensure the health of surrounding waterways. The SWMAP includes MCBQ's Municipal Separate Storm Sewer Systems permit (Virginia Pollution Discharge Elimination System (VPDES) Permit Number VAR040069) and MCBQ's Stormwater Pollution Prevention Plan, and Industrial Stormwater permit (VPDES Permit Number VA0002151).

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this Storm Water Management Program (SWM). A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. "High" categorization. Location has a history of noncompliance or a location in a significant sensitive area with a medium to high amount of outdoor activity that could cause storm water pollution. Inspections are conducted quarterly by the tenant authority and NREA conducts one comprehensive inspection annually.

b. "Low" categorization. No history of noncompliance, very little outdoor activity that could cause storm water pollution, not in a sensitive area. These sites are not covered by the NPDES permit since they do not meet the formal definition of an industrial activity site.

c. "Medium" categorization. No recent history of noncompliance, not in a sensitive area, very little outdoor activity that could cause storm water pollution. Inspections are conducted quarterly by the tenant authority and NREA conducts one comprehensive inspection annually.

d. Storm water. Precipitation and run off attributed to storm events.

e. Comprehensive Storm Water Management Action Plan (SWMAP). Guidance document describing the implementation of MCBQ's Storm Water Management Program. This document replaces the Storm Water Management

Plan, the Source Water Pollution Prevention Plan, and includes Municipal Separate Storm Sewer System (MS4) requirements for program implementation and reporting.

f. Storm Water Pollution Prevention Team (SWPPT). A group composed of ECs from activities and tenant commands that assist in the implementation of the Storm Water Pollution Prevention Plan.

4. Program Overview

a. There are approximately 18 permitted stormwater outfalls located at MCBQ. These outfalls discharge water from various areas and activities, including vehicle maintenance areas, floor drains, miscellaneous industrial activities, and storm water drains. Types of materials that may discharge via storm water include petroleum oils, construction/demolition materials, paints, salts, pesticides/herbicides, and other types of chemicals. Due to the ability of pollutants to contaminate storm water, one of the purposes of the SWMAP is to ensure pollutants do not discharge from these outfalls into the various water bodies surrounding MCBQ.

b. MCBQ is governed under a VPDES Phase I Storm Water Associated with Industrial Activities Permit and a VPDES General Permit for Discharge of Storm Water from a MS4. Each of these permits governs separate portions of MCBQ and includes requirements to reduce and/or eliminate pollutants entering the storm water system.

c. Activities governed under the Storm Water Associated with Industrial Activity Permit are described in the list below. The Permit requires a management plan (i.e., MCBQ SWMAP) to be established in order to govern these activities and ensure the guidelines of the permit are followed.

(1) Aircraft/vehicle maintenance (e.g., washing and fueling).

(2) Outdoor storage of hazardous material(s).

(3) Outdoor storage of hazardous/solid waste(s).

(4) Pesticide, herbicide, and fertilizer application.

(5) Water/wastewater treatment options.

d. Activities governed under the MS4 permit include the following list. To institute the MS4 Permit, Best Management Practices (BMPs) must be established; efforts to implement and operate the BMPs must also be documented. BMPs for each of the following categories are further described in the MCBQ SWMAP.

(1) Personnel education and outreach.

(2) Public participation and involvement.

(3) Illicit discharge detection and elimination.

(4) Construction site runoff control.

(5) Post-construction runoff control.

(6) Pollution prevention and good housekeeping.

5. Program Roles and Responsibilities. An in-depth description of SWM roles and responsibilities is provided in the MCBQ SWMAP. A summary is provided as follows:

a. The Base Commander is responsible for ultimate oversight and implementation of the Installation's SWMAP. The Base Commander has delegated authority for operation of the SWMAP to the Head, Environmental Compliance Section, NREA Branch.

b. The Water Programs Manager is responsible for day-to-day implementation of the Installation's SWMAP. The Water Programs Manager is the point of contact for issues involving the VDEQ. Other responsibilities include:

(1) Coordination with the Resident Officer in Charge of Construction is necessary to ensure all on-base construction/ renovation projects comply with applicable storm water management and pollution prevention regulations and policies.

(2) Acts as Lead for the SWPPT and conducts semi-annual meetings to review/discuss pertinent storm water management issues.

(3) Conducts annual compliance evaluations and performs follow-up visits, if needed.

(4) Provides storm water awareness training to all required sites and updates the Installation SWMAP as needed.

c. PWB is responsible for ensuring all storm water conveyance systems operate properly and must provide repair/maintenance when such systems are inoperable.

d. Members of the SWPPT are tasked with performing the following actions at their respective facilities:

(1) Implementing the provisions of the Installation SWMAP.

(2) Identification of actual and potential sources of pollution.

(3) Conducting quarterly storm water pollution prevention audits at their respective sites.

6. Training Requirements. All appropriate personnel shall receive Storm Water Pollution Prevention Training within 90 days of initial hire or assignment. Annual refresher training must also be obtained. Topics discussed in the training include: education on the components of the Installation's SWMAP and familiarity with BMPs to minimize the occurrence of spills.

7. Communications. The NREA Branch, Waters Program Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies delegated the authority to implement the CWAA and associated water regulations. Official reports and correspondence provided to regulatory agencies require the signature and approval of the NREA Branch Head or Deputy, unless otherwise delegated. The Water Programs Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures. Refer to the MCBQ SWMAP for greater detail concerning SWM communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this chapter, practices performed at MCBQ that are associated with the SWM Program are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Water Programs Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to chapter 21.

b. Refer to the MCBQ SWMAP for greater detail concerning SWM practice controls.

c. Rainwater harvesting systems are not permitted for use at MCBQ unless approved by the GF, PWB, Water Management Program through the NEPA process. Waivers, if provided, are limited to systems that will be used for irrigation purposes or in unique circumstances where controls are in place that would eliminate cross-connection concerns in MCBQ's potable water system (see Chapter 27).

d. All other SWM Program operational controls such as permits, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Practices performed at MCBQ that could result in potential emergency situations associated with the SWM Program are managed through the Base's Integrated Spill Management Plan (ISMP) by the Spill Prevention and Response Program (refer to Chapter 10).

10. Records Control. Specific recordkeeping provisions are documented in MCBQ's storm water permits. A synopsis of requirements is described below:

a. Quarterly visual monitoring inspection reports for permitted outfalls; these are not required to be submitted to VDEQ unless directed.

b. Quantitative sampling results for permitted outfalls; these must be submitted to VDEQ along with the Installation's Discharge Monitoring Report (DMR).

c. Annual comprehensive site evaluation; this is not required to be submitted to VDEQ unless directed.

d. Periodic area site inspections; these are not required to be submitted to VDEQ unless directed.

e. Meeting minutes recorded during the SWPPT meetings will be filed at the NREA office and maintained indefinitely.

f. Storm water training records are to be maintained by the Water Programs Manager and personnel receiving training.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Regular inspections for storm water compliance are conducted across the entire Installation. Inspections are a method to identify possible sources of pollution and enact a means of prevention before they pose a risk by discharging into surrounding waters bodies. Areas are ranked based on their potential for contamination or history of past contamination and inspected accordingly.

b. All industrial sites are visually inspected for storm water compliance on an annual basis. For areas categorized as "High" ranked areas, a mandatory Comprehensive Site Compliance Evaluation must be conducted. Sites categorized as "medium" shall perform quarterly internal audits.

c. Additional inspections include BMP inspections and dry weather inspections. BMP inspections ensure that SWMAP BMPs are being implemented and followed. Dry weather inspections are conducted every few years to determine potential illicit discharges.

d. Two types of monitoring are required by conditions in the Installations storm water permits. Detailed information regarding specific outfalls and monitoring conditions are contained in the Installation's SWMAP.

(1) Quantitative Monitoring. Various outfalls require monitoring in accordance with EPA's analytical laboratory test

methods. Results of monitoring are sent to VDEQ on a monthly basis with the DMR.

(2) Qualitative Monitoring. Each permitted storm water outfall must undergo at least quarterly visual inspections.

e. An annual report is submitted to VDEQ containing the Installation's progress meeting BMPs, any new BMPs planned for implementation, monitoring data, and outfall characterizations. This information is recorded and reported using a commercially available database product. Any additional reporting provisions will be described in the Installation's storm water permits.

12. Pertinent Documents

a. Operational Control Documents

(1) Marine Corps Base Order 6280.1B, Handling, Transfer, and Disposal of Hazardous Materials and Hazardous Waste.

(2) MCBQ SWMAP.

(a) MCBQ's Municipal Separate Storm Sewer Systems permit,(VPDES Permit Number VAR040069.

(b) MCBQ's Industrial Stormwater permit, VPDES Permit Number VA0002151.

(c) MCBQ's Stormwater Pollution Prevention Plan

(3) MCBQ Backflow Prevention Plan

b. Reference Documents

(1) 33 USC 1251, *et seq.*, The Clean Water Act.

(2) 33 USC 2701, *et seq.*, The Oil Pollution Act.

(3) 4 VAC 50-30, *et seq.*, Virginia Erosion and Sediment Control Regulation.

(4) 4 VAC 50-60, *et seq.*, Virginia Stormwater Management Program Permit Regulations.

(5) 9 VAC 25-151, *et seq.*, VPDES Permit for Discharges of Storm Water Associated with Industrial Activity.

(6) 10.1 Code of Virginia 561, *et seq.*, Virginia Erosion and Sediment Control Program.

(7) 10.1 Code of Virginia 603, *et seq.*, Virginia Stormwater Management Law.

(8) 10.1 Code of Virginia 2100, ***et seq.***, Chesapeake Bay Preservation Act.

(9) 62.1 Code of Virginia 44.2-44.34, Commonwealth Water Control Law.

(10) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 20 – Water Quality Management.

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Chapter 12

Storage Tank Management

1. Requirements. MCBQ uses storage tanks for containing POLs, and other HMs. Federal and state regulations govern the storage of these substances or materials when contained in tanks that exceed applicable threshold capacities. MCBQ implements a Storage Tank Management Plan which addresses not only regulatory compliance, but also prescribes maintenance and related best management practices that eliminate or minimize the occurrence(s) of spills or releases from tanks and other types of containers. The Storage Tank Management Plan satisfies the provisions of Chapter 18, MCO P5090.2A (W/CH 1-2), which dictates compliance with federal and state underground storage tank regulations. The Plan also satisfies the provisions of federal and state regulations that govern aboveground storage tanks (ASTs) and other related containers.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this Storage Tank Management Program (STMP). A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Aboveground Storage Tank (AST). A fixed container that stores, or contains, hazardous materials (including POLs) and is on or less than 10 percent of it is in the ground. Under Federal Oil Spill Prevention Regulations (40 CFR 112), an AST is regulated if it is greater than, or equal to 55 gallons in capacity. Under the state AST Regulations (9 VAC 25-91-10), an AST is regulated if it is greater than, or equal to 660 gallons in capacity. Exemptions to AST requirements described in this chapter are found in federal regulation 40 CFR 112.1(d) and Commonwealth of Virginia regulation 9 VAC 25-91-30.

b. Underground Storage Tank (UST). A fixed container that stores, or contains, hazardous materials (including POLs) and where the volume of the container is at least 10% below ground level. USTs are regulated under Federal UST Technical Standards (40 CFR 280). USTs are also regulated under Commonwealth of Virginia UST Regulations (9 VAC 25-180-10)

c. Class A Underground Storage Tank (UST) Operator. Class A operator has primary responsibility to operate and maintain the underground storage tank system. The Class A operator's responsibilities include managing resources and personnel, such as establishing work assignments, to achieve and maintain compliance with regulatory requirements.

d. Class B UST Operator. Class B operator implements applicable underground storage tank regulatory requirements and standards in the field. This individual implements day-to-day aspects of operating, maintaining, and recordkeeping for underground storage tanks at one or more facilities.

e. Class C UST Operator. Class C operator is an employee and is, generally, the first line of response to events indicating emergency conditions. This individual is responsible for responding to alarms or other indications of emergencies caused by spills or releases from underground storage tank systems. This individual notifies the Class B or Class A operator and appropriate emergency responders when necessary.

f. Petroleum, Oil, and Lubricant (POL). A common acronym that describes all types of petroleum-based liquids (e.g., gasoline, diesel fuel, jet fuel, motor oil, cooking oil, etc.). ASTs and USTs are commonly used to store POLs; other storage containers include drums and totes.

4. Program Overview

a. The STMP is an important component of the ISMP in effectively managing hazardous substances (including POLs) at MCBQ. MCBQ's STMP addresses compliance requirements and inspection frequencies of storage containers, while other NREA Branch programs manage substances stored within those containers. For example, management of used oil is conducted by the Hazardous Waste Program and management of new motor oils is conducted by the Hazardous Materials Program. Refer to Chapter 3 for a discussion of the Hazardous Materials Management Program and Chapter 4 for a discussion of the Hazardous Waste Management Program. Management of prefabricated ASTs, field-constructed ASTs, and USTs are all addressed by MCBQ's Tank Management Program. A three tier approach to storage tank management is utilized at MCBQ.

b. The first tier is tank owners/operators at the shop or organization level. These are individuals tasked with conducting regular recurring inspections (i.e., daily, weekly, and/or monthly) as well as notifying the MCBQ STMP Manager, their organization's EC, and FMS of any tank deficiencies, recommended repairs, or necessary corrective actions. Examples of shop or organizational tanks include, but are not limited to: waste oil tanks at vehicle maintenance shops, fuel tanks at the Marine Corps Exchange, and chemical storage tanks at the Sewage Treatment Plant.

c. The second tier is the EC. They may act as tank owners/operators in the event that a designated owner/operator is out or unable to fulfill their duties. If this is the case, ECs must receive requisite tank training as described in Paragraph 4. The primary responsibility of the EC is to act as a liaison between the

MCBQ STMP Manager and organizational tank owners/operators. ECs ensure their organization is implementing NREA guidance to meet regulatory requirements and help report deficiencies and work requests in a timely manner.

d. The third tier is the MCBQ STMP Manager, who ensures overall compliance with federal and state regulations, Navy and Marine Corps policies and order. The MCBQ Storage Tank Program Manager is also the point of contact for all storage tank related matters aboard the Installation. The Storage Tank Manager coordinates design, installation, maintenance, closure, and replacement of storage tank systems with organizations who own or operate tanks aboard MCBQ. On a routine basis, the Storage Tank Program Manager performs unannounced inspections or site visits to organizational users to ensure tank requirements are satisfied and records are maintained.

e. The fourth tier, G-4 Logistics Division and GF Installation and Environment Division, have certain tank maintenance requirements as further specified in the STMP Plan.

5. Program Roles and Responsibilities

a. The MCBQ STMP Manager is responsible for:

(1) Maintaining an accurate inventory of ASTs and USTs. Registration of tanks with Virginia’s Department of Environmental Quality.

(2) Reviewing storage tank installation or construction drawings for engineering adequacy and regulatory compliance.

(3) Coordination of applicable testing requirements for regulated storage tank systems.

(4) Oversight and management of corrective actions resulting from compliance assessments of storage tank systems.

(5) Oversight on AST or UST tank installations to ensure compliance with the regulations and conformance with adopted industry standards.

b. The Hazardous Materials Program is responsible for management of hazardous materials containers that are less than 55 gallons in capacity. The Hazardous Materials Program also manages the acquisition of new drums of hazardous material (including drums). Refer to Chapter 3, Hazardous Materials Management Program, for more information.

c. The Hazardous Waste Program is responsible for management and disposal of hazardous wastes stored in ASTs. The Hazardous Waste Program also performs inspection of storage containers at Satellite

Accumulation Areas throughout MCBQ. Refer to Chapter 4 Hazardous Waste Management Program, for more information.

d. ECs liaison between tank owners/operators and the MCBQ Tank Program Manager. ECs may act as tank owners/operators on an as needed basis. ECs distribute, and help implement, policies and directives from the NREA. They are also responsible for ensuring personnel within their organization attend necessary training described in Paragraph 6.

e. Tank owners/operators are responsible for:

(1) Performing regular, recurring inspections of AST and UST systems in accordance with federal, state, and Marine Corps requirements. Refer to Paragraph 11 for more information on inspection frequencies.

(2) Managing the upkeep of AST and UST systems; requesting maintenance support and submitting work orders if tank systems are in need.

6. Training Requirements

a. ECs are required to attend an AST or UST training seminar as appropriate per the type of storage tank(s) located within their organization. Tank owners/operators are also required to attend this class in order to understand the inspection and recordkeeping requirements for their storage tank. ECs will coordinate tank owner/operator attendance with the MCBQ Storage Tank Manager.

b. ECs and tank owners/operators must attend annual Oil Spill Handling and Discharge Prevention Briefings in accordance with 40 CFR 112 (Oil Spill Prevention) and MCBQ's Integrated Spill Management Plan. The MCBQ CETEP Coordinator provides these classes on a monthly basis. ECs will coordinate tank owner/operator attendance with the MCBQ CETEP Coordinator.

c. In accordance with the Energy Policy Act of 2005, operators of UST systems are required to attend UST Operator Training and be trained to either Class A, Class B, or Class C level. Each UST system must have a Class A, Class B, and Class C operator designated. Refer to Paragraph 3 for definitions of each operator class.

d. ECs will brief the tank owners/operators within their command on applicable ESOPs (e.g., ESOP #11 – Fuel Storage-Aboveground Storage Tanks). Tank owners/operators will sign and date the ESOP signifying they have been trained.

7. Communications. The STMP Manager acts as the liaison for general correspondence between MCBQ and the regulatory agencies as further described in the MCBQ STMP Plan. Official reports and correspondence provided to regulatory agencies require the signature and approval of

the NREA Branch Head or Deputy, unless otherwise delegated. The STMP Manager uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning EMS communication procedures. Refer to the MCBQ STMP Plan for greater detail in communication procedures concerning the MCBQ STMP.

8. Practice Control

a. As mentioned in Paragraph 2 of this chapter, practices performed at MCBQ that are associated with the MCBQ STMP are listed in Table A-1, Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The MCBQ STMP Manager reviews all applicable draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For further information concerning spill prevention and response procedures, please refer to the MCBQ STMP Plan.

c. All other STMP operational controls such as permits, regulatory requirements, and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Refer to the Spill Prevention, Control and Countermeasure Plan (SPCC) section of the MCBQ ISMP (described in Chapter 10) for emergency response procedures for a release of fuels, POL(s), HM and HW to the environment.

10. Records Control

a. The MCBQ STMP Manager maintains records of all AST and UST training courses provided to MCBQ personnel. Certificates are also distributed to personnel who complete AST and UST storage tank training. Records of Oil Spill Handling and Discharge Prevention Briefings are maintained by the MCBQ CETEP Coordinator; copies are provided to the organization EC as well as tank owner/operators. Records of ESOP briefings are maintained by the EC. Copies of all AST/UST training certificates and Oil Spill Handling and Discharge Prevention Briefings must be maintained in the organization's EC Turnover Folder. ECs must also maintain records of completed ESOP training in their turnover folder. Records must be maintained as long as personnel are on-site and performing their job duties.

b. For ASTs, regular inspections (i.e., daily, weekly, monthly, or annual) will be maintained by the tank owner/operator. Records of any repairs or upgrades to the AST system will also be maintained by the owning organization and the organization completing the repair

(e.g., FMS). These records will be kept for no shorter than five years and will be available to the NREA upon request.

c. For USTs, inspection, maintenance and performance records will be maintained for leak detection and corrosion protection systems (i.e., cathodic protection). Records will be maintained for all repairs or upgrades to the UST system. In accordance with 9 VAC 25-580-40, Permitting and Inspection Requirements for all UST systems, inspections of repairs, upgrades, and/or closure will be conducted as well. These records will be maintained by the tank owner/operator. Records of UST closure must be maintained by the MCBQ Tank Program Manager. All records will be kept for no shorter than three years.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Inspections. ASTs and USTs are required to undergo regular inspections in order to prevent leaks and ensure equipment functions properly. The type of inspection varies with the type and size of tanks, but could include daily, weekly, and monthly inspections and also formal internal and external inspections as dictated by industry standards (e.g., Steel Tank Institute). The MCBQ contains a full listing of storage tanks, as well as the required inspection frequency. Refer to Annex 8, Section 8.9.1 of the MCBQ ISMP for additional information.

b. Tank Registration

(1) Unless specifically exempted under 9 VAC 25-91-30, MCBQ is required to register all ASTs that are 660 gallons (1,320 liters) or larger with VDEQ. Information that is provided to VDEQ includes: owner information, facility information, tank information, and owner certification of information.

(2) Under 9 VAC 25-580-70, MCBQ is required to submit UST registration packets for regulated USTs that are brought into operational use. Information on the ownership, tank status, tank/piping systems, substance(s) stored, installation certifications (if required), and financial responsibility documentation must be provided to VDEQ. Tank operators must coordinate with the MCBQ STMP Manager to ensure correct UST registration is accomplished. Notification of UST closure must be conducted within 30 days prior to initiation of closure work.

c. Spills of regulated hazardous materials, either from ASTs or USTs, must be promptly reported to the VDEQ. The STMP Manager will handle reporting of all spills. Refer to Chapter 10, Spill Prevention and Response for more information relating to control and mitigation of spilled hazardous materials.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO 5090.7, Oil and Hazardous Substances Spill Contingency Plan, 09 October 1998.

(2) MCBQ Integrated Spill Management Plan.

(3) STMP Plan.

b. Reference Documents

(1) 40 CFR 112, Oil Pollution Prevention.

(2) 40 CFR 280, Technical and Corrective Action Requirements for Owner and Operators of USTs.

(3) 40 CFR 281, Approval of Commonwealth Underground Storage Tank Programs.

(4) 40 CFR 282, Approved Underground Storage Tank Programs.

(5) 9 VAC 25-91-10 *et seq.*, Facility and Aboveground Storage Tank Regulation.

(6) 9 VAC 25-580-10 *et seq.*, Underground Storage Tank; Technical Standards and Corrective Action Requirements.

(7) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 18 – Underground Storage Tanks.

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Chapter 13

Waste Water Management Program

1. Requirements. The Clean Water Act (CWA) was enacted to control pollutant discharges from various sources (e.g., industrial, agricultural, construction, etc.) into federal and state waters. As required by MCO P5090.2A, MCBQ must comply with all provisions of the CWA and ensure that no discharge is released outside of compliance standards. The Waste Water Management Program (WWMP) exists to satisfy the requirements of the CWA and ensure MCBQ maintains compliance with applicable regulations.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1 of Appendix A.

3. Definitions

a. Discharge. Addition of any pollutant or combination of pollutants to waters of the United States from any point source.

b. Outfall. A discharge point for waste water or storm water runoff into a body of water.

c. Permit. Authorization, license, or equivalent control document issued by the EPA or VDEQ allowing discharge(s) into federal or state waters.

d. Sewage Treatment Plant (STP). Industrial facility designed to remove contaminants from waste water generated in buildings and shops within MCBQ.

4. Program Overview

a. MCBQ is divided into four geographic areas and one septic area of wastewater coverage: three are maintained by MCBQ and two by contracts for offsite wastewater treatment. The four geographical waste water areas are:

(1) Mainside. Waste water originating from the Mainside Zone is directed to an STP with advanced waste water treatment capabilities and a treatment capacity of 2.2 million gallons per day (MGD). The STP is permitted to discharge to two outfalls (VA0028363 and VAN010043). To move waste water from their point of origin to the STP, MCBQ utilizes 32 active sewer pumping stations. Operations for the Mainside waste water zone are maintained by PWB, Facilities Maintenance Section (FMS).

(2) Camp Upshur. Waste water originating from facilities located at Camp Upshur is directed to an STP with a treatment capacity of 40,000 gallons per day (GPD). The Camp Upshur STP is permitted to discharge to one outfall (VA0028371). There are three pump stations located at Camp Upshur to move waste water from their point of origin to the STP. Operations for the Camp Upshur waste water zone are maintained by PWB/FMS.

(3) West Side. There is one 750,000 GPD pump station located in the West Side zone that directs waste water to Stafford County via a pretreatment permit (STFRD-003). Stafford County operates and maintains the pump station. There are an additional 12 pump stations to move waste water from the point of origin to the pump station. Operations of the pump stations are maintained by PWB/FMS. PWB/ Facilities Management coordinates any necessary permitting.

(4) The National Museum of the Marine Corps (NMMC). Waste water originating from the NMMC Campus is directed offsite via gravity flow to the Prince William County zone. All operation and maintenance is handled by the NMMC Base Operations Support Service (BOSS) contractor while PWB, Facilities Support Contracting Section provides oversight of the BOSS contractor.

(5) The remaining areas of MCBQ not covered by waste water treatment systems are equipped with septic tanks. A large portion of West Side used to be on septic systems until they were provided with access to STPs. There are 11 septic tanks in areas such as Explosive Ordnance Disposal (EOD), Ammunition Supply Point, the Lunga Recreational Facility, and the Buffalo Test Area. All septic system operations are maintained by PWB/FMS.

5. Program Roles and Responsibilities

a. The Commander is ultimately responsible for all waste water issues as they relate to MCBQ. The Commander has delegated operational authority to the Assistant Chief of Staff (AC/S), GF Installation and Environment Division. In turn, the AC/S, GF has delegated day-to-day oversight of waste water issues to the following: PWB, Facilities Management (planning and engineering design), PWB/FMS (day-to-day operations), and the NREA Branch, Environmental Compliance Section.

b. The NREA Branch, Environmental Compliance Section is responsible for:

(1) Ensuring all required permits (federal, state, and local) are obtained.

(2) Creating and implementing a Base Order to address the specific requirements of MCO P5090.2A, as they apply to MCBQ.

(3) Institute management practices and procedures to proactively limit pollutant discharge into waters surrounding MCBQ.

(4) Liaison with federal, state, and local regulatory personnel when needed.

c. PWB, Facility Management is responsible for managing any waste water related projects within MCBQ's fenceline.

d. PWB/FMS is responsible for:

(1) Monitoring effluent levels to ensure they are in compliance with permit requirements.

(2) Ensuring treatment plant personnel have current training, as applicable.

6. Training Requirements

a. In accordance with 9 VAC 25-31-200D and 9 VAC 25-32-190, owners of facilities with wastewater treatment plants are required to "employ or contract the services of at least one licensed operator appropriate for the permitted facility". The level of licensing is based upon the volume of water treated; MCBQ Mainside STP is categorized as a Class 2, Advanced Waste Treatment and MCBQ Camp Upshur is categorized as a Class 3, Biological Waste Treatment. Personnel categorized as operators must have licenses approved and issued by the state. Initial training requirements to become a licensed operator are available in 18 VAC 160-20-90, qualifications for licensure of waterworks operators and wastewater works operators. Renewal of licenses must be done every two years, as required by 18 VAC 160-20, Part III – Renewal. In addition, continuing education credits are required for each operator class. The amounts of continuing education credits are outlined below:

(1) Class 1, 2, and 3 wastewater works operators shall obtain a minimum of 20 contact hours.

(2) Class 4 wastewater works operators shall obtain a minimum of contact 16 hours.

(3) Class 5 wastewater works operators shall obtain a minimum of eight contact hours.

(4) Class 6 wastewater works operators shall obtain a minimum of four contact hours.

b. In addition to state licensing requirements, operators at the wastewater works must receive Hazardous Waste Operations and Emergency Response (HAZWOPER) training in accordance with 29 CFR 1910.120. Operators must also have specialized confined space entry training that conforms to 29 CFR 1910.146. In terms of environmental training,

operators must receive education on topics such as storage tank management, storm water pollution prevention, Hazardous Waste (HW) / Hazardous Material (HM) security and storage, and any other applicable topics as described in MCO P5090.2A. Specific information can be obtained from MCBQ's Comprehensive Environmental Training and Education Program (CETEP) Coordinator.

7. Communications. All questions or concerns regarding the WWMP should be directed to the Water Program Manager, who can be reached at (703) 432-0528. The Water Program Manager uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in Paragraph 2 of this Chapter, practices related to the WWMP are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Water Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Reclaimed water systems are not permitted for use at MCBQ unless approved by the GF,PWB, Water Management Program through the NEPA process. Waivers, if provided, are limited to unique circumstances where controls are in place that would eliminate cross-connection concerns in the potable water system (see Chapter 27).

c. All other operational controls are documented through MCBQ's Mainside STP Permit (VA0028363), Camp Upshur STP Permit (VA0028371), Permit for Bluing Operations (STFRD-002), Mainside STP Nutrient Permit (VAN010043-MS), Chesapeake Bay Quarterly Report, and other regulatory requirements and mandates referenced in paragraph 12 of this chapter.

9. Emergencies. For emergencies related to the WWMP that require immediate assistance, dial 911. Refer to the MCBQ ISMP for emergency response procedures for a release of fuels, POL(s), HMs and HWs to the environment. Emergency procedures for sewage backups, line breaks and/or leaks are as follows. For further information, refer to Commander's Policy Letter 3-12, Sewage Spill Response, Reporting, and Management.

a. Notify the Facilities Maintenance Section (FMS) Help Desk at 703-784-2072. The FMS Help Desk will notify the FMS Shop 61 and the Mainside Sewage Treatment Plant (MSTP). If the FMS Help desk is unavailable, contact the MSTP directly at 703-784-2147. Either

potential points of contact will: notify the NREA Branch; notify FMS Shop 61; make the determination to call someone in after business hours, if needed; and make the repairs to the sewage line.

b. Subsequent to notifications, Shop 61 will control the repairs and will isolate the source to stop the discharge.

c. After the backup, break, or leak has been isolated, repairs will take place. The most critical issue with any line break or leak is to limit the amount of waste water being discharged.

d. The affected area will be cleaned and disinfected once repairs have been completed. Subsequently, a final check of the system will be performed prior to it being placed back into service.

e. The NREA Branch is responsible for notifying all applicable regulatory agencies for reporting purposes. During weekends and after hours, the MSTP staff are responsible for directly reporting the spill to the Virginia Department of Emergency Management at 1-800-468-8892 within 24 hours of its occurrence. The MSTP staff is responsible for notifying the NREA Branch the morning of the next business day.

10. Records Management

a. The NREA Branch, Environmental Compliance Section and PWB/FMS maintain records for discharge monitoring conducted at MCBQ. These records must be maintained for a minimum of three years, unless otherwise described in applicable permits or guidance documents. Records for permit violations must also be maintained by the NREA Branch, Environmental Compliance Section as well as corresponding documentation of corrective actions.

b. Records must also be maintained to document meter readings, tests, equipment, chemical use, correspondence, and any odor problems.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. Sampling, monitoring, and reporting requirements are described in the permits for each STP. Reporting criteria (e.g., analytical sampling) must be submitted to the VDEQ in accordance with permit requirements. The Water Program Manager and FMS maintain a listing of all sampling and submittal requirements.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBQ’s Mainside STP Permit (VA0028363).

(2) Camp Upshur STP Permit (VA0028371).

(3) Permit for Bluing Operations (STFRD-002).

(4) Mainside STP Nutrient Permit (VAN010043-MS).

(5) Chesapeake Bay Quarterly Report.

(6) MCBQ Backflow Prevention Plan

(7) Commander's Policy Letter 3-12, Sewage Spill Response, Reporting, and management

b. Reference Documents

(1) 33 USC 1251, *et seq.*, The Clean Water Act (CWA).

(2) 42 USC 300(f), *et seq.*, The Safe Drinking Water Act (SDWA).

(3) 9 VAC 25, *et seq.*, The State Water Control Board.

(4) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 20 – Water Quality Management.

Chapter 14

Environmental Compliance and Conformance Evaluation Program

1. Requirements. The USMC established the Environmental Compliance Evaluation (ECE) Program per MCO P5090.2A to evaluate environmental compliance at USMC installations, including command and tenant activities. Each USMC installation is required to participate in the ECE program, including a three year compliance assessment sponsored and conducted by HQMC (i.e., the Benchmark ECE) and an annual self-audit. Plans of Action and Milestones (POA&Ms) are required to be submitted to the CMC (LF) following each three year ECE in order to respond to findings identified. All POA&Ms shall be maintained and tracked in HQMC-sponsored software. The Commandant of the Marine Corps (CMC) letter dated 3 Mar 04, states that each active base shall implement an EMS covering all Base DoD tenant organizations and commands that have activities and functions potentially impacting the environment. Beginning in 2005, HQMC's ECE also included an EMS conformity audit that each USMC installation is subject to. To meet the requirements established in MCO 5090.2A and MCBO 5090.2D, an Internal Audit Plan (IAP) shall be implemented to ensure that "every permitted site and source, every process which generates a waste or may be considered a potential source, and every command/unit and tenant" at MCBQ are assessed annually.

2. Practices. All potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. All Base practices are associated with this program as illustrated in Table A-1, of Appendix A.

3. Definitions

a. Compliance Evaluation. Identification, characterization, and documentation of compliance deficiencies related to either practices or environmental programs conducted by environmental management office personnel or other environmental professionals designated by the installation. This includes oversight of any inspections that have been performed by practice owners.

b. ECE Program. HQMC-sponsored compliance and conformance assessment program that consists of both a triennial, HQMC-sponsored assessment, and a continuous self-audit program. The program provides the Commander with an assessment of MCBQ's environmental compliance and conformance status.

c. EMS conformity audit. Evaluation of MCBQ's EMS against federal, DoD, USMC, and installation-level requirements.

d. Inspection. On-site examination of practices and related environmental control measures by or on behalf of the practice owners to determine whether environmental compliance requirements are being satisfied. This includes documentation and reporting of deficiencies as arranged with the installations environmental management office and any sampling, analysis, or other monitoring activities that the practice owners perform in order to maintain compliance.

e. POA&Ms. Documented follow-up procedure that outlines objectives, dates, and targets to address findings stemming from self-audit assessments or Benchmark ECE's.

f. Practice. Any activity conducted by an installation or its tenants in performing their mission that has an actual or potential impact on the installation's assets. This includes both business and management practices.

g. Practice Owner. The person, unit, or organization that operates, conducts, controls, or is otherwise responsible for a practice.

h. Self-audit program. An internal plan for the Commander to assess compliance and conformance within their fenceline, including all tenant commands and activities. The self-audit program will use HQMC-sponsored software as a tool to track compliance and conformance with MCBQ's EMS. POA&M's generated from self-audits are for installation/tenant use.

i. For a complete list of definitions pertaining to the Environmental Compliance and Conformance Evaluation Program (ECCEP), refer to MCO P5090.2A, Chapter 4, the MCBQ MCP, and the MCBQ IAP.

4. Program Overview. The ECCEP provides the Commander and HQMC a tool to achieve, monitor, and continually improve MCBQ's compliance with environmental requirements and conformance to the MCBQ EMS. Audits are based on a regular inspection schedule and focus, as specified in MCBQ IAP. The audits shall be based on the identified environmental processes, business practices, environmental aspects, environmental assets, and the associated impacts.

5. Program Roles and Responsibilities. Refer to the MCBQ IAP for a complete description of ECCEP responsibilities. Refer to the MCBQ MCP for a description of responsibilities concerning how all environmental audits and inspections are tracked through the MCBQ EMS.

6. Training Requirements

a. Lead Auditors must receive USMC EMS Lead Auditor training, or other equivalent training that is approved by HQMC(e.g., DON, EMS Lead Auditor training).

b. All personnel aboard MCBQ must be trained on environmental policy and procedure via their respective commands.

c. Environmental Coordinators, via the assistance of applicable Environmental Media Managers, will ensure all practice owners are trained for their assigned responsibilities.

d. For more specific training requirements, refer to the MCBQ IAP and MCBQ MCP.

7. Communications. The MCBQ ECCEP uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ IAP for greater detail concerning how audits and audit results are communicated; likewise, refer to the MCBQ MCP for greater detail concerning EMS communication procedures.

8. Practice Control

a. The ECCEP is used to audit all Practices performed at MCBQ, as specified in the MCBQ IAP.

b. MCBQ's EMS is used to track progress at addressing audit findings through Plans of Action and Milestones (POA&M).

c. For a complete discussion of practice controls, refer to the MCBQ IAP and MCBQ MCP.

d. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. The ECCEP is used to audit emergency response procedures as specified in the MCBQ IAP. Emergency preparedness and response information may be related to environmental compliance, Base operations, or ESOPs. For a more in-depth discussion of emergency preparedness and response as it relates to the MCBQ EMS, refer to the MCBQ MCP.

10. Records Control. Refer to the MCBQ IAP and MCP for information concerning ECCEP records control.

11. Sampling, Monitoring, Measuring and Reporting Requirements. All internal and external environmental audit requirements and schedules are provided in detail though the MCBQ IAP.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBQ IAP.

(2) MCBQ MCP.

b. Reference Documents

(1) MCO P5090.2A, Environmental Compliance and Protection Manual, W/CH 2, Chapter 4, Environmental Compliance Evaluations.

(2) Marine Corps EMS Policy of 3 Mar 04.

(3) MCBQ IAP.

(4) MCBQ MCP.

Chapter 15

Conservation Law Enforcement Office Program

1. Requirements. The Conservation Law Enforcement Program (CLEP) ensures the enforcement of nine federal conservation laws set forth in the 2003 Memorandum of Agreement(MOA) between the USMC and the U.S. Fish and Wildlife Service (USFWS): Airborne Hunting Act; Archeological Resources Protection Act of 1979; Bald and Golden Eagle Protection Act; Endangered Species Act of 1973; Lacey Act and Lacey Act Amendments of 1981; Marine Mammal Protection Act; Migratory Bird Hunting and Conservation Stamp Act; Migratory Bird Treaty Act; National Wildlife Refuge System Improvement Act. In order to comply with MCO P5090.2A and NAVMC DIR 5090.4A, the MCBQ Conservation Law Enforcement Office (CLEO) shall carry out and enforce laws aimed at protecting natural and cultural resources aboard MCBQ (listed above). Protecting MCBQ natural and cultural resources sustains the use of MCBQ lands and USMC mission readiness.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions. Refer to NAVMC DIR 5090.4A, Chapter 6, Use of Force and Pursuit Procedures, Paragraph 1602, for terms and definitions used in the practical application of the use of force.

4. Program Overview. Conservation law enforcement (CLE) officers will perform law enforcement activities to enforce natural and cultural resource laws, including but not limited to the following: investigating fish and wildlife crimes; patrolling; surveillance; interviewing witnesses; interrogating suspects; searching for physical evidence and clues; seizing wildlife or archaeological contraband, equipment, and vehicles; searching and serving warrants; making arrests; and testifying in federal courts and when authorized, state courts, for violations of any of the nine federal conservation laws set forth in the 2003 USMC and USFWS MOA.

5. Program Roles and Responsibilities

a. The Commander has primary responsibility for enforcing natural resources law aboard the Base. The Commander shall be accountable for base-level responsibilities and has delegated authority to the MCBQ natural resources program manager for coordinating and/or managing the MCBQ CLEO program.

b. CLE officers are responsible for:

(1) Ensuring the protection and preservation of human life, personal property, and natural and cultural resources found on lands and facilities aboard MCBQ.

(2) Investigating and arresting anyone suspected of violating the nine federal laws listed in the 2003 USMC and USFWS MOA.

(3) Enforcing state laws on lands acquired or reserved by the Federal Government when the act is not covered by federal statute, per 18 U.S.C. 13, Assimilative Crimes Act.

(4) Assisting the Provost Marshal's Office (PMO) in times of need with manpower support in remote areas and perimeters aboard MCBQ.

c. Per a cooperative agreement between the USMC and the USFWS, the CLEO is allowed to provide law enforcement support to agencies and lands outside of MCBQ's fenceline. For a complete listing of these agencies and lands, refer to Chapter 9, Facilities and Services, of the MCBQ Integrated Natural Resources Management Plan.

d. CLE maintains liaison with the United States Attorney's Office and reports all case information to the Regional Fish and Wildlife Service Office.

6. Training Requirements. CLE officers must be trained in, but not limited to, the following:

a. Natural resources, Marine resources, and Endangered Species Act training.

b. 40-hour Law Enforcement In-service training.

c. Cultural and Historic Resource Law training.

d. Training for supervisors.

e. Environmental compliance enforcement training.

f. Training Officer Functions, Responsibilities, and training.

g. Firearms training.

(1) Sidearms

(2) Shotguns

(3) Rifles

(4) Firearms transition training

h. For additional CLEO training requirements, refer to NAVMC DIR 5090.4A, Chapter 3, Training Requirements, Firearms, Requalification, and Equipment.

7. Communications. All questions or concerns regarding the CLEO should be directed to the CLEO Section, which can be reached at (703) 432-6793/6794/6795. The CLEO Section uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the CLEO Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The CLEO reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Refer to the MCBQ Integrated Natural Resources Management Plan (INRMP) for additional information concerning MCBQ's CLEO Program. All other CLEO Program operational controls such as regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. In the event of an emergency, contact the Provost Marshal's Office (PMO) Desk Sergeant at (703)784-2251/2252/2253. If the emergency event is related to a fire, medical care or terrorism, contact Quantico Fire and Emergency Services (QF&ES) at (703)784-2652.

b. In the event that a hunter is lost or injured, the CLEO follows the procedures outlined in MCO 3570.1B.

c. In the event of anyone lost or injured on water within or flowing from MCBQ's fenceline (e.g., the Potomac River, Chopawamsic Creek, etc.), the CLEO works in conjunction with QF&ES.

10. Records Control. The chief CLE officer at MCBQ shall maintain all firearms records referred to in this chapter and referenced in NAVMC DIR 5090.4A.

a. Training records shall indicate pass/fail and/or numerical scores. These records shall be maintained for five years, per reference (b), SSIC, 12410.14. The records shall indicate the date of

firing, time of day, weather conditions, course of fire, number of rounds, ammunition type, weapon used, and range location. Training records shall identify the certified firearms instructor under whose supervision the firing occurred and note any specialized instructions given to individual shooters.

b. Records of annual ammunition allotment for the USMC Conservation Law Enforcement Program (CLEP) shall be maintained by the delegated MCBQ CLEO.

c. The chief CLE officer shall maintain records of annual firearm inspections and repairs.

d. All records shall be maintained in a designated turnover folder.

11. Sampling, Monitoring, Measuring and Reporting Requirements

a. Conservation law enforcement officers shall complete a Standardized Incident Complaint statement which will be forwarded to the MCBQ PMO for inclusion into the Consolidated Law Enforcement Operations Center.

b. MCBQ shall provide fiscal year conservation law enforcement reports to CMC (LFL) by the end of each October.

c. The Chief CLEO or the designated Chief Firearms Instructor for each installation is responsible for reporting expended rounds and qualification sheets to the MCBQ CLEO.

12. Pertinent Documents

a. Operational Control Documents. MCBQ INRMP, Chapter 9, Facilities and Services.

b. Reference Documents

(1) 18 U.S.C. 13, Assimilative Crimes Act.

(2) Other federal environmental laws and regulations cited in Appendix A of MCO P5090.2A (e.g., Archeological Resources Protection Act of 1979, Bald and Golden Eagle Protection Act, etc.).

(3) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 11 – Natural Resources Management, Section 2: Marine Corps Policy, May 2009.

(4) MCO 3570.1B, Range Safety.

(5) NAVMC DIR 5090.4A, Guide to Conservation Law Enforcement Program, of February 13, 2007.

Chapter 16

Fish, Wildlife, and Agronomy Program

1. Requirements. The Endangered Species Act, the Sikes Act (Conservation Programs on Military Installations), and the Sikes Act Amendments of 1998, require responsible land management through proper planning and conservation initiatives. The Fish and Wildlife Conservation Act of 1980 promotes state programs for the purposes of conserving, restoring, or otherwise benefiting nongame fish and wildlife, its habitats, or its uses. The Virginia Department of Game and Inland Fisheries manage and set regulations for inland fisheries and wildlife within the state. Per MCO P5090.2A, Chapter 11, each USMC installation shall, to the extent practicable and consistent with military mission requirements, conserve and promote conservation of nongame fish, wildlife, and their habitats.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Conservation. Planned management, use, and the protection of natural resources to provide sustained use and continued benefit for present and future generations, as well as the prevention of exploitation, destruction, waste, and/or neglect.

b. Endangered species. Species which are in danger of extinction throughout all or a significant portion of its range.

c. Forest Management. An integrated program for managing forest resources to ensure that the health, vigor, and diversity of forest ecosystems are maintained, while providing for a diverse, quality military training environment and the production of a sustained yield of commercial timber products.

d. MCBQ Integrated Natural Resources Management Plan (INRMP). Plan that describes what fish, wildlife, and agronomy-related resources are located aboard MCBQ and how they are managed.

e. Threatened species. Species which are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

4. Program Overview

a. Manage fish, wildlife, soil, water and vegetation resources through cooperative conservation programs and practices that will support the military mission and sustain quality natural habitats and

diversified biological communities; and promote the morale and welfare of military personnel and the public by providing for hunting, fishing, wildlife viewing and other wildlife related recreation in keeping with appropriate safety provisions.

b. Management objectives include:

(1) Inventory and monitor the status of fish, wildlife, threatened and endangered species to gather data beneficial to sustaining native biological communities.

(2) Establish procedures to define the extent of public participation in fish and wildlife recreational and educational programs and manage the operations of such programs.

(3) Identify the need for and means to accomplish control of invasive plant and animal species.

(4) Apply agronomic practices to support military training, multiple-use land management, erosion control, and habitat improvement projects on semi-improved training lands and forest wildlife openings.

(5) Enhance terrestrial and aquatic habitat through interdisciplinary actions to:

(a) Implement the Navy "no-net loss" wetlands policy.

(b) Use prescribed burning to enhance native grassland habitats.

(c) Install habitat structures.

5. Program Roles and Responsibilities

a. The Commander must ensure that the natural resources aboard MCBQ remain healthy and available for future generations. This is accomplished through the MCBQ Fish, Wildlife, and Agronomy (FWA) Program. Responsibility for implementing the FWA Program is assigned to the Head, NREA Branch, GF Installation and Environment Division.

b. Day-to-day operations of the FWA Program are managed by the FWA; Forestry; and, CLE Sections. The heads of each section must:

(1) Ensure natural resource programs are maintained in compliance with all applicable laws and regulations.

(2) Implement programs that properly maintain and/or enhance fish, wildlife, and agronomy-related resources for military training and recreational use.

(3) Review proposed actions that may affect fish, wildlife, and agronomy-related resources.

(4) Prepare and regularly update an INRMP that supports the Base's mission.

(5) Consult with USFWS, Virginia Department of Game and Inland Fisheries, EPA, Chesapeake Bay Program, and other organizations as required, when working with sensitive fish, wildlife, and agronomy-related resources.

(6) Maintain training records and ensure all records for their personnel are forwarded to the appropriate office for recordkeeping.

c. In addition to direct line management, all personnel who live and work aboard MCBQ must take responsibility for the conservation and protection of MCBQ fish, wildlife, and agronomy-related resources. This means that no inappropriate actions, abuse, or misuse of land should occur at any time. If personnel notice a situation where fish, wildlife, and agronomy-related resources are being inappropriately used or illegally harvested, they have a duty to report it to the Head, NREA Branch, assigned Conservation Law Enforcement Officers, or other assigned NREA Branch staff members. Personnel also have a duty to follow appropriate land-use conditions set forth in the MCBQ INRMP.

6. Training Requirements

a. Personnel who are involved in fish, wildlife, and agronomy management activities must be trained in several types of media areas. A general list of training requirements is included below:

(1) HAZCOM, hazardous materials storage; solid waste management, and RCRA training (solid landfill).

(2) Chainsaw and heavy equipment operation, machine guarding, lockout-tagout, and portable generator operations/maintenance.

(3) Urban wildlife management, timber management, fish and wildlife management, agriculture training.

(4) Excavation/grading, pesticide, wild land fire management and prescribed burning.

(5) Chemical immobilization of animals.

(6) Spill and emergency management training.

(7) Tire replacement training, boating operations, and various workshop-related activities.

(8) For additional training requirements, refer to the MCBQ INRMP.

7. Communications. All questions or concerns regarding the MCBQ FWA Program should be directed to the FWA Section, NREA, which can be reached at (703) 784-5383/5810. The FWA Program uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the FWA Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Head, FWA Section, reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Refer to the MCBQ Integrated Natural Resources Management Plan (INRMP) for additional information concerning MCBQ's FWA Program. All other FWA Program operational controls, such as regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. In the case of an emergency such as a forest fire, dial 911 and report your location. The 911 dispatcher will direct your call to the nearest MCBQ Fire Station.

b. For instances of poaching, the Conservation Law Enforcement Office and the FWA Section can be reached at (703) 784-5383/5810.

10. Records Control

a. The NREA Branch maintains and updates MCBQ's INRMP. The MCBQ INRMP specifies procedures for collecting and monitoring data related to fish, wildlife, and agronomy-related resource management. Several types of databases and record-keeping documents exist to help personnel account for population levels of different types of flora and fauna (including T&E species). Hunting records are also maintained to document harvest counts of deer, waterfowl and other hunting species. Various other recordkeeping requirements exist and are described in detail in MCBQ's INRMP.

b. The FWA Program maintains a GIS database pertaining to environmental data found at MCBQ. Categories within the GIS include soil classification, wetland areas, vegetation types, forest cover types, and T&E species occurrence.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. The FWA Program has multiple federal and state sampling, monitoring, and reporting requirements to fulfill. Refer for the MCBQ INRMP for a description of these requirements.

b. Formal updates to the MCBQ INRMP are required every five years.

12. Pertinent Documents

a. Operational Control Documents.

(1) MCBO P11015.2A, Fish and Wildlife Management Procedural Manual.

(2) MCBQ INRMP.

b. Reference Documents

(1) Federal environmental laws and regulations cited in Appendix A of MCO P5090.2A (e.g., Endangered Species Act, National Environmental Policy Act, the Sikes Act, etc.).

(2) 4 VAC 15 *et seq.*, Department of Game and Inland Fisheries.

(3) OPNAVINST 5090.1C, Navy Environmental and Natural Resources Program Manual.

(4) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 11 - Natural Resources Management.

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Chapter 17

Forest Resources Management Program

1. Requirements. The Endangered Species Act, the Sikes Act (Conservation Programs on Military Installations), and the Sikes Act Amendments of 1998, require responsible land management through proper planning and conservation initiatives. Per MCO P5090.2A, Chapter 11, each USMC installation containing forests or lands with the potential to grow and produce forest products will ensure the improvement and sustainable yield of forest resources consistent with local ecosystem conditions and the military mission.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Conservation. Planned management, use, and the protection of natural resources to provide sustained use and continued benefit for present and future generations, as well as the prevention of exploitation, destruction, waste, and/or neglect.

b. Endangered species. Species which are in danger of extinction throughout all or a significant portion of its range.

c. Forest Management. An integrated program for managing forest resources to ensure that the health, vigor, and diversity of forest ecosystems are maintained, while providing for a diverse, quality military training environment and the production of a sustained yield of commercial timber products.

d. MCBQ Integrated Natural Resources Management Plan (INRMP). Plan that describes what forest resources are located aboard MCBQ and how they are managed.

e. Threatened species. Species which are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

4. Program Overview

a. Proper management of forest resources is required by law, enhances the natural environment, provides realistic military training opportunities, and supports outdoor recreational opportunities. Forest resources include, but are not limited to, all flora and fauna occurring on the base. The MCBQ INRMP is used as a guide to manage forest resources.

b. The MCBQ INRMP is implemented by the NREA Branch, GF Installation and Environment Division and provides detailed guidance on appropriate maintenance, restoration, and protection of natural resources and how to provide quality recreational opportunities and training environments for Base personnel, dependents, and civilian users.

c. Threatened and Endangered (T&E) species found at MCBQ include the Small Whorled Pogonia (threatened), Harperella (endangered), and the Dwarf Wedge Mussel (endangered). All sites proposed for potential land disturbance are surveyed for T&E species presence. Any actions that may affect federal or state-designated T&E species require review and coordination with the U.S. Fish and Wildlife Service (USFWS) and appropriate Virginia agencies. The NREA Branch also consults with other agencies/programs for guidance on issues such as wetland protection and riparian area management.

d. The Base's INRMP outlines all program operations and is publically available at the NREA Website.

5. Program Roles and Responsibilities

a. The Commander must ensure a Forest Resources Management Program is implemented and enforced aboard the Base. Responsibility for implementing the Forest Resources Management Program is assigned to the Head, NREA Branch, GF Installation and Environment Division.

b. Day-to-day operations of the Forest Resources Management Program are managed by the FWA; Forestry Program; and, CLEP. The program managers must:

(1) Ensure natural resource programs are maintained in compliance with all applicable laws and regulations.

(2) Implement programs that properly maintain and/or enhance forest resources for military training and recreational use.

(3) Review proposed actions that may affect the environment.

(4) Prepare and regularly update an INRMP that supports the Base's mission.

(5) Consult with USFWS, Virginia Department of Game and Inland Fisheries, EPA, Chesapeake Bay Program, and other organizations as required, when working with sensitive forest resources.

(6) Maintain training records and ensure all records for their personnel are forwarded to the appropriate office for recordkeeping.

c. In addition to direct line management, all personnel who live and work aboard MCBQ must take responsibility for the conservation and protection of MCBQ forest resources. This means that no inappropriate

actions, abuse, or misuse of land should occur at any time. If personnel notice a situation where natural resources are being inappropriately used or illegally harvested, they have a duty to report it to the Head, NREA Branch, assigned Conservation Law Enforcement Officers, or other assigned NREA Branch staff members. Personnel also have a duty to follow appropriate land-use conditions set forth in the MCBQ INRMP.

6. Training Requirements

a. Personnel who are involved in forest management activities must be trained in several types of media areas. A general list of training requirements is included below:

(1) Hazard communication (HAZCOM), hazardous materials storage; solid waste management, and RCRA training (solid landfill).

(2) Chainsaw and heavy equipment operation, machine guarding, lockout-tagout, and portable generator operations/maintenance.

(3) Urban wildlife management, timber management, fish and wildlife management, agriculture training.

(4) Excavation/grading, pesticide, wild land fire management and prescribed burning.

(5) Chemical immobilization of animals.

(6) Spill and emergency management training.

(7) Tire replacement training, boating operations, and various workshop-related activities.

(8) For additional training requirements, refer to the MCBQ INRMP.

7. Communications. All questions or concerns regarding the MCBQ Forest Resources Management Program should be directed to the Forestry Section, NREA, who can be reached at (703) 784-5383/5810. The Forest Resources Management Program uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the Forestry Resources Management Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating

Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Forestry Program Manager, reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For a complete discussion of Forestry Program practice controls, refer to the MCBQ INRMP.

c. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. In the case of an emergency such as a forest fire, dial 911 and report your location. The 911 dispatcher will direct your call to the nearest MCBQ Fire Station.

b. For instances of poaching, the Conservation Law Enforcement Office and the Forestry Section can be reached at (703) 784-5383/5810.

10. Records Control

a. The NREA Branch maintains and updates MCBQ's INRMP. The MCBQ INRMP specifies procedures for collecting and monitoring data related to forest resource management. Several types of databases and record-keeping documents exist to help personnel account for population levels of different types of flora and fauna (including T&E species). Hunting records are also maintained to document harvest counts of deer, waterfowl and other hunting species. Various other recordkeeping requirements exist and are described in detail in MCBQ's INRMP.

b. The Forestry Section maintains a GIS database pertaining to environmental data found at MCBQ. Categories within the GIS include soil classification, wetland areas, vegetation types, forest cover types, and T&E species occurrence.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. The Forestry Section has multiple federal and state sampling, monitoring, and reporting requirements to fulfill. Refer for the MCBQ INRMP for a description of these requirements.

b. Formal updates to the MCBQ INRMP are required every five years.

12. Pertinent Documents

a. Operational Control Documents.

(1) MCBO 11015.1A, Woodland Tree and Shrub Removal.

(2) MCBO P11015.2A, Fish and Wildlife Management Procedural Manual.

(3) MCBQ INRMP.

b. Reference Documents

(1) Federal environmental laws and regulations cited in Appendix A of MCO P5090.2A (e.g., Endangered Species Act, National Environmental Policy Act, the Sikes Act, etc.).

(2) OPNAVINST 5090.1C, Navy Environmental and Natural Resources Program Manual.

(3) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 11 - Natural Resources Management.

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Chapter 18

Comprehensive Environmental Training and Education Program (CETEP)

1. Requirements. Several federal laws require on-duty personnel working with or around regulated materials and/or in regulated working areas to obtain appropriate environmental training to minimize or eliminate risks to human and environmental health. The MCO P5090.2A has standardized USMC environmental training by requiring all personnel to be trained to perform their jobs and maintain combat readiness in a manner supportive of USMC environmental goals. Additionally, the MCO P5090.2A identifies specific environmental training requirements and responsibilities.

2. Practices. All potential and actual environmental impacts from practices performed at MCBQ are mitigated or reduced through this program. A summary of all Base practices is provided in Table A-1, of Appendix A.

3. Definitions

a. Explicitly Required Training and Education. Training specifically required by laws, regulations, or USMC direction.

b. Implicitly Required Training and Education. Training not required by law, regulation, or USMC direction.

4. Program Overview

a. The goal of the MCBQ CETEP is to enable workers to perform their assigned duties in a lawfully compliant and competent manner that minimizes risk to human health and the environment. The MCBQ CETEP Manual should be read and understood by all personnel aboard the Base who work in, or are responsible for, environmental compliance, hazardous material or waste management, or unit environmental training.

b. The MCBQ CETEP promotes long-term viability of the military mission at MCBQ through training in environmental stewardship.

c. The Commanding General/Commanding Officer (CG/CO) and Senior Executive Service (SES) Education Component ensures senior Marine Corps civilian and military leadership understand their environmental program responsibilities.

(1) Environmental compliance responsibilities shall be part of the in-briefing each CG/CO receives upon assuming command on an installation. These responsibilities include an awareness of and access to environmental compliance publications, such as this ECPSOP, ESOPs, the CETEP Manual, installation environmental orders and

policies for ensuring operations comply with environmental requirements and achieve stated EMS objectives.

(2) Commanders of each unit visiting an installation shall be informed of their environmental responsibilities before conducting unit operations (e.g., training) on the installation. These responsibilities shall be included in any written agreements between the unit and installation and should be included in range regulations.

d. Environmental training requirements are defined by federal, state, local laws and regulations, as well as DoD guidance and base instructions. There are two basic levels of training promulgated under MCO P5090.2A:

(1) General Environmental Awareness Training is designed to ensure all USMC personnel become aware of USMC environmental policies and programs to ensure regulatory compliance, natural resource conservation, and pollution prevention.

(2) Job-Specific Required and Necessary Training and Education supports the USMC's goal of total compliance with all applicable environmental laws and requirements. There are two categories of Job-Specific Required and Necessary Training and Education:

(a) Explicitly Required Training and Education applies to personnel based on the nature of their work or existing conditions at their work site. Examples of such training are courses for the Hazardous Waste Handler(s), Emergency Responder(s), and UST Manager(s).

(b) Implicitly Required Training and Education can reasonably be inferred from work assignments, job functions, or required certifications and licenses. Examples of such training are ESOPs, NEPA planning, EPCRA reporting, and endangered species conservation.

5. Program Roles and Responsibilities

a. The Commander, through the NREA Branch, is responsible for developing and overseeing CETEP aboard MCBQ, including providing environmental training and education to MCBQ personnel and tenant commands. The Commander must also appoint the CETEP Coordinator to his/her position in writing.

b. The Director, Safety Division is responsible for managing the Hazard Communication program and respirator training.

c. MCBQ activity commanders and tenant organizations are responsible for ensuring subordinates are sufficiently trained for their environmental duties in accordance with MCO P5090.2A. Commanders and tenant organizations shall also:

(1) Appoint an Environmental Coordinator (EC) to manage compliance in accordance with this ECPSOP; ensure that the appointed EC attends bimonthly EC meetings.

(2) Through the EC, ensure subordinate training and education records in accordance with this ECPSOP.

(3) Maintain environmental training and education records in accordance with this ECPSOP.

(4) Assign personnel for environmental training in accordance with this ECPSOP and all applicable references.

d. The MCBQ CETEP Coordinator is responsible for performing the following actions:

(1) Determine the training requirements of base (military and civilians) and tenant personnel aboard MCBQ; prepare and present applicable training sessions.

(2) Conduct training(s) in accordance with federal, state, and local requirements.

(3) Maintain accurate records of completed CETEP training classes, including class rosters and completion certificates.

(4) Maintain the Base Environmental Training Calendar.

(5) Update the MCBQ CETEP Plan as needed.

6. Training Requirements. The CETEP Coordinator, as well as any designated USMC Environmental Instructor(s), must meet specific training requirements. These requirements are described in paragraph 5203 of MCO P5090.2A, and to a lesser extent in the MCBQ CETEP Manual.

7. Communications. All questions or concerns regarding the MCBQ CETEP should be directed to the MCBQ CETEP Coordinator, who can be reached at (703) 432-0533. The MCBQ CETEP Coordinator uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices mitigated by the MCBQ CETEP are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The CETEP

Coordinator reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Refer to the MCBQ CETEP Plan for additional information concerning MCBQ's CETEP. All other CETEP operational controls, such as regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. There are no emergency situations associated with the MCBQ CETEP. The MCBQ CETEP provides training to personnel aboard MCBQ in order to reduce or eliminate the potential of an emergency situation. If environmental training is required for practices that could lead to emergency situations, or there is uncertainty whether environmental training is required, contact the MCBQ CETEP Coordinator at (703) 432-0533.

10. Records Control

a. Paper records are maintained by the MCBQ CETEP Coordinator for all personnel who have enrolled in, and completed, training courses and seminars.

b. The MCBQ CETEP Coordinator also publishes an electronic calendar of training classes available to personnel at MCBQ. This calendar lists mandatory and voluntary training along with the dates of availability.

c. Units must maintain complete and accurate records to document all environmental instruction. Training records must be retained for three years after personnel last worked at the site, and training logs must be retained for three years following the training session. In order to meet inspection standards, individual training records must, at a minimum, contain the following information:

(1) Job Title

(2) Job Description, to include duties and requisite skills, education, or other qualifications.

(3) Description of the introductory and continuing training that shall be given to each position.

(4) Records demonstrating completed training.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. There are no requirements under this section which are applicable to the Base's CETEP.

12. Pertinent Documents

a. Operational Control Documents. MCBQ CETEP Manual.

b. Reference Documents

a. Federal environmental laws and regulations cited in Appendix A of MCO P5090.2A (e.g., The Clean Water Act, Clean Air Act, National Historic Preservation Act, etc.).

b. Department of Defense Instruction (DoDI) 4715.10, Environmental Education, Training and Career Development.

c. MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 5 – Environmental Training and Education.

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Chapter 19

Historic and Cultural Resources Program

1. Requirements. MCBQ has been inhabited for thousands of years before European exploration in the 1600's. The nearby town of Dumfries was an important tobacco port prior to the Revolutionary War. Quantico was the site of important batteries and large encampments during the Civil War, and became a modern military installation during World War I. Reflecting this long and varied history, there are numerous and diverse historic properties on MCBQ, a term referring to both buildings and archaeological sites eligible for inclusion in the National Register of Historic Places (NRHP). The NHPA, the Archaeological Resources Protection Act (ARPA), and the Native American Graves Protection and Repatriation Act (NAGPRA) are laws enacted to preserve historic resources. Executive Order (EO) 11593 also requires federal agencies to identify historic properties eligible for the National Register of Historic Places (NRHP) in order to preserve such assets for future generations, and EO 13287 which reemphasizes that EO, adding the directive to interpret historic resources to the public. Per MCO P5090.2A, Chapter 8, each USMC installation shall comply with all applicable federal historic, cultural, and archaeological legal requirements.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Adverse effects. A harmful impact from development, construction, renovation, or other activity that is not considered desirable.

b. Archaeological Resource. According to 32 CFR 229, any "material remains of past human life or activities which are of archaeological interest, as determined under uniform regulations."

c. Geographic Information Systems (GIS). Computer-generated mapping that allows researchers to plot and analyze site distributions against environmental and other background data derived from remote sensing, digitized maps, and other sources.

d. Programmatic Agreement (PA). A written agreement among a federal agency, the Advisory Council on Historic Preservation (ACHP), and others, usually including the State Historic Preservation Officer (SHPO), that adjusts the NHPA Section 106 process set forth at 36 CFR 800 to accommodate an agency's program, usually by stipulating how an entire program or class of undertakings that are repetitive in nature

or similar in effect will be carried out in order to avoid or mitigate adverse effects.

4. Program Overview

a. MCBQ's historic and cultural resources are managed through the NEPA Coordination Section. The intention of the program is to provide guidance for the responsible management of all historic properties and cultural assets within MCBQ's fenceline.

b. Archaeological surveys have covered about 20% of MCBQ. More than 425 archaeological sites have been identified. Of these, three have been listed on the NRHP, 22 have been determined eligible, and another 150 require further study. Archaeological sites include Native American settlement and use sites dating from around 7,000 Before Common Era to 1650 Common Era and historic period sites dating from the late 1600's through the early 20th century. (These figures are current as of January 2011.)

c. Architectural surveys were begun in the mid 1990's and identified an initial group of 239 properties related to the development of the modern Marine Corps at Quantico; subsequently, these structures were listed on the NRHP as the Quantico Marine Corps Base Historic District in 2001. Base redevelopment projects have led to the demolition of all but 116 of these buildings, with further demolitions planned; however, new properties are likely to be added to the district as it is reevaluated in 2011.

d. Sponsors of proposed undertakings at MCBQ fill out a Request for Environmental Impact Analysis (REIA) form describing the project and then file it with the NEPA Coordination Section. The MCBQ Cultural Resources Manager (CRM) reviews the undertaking to determine whether it could cause effects to historic properties and if the effects would be adverse. Adverse effects to historic properties might result from projects which cause ground disturbance from excavation or grading, modification of historic structures, or construction within the viewshed of the historic district. Any undertaking with the potential to cause effects to historic properties must be reviewed by the SHPO and their staff. Under a PA, expected to be in place by the middle of 2011, the CRM would be delegated much of this responsibility, and would consult with SHPO only where there are adverse effects to NRHP listed or eligible properties.

e. If adverse effects to historic properties cannot be avoided, mitigation must be negotiated with the SHPO and other stakeholders. This is accomplished via a Memorandum of Agreement (MOA) in which the NHPA Section 106 consultation process has been documented and mitigation measures have been agreed upon. Mitigation measures may include large scale excavation on affected portions of archaeological sites, or in the case of buildings, documentation and other offsetting actions such as public education or the adaptation of other historic buildings to new uses to assure their retention. For NEPA compliance,

adverse effects to NRHP eligible properties necessitate an Environmental Assessment.

5. Program Roles and Responsibilities

a. The Commander is responsible for ensuring the following actions are conducted:

(1) Issuing Marine Corps Base Orders (MCBOs), implementing the Installation Cultural Resources Management Plan (ICRMP), and prohibiting the use of unauthorized metal detectors.

(2) Signing PA's, MOA's, and ARPA permits.

(3) Conducting government-to-government relations with federally recognized Indian tribes which have expressed interest in cultural resources at MCBQ.

b. GF Installation and Environment Division, NREA Branch, CRM is responsible for:

(1) Every five years, update the ICRMP and circulate to stakeholders as needed.

(2) Completing and implementing the PA.

(3) Reviewing actions and undertakings by all NREA sections for effects on cultural resources.

(4) Developing scope(s) of work for surveys in areas of ground disturbance that identify and evaluate archaeological resources in Areas of Potential Effect.

(5) Submitting reports to the SHPO on evaluations and surveys for architecture and archaeology.

(6) Updating the Installation predictive model for archaeological resources as new data is collected.

(7) Developing survey priorities for unsurveyed areas of MCBQ and perform evaluation of identified sites.

(8) Identify and prioritize sites vulnerable to erosion. Inspect these sites on a regular basis and take measures in accordance with Section 106 to halt erosion.

(9) Identify sites where there is a potential for vandalism and inspect these sites on a regular basis.

(10) Training Conservation Law Enforcement and other security personnel in archaeological resources protection law.

(11) Developing outreach material for incoming personnel, hunters, and recreationists on archaeological resources protection law.

(l2) Review MCBQ tenant leases for potential effects to cultural resources.

c. GF Installation and Environment Division, PWB and the Navy Resident/Regional Officer in Charge of Construction (ROICC) are responsible for:

(1) Reviewing the Base Master Plan and Base Exterior Architecture Plan for consistency with historic preservation objectives indicated by the ICRMP.

(2) Submitting project plans to NREA for review and coordinate with NREA to avoid adverse effects to historic properties.

(3) Include funding in construction/demolition projects to mitigate adverse effects to historic properties.

d. Range Management Branch, Plans, Policy, and Training Branch are responsible for the following actions:

(1) Submitting general training plans to NREA for review of potential effects on archaeological sites.

(2) Submitting plans for new patterns of training to NREA for review.

e. Tenant Activities must ensure the following steps are always conducted:

(1) Submitting master plans to NREA for review.

(2) Submitting project plans and new training patterns to NREA for review.

(3) Submit maintenance plans when the tenant activity controls historic properties.

f. If unexpected archaeological resources are encountered during construction/demolition activities, the activity must cease and the CRM will be contacted. The CRM will evaluate the resource and determine if it is significant enough to warrant mitigation and/or consultation with the SHPO.

6. Training Requirements

a. The CRM must have education and experience meeting professional requirements as stated in 36 CFR 61. In addition, the CRM coordinates training opportunities, including scheduling

workshops in the application of appropriate historic preservation topics, for personnel undertaking repair and maintenance work involving historic buildings. The training shall occur annually, contingent on receipt of funds for this purpose. Training opportunities may include courses in association with the SHPO.

b. Associated NEPA staff, as well as planners in PWB, should have, at a minimum, an introductory course on the NHPA Section 106 review process and be well acquainted with MCBQ's ICRMP.

7. Communications. All questions or concerns regarding the Historic and Cultural Resources Program should be directed to the NEPA Coordination Section, NREA, which can be reached at (703) 784-4030. The Historic and Cultural Resources Program uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the Historic and Cultural Resources Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The CRM reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. There are no emergency situations associated with the Historic and Cultural Resources Program.

10. Records Management

a. A GIS database is maintained by the NREA Branch. Historic and cultural resources (i.e., archaeological sites) present at MCBQ are available in the GIS database.

b. Artifacts collected during archaeological surveys are permanently stored at the Regional Archaeological Curation Facility at Fort Lee, Virginia; field notes and associated documents are also stored there. During study and review of documents, temporary curation of documents and artifacts is at the CRM's laboratory and

office. Items may also be temporarily stored at contractor laboratories and offices.

c. Other types of historic documents and resources are maintained by the Department of the Navy (DoN) at the Washington Navy Yard. Engineering and architectural diagrams that exist for historic buildings may be located with the Engineering Section of PWB. Lastly, the Marine Corps Air-Ground Museum and Marine Corps University Library Archives maintains old photos and records of MCBQ.

d. The CRM maintains an indexed collection of all cultural resource surveys and studies, both archaeological and architectural, which have been conducted aboard MCBQ. GIS feature classes exist and are maintained for archaeological site boundaries, archaeological survey areas, cemeteries, and historic districts. Information tables on archaeological site evaluation status, brief descriptions including function and cultural affiliation, and report references are kept which can be joined to the archaeological site attribute tables. Similar information is maintained for buildings over 50 years old.

e. Archaeological site information may be restricted per ARPA to distributions which will serve to further the preservation of the resources. Decisions involving historic properties should be made with information provided by the CRM, and known to be current.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. As required by Section 110 of the NHPA, a comprehensive inventory of historic and cultural resources is maintained and updated on a continual basis.

b. An architectural inventory was conducted to review all built facilities within the boundary of MCBQ and evaluated them for listing on the NRHP. This survey has been updated as additional facilities cross the 50-year threshold and become potentially eligible for NRHP listing. An initial survey was conducted 1993-1995, an update survey in 2006-2007, and additional surveys in 2009 and 2011.

c. Archaeological surveys can be categorized by the level of intensity and stage in the evaluation process. Reconnaissance (or Phase IA) surveys may only identify features and artifacts visible on the surface, with limited subsurface testing at known or suspected archaeological deposits. Phase I (or Phase IB) surveys employ systematic subsurface testing, basic historical research, and detailed mapping of sites. Phase I surveys are employed for compliance in Section 106 undertakings where no previous survey has been carried out for Section 110 compliance, and serve to demonstrate the presence or absence of archaeological resources. Phase II excavations are conducted at sites identified in Phase I which are recommended as potentially eligible for the NRHP. All levels of an archaeological survey may be conducted in the context of Section 106 or Section 110

compliance. Sites shall be monitored for adverse effects from natural processes such as erosion, impacts from training, or looting.

d. In addition to surveys and inventories described above, NEPA documentation is prepared for all major federal activities, as required. A description of records for NEPA documentation and historic/archaeological surveys is the preceding section, Records Management.

12. Pertinent Documents

a. Operational Control Documents. MCBQ ICRMP.

b. Reference Documents

(1) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 8 - Cultural Resources Management.

(2) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 12 - National Environmental Policy Act (NEPA).

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Chapter 20

Installation Restoration Program

1. Requirements. The Installation Restoration Program (IRP) is mandated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and the 1984 Hazardous and Solid Waste Amendments (HWSA) to the Resource Conservation and Recovery Act (RCRA) of 1976. Regulations such as CERCLA, SARA, and RCRA have been established to protect human health and the environment from exposure to HW and hazardous substances. MCBQ accomplishes compliance with these regulations by implementing a comprehensive IRP. The IRP is a component of the overall Environmental Restoration Program, which also includes the Munitions Response Program (MRP). The MRP addresses former ranges that have been closed by DoD. This program is addressed in Chapter 22.

2. Practices. There are no active practices mitigated by this program. The IRP mitigates potential and/or actual environmental impacts from practices conducted in the past. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Areas of Concern (AOC). Areas where releases or unsafe storage/disposal of HWs or other pollutants may have taken place. These areas are generally investigated to determine if they require remedial action.

b. Facility Assessment. A survey conducted under the supervision of the EPA to determine potential solid waste management sites. A RCRA Facility Assessment is conducted for active sites whereas a CERCLA Facility Assessment is conducted for historic sites that may or may not have been abandoned.

c. Federal Facilities Agreement (FFA). A legal agreement between the EPA and DoN/USMC that establishes roles and responsibilities for IR at MCBQ (as well as other DoN/USMC installations).

d. Initial Assessment Study. A preliminary study to identify and assess sites that may pose a threat to human health and the environment. Typically, sites identified have hazardous materials/residues as a result of past activities. The first "initial assessment study" conducted at MCBQ was in 1984 and identified 17 potentially contaminated sites.

e. National Priority List (NPL). A list of sites where known releases of HWs, pollutants or other contaminants have occurred throughout the United States and its territories. The NPL is intended

primarily to guide the EPA in determining which sites warrant further investigation.

f. Navy Environmental Restoration Program Manual. A formal document that describes guidance for Navy and USMC installations to follow in implementing their Installation Restoration and Munitions Response programs.

g. Quantico Project Managers Team (QPMT) IR Partnering Team. A group composed of representatives from the Regional Environmental Command (i.e., NAVFAC Washington), MCBQ, and regulatory agencies. The QPMT IR Partnering Team acts as a mechanism for exchanging information about IR activities at MCBQ.

h. U.S. EPA's Environmental Photographic Interpretation Center. A repository of satellite imagery and aerial photography that was used to identify historical areas that may have been associated with HW storage or disposal activities.

4. Program Overview

a. The purpose of the IRP is to reduce, in a cost-effective manner, the risk to human health and the environment of hazardous substance contamination from past DoD activities.

b. Under the FFA, Marine Corps Combat Development Command (MCCDC), and thereby MCBQ, was listed on the NPL in 1994. The DoN, EPA, and VDEQ, along with MCBQ, have conducted formal partnering since the mid-1990s. Partnering represents a shared approach to IR where all parties benefit from working closely together. Funding for IR sites at MCBQ is provided through the Environmental Restoration, Navy Program.

c. There are several phases to the CERCLA IR process:

(1) Preliminary Assessment/Site Inspection. Investigation of site conditions. If a release of hazardous substance(s) occurred and requires immediate or short-term response actions, these are addressed under the Emergency Response program of Superfund, NPL Site Listing Process (list of the most serious sites identified for possible long-term cleanup).

(2) Remedial Investigation/Feasibility Study. Determines the nature and extent of contamination. Assesses the treatability of site contamination and evaluates the potential performance and cost of treatment technologies.

(3) Proposed Remedial Action Plan. A document which summarizes a Feasibility Study that is presented to the surrounding community. Describes the remedial alternatives that were considered for cleanup and identifies the proposed remedial alternative, as well as the rationale for its selection.

(4) Records of Decision. Explains which cleanup alternatives shall be used at a site(s). When remedies exceed $25 million, they are reviewed by the National Remedy Review Board.

(5) Remedial Design/Remedial Action. Preparation and implementation of plans and specifications for applying site remedies. The bulk of the cleanup usually occurs during this phase. All new fund-financed remedies are reviewed by the National Priorities Panel.

(6) Construction Completion. Identifies completion of physical cleanup construction, although this does not necessarily indicate whether final cleanup levels have been achieved. This is where the remedial design is fully implemented.

(7) Post Construction Completion. Ensures that Superfund response actions provide for the long-term protection of human health and the environment. Included here are Long-Term Response Actions, Operation and Maintenance, Institutional Controls, Five-Year Reviews of the remedial alternative, Remedy Optimization.

(8) National Priorities List Deletion. Removes a site from the NPL once all response actions are complete and all cleanup goals have been achieved.

(9) Site Reuse/Redevelopment. Information on how the Superfund program is working with communities and other partners to return HW sites to safe and productive use without adversely affecting the remedy.

d. The identification of sites is typically conducted through the QPMT IR Partnering Team or through completion of a CERCLA/RCRA study (e.g., Initial Assessment Study, Facility Assessment, or the U.S. EPA Environmental Photographic Interpretation Center). IR sites can also be designated by the QPMT. Once identified, IR sites are classified based on the unit type and function. Typically, units receive a one to three letter code similar to the following examples: AOC- (Area of Concern), BA- (Battery accumulation area), TP- (Sewage treatment plants), etc.

e. There are a total of 228 IR sites were originally identified at MCBQ. IR sites are typically older, closed parcels of land that were used for waste disposal, ranges, or other areas that may have contained HW. Of the 228 IR sites, 209 have been closed with no action. 10 sites have been deferred to other programs. Restoration activities are on-going for the remaining nine sites.

f. MCBQ has instituted a Community Relation Plan (CRP) in accordance with MCO P5090.2A and the Navy Environmental Restoration Program Manual. The CRP and public participation are intended to draw the community into the CERCLA process. These actions are conducted to ensure surrounding communities are aware of remediation activities

occurring around them. It also serves as a forum for the public to discuss suggested remediation actions and help determine the best course of action. Records of public events, outreach materials, and final decisional documents are available to the public in the Administrative Record.

5. Program Roles and Responsibilities

a. The Base Commander is responsible for implementing a functional IRP that shall address and mitigate any NPL sites located within MCBQ's fenceline. Operational authority of the IRP has been delegated to the IR Program Manager; however, the Base Commander provides the final approval for MCBQ.

b. The IR Program Manager is responsible for:

(1) Providing oversight of MCBQ's IRP; provide planning and management to identify, remediate, and close-out identified IR sites.

(2) Perform as a technical expert to MCBQ personnel in regards to IR questions and concerns.

(3) Coordinate remedial and investigative action with federal and state regulators, as applicable. Participate in partnership meetings and serve as a member of the QPTM.

(4) Maintain documentation related to site investigations, remedial actions, and closures.

(5) Coordinate public notifications and facilitate public meetings through the QPTM Partnering Team.

c. Partnering Teams: Partnering is a process that brings key players together to work as a team to achieve mutually beneficial goals. The relationship is based on trust, dedication to common goals, and an understanding of each team member's individual expectations and values. The common goal is to protect human health and the environment while reducing cleanup cost and time. Partnering principles are used by the VDEQ, EPA Region III, the Navy, the Marine Corps, and their consultants to investigate and cleanup former disposal sites. The Navy, Marine Corps, EPA Region III and VDEQ coordinate cleanups at Virginia installations through three different tiers (levels) of partnering teams. At each tier, participants contribute expertise and resources to achieve common goals and provide installations with tools to effectively address cleanup. Operational Control is fully described in the MCBQ Partnering Deliverable.

(1) Tier I teams include individuals representing the installation's environmental office; the Navy (or Marine Corps), State and EPA project managers; contractor staff; and technical specialists. By meeting regularly to develop strategies, evaluate studies, and

decide and execute required remedies they improve the quality and consistency of actions taken at the installation.

(2) Tier II teams are made up of program managers that mirror Tier I representatives. Their primary role is to support Tier I teams by resolving issues raised by Tier I, discussing new guidance & policy, providing clarification and guidance, and addressing technical concerns. Policy conflicts that can't be resolved at the Tier II level are elevated to Tier III.

(3) Tier III consists of senior level managers responsible for key environmental policy, programming and budgeting decisions. These managers work together to resolve potential differences in organizational policies and goals that might hinder the progress of Tier I and II. Tier III also assists in making sure resources are available for Tier I and II and are able to share ideas and resources across Virginia.

6. Training Requirements

a. Any Base personnel who conduct operations in, or frequently make visits to, IR sites must be trained in accordance with applicable OSHA Regulations (29 CFR 1910.120). Personnel can be trained to the:

(1) General Site Worker level. Personnel involved in hazardous substance removal or other activities in which they may be potentially exposed to hazardous substances or health hazards.

(2) Occasional Site Worker level. Personnel on-site to complete a specific task and are unlikely to be exposed over permissible exposure limits and published exposure limits.

(3) Permissible Exposure Worker level. Personnel who work in areas that are fully characterized, indicating exposures are under permissible exposure limits. Also, there are published exposure limits where respirators are not necessary, and the characterization indicates that there are no health hazards or the possibility of an emergency developing.

b. The use of contractors to accomplish site remediation is a common occurrence. The IR Program Manager shall ensure the Scope of Work (SOW) for all contractors requires that any personnel brought to work on an on-site IR area shall be trained to the required level as applicable by activity. They may be required to provide training certificates if requested by the NREA Branch or other MCBQ staff.

7. Communications. All questions or concerns regarding the MCBQ IR Program should be directed to the IR Program Manager, who can be reached at (703) 432-0521. The IR Program Manager uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in Paragraph 2 of this Chapter, practices related to the IRP are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The IR Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For further information concerning the IRP, please refer to the Environmental Restoration Program Site Management Plan for (MCBQ).

c. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Practices performed at MCBQ that could result in potential emergency situations associated with the IR Program are managed through the Base's Integrated Spill Management Plan (ISMP) by the Spill Prevention and Response Program (refer to Chapter 10).

10. Records Management

a. MCBQ maintains an Administrative Record of all CERCLA actions conducted aboard MCBQ. The IR Program Manager maintains the Administrative Record and ensures new decision documents, regulatory correspondence, or similar items are added as required.

b. Records of hazardous material/waste spills at MCBQ are kept by the NREA Branch, Environmental Compliance Section. Items that are recorded include: spill location, identifying characteristics (e.g., weather, wind, storage conditions), and the material spilled. Regulatory guidance pertaining to spills are also maintained for the required time period(s) in accordance with the MCBQ ISMP and HWMP (See Chapters 4 and 10).

c. An inventory of known IR sites within MCBQ's fenceline is maintained in the DoN's Normalization of Data (NORM) database. The Regional Engineering Command (i.e., NAVFAC Washington) maintains this database for MCBQ.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. The DoD annually reports to the U.S. Congress information on its environmental restoration programs. Preparation of this report occurs

during the first and second quarters of each fiscal year. The type of information submitted to the U.S. Congress includes items such as:

a. Success stories that highlight significant environmental restoration activities, which reduce risk to human health and the environment.

b. The number of environmental restoration sites, per state, listed on the NPL.

c. A summary of environmental restoration actions at each NPL-listed installation.

12. Pertinent Documents

a. Operational Control Documents.

(1) Environmental Restoration Program Site Management Plan for MCBQ, updated annually before the beginning of each Fiscal Year (October).

(2) MCB Quantico Partnering Deliverable, revised as needed.

b. Reference Documents

(1) Federal Facilities Agreement, dated December 8, 1998.

(2) 42 USC 4321, *et seq.*, National Environmental Policy Act.

(3) 42 USC 9601, *et seq.*, Comprehensive Environmental Response, Compensation, and Liability Act, Resource Conservation and Recovery Act, and subsequent amendments.

(4) 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

(5) Department of Navy Environmental Restoration Program Manual.

(6) EO 12088, Federal Compliance with Pollution Control Standards, October 13, 1978.

(7) EO 12580, Superfund Implementation, January 23, 1987.

(8) MCO P5090.2A, Environmental and Compliance Protection Manual, Chapter 10 – Installation Restoration Program.

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Chapter 21

Management Coordination

1. Requirements. EO 13148 "Greening the Government Through Leadership in Environmental Management" and EO 13423 “Strengthening Federal Environment, Energy, and Transportation Management” require an Environmental Management System (EMS) to be implemented at all applicable federal facilities. The Commandant of the Marine Corps (CMC) letter dated 3 Mar 04, states that each active base shall implement an EMS covering all base DoD tenant organizations and commands that have activities and functions potentially impacting the environment. Consistent with both EOs and subsequent related Department of Defense (DoD) and USMC EMS policies, the Marine Corps EMS provides a systematic approach to integrating environmental considerations into mission decisions and operations, while continuing to improve upon environmental compliance.

2. Practices. All potential and actual environmental impacts from practices performed at MCBQ are mitigated through EMS. A summary of all Base practices is provided in Table A-1, of Appendix A.

3. Definitions

a. Aspect. Characteristic associated with a practice that can cause (under normal, abnormal, or emergency operating conditions) an impact (positive or negative) on the human environment or other protected resources.

b. Environmental Standard Operating Procedure (ESOP). An established method that describes steps to be followed for a given practice in order to prevent or mitigate negative environmental impacts associated with the practice.

c. Impact. Effect of a practice's aspect on the human environment or other protected resources.

d. Practice, Aspect, Impact (PAI) Inventory. Survey of all applicable/active HQMC-listed practices, aspects, impacts, and associated location and practice owner information within a designated fenceline.

e. Practice. Unit process, activity, or operation that supports the MCBQ mission and has the potential to impact human health, the environment, or other protected resources.

f. Risk scoring. The act of assigning risk ratings to aspects associated with a given practice and location

g. Risk to mission. Any practice that may affect the environment that would hinder or stop the mission of MCBQ.

h. Significant practice. A high risk practice, either identified by a practice's risk score or identified by the E^2MS Core Team.

i. For a complete list of definitions pertaining to the Management Coordination Program, refer to the MCBQ Management Coordination Plan (MCP).

4. Program Overview

a. The USMC EMS shall be implemented at MCBQ through the Base's EMS Manual per MCBO 5090.2D, including this ECPSOP and MCP.

b. All organizations (e.g., commands, tenants, units) are included in the Base's MCP with the exception of the Federal Bureau of Investigation (FBI), Drug Enforcement Agency (DEA), and Lincoln Military Housing - PPV.

c. The USMC EMS is a framework of several interrelated components that together emphasize a process of continual improvement:

(1) Policy

(2) Planning

(3) Implementation

(4) Checking and Corrective/Preventive Action

(5) Management Review

d. For a complete description of each EMS component, refer to the MCBQ EMS Manual within MCBO 5090.2D, ECPSOP, and MCBQ MCP.

5. Program Roles and Responsibilities

a. The Commander shall ensure that the Base implements an EMS that includes all organizations and commands that have activities and functions potentially impacting the environment. The Commander has delegated authority to the MCBQ EMS Coordinator for coordinating and/or managing the MCBQ EMS.

b. The Environmental Management System and Energy (E^2MS) Core Team shall:

(1) Meet and discuss the Commander's environmental intentions and initiatives; ensure they are adequately acted upon and enforced.

(2) Identify environmental procedures necessary to conduct day-to-day operations that are not covered elsewhere in the MCBQ MCP.

(3) As required, review adequacy of MCBQ MCP procedures. Direct updates and provide concurrence when needed.

c. The E^2MS Implementation Team shall:

(1) Act as a cross-functional team to provide a "hand's on" approach to implementing the Commander's environmental intentions and initiatives.

(2) Provide a level of EMS and media-specific review to ensure policies, procedures, and action plans are technically sound.

(3) Monitor the Base's environmental resources.

d. The EMS Coordinator shall:

(1) Maintain a list of required EMS procedures; as required, develop and/or update EMS procedures with the assistance of the E^2MS Implementation Team.

(2) Maintain an accurate PAI Inventory; perform risk prioritization; designate significant practices; and conduct updates on a regular basis.

(3) Ensure availability of current EMS procedures and related documents to appropriate MCBQ personnel.

e. EC / practice owners. For a complete list of roles and responsibilities, refer to the MCBQ MCP.

6. Training Requirements. For a complete list of EMS training requirements, refer to the MCBQ MCP.

7. Communications. All questions or concerns pertaining to the MCBQ Management Coordination Program should be directed to the MCBQ EMS Coordinator, who can be reached at (703) 432-0525. The MCBQ Management Coordination Program uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. MCBQ's practice list shall be updated on a periodic basis by EC's in coordination with the Environmental Planning Section to reflect subtractions, additions, or modifications. MCBQ's practice list may also be updated as a result of PAI Inventories conducted aboard the Base.

b. Significant Practice Control

(1) The E^2MS Core Team meets biannually and identifies significant practices from MCBQ's current PAI Inventory that require ESOPs. These are known as "significant practices."

(2) Once significant practices have been identified, the E^2MS Implementation Team shall: provide input on ESOP content; review ESOPs prior to dissemination; review existing ESOPs when modifications to processes or operating procedures are identified; assess and schedule ESOPs for development and/or revision.

(3) For a complete discussion on significant practice controls, refer to the MCBQ MCP.

(4) All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Emergency preparedness and response information may be related to environmental compliance, Base operations, or ESOPs. For a more in-depth discussion of emergency preparedness and response as it relates to the MCBQ EMS, refer to Chapter 14 of the MCBQ MCP.

10. Records Control. Refer to the MCBQ MCP for information on records control.

11. Sampling, Monitoring, Measuring and Reporting Requirements

a. The E^2MS Core Team and Environmental Planning Section requisition the appropriate resources (financial, personnel, and technical) to track progress of the Base's EMS.

b. Monitoring and measurement efforts are designed to ensure that environmental performance is consistent with the Base's EMS Policy and they encourage continual improvement by highlighting successes and revealing areas that may need improvement.

c. Environmental performance may concern either environmental compliance or EMS operation and conformance. The level of environmental performance may be judged by an environmental performance indicator (EPI), through an environmental compliance self-audit, and/or through other methods as appropriate.

d. For more information about sampling, monitoring, measuring and reporting requirements in relation to MCBQ's EMS, refer to the MCBQ MCP.

12. Pertinent Documents

a. Operational Control Documents.

(1) MCBO 5090.2D and attached MCBQ EMS Manual

(2) MCBQ MCP.

b. Reference Documents

(1) EO 13148, Greening the Government Through Leadership in Environmental Management, of April 21, 2000.

(2) EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management, of January 24, 2007.

(3) DoDI 4715.17, Environmental Management Systems, April 15, 2009.

(4) USMC EMS Conformance Guide, December 2004.

(5) USMC Short Guide to EMS, 2000.

(6) MCO P5090.2A, Environmental Compliance and Protection Manual, W/CH 2.

(7) USMC Environmental Management System (EMS) Policy of 3 Mar 04.

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Chapter 22

Munitions Response Program (CERCLA)

1. Requirements. The National Defense Authorization Act (NDAA) of 2000 requires the DoD to establish a program addressing military munitions as part of the Defense Environmental Restoration Program. MCBQ's Munitions Response Program (MRP) of closed ranges is performed by the IRP through the CERCLA process, providing a means of complying with the NDAA. MCBQ's MRP also provides guidelines for the identification, classification, and removal of unexploded ordnance (UXO) from within MCBQ's fenceline. The MRP does not address chemical warfare material or munitions from active ranges which is managed through the RCRA Process (see Chapter 7).

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Discarded Military Munitions (DMM). Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. Does not apply to UXO or military munitions planned for future use or disposal or military munitions that have been properly disposed.

b. Military Constituents (MCs). Any material(s) originating from unexploded ordnance (UXO), DMM, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

c. Munitions and Explosives of Concern (MEC). Military munitions that are classified as UXO, DMM, or MCs present in high enough concentrations to pose an explosive hazard.

d. Unexploded Ordnance (UXO). Military munitions that: have been primed, fused, armed, or otherwise prepared for action; have been fired, dropped, launched, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and remain unexploded either by malfunction, design, or any other cause.

4. Program Overview

a. The DoN and USMC originally undertook an effort to investigate sites that might have required a munitions response. The investigation covered areas other than operational ranges, meaning "closed" ranges and ranges that were in the process of transferring from "active" to "closed". This inventory was shared between NAVFAC

Washington, MCBQ, the EPA, and VDEQ as well as with public stakeholders.

b. The MRP does not address the removal of chemical warfare material (CWM) discovered at MCBQ. Discoverers of CWM must contact the MCBQ Fire Department who is responsible for notifying Marine Corps Systems Command (MARCORSYSCOM) and relaying the appropriate information and subsequently notifying the NREA Branch IRP Manager.

c. Response actions begin with the discovery of some type of DMM, MC, MEC, and/or UXO.

(1) Once reported, the MCBQ Remediation Program Manager coordinates a Preliminary Assessment (PA) or Site Investigation (SI) of the Area of Concern. Coordination between the Remediation Program Manager and Explosive Ordinance Disposal (EOD) unit may also take place. The results of a PA/SI dictate the appropriate level of response (e.g., emergency) and level of remediation (e.g., removal) for the discovered munitions. Once a PA has been conducted, the Munitions Response Site (MRS) Prioritization Protocol will be implemented to determine the risks associated with each Munitions Response Site. The Remediation Program Manager must submit an Explosives Safety Submission, for approval, to MARCORSYSCOM prior to any intrusive on-site work.

(2) Once a method of remediation is implemented, it will continue until a Response Complete designation has been attained (i.e., when all required actions have been taken). Once a Response Complete designation has been obtained, the Remediation Program Manager must submit an After Action Report to MARCORSYSCOM for review and endorsement. There are different scenarios that may preclude a MRS from ever achieving Site Closeout. These could include technology limits or when MCs left on-site do not preclude unrestricted use or unlimited exposure. If the Remediation Program Manager can prove that the best available technology was used to detect and remove MCs, and strong evidence exists that no remaining risks exist, the Remediation Program Manager may initiate communication with federal and state regulators that no further action is required at a Munitions Response Site.

d. Currently, there are 37 sites listed in MCBQ’s MRP, 16 of which have remedial activities occurring. A site can be added at any time depending on discovery and consultation with the QPMT (i.e., NAVFAC Washington, MCBQ, EPA, and VDEQ). Also, because a site is listed in MCBQ’s MRP does not mean that response activities must occur. For example, if a munitions response area (MRA)/ MRS is located in an “active” training area, it is not eligible for response activities. Training occurs throughout MCBQ and there were, or are, operational ranges located on both Mainside and Westside (i.e., Guadalcanal area). Some of these former ranges have been converted into other uses, such as administrative areas, commercial areas, and housing areas.

(1) There are two MRAs located on Mainside (MRA 1 and MRA 2) and multiple MRSs located within each MRA. Any active training areas, indoor ranges, and munitions storage areas are not considered to be eligible for inclusion in the MRAs. Inactive ranges within the boundaries of MRA 1 and MRA 2 were considered and are included. Examples of sites that were not originally identified, but later added to the MRP, include: The Clubs at Quantico MRS, The Chopawamsic Skeet Range 1 & 2 MRSs, and the Marine Corps Exchange MRS. These sites were added due to discovered munitions (e.g., mortars) and historical evidence (e.g., aerial photographs).

(2) Most of the ranges on MCBQ's Westside are considered to be "active" ranges, and therefore exempt from MRP requirements. However, there are four MRAs containing MRSs that have been identified. These MRSs are located near Camp Barrett, Camp Upshur, the FBI Academy, and Lunga Recreation Area. SIs and accompanying reports or work plans are currently ongoing to remediate these areas.

5. Program Roles and Responsibilities

a. The Commander is responsible for implementing a functional MRP that will address and mitigate any DMM, MC, MEC, and/or UXO located within MCBQ. Operational authority of the MRP has been delegated to the Remediation Program Manager; however, the Base Commander must provide final authorization on all decisional documents for active MRP sites.

b. The Remediation Program Manager is responsible for:

(1) Performing notification to the chain-of-command, to regulatory agencies, and local stakeholders if MECs or MCs are discovered in a previously unknown location.

(2) Compliance with all regulatory requirements that encompass the entire munitions response procedure (e.g., safety and health assessments, remedial investigation requirements, natural resources assessments, etc.).

(3) Adequately reviewing all MRP plans and documents; forward comments to the appropriate action agency/organization.

(4) Prepare and implement a public participation program for MRP sites; participate in partnership meetings with regulatory agencies and NAVFAC Washington.

(5) Consider MRP site conditions and land-use restrictions when reviewing land-use planning documentation, development, or operations.

(6) Additional responsibilities are elaborated in Chapter 19 of OPNAVINST 5090.1C.

c. MCBQ EOD unit is required to:

(1) Maintain an archive of munitions response activities.

(2) Review and approve Explosives Safety Submissions prepared by the Installation Remediation Program Manager; additionally, review After Action Reports prepared by the Remediation Program Manager.

(3) Provide explosives safety oversight, respond to EOD calls, review explosive mishap reports and EOD incident reports.

(4) Provide verification that final response actions were completed in accordance with approved safety documentation.

d. QPMT IR Partnering Team. Manages Munitions Response Sites in a manner consistent with IRP Sites (see Chapter 20).

6. Training Requirements. Generally staff and personnel involved in UXO operations should be trained on any applicable federal and state regulations, DoD, and USMC policy. Also, staff must be trained in technical areas which enable them to perform their job. Specific positions (e.g., Remediation Program Manager) require individualized training programs. Information on pertinent training can be found in OPNAVINST 5090.1C, Chapter 19 as well as the Department of the Navy Environmental Restoration Program Manual, Chapter 17.

7. Communications. All questions or concerns regarding the MCBQ MRP should be directed to the Remediation Program Manager, NREA Branch, who can be reached at (703) 432-0521. The MRP uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the MRP are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Remediation Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. Although the MRP applies to inactive aspects (e.g., DMM, MCs, etc.), emergency risks are still posed by some UXOs. In the case of an emergency, dial 911 and report your location. The 911 dispatcher will direct your call to the nearest MCBQ Fire Station, as needed.

10. Records Control. All records must be maintained in accordance with OPNAVINST 5090.1C and the Navy Environmental Restoration Program Manual.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. Prior to any in-ground remediation of munitions, an Explosives Safety Submission must be provided to and authorized by MARCORSYSCOM.

b. Following completion of remediation activities, an after action report must be submitted to MARCORSYSCOM for endorsement.

12. Pertinent Documents

a. Operational Control Documents

(1) Environmental Restoration Program Site Management Plan for MCBQ, updated annually before the beginning of each Fiscal Year (October).

(2) MCB Quantico Partnering Deliverable, revised as needed.

b. Reference Documents

(1) Federal Facilities Agreement, dated December 8, 1998.

(2) 42 USC 4321, *et seq.*, National Environmental Policy Act.

(3) 42 USC 9601, *et seq.*, Comprehensive Environmental Response, Compensation, and Liability Act, Resource Conservation and Recovery Act, and subsequent amendments.

(4) 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

(5) Department of Navy Environmental Restoration Program Manual.

(6) EO 12088, Federal Compliance with Pollution Control Standards, October 13, 1978.

(7) EO 12580, Superfund Implementation, January 23, 1987.

(8) MCO P5090.2A, Environmental and Compliance Protection Manual, Chapter 10 - Installation Restoration Program.

Chapter 23

National Environmental Policy Act Coordination Program

1. Requirements. The National Environmental Policy Act (NEPA) of 1969 was signed into law as a response to decades of environmental disregard by federal organizations and activities. Essentially a decision-making process, NEPA requires all federal entities, or projects funded or licensed by federal entities, to consider environmental impacts early in the programmatic schedule. Reasonable alternatives to the proposed action, along with the "No Action Alternative," must be explored to determine if related actions with less environmental impacts exists. NEPA also requires citizen involvement through such avenues as scoping meetings and public comment submission. By utilizing these steps, NEPA assists agency decision makers with protecting the environment, and, when possible, selecting actions which have reduced environmental impact.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Action Proponent. An office or program initiating a project requiring NEPA consideration.

b. Alternative(s). A reasonable option to the proposed action that may accomplish the same objective(s).

c. Categorical Exclusion (CE). Actions which do not pose significant environmental impacts (individually or collectively) and/or are common actions which have been adopted by published organizational procedures.

d. Environmental Assessment (EA). A brief environmental document written to provide evidence that a proposed action will not cause a significant environmental impact or justifies the preparation of an Environmental Impact Statement (EIS).

e. Environmental Impacts. Positive or negative effects attributed to the proposed action(s) and/or alternatives.

f. EIS. A detailed environmental document explicitly written to describe environmental impacts to all media areas (including unavoidable adverse impacts) from a proposed action and list of alternatives.

g. No Action Alternative. Condition which would exist if the proposed action were not implemented (i.e., current conditions persist to the future).

h. Proposed Action. Preferred alternative advocated by the Action Proponent.

4. Program Overview

a. At MCBQ, the NEPA process and tracking of associated documentation is managed by the NEPA Coordination Section, in accordance with MCO P5090.2A, MCBO 5090.1B and MCBO 5090.2B.

b. The Action Proponent completes Section I of the Request for Environmental Impact Analysis (REIA) form (available on the NREA Branch website). It is imperative that the proposed action is described in sufficient detail; additional space is available on page 2, "Additional Info/Remarks." The REIA form is submitted to the NEPA Coordination Section when completed.

c. The REIA form is forwarded to appropriate NREA staff for review of potential environmental impacts (Section II, lines 10-19).

d. If a CE applies, and no adverse impacts are found, then Section II, line 20 is filled in by the NEPA Coordination Section, indicating a CE is appropriate and the required signatures are to be obtained. If CE is conditional (e.g., additional information or actions are required from the Action Proponent), a CE Memorandum is completed, with special conditions or considerations annotated, and goes before the Environmental Impact Review Board (EIRB). After a CE Memorandum is approved, a Decision Memorandum is completed and signed by the Director, GF. Completed REIA forms or CE Memoranda (with Decision Memo attached) are returned to action proponent. The action proponent must countersign Decision Memos and return to the NEPA Coordination Section within 10 days of receipt.

e. If no CE applies and/or NREA staff determines possible adverse environmental effects are likely, Section II, line 22 is checked and further analysis is conducted. The NEPA Coordination Section shall contact the action proponent and inform them of the possible adverse effects and further analysis may be required. This additional analysis typically takes the form of an EA, or possibly an EIS. The action proponent is responsible for consulting and coordinating with NREA staff to determine what actions and/or documents are required (whether they can be accomplished in-house or contracted) and is responsible for funding surveys or other contract actions as necessary. Generally the NEPA process requires active public participation (e.g., public comment periods, scoping meetings, etc.); however, portions may be limited if the proposed action is sensitive in nature. Action proponents should be cognizant of the fact that coordination with other agencies often is required (e.g., U.S. Army Corps of Engineers, State Historic Preservation Office, or VDEQ, etc.)

and an additional sixty to ninety days (or more) could be required to complete the NEPA process.

f. A Notice of Intent (NOI) must be published in the Federal Register to provide thirty days of public scoping prior to drafting an EIS. All EAs and EISs go before the EIRB for review and approval by the Commander, or the Commander's designated representative. A Finding of No Significant Impact (FONSI) shall be signed by the Commander if an EA demonstrates environmental impacts can be avoided or mitigated. FONSIs must undergo thirty days of public comment/review, including notices in local newspapers, before they can be finalized. A Record of Decision (ROD) is completed for EISs after EIRB approval. RODs must be published in the Federal Register and shall be subject to a ninety-day public comment/review period.

5. Program Roles and Responsibilities

a. The Commander has overall responsibility for ensuring that compliance with NEPA is met at the Base. The Commander chairs the EIRB and has signature authority for FONSIs.

b. The EIRB is a multidisciplinary panel, designated by the Commander, to review all NEPA documentation for legal and procedural compliance. The EIRB is composed of legal guidance, the heads of facilities, environment, operations, the comptroller, public affairs, community planning, and other departments as appropriate. The EIRB also performs the following actions:

(1) Assisting the action sponsor(s) in determining the level of documentation required by the action.

(2) Ensuring all NEPA documentation has undergone appropriate review.

(3) Reviewing EAs and providing guidance to the Commander on how they should proceed (e.g., FONSI, EIS, or no action).

(4) Reviewing and preparing NOIs, Draft EISs, and Final EISs.

(5) Providing NOIs to the Commander for signature.

(6) For more information on the EIRB, refer to MCBO 5090.1B.

c. The NEPA Coordination Section oversees the REIA analysis and NEPA documentation process. Other responsibilities include:

(1) Routing REIA forms through necessary base staff elements and, when necessary, completing CEs.

(2) When possible and feasible, conduct analysis and complete documentation for EAs (typically EAs are contracted out).

(3) Prepares information for EIRB review of various REIAs and takes minutes for EIRB meetings. Completed documentation is scanned and sent electronically back to the action proponent.

d. Action proponents are those personnel or organizations who act as points-of-contact for proposed actions. Their main role in the NEPA process is to provide information and funding, as needed, to Base environmental staff so they can prepare documentation that is commensurate with the proposed action. They may be required to prepare EAs or EISs to support the proposed action.

6. Training Requirements. NEPA Coordination Section personnel have a basic requirement for training in NEPA (the law and its requirements), and additional training in other environmental laws and regulations as time and budget permit. General awareness training for PWB personnel, and others, is provided on an as-requested basis.

7. Communications. All communications concerning NEPA should be directed to the NEPA Coordination Section, NREA Branch, who can be reached at (703) 784-5383/5810. The NEPA Coordination Section uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the NEPA Coordination Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The NEPA Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. There are no emergency situations directly associated with the NEPA Coordination Program. The NEPA Coordination Program is administrative and facilitates the NEPA process aboard MCBQ. Where emergency circumstances (e.g., natural disaster) outside MCBQ control make it necessary to take an action with significant environmental impact without observing NEPA review procedures; the Action Proponents must contact the NEPA Program Manager to consult and make alternative arrangements as appropriate. Alternative

arrangements are limited to those aspects of a proposal that must proceed on an emergency basis. Remaining action(s) to be taken is subject to normal NEPA review. The failure to plan properly does not establish an emergency.

10. Records Control. Records and all decision documents (e.g., EAs, FONSIs, EISs, RODs, etc.) shall be kept for at least ten years, and in general are retained indefinitely.

11. Sampling, Monitoring, Measuring and Reporting Requirements. Installations must provide copies of all FONSI's and minutes from EIRB meetings to HQMC. Action proponents are responsible for meeting all requirements regarding sampling, monitoring, measuring and reporting to ensure all environmental compliance requirements determined in the NEPA process are met. The Council on Environmental Quality and P5090.2A, Chapter 12 requires monitoring of mitigation measures set forth in EAs and EISs. Mitigation monitoring reports are to be submitted to HQMC, I&L, LFL-1.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO 5090.1B, Environmental Impact Review Board.

(2) MCBO 5090.2D, Environmental Compliance and Protection.

b. Reference Documents

(1) 42 USC 4321, *et seq.*, The National Environmental Policy Act of 1969.

(2) Other federal environmental laws and regulations cited in Appendix A of MCO P5090.2A (e.g., The Clean Water Act, Clean Air Act, National Historic Preservation Act, etc.).

(3) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 12 "The National Environmental Policy Act."

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Chapter 24

Noise Monitoring and Abatement

1. Requirements. The Noise Pollution and Abatement Act of 1972 requires all federal agencies to incorporate noise management into their actions. Chapter 13 of MCO P5090.2A, Noise Management, establishes USMC responsibilities for complying with legal requirements for reducing environmental noise. MCBQ's Noise Monitoring and Abatement Program satisfy these requirements as well as integrate USMC mission requirements into an effective noise management program.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Accident Potential Zone (APZ). Imaginary services and zones that aid in the elimination of objects that may present a hazard to aircraft flight patterns.

b. Air Installation Compatible Use Zone (AICUZ) Program. Planning initiative to identify and address incompatible development in areas that may receive heightened sound levels from military air installations.

c. Day-Night Average Sound Level (Ldn). The average noise level over a 24-hour period.

d. Environmental Noise. The intensity, duration, and character of sounds from all sources.

e. Low-Noise Emission Product. Any product that emits noise in amounts significantly below the levels specified in noise emission standards applicable to that type of product under the Noise Control Act at the time of procurement.

f. Range Compatible Use Zones (RCUZ). Noise and safety hazards generated from training activities conducted on ranges.

4. Program Overview

a. Due to the nature of military bases, environmental noise originate from a variety of sources. Generally, noise at MCBQ falls into one of three categories: noise from ranges, noise due to transportation or mechanical operation (e.g., motor vehicles or aircraft), and short-duration, high-intensity training events (e.g., artillery or explosions).

b. In order to accommodate reduced noise contours over populated areas within and surrounding MCBQ, the Base has adopted several noise abatement techniques. With the exception of take-offs or final approaches, aircraft must maintain strict distance and height restrictions over areas such as Mainside - west of the Marine Corps Air Facility (MCAF), Chopawamsic Creek, and protected Bald Eagle nesting areas along the Potomac River.

c. While AICUZs define areas where certain noise levels are allowed and not allowed, the Base has also implemented a set of APZs. These also work to keep aircraft operations isolated from populated areas of the Base and reduce the amount of noise that non-MCAF personnel are exposed to.

d. In addition to AICUZs and APZs, which address noise associated with aircraft and helicopter operations, the Base also issues "Noise Advisories" when operations will be conducted that may impact noise levels in and around MCBQ. These advisories encompass planned detonations, troop exercises, and/or explosives training. Noise advisories are released by The Public Affairs Office, are posted to the MCBQ Website, and are thereby accessible to the general public.

5. Program Roles and Responsibilities

a. The Base Commander must implement a standard or Base Order implementing the requirements of MCO P5090.2A, Chapter 13 – Noise Management. The Base Commander must also:

(1) Implement procedures for limiting off-base noise consistent with local noise standards.

(2) Coordinate with the Safety Division to limit noise exposure.

b. The Public Affairs Office is responsible for fielding noise complaints from off-base and on-base individuals. Information that should be provided / collected include: a description of the event, how long the individual has lived at the residence, and if there was any damage.

c. The Planning Section is responsible for reviewing all REIAs for potential to impact noise exposure zones, APZs, or other noise-related infrastructure. If impacts are expected, the NEPA Coordination Section shall direct the project/action owner to conduct noise monitoring, abatement, or a combination of both.

d. A project or action owner is responsible for completing a REIA form found in MCBO 5090.1B, Environmental Impact Review Board, and providing it to the NEPA Coordination Section, NREA Branch. If an action is found to impact noise exposure zones, APZs, or other noise-related infrastructure, the NEPA Coordination Section may require the

project/action owner to conduct noise monitoring and/or noise modeling. If required, this must be undertaken concurrent to the NEPA process. All required monitoring/abatement shall be conducted by the project/action owner.

6. Training Requirements. Personnel who conduct noise monitoring shall be adequately trained to operate the equipment they use and also to retrieve the data stored within it. Training shall be consistent with industry standards. Data interpretation shall be conducted by personnel who have experience comparing noise levels at military installations and associating them with any potential environmental impacts.

7. Communications. All communications regarding the Noise Monitoring and Abatement Program should be directed to the NEPA Coordination Section, NREA Branch, who can be reached at (703) 784-5383/5810. The NEPA Coordination Section uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the Noise Monitoring and Abatement Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The NEPA Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. For further information concerning noise control, refer to MCBO 3570.1, the MCBQ AICUZ Update, RCUZ Study, and MCBQ Encroachment Control Plan.

c. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. No practices performed at MCBQ have potential emergency situations associated with the Noise Monitoring and Abatement Program.

10. Records Control

a. The NEPA Coordination Section maintains electronic and paper records of all REIAs.

b. GIS data pertaining to noise management (e.g., ranges, impact areas, AICUZs) is maintained by the NEPA Coordination Section. Any updates to noise monitoring/abatement data shall be provided to the NEPA Coordination Section so that they can maintain a current database of noise parameters within MCBQ.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. In 2009, a study was conducted to determine facilities that fall within the airfield's AICUZ Ldn. This study is updated as necessary to account for changes to MCBQ's mission and/or facility infrastructure.

b. If a change of operations (e.g., flight tracks, new aircraft, etc.) is anticipated, periodic monitoring may be conducted to determine if the AICUZ are still adequate. This monitoring would be conducted subsequent to any NEPA documentation required to address changes to operations.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO 5090.1B, Environmental Impact Review Board.

(2) MCBQ AICUZ Study Update Marine Corps Air Facility Quantico, Virginia.

(3) MCBQ RCUZ Study.

(4) MCBQ Encroachment Control Plan.

(5) MCBO 3570.1

b. Reference Documents

(1) EO 12088, Federal Compliance with Pollution Control Standards.

(2) 42 USC 4901, *et seq.*, The Noise Control Act.

(3) OPNAVIST 5090.1C, Navy Environmental and Natural Resources Program Manual, Chapter 20 – Noise Prevention Ashore.

(4) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 13 – Noise Management.

Chapter 25

Pollution Prevention (P2) Program

1. Requirements. EO 13423 requires all federal agencies to incorporate Pollution Prevention (P2) at its facilities and in its compliance funding policies to achieve energy security and environmental performance goals such as reducing dependence on hazardous materials, especially if a non-hazardous alternative exists. Per MCO P5090.2A, Chapter 15, MCBQ shall comply with P2 and Toxic Release Inventory (TRI) reporting requirements under the EPCRA and the Pollution Prevention Act. Additionally, EO 13514 requires improvements in environmental, energy, and economic performance by establishing strategies for sustainability.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Virtual Hazardous Material Minimization Center (HAZMINCEN). Implementation of a system for tracking storage, acquisition, and usage information for hazardous materials. Differs from an actual HAZMINCEN in that there is not a centralized location to turn in HM containers and receive new stocks of HM.

b. Waste Minimization. The practice of reducing the amount of waste produced (hazardous and non-hazardous) by an installation. Methods to decrease waste production comprise the three “r’s” concept: re-use, reduce amounts used, and recycle.

4. Program Overview

a. MCBQ’s P2 Plan complies with federal laws and conforms with EOs that require source reduction and other P2 measures.

b. P2 operates according to four tenets: Environmental Compliance, Source Reduction, Waste Minimization, and Outreach. These tenets are described below:

(1) Environmental Compliance. Incorporate P2 concepts, procedures, and technologies into all environmental compliance programs. This effort maintains compliance with environmental regulations, conserves operating funds, and enhances readiness by reducing or eliminating the need for environmental controls.

(2) Source Reduction. The substitution of HMs with environmentally friendly products and less hazardous alternatives

enhances employee safety, decreases the amount of HW produced, and conserves operating funds.

(3) Waste Minimization. MCBQ seeks innovative and cost-effective procedures and technologies to reduce the quantity and cost of hazardous and non-hazardous waste generation and disposal.

(4) Outreach. Communication of MCBQ's P2 policy, P2 program goals, opportunities, and successes ensures support of the P2 program and a willingness to participate by base personnel and senior officials.

c. MCBQ has implemented the following P2 initiatives:

(1) Hazardous Material Management System (HMMS). Establishment of a virtual HAZMINCEN to track consumption and storage information of HMs has been implemented throughout MCBQ. The HMMS is instrumental in the reduction of unnecessary and old HMs and ensures that shops only keep the HMs they need on hand.

(2) Water and Energy Conservation. Conservation actions include the deactivation of the Central Heat Plant, retrofitting of light fixtures with motion sensors, and installation/retrofitting of low flow toilets and showers. Refer to Chapter 26, Base Energy and Water Management Program for additional information on MCBQ water and energy conservation initiatives.

(3) Sulfur Dioxide Emissions Reduction. MCBQ accomplishes this goal by purchasing diesel fuel with reduced sulfur content.

(4) Training. Personnel throughout MCBQ must attend training classes in which P2 topics such as green procurement and recycling are covered.

(5) Green Procurement. Creation of an MCBQ Green Procurement Plan encourages the purchase of recycled materials as well as energy efficient products. The green procurement initiative also emphasizes procurement of environmentally-friendly materials for day-to-day supplies.

d. MCBQ is meeting the sustainability requirements of EO 13514 through the development and implementation of a Base Sustainability Plan.

5. Program Roles and Responsibilities

a. The Commander is responsible for implementing a P2 Program and P2 Plan in accordance with the Marine Corps Pollution Planning Guide. Day-to-day operation of the P2 Program has been delegated to GF Installation and Environment Division, NREA Branch.

b. The NREA Branch is responsible for:

(1) Reviewing the P2 Plan on an annual basis, reissuing updated versions of the P2 Plan, and providing copies of updated P2 Plans to CMC (LF).

(2) Identifying P2 options, determine their feasibility, and ensure their implementation.

(3) Reviewing past P2 options that were deemed technically or economically unacceptable and determine if they can be implemented.

(4) Coordinating P2 opportunities with Activities and Tenant Commands throughout MCBQ.

(5) Providing training to MCBQ personnel on P2 topics.

c. Activity and Tenant Command ECs are responsible for ensuring P2 options are implemented at their facilities/shops. This shall include direct communication with the NREA Branch personnel on implementation strategies, operating procedures, and reporting requirements.

d. The EMS Coordinator and Energy Program Manager are responsible for developing and tracking the implementation of the MCBQ Sustainability Plan.

6. Training Requirements. There are no specific training requirements for the P2 Program; however, NREA Program Managers, as well as Base personnel, are encouraged to attend general P2 training, Storm Water P2 training, Air P2 Training, and/or Green Procurement training. The Naval Civil Engineer Corps Officers School offers web based Pollution Prevention Awareness training and Green Purchasing Training. MCBQ personnel who enroll in the monthly Hazardous Materials/Waste Awareness training will also be exposed to P2 ideas, strategies, and information.

7. Communications. All questions or concerns regarding the P2 Program and sustainable strategies should be directed to the EMS Coordinator, who can be reached at (703) 432-0525. The EMS Coordinator uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures.

8. Practice Control. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the P2 Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The EMS

Coordinator and HM Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21. For further information of P2, refer to the MCBQ P2 Plan. Likewise, refer to the MCBQ Sustainability Plan for information concerning Base Sustainability Strategies. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. There are no emergency situations associated with the P2 Program or sustainability strategies.

10. Records Control. Data and records pertaining to information required for the P2 Annual Data Summary (P2ADS) are maintained by the NREA Branch. Types of data typically reported in the P2ADS include types of waste streams, quantities of waste streams, and types of waste sent off-site for recycling and disposal. Records pertaining to EPCRA reporting (i.e., TRIs) are maintained by the NREA Branch and the MCBQ Range Complex. Sustainability strategy implementation records are maintained in accordance with the MCBQ Sustainability Plan.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. The P2ADS must be completed on an annual basis and submitted to HQMC.

b. Every three years, the P2 Plan must be updated and reissued. Copies of the updated P2 Plan must be provided to CMC (LFL) in accordance with MCO P5090.2A.

c. Sustainability metrics are described in the MCBQ Sustainability Plan

12. Pertinent Documents

a. Operational Control Documents

(1) MCBQ P2 Plan, 2008.

(2) MCBQ Sustainability Plan

b. Reference Documents

(1) Federal environmental laws, EOs, and regulations cited in Chapter 15 of MCO P5090.2A (e.g., Pollution Prevention Act of 1990, CERCLA of 1980, as Amended, etc.).

(2) EO 13148, Greening the Government Through Leadership in Environmental Management.

(3) EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management.

(4) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 15 – Pollution Prevention.

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Chapter 26

Base Energy and Water Management Program

1. Requirements. Multiple federal laws and regulations have been passed with the intent of reducing the nation's dependence on non-renewable resources and foreign oil, increasing environmental protection, and promoting sustainable practices. MCBQ's Energy and Water Management Program is designed to meet these federal energy and water mandates while also aiming to increase operational effectiveness, promote utility self-reliance and security, reduce the cost of purchased utilities, and ensure continuity of operational capability in the event of utility disruption (e.g., natural disasters, failure of old infrastructure, or terrorist acts).

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. B-A-S-E Plan. MCBQ's plan for creating a sustainable base that is committed to conserving energy and water resources.

b. Energy Conservation Officer (ECO). ECO's are Base personnel responsible for energy and water conservation matters at designated facility(s).

c. Environmental Management System and Energy(E^2MS) Core Team. MCBQ's executive management team responsible for setting Base policy for environmental and energy goals. The E^2MS Core Team is also responsible for setting MCBQ's environmental and energy objectives and providing guidance to meet them. The E^2MS Core Team is composed of the Commander, the Base Chief of Staff, the Assistant Chiefs of Staff/Directors of Base divisions, and heads of large tenant organizations.

4. Program Overview. The MCBQ Energy and Water Management Program was implemented to reduce utility consumption aboard MCBQ and meet federal-mandates energy and water reduction goals. This effort is a means of improving self-sufficiency and reducing commercial utility costs, ensuring operational security with no loss of mission readiness. The Energy and Water Management Program attains these goals by implementing federal and DoD sustainability guidelines and implementing the B-A-S-E Plan.

5. Program Roles and Responsibilities

a. The Commander serves as the E^2MS Core Team Chair. In the Base Commander's absence, the Chief of Staff may serve as the E^2MS Core Team Chair.

b. The E^2MS Core Team shall meet on a biannual basis to address energy and water conservation issues at MCBQ. Additionally, the E^2MS Core Team shall:

(1) Inform activities and tenant commands about energy and water conservation policies and programs. The E^2MS Core Team shall also ensure these policies are being adhered to.

(2) Provide feedback to Base personnel about the energy and water management program.

(3) Designate ECOs for each facility within the activity or tenant command to act as the single point-of-contact for energy or water conservation issues.

(4) Ensure active program participation from ECOs.

c. The Base Energy Manager is responsible for implementing MCBQ's Energy and Water Management Program and B-A-S-E Plan. The four pillars of the B-A-S-E Plan include:

(1) **B**enchmark Building Performance.

(2) **A**ctivities and Tenant Command Commitment.

(3) **S**ustainable Facilities.

(4) **E**nergy Awareness Campaign.

(5) For a complete description of each pillar of the B-A-S-E Plan, refer to MBCO 4100.1B, Enclosure (2).

d. ECOs are responsible for assisting the Base Energy Manager in monitoring energy and water consumption throughout MCBQ facilities. ECOs act as the local "eyes and ears" for the Base Energy Manager. For a complete list of ECO responsibilities, refer to MCBO 4100.1B, Enclosure (4).

e. Responsibilities also are delegated to several MCBQ activities and tenant commands. Refer to MCBO 4100.1B for a full description of responsibilities assigned to Base personnel.

6. Training Requirements

a. The Base Energy Manager is responsible for seeking, applying for, and receiving training to maintain proficiency in energy issues such as policy, regulations, codes, building energy efficient models, life cycle costing, innovative technology, and energy efficiency / conservation strategies. Applicable training includes, but is not limited to:

(1) Association of Energy Engineers Certified Energy Manager course.

(2) Life Cycle Cost Analysis course.

(3) Measurement and Verification course.

(4) Conferences, symposiums, and workshops as available.

b. The Base Energy Manager shall provide annual training to all appointed ECOs. This training shall cover information necessary for ECOs to conduct their assigned duties. Information such as adherence to energy and water conservation goals, common conservation practices, and familiarity with the Building Energy Monitor's Guide shall be covered.

c. ECOs shall also receive sustainable facilities training so they are capable of identifying sustainable improvements to their buildings..

7. Communications. For questions or concerns regarding the Energy and Water Management Program, contact MCBQ's Energy Program Manager at (703) 432-2590. The Base Energy Manager uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ MCP for greater detail concerning the communication procedures. For a complete list of communication guidelines related to the Base Energy and Water Management Program, refer to MCBO 4100.1B.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the Base Energy and Water Management Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Energy Program Manager reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Refer to MCBO 4100.1B for a full description of the MCBQ Energy Program. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. For natural gas leaks, refer to the following steps:

(1) If you smell the "rotten eggs" odor of natural gas inside, leave immediately.

(2) From a safe location, call 911 and Columbia Gas of Virginia at 800-544-5606.

(3) If you detect or smell natural gas, do not use matches, electric switches or any kinds of appliances or motorized tools.

b. Refer to ESOP #11, Fuel Storage – Aboveground Storage Tanks and ESOP #12, Fuel Storage – Underground Storage Tanks for response procedures related to leaks from petroleum storage containers.

10. Records Control. Records are maintained by PWB for: ECO Appointment Letters, utility reports, and E^2MS Core Team Meeting Minutes. Records for these items are kept indefinitely.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. The Base Energy manager submits Defense Utility and Energy Reporting System data on a quarterly basis to Naval Facilities Engineering Support Center.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO 4100.1B, Energy and Water Management Program, April 11, 2011.

(2) MCBQ Sustainability Plan

b. Reference Documents. Federal, DoD, and USMC environmental laws and regulations cited in Enclosure (8) of MCBO 4100.1B (e.g., Energy Policy Act of 2005, Energy Independence and Security Policy Act of 2007, etc.).

Chapter 27

Potable Water Management Program

1. Requirements. Under the Federal Safe Drinking Water Act (SDWA) of 1974 and subsequent 1986 Amendments, legal limits are set on the levels of certain contaminants in potable water. The VDEQ enforces SDWA standards. As required by MCO P5090.2A, Chapter 16, MCBQ must preserve potable water to support future USMC training and quality of life needs.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Acute violation. A violation of drinking water standards that may result in an immediate risk to human health.

b. Coliform Bacteria (BAC-T). A common type of bacteria that is used to gauge the sanitary quality of foods and water.

c. Non-acute violation. A violation of drinking water standards that is not an immediate risk to human health (i.e., acute violation), but still warrants public notice.

d. Potable water. Water with high enough quality that it is fit for human consumption.

4. Program Overview

a. The potable water system at MCBQ consists of three separate permitted systems. Each of these systems provides water used for personal consumption, irrigation, fire-fighting, maintenance, and other as-needed Base activities.

(1) The Mainside system is composed primarily of water from the Breckenridge Reservoir and is distributed via the Mainside Water Treatment Plant (WTP) to various storage points and distribution areas. Gray Reservoir serves as a backup to the Breckenridge Reservoir. The Supervisory Control and Data Acquisition (SCADA) system monitors water filter capacity, chlorine levels, fluorine levels, pH, flow, and turbidity in real time at the Mainside WTP. Average daily water use is approximately one million gallons per day (gpd).

(2) The Camp Upshur system is dependent on ground water wells for potable water. There is treatment, storage, and distribution

infrastructure located at Camp Upshur as well. Average daily water use is sixteen thousand gpd.

(3) The Camp Barrett system is dependent on water from Stafford County. Stafford County's primary water source is Smith Lake (also located on MCBQ). There is an agreement between MCBQ and Stafford County for MCBQ to supply Smith Lake with an equal amount of water to what is provided by Stafford County to Camp Barrett. That resupply is provided by MCBQ's backup water source, Lunga Reservoir, located upstream. There is also storage and distribution infrastructure located at Camp Barrett. Decontamination and water treatment is handled by Stafford County before water is piped on-base. Average daily water use is 350,000 gpd.

b. The USMC Range Environmental Vulnerability Assessment (REVA) is used to identify whether there is a release or substantial threat of a release of munition constituents from operational range or range complex areas to off-range areas. This is accomplished through an assessment of operational range areas and periodic five-year review assessments including fate and transport modeling, where applicable. Modeling results that exceed a trigger value may warrant further site-specific sampling to further evaluate the potential of munition constituents release and support the installation in assessing the potential for degradation of groundwater and/or surface water quality. Refer to the latest REVA, referenced in Paragraph 12, for further information.

c. MCBQ's Backflow Prevention Plan is used to prevent the backflow of pollution or contamination into the waterworks from a consumer's water supply system by installing an appropriate backflow prevention device or by backflow prevention by separation at the service connection. Refer to the MCBQ Backflow Prevention Plan, reference in paragraph 12, for further information.

5. Program Roles and Responsibilities

a. PWB/FMS is responsible for conducting monthly BAC-T and chlorine residual sampling for the three Base potable drinking water systems.

(1) In addition to conducting monthly sampling, the Utilities Section of PWB is responsible for performing regular maintenance on all potable water infrastructure. This includes ensuring the functionality of all potable water storage tanks/towers and water distribution infrastructure.

(2) If there is a problem with the storage/transport infrastructure, PWB/FMS is responsible for repairing the system or obtaining the means to do so.

6. Training Requirements

a. In accordance with 9 VAC 25-31-200D and 9 VAC 25-32-190, owners of facilities with potable water treatment plants are required to "employ or contract the services of at least one licensed operator appropriate for the permitted facility." The level of licensing is based upon the volume of water treated; MCBQ Mainside WTP is categorized as a Class 2, MCBQ Camp Upshur and Camp Barrett are categorized as Class 4. Personnel categorized as "Operators" must have licenses approved and issued by the Commonwealth of Virginia. Initial training requirements to become a licensed operator are described in 18 VAC 160-20-90. Operator licenses must be renewed every two years, as required by 18 VAC 160-20, Part III. In addition continuing education credits are required for each operator class. The amounts of continuing education credits for renewal of licenses are outlined below:

(1) Class 1, 2, and 3 operators must obtain a minimum of 20 hours.

(2) Class 4 operators must obtain a minimum of 16 hours.

(3) Class 5 waterworks operators must obtain a minimum of eight hours.

(4) Class 6 waterworks operators must obtain a minimum of four hours.

b. In addition to state licensing requirements, operators at the waterworks must receive HAZWOPER training in accordance with 29 CFR 1910.120. Operators must also have specialized confined space entry training that conforms to 29 CFR 1910.146. In terms of MCBQ specific environmental training, operators must receive education on topics such as storage tank management, storm water pollution prevention, HW / HM security and storage, and any other applicable topics as described in MCO P5090.2A. Specific information can be obtained from MCBQ's CETEP Coordinator.

7. Communications

a. MCBQ must provide public notifications as follows:

(1) Non-acute violations. Provide notice by publication in a daily newspaper in the area served as soon as possible, but within 14 days after a violation. Notification must be provided by mail or hand delivered within 45 days of violation or failure.

(2) Acute violations. Provide notice by radio or television as soon as possible, but no later than 72 hours after a violation.

b. All communications concerning the Potable Water Program should be directed to PWB, who can be reached at (703) 784-5444. PWB uses the MCBQ EMS to communicate program requirements internally to MCBQ

host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the Potable Water Program are listed in Table A-1, of Appendix A. Of those practices, a standardized risk ranking procedure is performed by the EMS Coordinator, as described in Chapter 21. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). PWB reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. The primary operational controls for the Potable Water Management Program are the Mainside WTP Permit (6153675); Camp Upshur WTP Permit (6153063); Camp Barrett Distribution System Permit(6153060); and the Annual General Water Withdrawal Report provided to the VDEQ.

c. Non-potable systems (e.g., rainwater harvesting and reclaimed water systems) are not permitted for use at MCBQ unless approved by the GF,PWB, Water Management Program through the NEPA process. Waivers, if provided, are limited to unique circumstances where controls are in place that would eliminate backflow concerns in the potable water system. Additional non-potable water system controls include:

(1) Non-potable systems are classified as a "high hazard" under the Waterworks regulations. Cross connection prevention for is required. [Reference paragraph 12.b.(9 and 10)].

(2) Any existing non-potable water systems requiring a potable water backup will be separated from the potable water supply by an air gap device. Reduced pressure zone device(s) will not be accepted as adequate protection by MCBQ [Reference paragraph 12.b.(11)].

(3) All non-potable systems will comply with plumbing code (purple pipe) requirements for the entire run of the non-potable system [Reference paragraph 12.b.(8 and 11)].

(4) All non-potable systems with use inside the building envelope will have water treatment to meet minimum water quality standards including but not limited to: limiting fecal coliform to a number less than 2 of a most probable number (MPN) per 100 ml, Legionella, and pH levels between 6.5 and 7.9 [Reference paragraph 12.b.(10)]. Roofing material compatibility may also be evaluated with

acid rain which may increase leaching of metal and other materials into a non-potable water system.

(5) All non-potable systems and fixtures require signage at each delivery point stating source water is non-potable. [Reference paragraph 12.b.(8, 10, 11 and 12)].

(6) All non-potable water systems with potable water connections will have a maintenance agreement executed by the building owner and the utility (4 VAC 50-60-124) [Reference paragraph 12.b.(10)].

(7) All systems will be metered and report usage monthly to commodity managers for utility tracking and reporting [Reference paragraph 12.b.(13)].

d. Additional controls include the REVA and MCBQ's Backflow Prevention Plan. All other operational controls, permits, and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. Emergency procedures for potable water line breaks and/or leaks are as follows:

(1) Notify the Mainside WTP at (703) 784-2698, who will then notify Shop 61 (Utilities Shop with FMS) at (703) 784-1497. If the Mainside WTP cannot be reached, instead contact the Trouble Desk at (703) 784-2072. Either potential points of contact will: notify the NREA Branch; make the determination to call someone in after business hours, if needed; and make the repairs to the water line.

(2) Subsequent to notifications, Shop 61 will control the repairs. Shop 61 will isolate the water break to stop the discharge.

(3) After the break or leak has been isolated, repairs will take place. The most critical issue with any line break or leak is to limit the amount of water being discharged.

(4) The affected area will be cleaned and disinfected once repairs have been completed. Subsequently, a final check for leaks of the system will be performed prior to it being placed back into service.

(5) The NREA Branch is responsible for notifying all applicable regulatory agencies for reporting purposes.

b. For all other emergency situations pertaining to potable water aboard MCBQ, contact:

(1) Water Treatment Plant at (703) 784-2698.

(2) MCBQ Help desk at (703) 784-2072.

10. Records Control. The following records are maintained by the Utilities Section, PWB:

a. Bacteriological analysis records for no less than five years.

b. Chemical analysis records for no less than ten years.

c. Records of actions taken to correct National Primary Drinking Water Regulation violations for no less than three years after the last action taken in respect to the violation involved.

d. Records of sanitary survey reports, summaries, or related correspondence for no less than ten years after the survey was completed.

e. Records concerning a variance or exemption granted by the Virginia Department of Health, Office of Drinking Water, to the system for no less than five years following expiration of the variance or exemption.

11. Sampling, Monitoring, Measuring, and Reporting Requirements

a. All elevated tank levels are monitored remotely using the SCADA system, as are flow rates and pressure levels at each of the pump stations. The SCADA system also monitors chlorine residuals in the Camp Upshur wellheads.

b. Monthly sampling is conducted for BAC-T and chlorine residuals from 15 pre-set monitoring stations throughout the Mainside distribution system, six stations at Camp Barrett, and one station at Camp Upshur. The chlorine residuals are analyzed on-site at the WTP and BAC-T samples are shipped to an offsite laboratory. Should an event occur that requires a water quality sample be collected and analyzed (i.e., water main break or positive BAC-T reading), the area of concern must be determined and isolated. Samples must be collected from upstream and downstream locations, and the affected area is required to be super-chlorinated.

c. Additional sampling and reporting requirements (as well as reporting timeframes) are described in subparts C and D, respectively, of the National Primary Drinking Water Standards (NPDWS).

12. Pertinent Documents

a. Operational Control Documents

(1) MCBQ Backflow Prevention Plan

(2) Range Environmental Vulnerability Assessment

(3) WTP Operations and Maintenance Manuals

b. Reference Documents.

(1) 42 USC 300f, *et seq.*, The Safe Drinking Water Act (SDWA) and subsequent amendments (e.g., 1986).

(2) Public Law 102-486, The Energy Policy Act (EPACT) of 1992.

(3) 40 CFR 141, National Primary Drinking Water Standards.

(4) 9 VAC 25, *et* seq., State Water Control Board.

(5) 12 VAC 5-590, Waterworks Regulations.

(6) 18 VAC 160-20, Board for Waterworks and Wastewater Works Operators.

(7) MCO P5090.2A, Environmental Protection and Compliance Manual, Chapter 16 – Drinking Water Systems and Water Conservation.

(8) 2012 International Plumbing Code

(9) 9VAC25-740-10 et seq. – DEQ water reclamation and reuse regulation

(10) Virginia DCR Stormwater Design Specification No. 6, Rainwater Harvesting

(11) Virginia Rainwater Harvesting Manual, Cabell Brand Center, 2009

(12) Virginia Rainwater Harvesting & use Guidelines, VDH, 2011

(13) EO 13123 Greening the Government Through Efficient Energy Management

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Chapter 28

Asbestos Control Program

1. Requirements. Three major federal asbestos regulations have been established to protect and limit personal exposure to asbestos. These regulations include OSHA's Construction Standards (29 CFR 1926.1101); National Emissions Standards for Asbestos (40 CFR 61, Subpart M); Worker Protection Rule, Asbestos School Hazard Emergency Response Act of 1986, and the Asbestos School Hazard Abatement Reauthorization Act of 1990 (40 CFR 763). Additional state standards apply to all asbestos containing materials (ACM) generated by asbestos mills, manufacturing, fabricating, and spraying operations, and Regulated Asbestos Containing Material (RACM) generated in the course of demolition and renovation of installations, structures, buildings, or other waste-generating activities. The USMC has also established requirements for asbestos mitigation and in accordance with MCBO P5100.1C, the MCBQ Asbestos Control Program (ACP) was established to provide procedures and requirements that will reduce or eliminate personal and environmental exposure to ACM. This program applies to all personnel aboard MCBQ that are, or have the potential to be, exposed to ACM.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Asbestos. A naturally-occurring mineral that has been used in many types of industrial, mechanical, and construction applications. It is known to be resistant to fire, heat, many chemicals and also does not conduct electricity.

b. ACM. Products and materials that may have been manufactured which contains more than 1%, by weight, of asbestos.

c. Friable asbestos. Type of asbestos that can easily be reduced to smaller fragments and fibers. Easily inhaled into the body.

d. RACM. Material that meets one of the following four conditions:

(1) Friable asbestos material.

(2) Category I non-friable ACM that has become friable.

(3) Category I non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading.

(4) Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations.

4. Program Overview

a. Exposure to certain types of asbestos, ACM, or RACM is known to cause severe health problems such as cancer, mesothelioma, and asbestosis in humans. To protect against this, federal, state, and DoD regulations have been established to protect worker's health and govern the removal and disposal of ACM/RACM.

b. MCBQ's Safety Division has instituted the ACP to comply with all applicable requirements, promote worker and general asbestos awareness, and mitigate hazards posed by unprotected contact to ACM and RACM.

5. Program Roles and Responsibilities

a. Safety Division, through authority directed by the Base Commander, shall create and maintain an ACP. The Asbestos Program Manager has the following duties delegated to him/her by the Director, Safety Division:

(1) Manage the ACP on behalf of the Commander.

(2) Obtain appropriate, job-specific training; provide general asbestos awareness training to Base personnel who do not have direct asbestos contact; maintain training records.

(3) Be aware of ongoing Base asbestos surveys and abatement.

(4) Provide support to PWB when reviewing contracts and work plans for asbestos surveys and abatement projects (e.g., ensure appropriate contractor health and safety plans, ensure correct procedures are in place, ensure correct tools/materials, etc.).

b. The Public Works Officer is responsible for:

(1) Ensuring all scheduled renovation and demolition projects for MCBQ include a provision for ACM sampling, as appropriate.

(2) Issuing requests to private companies for proposals/contracts to perform ACM sampling and abatement (if needed); forward responses and contract information to the Asbestos Program Manager for review/input; prohibit project kick-off until the Asbestos Program Manager submits their concurrence.

(3) Providing copies of personnel training to the Asbestos Program Manager.

(4) Working with the Asbestos Program Manager in the event of asbestos-related issues, provide copies of surveys/reports to Asbestos Program Manager on a quarterly basis.

c. The Superintendent of Base Schools is responsible for ensuring asbestos inspections are conducted on a regular basis and Asbestos Management Plans are implemented and updated every three years . These requirements apply for each school at MCBQ. The Superintendent must also ensure all staff receives appropriate awareness training.

d. Unit commanders must ensure all work under their responsibility is conducted in accordance with this ECPSOP as well as Chapter 18 of MCBO P5100.1C. If questions or issues arise, unit commanders or their environmental delegates are responsible for directing them to Safety Division.

e. All Base personnel shall report suspicion of asbestos or ACM to Safety Division. Base personnel shall also assume all suspicious building materials contain asbestos until they are either (1) removed from the construction/renovation site, or (2) surveyed and deemed as non-ACM.

f. For a complete listing of ACP personnel as well as their responsibilities, refer to Chapter 18 of MCBO P5100.1C.

6. Training Requirements. No Base personnel conduct active asbestos identification, removal, or abatement and therefore training requirements are fairly minor. Personnel who work in areas where asbestos may be present must receive two hours of annual awareness training. The Asbestos Program Manager must receive additional job-specific training such as a five-day asbestos abatement class and a three-day asbestos inspector class. Additional requirements are outlined in Chapter 18 of MCBO P5100.1C. Contractor personnel employed to conduct asbestos identification and abatement must comply with all applicable federal and state requirements as they relate to working with ACM, as well as MCBO P5100.1C and this ECPSOP.

7. Communications. For a complete listing of communication procedures, refer to Chapter 18 of MCBO P5100.1C. Safety Division uses the MCBQ EMS to communicate ACP requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for greater detail concerning the communication procedures.

8. Practice Control

a. Practices performed at MCBQ that are associated with the ACP are listed in Table A-1, of Appendix A. Of those practices, the EMS Coordinator, as described in Chapter 21 performs a standardized risk ranking procedure. If the practice is determined to be “significant” based upon potential impacts or actual impacts to the environment, ESOPs are prepared and provided to MCBQ host and tenant staff through MCBQ’s EMS to mitigate the risk of impact(s). The Safety Division

Deputy reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. Any construction, renovation, and demolition of real property at MCBQ must undergo an asbestos survey to determine what hazards exist (if any). PWB contacts private companies with a request to submit proposal(s) to survey and remediate potential asbestos sites. The Asbestos Program Manager receives notification of asbestos abatement projects and reviews contracts between PWB and private companies. All survey, removal, and licensed contractors conduct abatement work. Waste material is properly contained and transported to an offsite facility for disposal. Once work commences, PWB is responsible for managing project efforts. PWB also receives and maintains copies of completed asbestos surveys.

c. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. Minimal Exposures. In the event of minimal exposures to asbestos, contact The Safety Division at (703) 784-2866 to report the incident. The Safety Division will evaluate the incident and recommend medical evaluation, as necessary.

b. If personnel exposed to asbestos experience unusual health-related symptom(s), contact the Safety Division at (703) 784-2866 to report the symptom(s) immediately. If outside of normal business hours, dial 911 for immediate assistance.

10. Records Control

a. Survey results and records are managed using two methods. The Asbestos Program Manager and PWB both have access to a database containing the results of the Base’s asbestos survey, conducted in 2001. The database includes information such as the building surveyed, sample type, results of sample analysis, a picture of the sample location, and a diagram depicting the sample location within the building.

b. Since 2001, PWB has maintained the results of all asbestos surveys conducted at MCBQ. These files are managed separately from the Asbestos Survey Database and are available from PWB as needed. PWB is responsible for providing all results of asbestos-related activities to the Asbestos Program Manager.

11. Sampling, Monitoring, Measuring and Reporting Requirements. There are no requirements under this section which are applicable to the Base’s ACP.

12. Pertinent Documents

a. Operational Control Documents

(1) MCBO P5100.1C, Marine Corps Base Quantico Safety and Occupational Health Program, Chapter 18 – Asbestos Control Program.

(2) MCBQ school-specific Asbestos Management Plans.

b. Reference Documents

(1) 15 U.S.C. 2601, Subchapter I, Control of Toxic Substances, and Subchapter II, Asbestos Hazard Emergency Response.

(2) 29 CFR 1910.1001, Asbestos.

(3) 40 CFR 61, Subpart M, National Emissions Standards for Asbestos.

(4) 40 CFR 763, Asbestos.

(5) 9 VAC 20-81-620, Asbestos-Containing Waste Materials.

(6) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapters 6, 7, 9, 12, 15, and 17.

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Chapter 29

Lead Safety

1. Requirements. The Occupational Safety and Health Act was established to ensure worker and workplace safety. Subsequent federal (29 CFR 1926.62), state (16 VAC 25-35-10, *et seq*.), and DoD (Navy Marine Corps Directive [NAVMCDIR] 5100.8) regulations have been established to implement worker protection against occupational lead exposure. In compliance with these regulations, the MCBQ Lead Safety Program (LSP) was established to provide procedures and requirements that will reduce potential and actual lead exposures for all individuals aboard MCBQ to levels as low as reasonably achievable. It is the intent of MCBQ's LSP to comply with all applicable regulations, locate and remediate lead-based risks from structures and materials, and minimize exposure from lead containing materials (LCM).

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Action level. A concentration designated in 29 CFR 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average (TWA), which initiates certain required activities such as exposure monitoring and medical surveillance.

b. Lead. A soft metal used in a variety of materials. If consumed or absorbed into the body, high concentrations of lead have been proven to negatively affect the nervous and reproductive systems as well as the kidneys.

c. LCM. Materials that have been manufactured with lead as a material component (e.g., paints).

d. Lead Workers. Personnel who may have the potential for exposure above the Occupational Safety and Health Administration (OSHA) action levels.

e. Personal Protection Equipment (PPE). Clothing or other gear that is designed and worn to protect the body from injury or harmful conditions.

4. Program Overview

a. Exposure to LCM may present a heightened probability of health-hazard risks. For a complete list of operations aboard MCBQ, which may expose individuals to lead, refer to MCBO P5100.1C, Chapter 16. At-risk personnel may include:

(1) Construction workers.

(2) Personnel conducting weapons maintenance.

(3) Personnel receiving specialized training (e.g., breaching).

b. MCBQ's Safety Division manages the Base's LSP to reduce harmful impacts from inadvertent lead exposure. Engineering and management controls for limiting exposure to LCMs are contained in paragraph 6 of this ECPSOP chapter and Chapter 16 of MCBO P5100.1C.

c. When a facility or real property is scheduled to be demolished or undergo a renovation, a survey for LCM is conducted concurrent to an asbestos survey. The process for conducting an LCM survey is the same as it is for conducting an asbestos survey; that is, PWB contacts private companies for proposal submittals to perform a survey and remediation work, as needed. The Lead Program Manager (LPM) reviews and approves all contracts for compliance with applicable regulations and LSP requirements. Contractors perform all remediation work with oversight conducted by PWB.

5. Program Roles and Responsibilities

a. Director, Safety Division must:

(1) Appoint an individual responsible to act as Installation LPM.

b. The Commanding Officer, Naval Health Clinic (NHC) Quantico is responsible for performing or delegating the following actions:

(1) Appoint an Industrial Hygienist (IH) to provide assistance and technical support to Safety Division's LPM.

(2) Conduct a Lead Medical Surveillance Program.

(3) Conduct pediatric examinations in accordance with the Bureau of Medicine and Surgery Navy Pediatric Lead Exposure Prevention Program.

c. PWB is responsible for appointing personnel to work with Safety Division's LPM in order to ensure the following is conducted:

(1) Notify the Safety Division LPM of all proposed lead survey and abatement work scheduled to occur aboard MCBQ; allow the LPM to review/comment on proposed work.

(2) Provide survey results to LPM and other necessary personnel.

(3) Ensure lead-containing waste is disposed in accordance with all applicable regulations.

d. The LPM must:

(1) Obtain correct training in accordance with NAVMCDIR 5100.8; provide correct training to Base personnel, as required by applicable regulations.

(2) Communicate with PWB and the NHC Quantico IH to evaluate LCM risks.

(3) Communicate and interact with the IH to implement and manage PPE surveys and training.

(4) Review LCM contracts and work plans for surveys and abatement actions; notify IH when personnel must work inside LCM controlled zones.

e. The NHC Quantico's IH has the following responsibilities:

(1) Provide support and technical assistance to Safety Division's LPM as needed (e.g., monitoring data, training assistance, etc.).

(2) Evaluate lead-based risks and conduct monitoring, as needed.

(3) Determine required PPE for lead-based activities; recommend control boundaries to limit lead exposure.

(4) Notify personnel (verbally and written) who have been overexposed to LCM and notify LPM of facilities where LCM concentrations may require abatement.

f. Shop/unit supervisors are responsible for ensuring the day-to-day safety of their personnel. Actions, which fall under their purview, include:

(1) Notify the LPM prior to commencement of airborne-lead generating operations.

(2) Ensure personnel are properly trained and have obtained appropriate refreshers, as needed (including appropriate medical surveillance).

(3) Provide appropriate PPE to shop personnel and ensure exposure, above the OSHA action levels, is reported to the LPM.

(4) Establish standard operating procedures (SOPs); consult the Safety Division LSP and NHC Quantico IH for SOP concurrence;

maintain copies of all applicable SOPs and required regulatory documentation (e.g., SDS, references and info sheets).

g. All personnel who conduct airborne-lead producing activities must:

(1) Comply with established procedures (including use of proper PPE and respiratory protection).

(2) All personnel have a responsibility to notify their supervisors of any unsafe working conditions they observe.

h. Refer to MCBO P5100.1C, Chapter 16 for a comprehensive listing of personnel with responsibilities under MCBQ's LSP.

6. Training Requirements

a. All lead workers must receive training in accordance with 40 CFR 745. This training must be completed prior to any potential exposure to lead, lead dust, or lead fumes. Annual refresher training must be completed and include topics specified in MCBO P5100.1C.

b. No personnel aboard MCBQ conduct LCM removal or abatement at construction/renovation sites. Civilian contractors conduct this type of work and it is the responsibility of their company to ensure the correct training is acquired.

7. Communications. For questions or concerns regarding the LSP, contact Safety Division's main office at (703) 784-2866. Also, refer to MCBO P5100.1C, Chapter 16, for specific communication procedures. Safety Division also uses MCBQ's EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for detail concerning the communication procedures.

8. Practice Control

a. As mentioned in paragraph 2 of this Chapter, practices performed at MCBQ that are associated with the LSP are listed in Table A-1, of Appendix A. Of those practices, the EMS Coordinator, as described in Chapter 21 performs a standardized risk ranking procedure. If the practice is determined to be "significant" based upon potential impacts or actual impacts to the environment, Environmental Standard Operating Procedures (ESOPs) are prepared and provided to MCBQ host and tenant staff through MCBQ's EMS to mitigate the risk of impact(s). The Deputy, Safety Division reviews all draft ESOPs and revisions to ensure the technical content is correct and current. For further information concerning EMS, refer to Chapter 21.

b. General Controls. Minimizing risk of exposure to LCM can be accomplished using the following simple measures:

(1) Wear appropriate PPE, including respiratory protection when needed, when working in close proximity to known LCM.

(2) Maintaining a clean workspace that is devoid of free-lead particles and dust.

(3) Refrain from consuming or storing food products near known LCMs; wash hands after work with known LCMs.

(4) Post clear and concise signs warning of lead exposure in areas where work with LCMs is conducted.

c. For a complete list of general controls and requirements for specific operations, refer to MCBO P5100.1C, Chapter 16. All other operational controls and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies

a. Minimal Exposures. In the event of minimal exposures to lead, contact Safety Division at (703) 784-2866 to report the incident. Safety Division will evaluate the incident and recommend medical evaluation, as necessary.

b. If personnel exposed to lead experience unusual health-related symptom(s), contact Safety Division at (703) 784-2866 to report the symptom(s). If outside of normal business hours, dial 911 for immediate assistance.

10. Records Control. All survey results are received and maintained by PWB. They are available from PWB as needed. PWB is responsible for providing copies of all results from lead-remediation activities to the LPM.

11. Sampling, Monitoring, Measuring and Reporting Requirements. There are no requirements under this section, which are applicable to the Base's LSP.

12. Pertinent Documents

a. Operational Control Documents. MCBO P5100.1C, Marine Corps Base, Quantico Safety and Occupational Health Program, Chapter 16, Lead Safety.

b. Reference Documents

(1) 29 CFR 1910, Occupational Health and Safety Standards.

(2) 29 CFR 1926.62, Lead.

(3) 40 CFR 745, Lead-Based Paint Poisoning Prevention in Certain Residential Structures.

(4) 16 VAC 25-35-10 *et seq.*, Regulation Concerning Certified Lead Contractors Notification, Lead Project Permits and Permit Fees.

(5) MCO P5090.2A, Environmental Compliance and Protection Manual, Chapter 16, Drinking Water Systems and Water Conservation.

(6) NAVMC Directive 5100.8, Marine Corps Occupational Safety and Health Program Manual.

Chapter 30

Medical and Infectious Waste Management Program

1. Requirements. The Medical and Infectious Waste Management Program (MIWMP) exists to satisfy federal and state requirements on the safe handling and disposal of wastes associated with hospital, health clinic, and veterinary operations. Types of medical waste covered under this section include pathological, biological, and infectious wastes. It is the intent of the DON, MCBQ, and Naval Health Clinic (NHC) Quantico to perform these operations in a safe and environmentally sound manner.

2. Practices. Several potential and actual environmental impacts from practices performed at MCBQ are mitigated through this program. A summary of the specific practices associated with this program is provided in Table A-1, of Appendix A.

3. Definitions

a. Infectious Waste. Waste material that may contain pathogens capable of causing human sickness.

b. Medical Waste. Waste that is produced from health care (e.g., doctors, dentists, etc.) and/or veterinary facilities. Examples of medical waste are sharps and blood soaked material (e.g. gauzes and pads), soiled clothing are not regulated medical waste. Dental waste can include hazardous waste (amalgam) as a blood soaked material (medical waste).

4. Program Overview

a. MCBQ is equipped with several different medical clinics, a dental operation, and a small veterinary practice that performs immunizations. These types of organizations commonly produce medical and infectious waste.

b. Personnel must follow specific requirements in order to safely manage, store, and dispose of wastes that can potentially cause medical harm or infection. Refer to Section 8 of this chapter, Practice Control, for specific requirements on the safe management, storage, and disposal of wastes.

5. Program Roles and Responsibilities

a. Responsibility for the implementation of the MIWMP is assigned to the Commanding Officer, NHC Quantico. Day-to-day responsibility for the program has been delegated to the Operations Manager, Operations Management Division (OPMAN). The Head, Industrial Hygiene (IH) Division, provide oversight.

b. As the program manager, the Operations Manager is responsible for ensuring the following actions are conducted:

(1) Managing operations of the program, including responding to questions from shops generating medical waste.

(2) Maintaining logs and ensuring staff members are trained on handling, collecting and packaging regulated medical waste for disposal.

(3) Designating an individual who is responsible for maintaining the Regulated Medical Waste Log and tracking/printing final disposal receipts.

(4) Be present (or designate a responsible individual) during contractor pickup of regulated medical waste.

(5) Review contractual documents and oversee organization of regulated medical waste removal/disposal.

c. Waste handlers at facilities that generate regulated medical waste are responsible for:

(1) Inspecting waste-holding containers on a regular basis.

(2) Ensuring containers are not more than 3/4 full. Once containers are 3/4 full, they will be removed and placed in the Medical Waste Storage Room to await weekly pickup.

(3) Correctly package and label regulated medical waste for pickup.

d. Regulated medical waste removal/disposal contractors are responsible for providing appropriate training to their staff. Training should be compliant with applicable federal and state regulations. The removal/disposal contractor shall also provide waste labels to OPMAN for distribution to generating shops.

6. Training Requirements

a. Individuals responsible for handing medical and infectious waste must be identified by each command aboard MCBQ. These personnel shall be trained by OPMAN in the correct procedures of packaging medical and infectious waste as well as preparing it for off-site shipment.

b. Staff members shall receive training specific to their assignment during the orientation to their workspaces at the time of initial assignment. All staff members shall receive refresher training during required annual training.

c. Contractors who transport medical and infectious waste and perform off-site disposal are responsible for ensuring their personnel are adequately trained to federal and state requirements.

d. At a minimum, all personnel handling medical and infectious waste shall receive the following training:

(1) Initial blood-borne pathogen and refresher training.

(2) Hazard Communication training.

(3) General Environmental Awareness Training.

7. Communications. The Head, IH Division uses the MCBQ EMS to communicate program requirements internally to MCBQ host and tenant staff. Refer to the MCBQ Management Coordination Plan for detail concerning the communication procedures.

8. Practice Control

a. Wastes are collected from clinic treatment areas and transferred to a secure room to await pickup. Wastes must be correctly packaged (i.e., double-bagged, placed in a Biohazard box, taped shut and labeled with biohazard and contractor information stickers) before a contractor will pick them up. Additional details relating to the packaging of waste is described in the NHC Quantico Regulated Medical Waste Disposal SOP for Operating Management Division. In addition to the Regulated Medical Waste Disposal SOP, the Dental Clinic has created its own SOPs for Biohazard disposal. These SOPs are directed at regulated dental wastes, HW contaminated with bio-hazardous material, linens soiled with bio-hazardous materials, and reusable privacy curtains.

b. Due to the fact that refrigeration for medical waste does not exist at NHC Quantico, medical and infectious waste can only be held on-site for seven days. To comply with federal and state regulations, a contractor makes weekly visits to each facility, removes waste, and disposes it off-site. Only appropriately, trained and qualified personnel may be present during handoff from generating organizations to the disposal contractor.

c. For a complete list of practice controls for medical and infectious waste, refer to BUMEDINST 6280.1B, NHCI 6220.4G Bloodborne Pathogen Control Plan, 6240.1B Sanitary Regulations, Infection Control Manual. All other operational controls, permits, and other regulatory requirements and mandates are referenced in paragraph 12 of this chapter.

9. Emergencies. As outlined in 9 VAC 20-120.280, containment and cleanup procedures for regulated medical waste per state law are as follows: .

a. Take appropriate precautions to ensure personnel do not come into contact with any contaminants by wearing appropriate personal protective equipment.

b. Repackage spilled waste in accordance with the packaging requirements in 9 VAC 20-120-210.

c. Transport any regulated medical waste by a transporter registered in accordance with the provisions of 9 VAC 20-120-480, registration of transporters.

d. Clean and disinfect any areas having been contacted by regulated medical wastes. Materials used to decontaminate the area shall be disinfectants effective against mycobacteria.

e. Take necessary steps to replenish containment and cleanup kit.

10. Records Control

a. OPMAN is the sole organization responsible for maintaining records of regulated medical waste shipment and final disposal.

(1) Per federal regulations, shipping paperwork/manifests must be maintained for two years after the waste carrier accepted the regulated medical waste. The facility system for tracking shall include date, type of waste, amount (weight, volume, or number of containers) and disposition.

b. Yellow copies of shipping manifests are left with OPMAN, who maintain them in the Regulated Waste Log. On a weekly basis OPMAN checks the disposal contractor’s website for copies of the original manifest, indicating the waste has been disposed. The yellow and printed white manifest copies are placed together and filed in the Regulated Medical Waste Log and OPMAN Regulated Medical Waste Archives.

c. The removal/disposal contractor also maintains an online manifest archive where records of all past disposal activities are located.

11. Sampling, Monitoring, Measuring, and Reporting Requirements. The Waste Management Division shall designate personnel to perform environmental and medical audits. The Waste Management Division shall ensure that deficiencies noted during the inspections are corrected immediately. Actions taken to correct each deficiency shall be recorded on the inspection sheet.

12. Pertinent Documents

a. Operational Control Documents

(1) Naval Health Clinic Quantico Instruction 6220.4G, Blood Borne Pathogens Exposure Control and Regulated Medical Waste Plan.

(2) 6240.1B Sanitary Regulations, Infection Control Manual.

(3) NHC Quantico Regulated Medical Waste Disposal Standard Operating Procedure (SOP) for Operating Management Division.

b. Reference Documents

(1) 42 USC 300f, *et seq.*, The Safe Drinking Water Act (SDWA) and subsequent amendments (e.g., 1986).

(2) 29 CFR 1910.1030, Bloodborne Pathogens.

(3) 49 CFR 173.197 Regulated Medical Waste.

(4) 9 VAC 20-120-10 *et seq.*, Regulated Medical Waste Management Regulations.

(5) Bureau of Medicine Instruction 6280.1B, Management of Infectious Waste.

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Appendix A

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Table A-1
ECPSOP Practice Table by Environmental Program Manager

MCBQ Practices	Environmental Program Manager Note: This table depicts points of contact to liason with regulators/external auditors per US Team Guide, Program Media. Refer to the most current MCBQ PAI Inventory for a list of Practice Owners (operation/implementation managers) by Activity/Command/Unit.																												
	Natural Resources and Environmental Affairs(NREA)																							PWB		NHC	Safety Division	
	Air Program	HM Program	HW Program	ISWM Program	Pesticide Management Program	Munitions Response (RCRA)	PCB Management	Radon Program	Spill Prevention & Response	SWMP	STMP	WWMP	EC&C Evaluation Program	CLEO	FWA Program	FRM	CETEP	H&C	IRP	EMS	Munitions Response (CERCLA)	NEPA	Noise	P2	Energy	Potable Water	Medical & Infectious Waste	Asbestos	Lead
Aboveground storage tank (Fuel storage)	X	X	X						X		X	X					X	X		X		X							
Acid cleaning		X	X						X								X			X		X							
Aircraft Parking	X								X		X						X			X		X	X						
Aircraft takeoff and Landing	X																X			X		X	X						
Backflow prevention												X					X	X		X		X				X			
Battery Recharging																	X			X		X			X				
Battery replacement			X														X			X		X							X
Billeting (Housing/barracks)				X								X					X			X		X			X	X		X	X
Bluing/Parkerizing		X	X									X					X			X		X							
Boat, ramp, dock cleaning		X										X					X			X		X							

H&C – Historic and Cultural Resources; HM – Hazardous Materials; HW – Hazardous Material; ISWM – Integrated Solid Waste Management; RCRA – Resource Conservation and Recovery Act; P2 – Pollution Prevention; PCB – Polychlorinated Biphenyl; SWMP – Storm Water Management Program; STMP – Storage Tank Management Program; WWMP – Waste Water Management Program; EC&C – Environmental Compliance and Conformance; CLEO – Conservation Law Enforcement Office; FWA – Fish, Wildlife, and Agronomy; FRM – Forest Resources Management; CETEP – Comprehensive Environmental Training and Education Program; IRP – Installation and Restoration Program; EMS – Environmental Management System; CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act; NEPA – National Environmental Policy Act

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Boiler operation	X											X					X			X		X			X				
Building maintenance/repair (Asbestos)		X	X	X													X	X		X		X						X	
Building maintenance/repair (Lead-based paint)		X	X														X	X		X		X							X
Building maintenance/repair (Radon)		X	X					X									X			X		X							
Bulk Fuel Tank	X	X	X						X		X	X					X			X		X							
Chlorination		X	X									X					X			X		X				X			
Cooling tower O&M												X					X			X		X							
Degreasing (Aerosol)	X	X	X						X								X			X		X							
Degreasing (Aqueous)		X	X									X					X			X		X							
Degreasing (Solvent)	X	X	X						X								X			X		X							
Dining Hall/Restaurant Operation				X								X					X			X		X			X	X			

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Energy Use (Data Center)																	X			X		X			X				
Energy Use (Hanger)																	X			X		X			X				
Energy Use (Industrial)																	X			X		X			X				
Energy Use (Office/Education)																	X			X		X			X				
Energy Use (Residential)																	X			X		X			X				
Energy Use (Retail/ Food services)																	X			X		X			X				
Energy Use (Service/Health Care)																	X			X		X			X				
Energy Use (Warehouse/Storage)																	X			X		X			X				
Engine O&M (Emergency generators)	X								X								X			X		X			X				

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Engine O&M (Portable engine/generator)	X								X								X			X		X			X				
Engine testing (Jet engine test cell)	X								X								X			X		X	X						
Equipment disposal				X													X			X		X							X
Equipment O&M (Aircraft equipment)		X	X						X								X			X		X							
Equipment O&M (Electronics equipment)				X			X										X			X		X							
Equipment O&M (Lubrication)		X	X				X										X			X		X							
Fertilization (Lawn)		X	X									X					X	X		X		X							
Flare and Smoke Usage																	X			X		X							
Freon/Halon System O&M	X	X	X									X					X			X		X							
Fuel analysis (Aviation fuel)		X	X														X			X		X							

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Fuel drain		X	X						X								X			X		X							
Fuel Storage - Containers		X	X						X			X					X	X		X		X							
Fuel transfer (Tank truck)	X	X	X						X								X			X		X							
Fuel transport (Tank truck)		X	X						X								X			X		X							
Fueling (Aircraft/ helicopter)		X	X						X								X			X		X							
Fueling (Boat)		X	X						X								X			X		X							
Fueling (Vehicle)		X	X						X			X					X			X		X							
Grease Traps												X					X			X		X				X			
Grinding		X	X									X					X			X		X			X			X	X
HCP Operation		X															X			X		X							
HM storage		X							X		X	X					X			X		X					X		
HW satellite accumulation area			X						X		X						X	X		X		X					X		
HW storage, < 90-day site			X						X		X						X			X		X					X		
HW transportation			X						X								X			X		X							

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Infantry Training															X		X	X		X		X							
Janitorial services		X	X	X								X					X			X		X						X	
Laboratory		X	X						X								X			X		X			X	X			
Landscaping												X			X		X			X		X							
Laundry (Industrial)												X					X			X		X			X				
Laundry (Non-Industrial/Domestic)												X					X			X		X			X				
Live Fire Range Operations				X		X						X					X			X		X	X						X
Livestock operations	X														X		X			X		X							
Materiel storage/handling (Compressed gas)	X	X	X						X		X						X			X		X				X			
Materiel storage/handling (Salt)												X					X			X		X							
Medical/dental operations		X	X						X			X					X			X		X			X		X		

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Non-destructive inspection									X								X			X		X							
Oil-water separator									X			X					X			X		X				X			
Open burning/open detonation		X	X									X			X		X	X		X		X							
Paint booth (Dry filter)	X	X	X	X					X								X			X		X			X				
Paint gun cleaning	X	X	X						X								X			X		X							
Paint removal (Chemical stripping)	X	X	X						X								X			X		X							X
Paint removal (Dry abrasive blasting)	X		X	X													X			X		X							X
Painting (Aerosol)	X		X														X			X		X							
Painting (Brush)	X		X						X								X			X		X							
Painting (Paint gun)	X		X						X								X			X		X			X				

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Parts replacement (Brakes)		X		X													X			X		X						X	
Parts replacement (Capacitor)				X													X			X		X							
Parts replacement (Tires)				X													X			X		X							
Parts replacement (Transformer)							X		X								X			X		X							
Parts replacement (Vehicle/equipment)				X			X										X			X		X						X	
Pesticide/herbicide application		X	X						X						X		X			X		X							
Photographic developing			X						X			X					X			X		X							
Polishing	X	X	X	X													X			X		X							X
Pumping station/force main			X						X			X					X			X		X				X			

H&C – Historic and Cultural Resources; HM – Hazardous Materials; HW – Hazardous Material; ISWM – Integrated Solid Waste Management; RCRA – Resource Conservation and Recovery Act; P2 – Pollution Prevention; PCB – Polychlorinated Biphenyl; SWMP – Storm Water Management Program; STMP – Storage Tank Management Program; WWMP – Waste Water Management Program; EC&C – Environmental Compliance and Conformance; CLEO – Conservation Law Enforcement Office; FWA – Fish, Wildlife, and Agronomy; FRM – Forest Resources Management; CETEP – Comprehensive Environmental Training and Education Program; IRP – Installation and Restoration Program; EMS – Environmental Management System; CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act; NEPA – National Environmental Policy Act

Environmental Program Manager

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MCBQ Practices	Natural Resources and Environmental Affairs(NREA)																								PWB		NHC	Safety Division	
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Radioactive Material Storage		X	X						X								X			X		X							
Range Residue Clearance			X														X			X		X							
Recreational Facilities Operations	X																X			X		X			X				
Refrigerant replacement	X	X	X						X								X			X		X							
Retail Operations												X					X			X		X			X	X			
Row crop agriculture												X			X		X			X		X							
Runoff sedimentation basins	X	X									X	X			X		X			X		X							
School operation (Military school)				X								X					X			X		X			X				
School operation (Public school)												X					X			X		X			X				
Sediment traps												X			X		X			X		X							

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Sewers	X										X	X					X	X		X		X				X			
Sidewalk and road deicing		X										X					X			X		X							
Small Arms Range Operations	X		X														X			X		X	X						X
Soil excavation/grading	X										X	X			X		X			X		X							
Soldering		X															X			X		X							X
Solid waste collection/transportation	X	X		X							X						X	X		X		X						X	X
Solid Waste Landfill	X	X									X	X					X	X		X		X						X	X
Solid waste recycling collection/transportation (Local collection)		X		X													X			X		X						X	X
Solid waste recycling facility (Scrap Processing)		X															X			X		X						X	X

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Space heater operation	X																X			X		X							
Stump/brush removal	X										X	X			X		X			X		X							
Timber harvesting	X										X	X			X		X	X		X		X							
Underground storage tank (Fuel storage)	X	X							X								X	X		X		X							
Universal waste collection/storage		X	X				X										X			X		X							
Urban wildlife management															X		X	X		X		X							
Used oil/antifreeze storage		X	X						X								X			X		X							
UXO/EOD Operations	X					X											X			X		X	X						
Vehicle operations (Off-road operations)	X	X							X		X	X			X		X			X		X	X						

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Vehicle operations (Tactical vehicle)	X	X							X		X						X			X		X	X						
Vehicle Parking									X			X					X			X		X							
Vehicle Smog Inspection	X																X			X		X							
Vehicle/equipment fluid change		X	X						X								X			X		X							
Vehicle/equipment fluid change (Coolant)		X	X						X								X			X		X							
Vehicle/equipment fluid change (Oil)		X	X				X		X								X			X		X							
Warehouse operation				X													X			X		X			X			X	
Wash rack (aircraft)		X		X					X			X					X			X		X			X				
Wash rack (Vehicle)		X							X			X					X			X		X			X				

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Wastewater effluent discharge (POTW)	X		X						X	X		X					X			X		X				X			
Wastewater effluent discharge (Stream discharge)	X									X		X					X			X		X				X			
Wastewater sludge disposal				X								X					X			X		X				X			
Wastewater Sludge Treatment		X	X						X			X					X			X		X			X				
Wastewater treatment	X	X	X						X			X					X			X		X			X				
Wastewater treatment (physical/chemical treatment)		X	X						X			X					X			X		X			X				
Wastewater treatment (Primary settling)			X						X			X					X			X		X			X				

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Water chiller O&M	X	X										X					X			X		X							
Water distribution (Potable water)												X					X			X		X				X			
Water treatment (non-potable water)												X					X			X		X			X	X			
Water treatment (Potable water)		X										X					X			X		X			X	X			
Weapons cleaning		X	X	X					X								X			X		X							
Welding	X																X			X		X			X				X
Woodworking	X	X		X													x			X		X			X				

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NAVY RADON ASSESSMENT AND MITIGATION PROGRAM GUIDEBOOK

(PROVIDED DIGITALLY)

PART SIX – ATTACHMENTS

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NAVY RADON ASSESSMENT AND MITIGATION PROGRAM

GUIDEBOOK

FOR

NAVAL SHORE INSTALLATIONS

June 6, 2015

prepared for
NAVAL FACILITIES ENGINEERING COMMAND, PACIFIC
Environmental Compliance Product Line
Pearl Harbor, Hawaii 96860-7300
prepared by
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UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ACH	air change per hour
ASD	active soil depressurization
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
ATD	alpha track detector
Bq/m^3	Becquerel per cubic meter
BUMED	US Navy Bureau of Medicine and Surgery
CDC	Centers for Disease Control
cfm	cubic foot per minute
cm	centimeter
COMNAVFACENGCOM	Commander, Naval Facilities Engineering Command
CRM	continuous radon monitor
DoDDS	Department of Defense Dependent Schools
DoDEA	Department of Defense Education Activity
DOE	US Department of Energy
DON	Department of the Navy
DP	differential pressure
EACM	episodic air change measurement
EPA	US Environmental Protection Agency
ER	equilibrium ratio
ERV	energy recovery ventilation
FGS	Final Governing Standards
ft	foot
h	hour
h^{-1}	per hour
HEPA	high-efficiency particulate air
HVAC	heating, ventilating, and air-conditioning
IRAA	Indoor Radon Abatement Act
L	liter
LFE	lateral field extension
LLD	lower level of detection
MERV	minimum efficiency reporting value
NAVFAC EXWC	Naval Facilities Engineering and Expeditionary Warfare Center
NAVFAC Pacific	Naval Facilities Engineering Command Pacific
NAVRAMP	Navy Radon Assessment and Mitigation Program
NRPP	National Radon Proficiency Program
NRSB	National Radon Safety Board
O&M	operation and maintenance
ORNL	Oak Ridge National Laboratory
pCi	picocurie
pCi/h	picocurie per hour

pCi/L	picocurie per liter
PFET	pressure field extension test
ppm	parts per million
PPV	public private venture
QA/QC	quality assurance/quality control
RCP	risk communication plan
RDP	radon decay product
RMP	radon management plan
RPC	radon potential category
RPD	relative percent difference
RRNC	radon-resistant new construction
SAM	supplemental air makeup
SDWA	Safe Drinking Water Act
SMD	submembrane depressurization
SP	shell pressurization
SPT	subslab permeability test
SSD	subslab depressurization
TSCA	Toxic Substances Control Act
UIC	Unit Identity Code
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specification
USGS	US Geological Survey
USMC	US Marine Corps
WHO	World Health Organization
WL	working level
WLM	working level month

1. INTRODUCTION

This document was developed in support of the Naval Facilities Engineering Command Pacific (NAVFAC Pacific) under US Department of Energy (DOE) Proposal 2172-S515-A1 for the performance of radon technical support. DOE assigned the project to its Oak Ridge National Laboratory (ORNL) Building Technologies Research and Integration Center, managed by UT-Battelle, LLC, to assist with this agreement with NAVFAC Pacific.

1.1 PURPOSE OF THIS DOCUMENT

This document explains current radon policy for Navy and Marine Corps personnel in conducting the Navy Radon Assessment and Mitigation Program (NAVRAMP) and provides guidance for the implementation of radon-resistant new construction (RRNC), radon testing, radon mitigation, and radon system maintenance activities within all buildings except family housing. Also provided in this document (Appendix E) is a more detailed discussion of different aspects of radon (e.g., radon and geology, radon entry into structures, exposure risks, risk communication, radon measurement, US Environmental Protection Agency (EPA) protocols, mitigation diagnostics, and mitigation). This information has been provided to serve as an initial reference for installation personnel involved with NAVRAMP implementation and is also suitable for both internal and public dissemination as circumstances dictate.

1.2 DOCUMENT APPLICABILITY

This document is provided as the primary reference and implementation guide for all Navy and Marine Corps radon projects conducted in nonresidential buildings which for the purposes of this document included bachelor housing, lodges, temporary lodging facilities, and transient quarters. It is applicable to all naval installations worldwide. For radon guidance in family housing, please consult *Navy Radon Assessment and Mitigation Program Guidance Document for Navy Family Housing* (US Navy 2002).

1.3 DOCUMENT ORGANIZATION

The document is organized as follows.

Chapter 1: Introduction

- General overview of radon (Section 1.4)
- Suggested installation starting point (Flowchart 1)

Chapter 2: Overview of radon regulations and Navy/Marine Corps radon policy and implementation guidance

- Regulation (Section 2.1)
- Navy radon policy (Section 2.2)

- Marine Corps radon policy (Section 2.3)
- NAVRAMP implementation strategies
  - Radon testing (Sections 2.5 to 2.7)
  - Required NAVRAMP testing status actions for all Navy and Marine Corps installations worldwide (Section 2.8)

Chapter 3: Guidance and instructions for performing radon testing within nonresidential buildings, which for the purposes of this guidebook include bachelor housing, lodges, temporary lodging facilities, and transient quarters

- Radon testing device selection and procedures (Section 3.2.1 to 3.2.6)
- Measurement and data set validation procedures (Section 3.5)
- Testing contractor qualifications (Section 3.3.4)

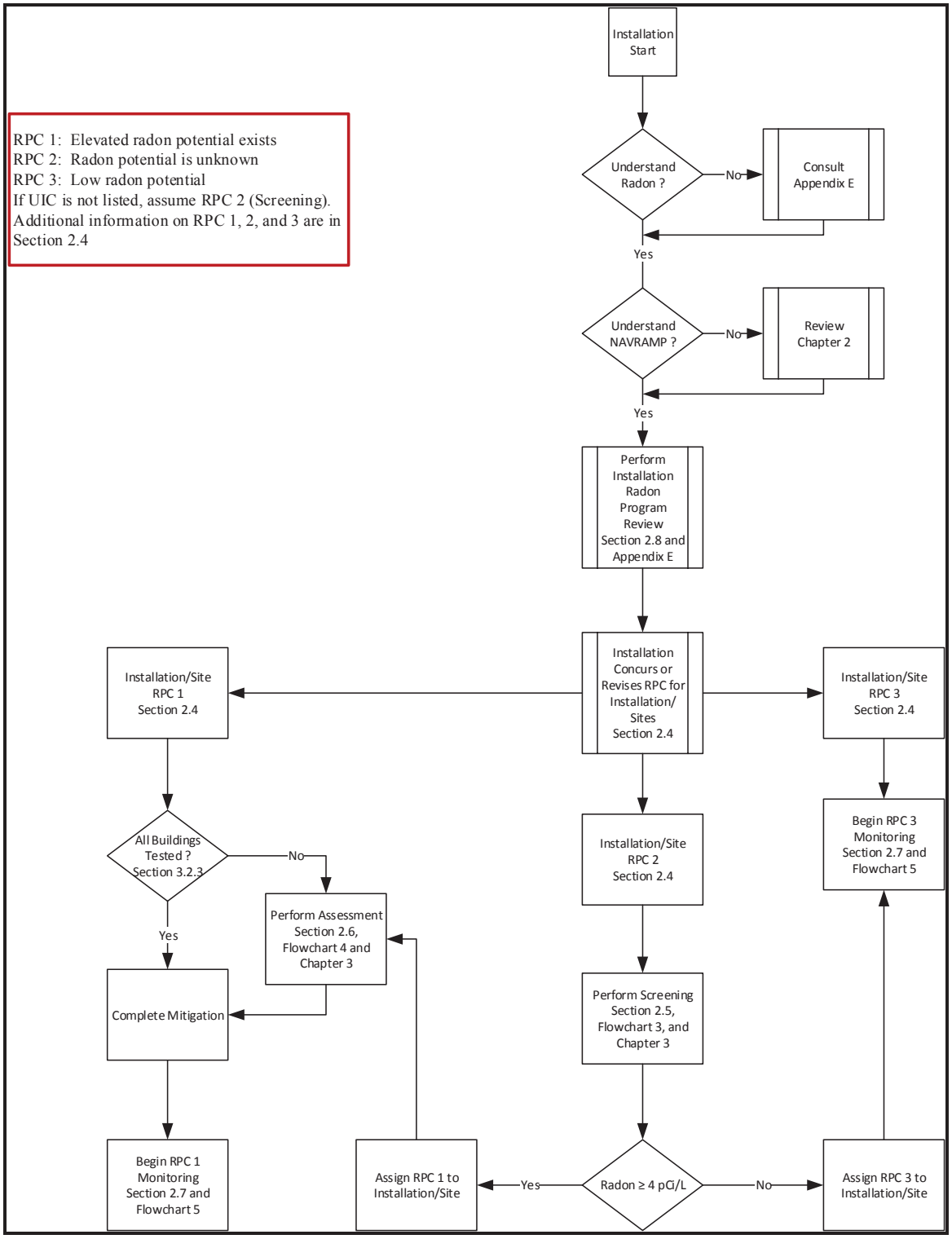
Chapter 4: Guidance and instructions for performing radon mitigation within nonresidential buildings, bachelor housing, lodges, temporary lodging facilities, and transient quarters

- Navy and Marine Corps requirements for radon mitigation systems (Sections 4.1 and 4.2)
- Required maintenance of radon mitigation systems (Section 4.4)
- Mitigation contractor requirements (Section 4.2.6)
- Design considerations for incorporating radon-resistant features in new construction (Section 4.3)

Appendix A: EPA correspondence
Appendix B: Initial radon potential category for naval installations
Appendix C: Example of a radon testing handout
Appendix D: Example of a radon mitigation system inspection form
Appendix E: Radon reference section

- Integration of various EPA, ASTM, and ANSI guidelines, recommendations, and procedures
- Overview of radon and radon entry and retention in structures
- Radon measurement overview
- Radon exposure risk and risk communication information
- Radon mitigation diagnostics and mitigation
- Radon resistance in new construction

Flowchart 1 provides a suggested initial starting point for the installation in the use of this guidebook.



Flowchart 1. Suggested installation starting point for initial use of the document.

1.4 OVERVIEW OF RADON

Radon is a naturally occurring, odorless, colorless radioactive gas that is released from rock, soil, and water as part of the natural decay of uranium. Although radon levels in outdoor air pose a relatively low threat to human health, indoors, radon can accumulate to dangerous levels. Exposure to indoor radon is the second leading cause of lung cancer in the United States and the number one cause among nonsmokers. The EPA estimates that radon causes more than 20,000 lung cancer deaths in the United States each year. Only smoking causes more lung cancer deaths. (EPA 2013, US Surgeon General 1989, BEIR 1998, 1999).

Although elevated indoor radon can come from water supplies or building materials, almost always, the problem comes from radon emanation from the soil under or surrounding a building (EPA 2012). The reason is that radon is chemically inert (it does not interact with other substances), so it can usually move unhindered through 1–2 meters of soil. Once in contact with building components in soil contact (e.g., slab, foundation, wall, crawlspace), it can easily enter into the building through cracks or openings and in some cases diffuse through pores in concrete masonry units or even through solid concrete. It is important to note that after radon enters the building from the soil, many factors influence its retention. Building design, usage, air change rate (a measure of the ventilation rate within a building), occupancy pattern, building shell pressure (buildings under negative pressure typically enhance radon entry), and type and operational patterns of a building's heating, ventilation, and air-conditioning (HVAC) system have all been shown to influence radon levels within a building (EPA April 1994a). Because none of these building factors, including the radon soil gas concentrations under the building, can be accurately measured or estimated, the only way to know for sure if radon is present at unacceptable levels is to test (EPA 2012).

Indoor radon measurements are relatively simple to perform and are essential to assess radon concentration in a building. Performing radon testing is typically not disruptive to the occupants (the most common types of detectors emit no noise or odors) and usually take only a few minutes per testing location to perform. However, radon concentrations within a building do vary from day to day because of episodic weather patterns (e.g., wind, and rain) and can vary significantly from season to season. Because the risk to radon exposure is based on an annualized dose, both the EPA (EPA 2012) and the World Health Organization (WHO 2009) recommend that the radon testing be performed for as long as practical to ensure a representative measurement.

In single-family homes and small commercial buildings (e.g., <5,000 ft^2), one testing location on the lowest occupied level of the building typically is sufficient to determine whether elevated radon is present. Regarding which room to test, studies have shown that most of the time the radon levels do not vary significantly from room to room on the same level in these types of structures. However testing in a centrally located area or room away from outside doors or windows usually gives the most representative results (EPA May 1993). Unlike in these smaller structures, radon levels within large buildings (e.g., >5000 ft^2) such as schools and commercial buildings can and do vary significantly from room to room. In fact, most of the time when elevated radon is found in a large

building, it is typically limited to only a few rooms and the rest have acceptable levels. The primary reasons are the differences in building structure and construction techniques, occupancy patterns, and HVAC operation (WHO 2009). To address this problem, EPA and the American National Standards Institute (ANSI) recommend that all ground-contact rooms in a large building be tested (EPA July 1993 and ANSI 2014a).

In the United States, radon is measured in picocuries per liter of air (pCi/L). EPA and the Centers for Disease Control and Prevention recommend that corrective actions be taken at 4 pCi/L or higher. In addition, EPA also recommends that Americans consider corrective actions for radon levels between 2 pCi/L and 4 pCi/L as well (EPA 2013). As for how soon corrective action should be taken, historically EPA recommended (EPA 1986) a timeline ranging from a few weeks to years, depending on the radon result (i.e., 4 to <20 pCi/L, a few years; >200 pCi/L, a few weeks). However, currently EPA recommends that corrective action be taken for any test result ≥4 pCi/L (EPA 2012) as soon as possible to lower the lifetime risk of radon-induced lung cancer.

EPA divides radon mitigation into two basic categories: passive and active (EPA August 1988). Passive mitigation is defined as a nonmechanical means of radon abatement or control. Examples include sealing cracks in contact with soil, balancing an existing mechanical system, or increasing the natural ventilation rate of the building substructure (i.e., crawlspace). Active mitigation entails the use of mechanical means, such as a fan or blower, to control radon entry into the inhabited space and can be grouped into two categories: pre-entry and post-entry mitigation. Pre-entry mitigation is a technique that retards radon entry into the building. Common examples of this type are shell pressurization (SP) and active soil depressurization (ASD); these include subslab depressurization (SSD) for buildings with slabs and sub-membrane depressurization (SMD) for buildings with crawlspaces. Post-entry mitigation involves the treatment of the radon-laden air inside the room or building. Examples are energy recovery ventilation (ERV) and supplemental air mitigation (SAM). The selection of the most appropriate mitigation method for a building depends on many factors, the most common being building design and usage, installation and long-term operation costs, and aesthetics. To assist with the selection of a mitigation method, EPA recommends that diagnostics (scientific tests that help with the selection of the most appropriate mitigation method) be performed (EPA April 1994a). After mitigation system installation, it is imperative that the system be routinely inspected and maintained and the building retested periodically (EPA April 1994b) to ensure that effective radon control is still occurring.

For proposed new construction, EPA recommends (EPA June 1994) that radon-resistant new construction (RRNC) techniques be considered for all buildings located within areas of known elevated radon potential. Briefly, RRNC entails placing a radon soil gas piping collection network in the subslab aggregated bed before pouring the concrete slab (ANSI 2013). The piping network is in turn connected to a vent riser, which passively exhausts the collected radon above the building, or stubbed out and capped in a convenient location in case it is needed later. If later testing finds elevated radon, this piping network can be made active with the installation of a fan on the vent riser.

Radon exposure represents about 37% of the annual radiation dose for a typical US citizen (Stanford University 2015). As a result, exposure to indoor radon is the second leading cause of lung cancer in the United States and the number one cause among nonsmokers. Since the precursors of radon (i.e., uranium and thorium) are found to some extent in virtually all soil and rock formations worldwide, varying concentrations of radon gas in soil can be found as well. Given the right combination of radon soil gas concentration, soil permeability, suitable entry pathways, and low indoor ventilation rates, virtually every building in the world has some risk potential for elevated radon (WHO 2009). Therefore, unlike the risks associated with lead-based paint or asbestos, the risk from radon exposure can never be removed—it can only be managed by taking appropriate measures. The only way to abrogate the lung cancer risk from radon exposure is to test and, if appropriate, mitigate. If mitigation is required, diligence in the form of inspection, maintenance, and periodic retesting is essential to ensure long-term risk reduction.

1.5 INDOOR RADON ABATEMENT ACT OF 1988

In recognition of the public health hazard presented by indoor radon, the US Congress passed the *Indoor Radon Abatement Act of 1988* (IRAA) and the President signed it into law. IRAA, part of Title III of the *Toxic Substances Control Act of 1988* (TSCA), declares the national goal to be "that the air within buildings in the United States should be as free of radon as the ambient air outside the buildings" (Public Law 100-551, 1988). In addition, the law stipulates that the head of each federal agency that manages a building will design a study to assess the extent of radon contamination in buildings within its jurisdiction and submit that study to EPA.

1.6 BACKGROUND OF THE NAVY RADON ASSESSMENT AND MITIGATION PROGRAM

In response to IRAA, the US Department of the Navy (DON), with concurrence from the Commandant of the Marine Corps, tasked the Commander, Naval Facilities Engineering Command (COMNAVFACENGCOM) to identify naval installations worldwide with elevated radon potential and take corrective action. As a result, COMNAVFACENGCOM created the Navy Radon Assessment and Mitigation Program (NAVRAMP), the goals of which are to

- identify potential hazards to Navy and Marine Corps personnel from exposure to naturally occurring radon gas,
- prioritize corrective actions, and
- coordinate these actions with the Budget Submitting Offices.

DON Message R 191631Z, dated January 1989, authorized the formation of NAVRAMP with the stated purpose of finding and mitigating all Navy and Marine-occupied structures with confirmed elevated levels of radon. When the program was initiated, dedicated funding was provided to enable completion of program objectives via a

centrally managed approach; this funding was subsequently eliminated and the program funding transitioned to being reimbursable and project-specific.

Since the inception of NAVRAMP, the stated overall objective has been to test all Navy and Marine Corps installations worldwide using a sampling protocol that would ensure an overall 95% statistical confidence that no single building would have elevated radon potential. By its conclusion as a centrally funded and managed program in 1994, approximately 31,000 radon measurements had been performed in family housing and 50,000 measurements performed within nonresidential buildings, including billeting and lodging. From those studies, the elevated radon potential of most Navy and Marine Corps installations worldwide was estimated, and the program consequently shifted from a worldwide screening program to more of an ongoing facility environmental program. With these considerations in mind, and relying heavily on lessons learned since the program's inception, COMNAVFACENGCOM has developed and updated implementation strategies to facilitate radon testing at the naval installation level as required under Chapter 25, Section 4 (Periodic Reevaluation and Revision of NAVRAMP) of OPNAV M-5090.1 (US Navy 2014). Therefore, the implementation guidance provided in this guidebook should be considered an extension of the primary policy requirements for full implementation of NAVRAMP at all Navy and Marine Corps installations.

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2. RADON REGULATION, NAVY AND MARINE CORPS POLICY AND GUIDELINES

2.1 REGULATORY OVERVIEW OF RADON

In recognition of the public health hazard presented by indoor radon, the US Congress passed the *Indoor Radon Abatement Act of 1988* and the President signed it into law. IRAA, part of Title III of the *Toxic Substances Control Act of 1988,* declares the national goal to be "that the air within buildings in the United States should be as free of radon as the ambient air outside the buildings" (Public Law 100-551, 1988). In addition, the law stipulates that the head of each federal agency that manages a building will design a study to assess the extent of radon contamination in buildings within its jurisdiction and submit that study to EPA. However, unlike the case for other indoor environmental hazards (e.g., lead-based paint, asbestos), IRAA did not require that any corrective action be taken. With respect to other federal laws, the Occupational Safety and Health Administration regulates radon only at privately owned and operated nuclear facilities under 29 CFR 1910 (CFR 1996). However, for all other types of buildings, at the federal level, radon is still considered a voluntary, nonregulated program.

At the state level, many states (e.g., Illinois, Pennsylvania, and New Jersey) have strict laws requiring that homes be tested and that radon test results be disclosed to the prospective home buyer, and some require radon levels to be reduced to acceptable levels prior to closing. In addition, a number of states (e.g., Pennsylvania, New Jersey, Nebraska, and Rhode Island) have strict laws requiring that the company performing radon services (e.g., testing and mitigation) be licensed within that state. However, at this time, the federal government has not relinquished primacy (e.g., jurisdictional control) to the states for radon.

The *Safe Drinking Water Act* (Public Law 104-102, 1996) directed EPA to make available a multimedia mitigation program to address radon risks in indoor air and from drinking water. However, health risk studies conducted by EPA (http://water.epa.gov/scitech/drinkingwater/dws/radon/proposal.cfm) found that by far, the greatest danger was from the release of radon into the indoor environment by typical water usage (e.g., heating water, cooking, showering). The studies also found that for most water supplies, the cancer risk from the ingestion of radon in drinking water was within the same range as the risk from municipally treated water supplies (e.g., water chlorination). As a result, in 1999 EPA offered the states and federal agencies the opportunity to develop enhanced radon programs to address the health risks from radon in indoor air without necessarily having to test water supplies for radon (EPA 1999). Currently, EPA is encouraging states and sister agencies to adopt this option because it is the most cost-effective way to achieve the greatest radon risk reduction.

More recently EPA (Appendix A) has provided the Navy with clarifications of past EPA protocols and guidelines and made some new recommendations with respect to the management of radon. Recognizing that elevated radon is a highly localized

phenomenon, meaning that radon concentrations can vary significantly from building to building, EPA's overall position is biased toward testing every building at all naval installations (i.e., screening is no longer a best practice). In addition, EPA also made the following points:

1. Family housing should be retested every 5 years and large buildings after every mechanical adjustment (e.g., HVAC systems).
2. EPA reemphasizes that mitigated buildings need to be retested at least every 2 years.
3. New residential construction should be tested before occupancy.
4. Radon action levels in the workplace are the same as those recommended in family housing (i.e., ≤4 pCi/L).
5. High-efficiency particulate air (HEPA) filtration is not recommended as a mitigation method.
6. Preconstruction radon predictions (i.e., soil flux measurements) and the use of radon test data from neighboring areas should not be considered substitutes for radon testing after construction has been completed.
7. RRNC practices are recommended for all new construction within EPA Radon Zones 1 and 2 (EPA 2015; map is included in Appendix E, Fig. 4).

2.2 US NAVY RADON POLICY

The current Navy Radon Policy established in Chapter 25, Section 3.2 of OPNAV M-5090.1 (US Navy 2014) provides the framework for the implementation of the radon program within the Navy. Briefly, it does the following:

1. Instructs all Navy installations to implement NAVRAMP worldwide.
2. Establishes 4 pCi/L as the action level for both residential and occupational radon exposures.
3. Limits radon testing to occupied buildings.
4. Requires periodic inspections and preventive maintenance as appropriate on mitigation systems and periodic retesting of buildings with mitigation systems (at least every 2 years) to ensure the systems are operating properly to reduce building radon levels below 4 pCi/L. In addition, retesting within these buildings is required, if the structures have been significantly modified, to ensure levels are still below 4 pCi/L.
5. Requires, where applicable, that radon-resistant features be incorporated into new building construction.
6. Requires installations to evaluate all existing and new lease agreements to ensure that Navy occupants are afforded the same protection from elevated radon as those that are in Navy-owned buildings.
7. Requires US Navy Bureau of Medicine and Surgery (BUMED) to assist COMNAVFACENGCOM in areas of radon public health assessment and risk communication and evaluate the appropriateness of radon action levels and mitigation schedules for Navy installations.

Chapter 25, Section 3.2 of OPNAV M-5090.1 (US Navy 2014) divides radon testing into three phases:

1. Screening: Installations are instructed to select a statistically significant sample of structures (Section 2.5) with priority given to hospitals, bachelor quarters, schools, child-care centers, and brigs. In the case of small activities, a screening becomes an assessment if the minimum statistically significant number of buildings (31 buildings per installation or 31 housing units per housing area) is equal to or greater than the total number of occupied buildings. Under normal circumstances, screening is performed only once and therefore should not be considered a recurring requirement.

2. Assessment: Installations test all occupied/occupiable testable buildings where valid, confirmed elevated radon levels (e.g., one room or building ≥4 pCi/L) were found during screening (Section 2.6).

3. Monitoring: The installation follows EPA recommendations for retesting after every renovation (e.g., weatherization, whole building replacement, and additions), HVAC modification or replacement, or damage by any events such as earthquakes and storms that would alter the building envelope, at installations with known elevated radon potential. In addition, periodic retesting is required within buildings that have radon mitigation systems to ensure that the radon levels are still <4 pCi/L (Section 2.7).

For installations with structures that have valid, confirmed radon levels ≥4 pCi/L, mitigation of those structures is required in accordance with the timeline outlined in Table 1.

Table 1. Corrective action timeline [a]

Category	**Radon level** (pCi/L)	**Action**
1	0 to <4	No action required
2	4 to <20	Mitigation within 2 years
3	20 to <200	Mitigation within 6 months
4	≥200	Mitigation within 3 weeks

[a] The schedule for corrective action (e.g., the mitigation clock) should be based upon the report date. In cases where confirmation is required, mitigation should be based upon the report date of the initial test.

Overseas Navy and Marine Corps installations may be required to meet the country-specific Final Governing Standards (FGSs) prepared by the Department of Defense (DoD) Environmental Executive Agent based on the host nation's environmental requirements and the Overseas Environmental Baseline Guidance Document.

Per OPNAVINST 5090.1D, Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) maintains a central data management system containing results for radon testing conducted per NAVRAMP implementation guidance (this

document). Installations shall keep records of all NAVRAMP testing data and mitigation projects and shall provide testing data to NAVFAC EXWC per guidance to be provided separately.

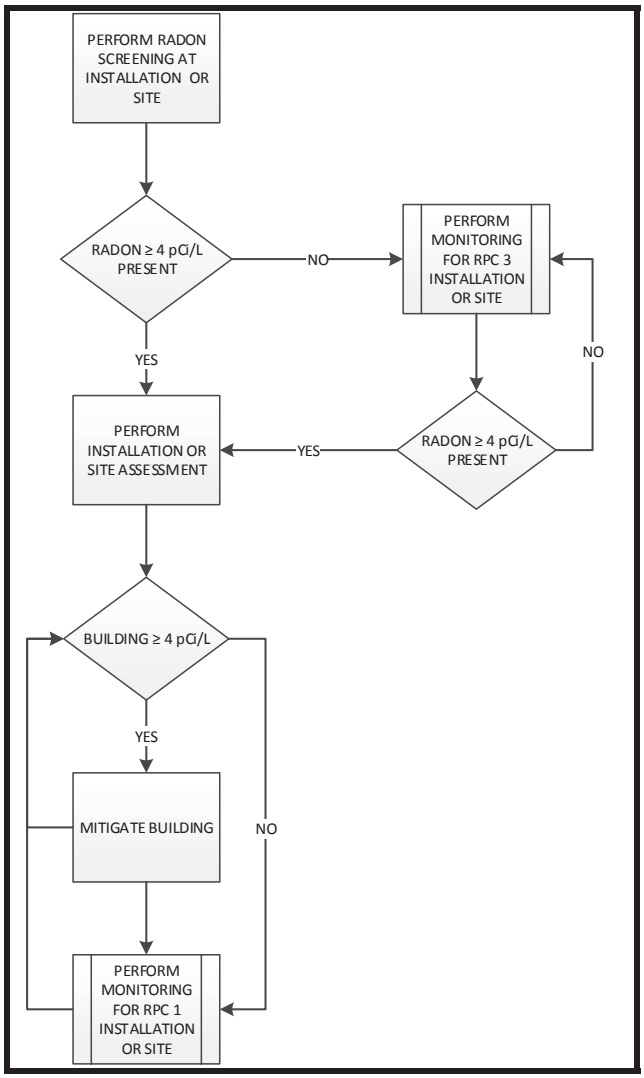
The Navy radon policies in this section have been reviewed and incorporated within NAVRAMP. Therefore any reference to NAVRAMP within this document should be considered synonymous with the policies listed in Chapter 25, Section 3.2 of OPNAV M-5090.1 (US Navy 2014).

2.3 US MARINE CORPS RADON POLICY

Marine Corps policy is established under Section 6207 of US Marine Corps MCO P5090.2A, *Environmental Compliance and Protection Manual* (US Marine Corps 2013). Briefly, the policy states that all Marine Corps installations must implement all phases of NAVRAMP and incorporate radon-resistant designs in new construction where required by historical elevated radon site data, geological conditions, or regulatory requirements.

2.4 NAVRAMP RADON POTENTIAL CATEGORIES

The testing phases listed in Section 2.2 outline a phased approach in which all installations undergo initial screening and, if required, assessment. At the conclusion of these testing phases, each installation is transitioned into a monitoring phase (e.g., screening and assessment under normal circumstances should not be considered a reoccurring requirement) in which additional testing is performed as needed to ensure that radon levels are still below 4 pCi/L (Flowchart 2). Because the monitoring (to some extent radon is found in all soils and geological formations worldwide, so the potential for elevated, indoor radon is always present) needs for each naval installation will ultimately depend on its radon potential, COMNAVFACENGCOM performed a comprehensive review of all Navy and Marine Corps residential and nonresidential radon data reported as of May 2015 (note data on file was collected from 1989 through May 2015). The review found that that a significant number of naval installations had completed the required screening and assessment (Appendix B) and were for all practical purposes in the monitoring phase. At some installations, however, screening and assessment had not been completed; at others, screening, although attempted, was inconclusive. Therefore, it was decided that a simple, easy-to-follow ranking system based on the current radon potential at each installation was needed to better manage the radon program at all levels of the Navy and Marine Corps (e.g., installation, region, and headquarters). The data review also revealed that installations needed additional options for radon management. For this reason, the option of subdividing an installation into smaller, better manageable sites was added (Section 2.4.1).



Flowchart 2. Overview of the NAVRAMP testing and mitigation phases.

Using all historical residential and nonresidential radon data on file as of May 2015, and property information from the Internet Naval Facilities Assets Data Store (iNFADS), COMNAVFACENGCOM assigned each naval installation with shore facilities an initial Radon Potential Category (RPC). The purpose of these assigned codes was twofold: (1) to identify installations in need of initial screening and assessment and (2) to provide an outline for continual monitoring and other actions based on radon potential. Also by design, the RPC designations (listed by unit identification code [UIC] in Appendix B) are changeable by the installation (Section 2.8) for justifiable reasons.

The RPCs are

RPC 1: installations or sites with known elevated radon potential (e.g., elevated radon has been confirmed in one or more rooms)
RPC 2: installations or sites with unknown radon potential

RPC 3: installations or sites with sufficient screening data that indicate low radon potential

For each RPC, the following specific actions are required under NAVRAMP:

- RPC 1 installation or sites
  - All testable buildings (Section 3.2.3) must have been assessed (Section 2.6).
    - Mitigate all buildings with confirmed radon levels ≥4 pCi/L in accordance with the NAVRAMP mitigation timeline (Table 1).
    - Retest all mitigated rooms at least every 2 years,
  - Implement RPC 1 monitoring (Section 2.7.1) at assessment completion.
    - Retest all testable buildings after every 5 years, or after every significant, earthquake, or severe weather event that would alter the building envelope.
    - Test all new or newly acquired buildings and retest significantly modified buildings (e.g., HVAC adjustment or replacement, building envelope modifications).
  - Incorporate RRNC features in all proposed new buildings planned for occupancy.

- RPC 2 installation or sites
  - Complete screening (Section 2.5).
  - Based upon the survey findings, assign as appropriate an RPC 1 or RPC 3 designation for the installation or site.

- RPC 3 installation or sites
  - Implement RPC 3 monitoring (Section 2.7.2).
    - Test all buildings constructed after 2003.
      - The rationale for testing all buildings constructed after 2003 is that some energy-saving features (primarily lower volumes of fresh makeup air, and tighter building envelopes) typically incorporated after this time have been shown to increase the probability of finding elevated radon.
    - Test all recently acquired untested buildings (e.g., newly constructed, or through transfer of ownership).
    - Test all untested Tier 1 buildings (e.g., hospitals, bachelor quarters, schools, child-care centers, brigs).
    - Perform optional monitoring on selected buildings as circumstances dictate (Section 2.7.2).

As was mentioned above, the installation can update the RPC assignments and testing phase (Appendix B) at any time for justifiable reasons. Section 2.8 provides a suggested outline for the installation to follow while conducting the review.

2.4.1 Option of Dividing Installations into Sites for RPC Assignments

During the radon data set review, it was recognized that not all installations are the same. Some naval installations may include just a few buildings at a central location, whereas others have hundreds of buildings distributed over thousands of square miles at numerous locations. Thus the potential exists that a single building with elevated radon at a remote location with respect to the main installation would require the testing of all occupied buildings at the installation. Although doing so is not required for implementing NAVRAMP (i.e., is optional), an installation may find it advantageous if warranted to split a single installation into smaller sites for radon testing and radon program management. The key advantage of this approach is that it would ensure that buildings at sites at the greatest risk from radon would get the required attention, while those with low potential would not be tested or retested unnecessarily.

Valid reasons for creating sites within installation are as follows:

1. Geology varies from location to location; hence, the radon potential could vary as well throughout the installation.
2. Building types vary at the installation. It is not unusual for a naval installation to have distinctly different types of buildings grouped within certain areas of the installation (e.g., shipyards usually have different types of buildings from naval magazines, and the two are usually not intermingled).
3. Administrative reasons may exist in cases of joint basing, for buildings under the jurisdiction of a separate command for which funding or jurisdictional issues may arise, or in cases in which NAVRAMP qualifying leased or international use buildings are involved (Section 2.9).
4. A single building or collection of buildings may not be within the traditional footprint of the installation (i.e., may be located some distance away).
5. A single building or few buildings (atypical buildings) at the installation may have a unique construction style or specialized application (e.g., silos, telecommunication facilities with underground cable vaults, underground facilities, armories, magazines, or other types of atypical structures) that has resulted in elevated radon levels.

If the site option is used, the installation shall assign the most appropriate RPC to each site and implement any required actions for the respective RPC (e.g., complete screening for an RPC 2 site or implement monitoring for an RPC 3 site). The reasons and/or rationale for dividing the installation into sites should also be documented in the installation Radon Management Plan (RMP; see Section 2.10). For administrative purposes, if one or more RPC 1 sites are present, then the installation RPC as a whole will remain RPC 1. However, for installations with combinations of RPC 2 and RPC 3 sites should be assigned the most representative RPC for the installation as a whole. For example, if 8 of 10 sites are RPC 3 and 2 are RPC 2, the installation should pick RPC 3 as the most representative for the installation as a whole (screening would still be need to be completed at the RPC 2 site in this example).

In cases where only one specific building or building type at a site or installation has elevated radon (e.g., an atypical building, see valid reason 5 above), it may be excluded from the installation or site RPC classification to more accurately represent the true radon potential at the site or installation (reason or rationale for using the atypical exception should be documented in the RMP). However, the atypical building will still need to be managed as an RPC 1 structure (i.e., retesting will be required in the future).

2.5 RADON SCREENING

The objective of screening (Section 2.2) is to reach a defensible testing conclusion using a statistically significant sample of structures (i.e., a minimum of 95% confidence that no more than one room has the potential for elevated radon). At the conclusion of the screening, the installation or site (if applicable) would be designated as either RPC 1 (known elevated radon potential) or RPC 3 (low radon potential) and further action taken as required (Section 2.7). Under normal circumstances, an entire installation or site (if applicable) should be screened only once; screening should not be considered a recurring requirement. Therefore, this section applies only to RPC 2 (Section 2.4) installations or sites.

Radon studies (Appendix E, Sections 1.3.3 and 3.1.8) have found that unlike housing, in which room-to-room radon levels are reasonably consistent, radon levels within large buildings may have significant room-to-room variation. Analysis of Navy and Marine Corps radon data in which all rooms in a building were sampled has confirmed this observation. Further analysis of data collected within individual large buildings has also shown that the data cannot be statistically sampled to provide a defensible confidence interval. In addition, within Naval Shore facilities (excluding family housing), studies have shown that buildings vary in size from 1 to over 200 rooms. This level of variation could potentially lead to a case in which a statistically significant number of buildings selected for screening would not offer a comparable and defensible statistical confidence if the total number of testable rooms (a room that is occupied or easily occupiable in a testable building and that is either in ground contact or over an unoccupied ground contact basemen room or crawlspace, see Section 3.2.4) within the population were taken into account. For these reasons, and to be consistent with EPA and ANSI testing guidelines (EPA July 1993, ANSI 2014a), in buildings selected for screening, the testing of all ground-contact, occupied or easily occupiable rooms is required. Additional information on radon testing, data validation, and other testing considerations is presented in Chapter 3.

2.5.1 Radon Screening Sampling Considerations

The primary advantage of screening vs. assessment (testing all buildings) is the presumption of a significant cost savings. Although analysis of past screening projects within the Navy and Marine Corps has demonstrated cost savings at large installations (e.g., >3,000 rooms), the total cost savings for screening at medium or small installation (e.g., <3,000 rooms) has been brought into question. In a screening project, a significant amount of effort must be invested in both the planning and the data analysis portions of the project. Whereas the conclusions in an assessment are mostly self-evident (all

buildings tested and no extrapolation is needed for potential rooms >4 pCi/L), a proper screening project requires a representative sampling of all types of buildings and a good geographical distribution at the installation or site (geology, hence radon potential, can vary significantly in small areas). Once testing is completed, calculations must be made to ensure that the 95% confidence interval was met and, in some cases (Section 2.5.2), statistical modeling is performed to estimate the number of rooms >4 pCi/L. The costs for these planning and data analysis efforts may in some cases exceed the actual costs of simply testing all of the buildings. Therefore, during the planning stages, total costs (planning, field testing, data analysis, and reporting) for statistical screening vs. assessment should be compiled and the best overall value for the Navy or Marine Corps selected.

The number of testable buildings (Section 3.2.3) proposed for screening at the installation or site is a consideration as well. Under NAVRAMP (Section 2.2), if the number of buildings is ≤31, all should be tested. Using average historical sample densities in past radon surveys in the Navy and Marine Corps (e.g., average rooms per building), 31 buildings equates to around 500 to 700 rooms. However, cost analysis of projects of this size has found no significant increase in costs for projects of up to 1,000 rooms or about 45 buildings. Therefore, it is recommended that if ≥32 buildings are present, but there are <1,000 testable rooms (Section 3.2.4) present, assessment be performed as well.

An important consideration may be a need for expediency due to potential health concerns or funding cycles for radon testing. In some cases, planning (i.e., the selection of the best method for screening and ultimately the selection of the buildings to test) may take several months to complete, in addition to the time for data analysis after the testing has been completed. Therefore, in these cases, assessment—which has a shorter life cycle compared with screening (typically 3 to 6 months less)—may be the more appropriate choice.

Another consideration is the probability that screening will find elevated radon potential (recall that all buildings will need to be tested if the screening finds one room with elevated radon). In that case, all the remaining buildings would need to be tested, making it necessary to accrue costs for another round of mobilization/demobilization. Therefore, in the initial planning stages of screening, an attempt should be made to ascertain the radon potential of the site or installation from US or host government sources (this would also include Navy, Marine Corps, and other DoD data collected in or near the installation) and past radon surveys at the installation. For naval installations located within the United States or its territories, radon potential information can be obtained online at http://www.epa.gov/radon/zonemap.html (Appendix E, Fig. 4) or from the EPA regional radon point of contact. For overseas locations, the applicable counterpart within the host government should be consulted. If it can be determined via these governmental or other reliable data sources that the installation or site is located within an area of known elevated radon potential (e.g., the installation or site is located within an EPA Radon Zone 1 or 2, see Appendix E, Section 1.2.1), then assessment (testing of all occupied buildings) is recommended over screening.

If the site option is used, it should not be considered unusual for some sites to be selected for screening while others are selected for assessment. Therefore, if doing so is desirable because of cost or other logistical considerations, the entire installation can be tested over several years based on the testing needs of each site (e.g., performing site screening in years 1–2 and site assessments in years 2–3).

In summary, all installations or sites (if applicable) are required to undergo initial screening. However, assessment in lieu of screening of an installation or site should be considered when

- the number of testable buildings is ≤31, or
- the total number of testable rooms is <1,000, or
- reliable data sources have indicated that the installation or site is within an area of known elevated radon potential (i.e., EPA Radon Zone 1 or 2 or the equivalent), or
- because of logistical or other considerations, the cost of screening is comparable to that of assessment.

2.5.2 Statistical Screening Implementation

For an RPC 2 installation or site, if none of the above criteria applies that would warrant assessment (i.e., ≤31 buildings or <1,000 rooms, or known elevated radon potential in the area), then screening should be performed. The following steps are provided as a guide.

Step 1: Estimation of Overall Population Size

In preparation for executing a statistical screening project, a list of all potentially testable buildings (those planned for demolition within the next 2 years should be excluded) should be prepared, including an estimate of the number of testable rooms per building (Section 3.2.4). The list shall also include NAVRAMP-qualifying leased buildings and international agreement buildings (Section 2.9). If applicable, these buildings then should be grouped into their respective sites. If the site option is used, the total number of testable buildings (Section 3.2.3) should be counted and the number of rooms summed. If the total number of testable buildings per site is ≤31 or <1000 rooms, then all buildings at that site shall be tested and removed from further screening consideration.

Step 2: Identification of Priority Buildings to Test

The primary usage of each building should be reviewed, each building placed in one of the following classifications, and the number of testable rooms in each tier totaled.

Tier 1: Includes all hospitals, bachelor quarters, schools, child-care centers, and brigs.

Tier 2: Includes all 24 h manned facilities, such as but not limited to command and communication facilities, fire stations, lodges, and security buildings.

Tier 3: Includes all offices and administrative buildings, exchanges, commissary, shops, recreational facilities (i.e., fitness centers, theaters), warehouses, and other work areas.

Tier 4: Includes atypical buildings such as but not limited to armories, occupied magazines, underground facilities, and buildings with unique construction characteristics.

Step 3: Selection of a Screening Option

Many statistical models are available for estimating sample size. However, it is difficult for most of those models to establish statistical confidence as the number of potential positive results in a population approaches 1 or 0 (DOE 1990). Therefore, the following options are proposed for installation or site screening to achieve the minimal 95% confidence interval that no more than one room contains elevated radon within the population. However, as discussed earlier, estimated costs for full assessment (i.e., testing of all buildings) should be collected as well to ensure that the best overall value for the Navy and Marine Corps is being obtained.

Screening Option 1: Fixed Sample Density

In this approach, a fixed sample density (e.g., percentage of rooms to test) of sufficient magnitude is used to ensure a 95% confidence interval, assuming a low frequency of elevated radon (i.e., 1%). In this approach, no special mathematical or computer skills are required for data analysis. For this option, the selected detectors (Section 3.2.2) must have ≤15% measurement error (accuracy and precision information is available from the manufacturer), and testing must be 1 year in duration (under NAVRAMP, any radon test between 335 and 395 days in duration is considered a 1 year test). To ensure adequate sample density, a minimum of 80% of the total testable rooms at the installation or at each site shall be tested for radon. All Tier 1 buildings will be included, with the remaining balance made up of Tier 2 followed by Tier 3 buildings. Exceeding the 80% minimum to include entire buildings for testing to make up the balance is permitted. Testing all Tier 4 buildings is also recommended (these buildings cannot be included in the 80%) because of the higher-than-expected frequency of elevated radon found in such buildings in other studies. In addition, installation maps should be consulted to ensure good spatial coverage. If required, additional buildings above the prescribed minimum may be added in some areas to ensure adequate coverage.

At the conclusion of the survey (assuming that all data quality objectives of the survey are met; see Section 3.5), RPCs (RPC 1 or 3) can be assigned to the installation or sites (if applicable) based on the highest single average radon result (e.g., RPC 3 if the highest single average result is <4 pCi/L and RPC 1 if the highest single average result is ≥4 pCi/L).

Option 2: Enhanced Statistical Method

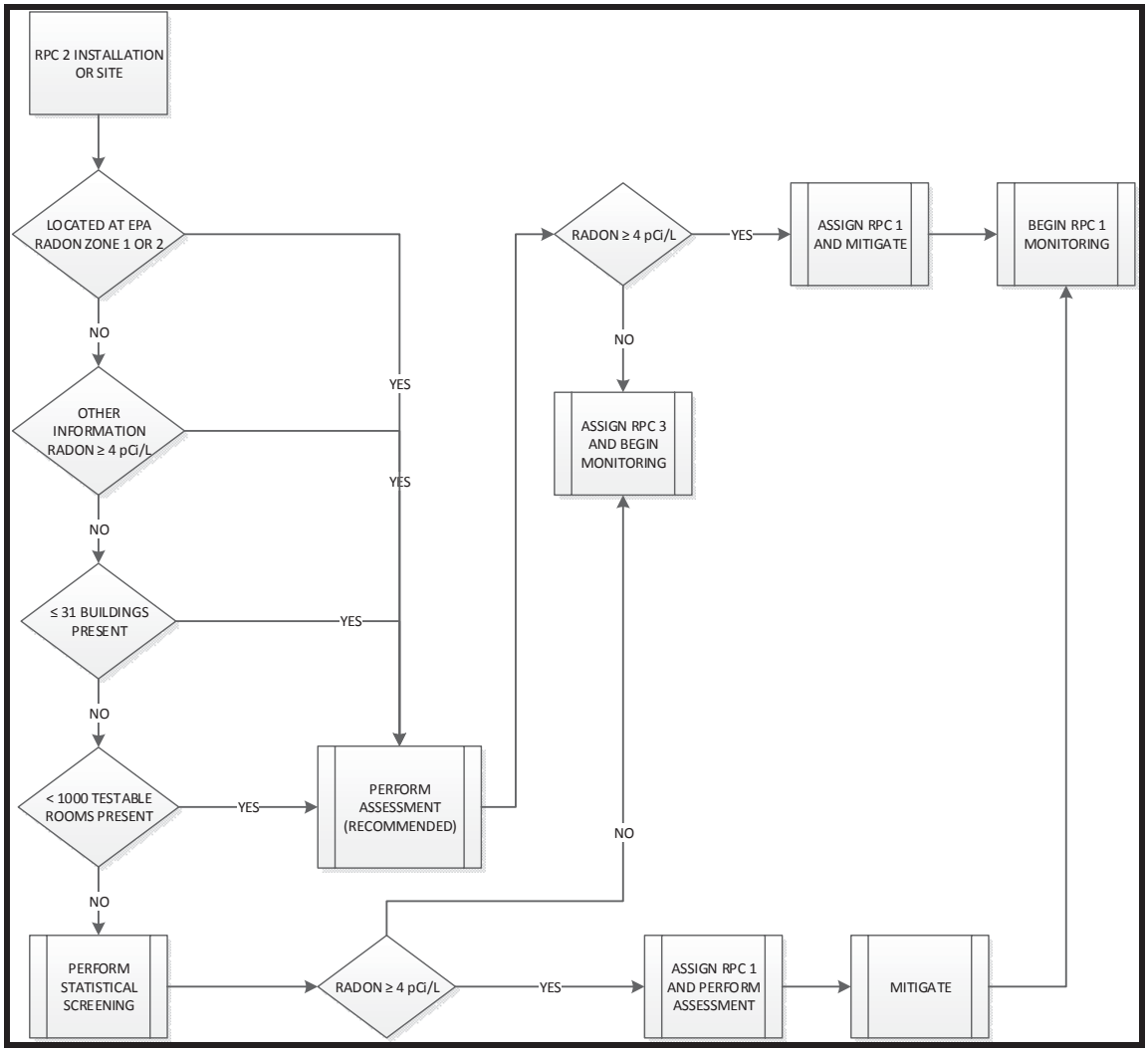
This approach takes advantage of the fact that a superior-quality radon data set (i.e., ≥175 results) collected at a site or installation usually (e.g., 90% of the time) follows a known statistical distribution (lognormal, normal, or exponential). Taking advantage of this fact can significantly reduce the total number of tests required to achieve a 95% confidence level (DOE 1990). However, during data analysis, advanced computer and statistical skills are required to generate the dataset curves for the installation or each site (if applicable) used to estimate the number of rooms ≥4 pCi/L. As a result, the cost per measurement for this approach is sometimes higher than for screening option 1 or for assessment. Therefore, this option should be considered for use only at larger installations or at sites with >3,000 rooms.

For this option, the selected detectors (Section 3.2.2) must have ≤15% measurement error (accuracy and precision information is available from the manufacturer) with no upper limits on the number of blanks and spike detectors (Section 3.3.1). In addition, the duration of the survey must be 1 year (under NAVRAMP, any radon test between 335 and 395 days in duration is considered a 1 year test). Furthermore, all of the sampling at the installation or each site should be performed within the same time period (e.g., detector placement and retrieval cannot be spread out over several months or years).

Sampling of at least 33% of the total testable rooms at the installation or site (excluding Tier 4) is required. However, because of other sampling considerations (e.g., primarily detector accuracy and precision), an accredited, professional statistician (i.e., American Statistical Association accreditation or equivalent) should review the proposed sample density to ensure that the proper minimum number of rooms are tested.

All Tier 1 buildings shall be included, with the remaining balance made up of Tier 2 followed by Tier 3 buildings. Testing all Tier 4 buildings is also recommended (although they should not be included in the model) because of the higher-than-expected frequency of elevated radon found in other studies. In addition, installation maps should be consulted to ensure good spatial coverage. If required, additional buildings may be added in some areas to ensure adequate coverage.

After the data have been collected and validated (Section 3.5), a simple inspection is used to verify that all results are <4 pCi/L. If valid data are found to be ≥4 pCi/L, the installation or site is assigned an RPC 1 Assessment designation and actions are taken as appropriate (Section 2.6). However, if all results are <4 pCi/L, then the results will need to be analyzed by an accredited, professional statistician using nonlinear regression models (as a minimum, lognormal, normal, and exponential) to determine the best fit for the data distribution. Using the best curve fit for the installation or site, estimate the number of rooms ≥4 pCi/L assuming a 95% confidence interval. If the number of rooms estimated is less than one, then the installation or site is assigned an RPC 3 designation. However, if one or more rooms are projected to be >4 pCi/L, then the remaining buildings at the installation or site should be tested before the final RPC assignment. An overview of the screening phase is shown in Flowchart 3.



Flowchart 3. Overview of screening phase.

2.6 RADON ASSESSMENT

Simply stated, the purpose of the radon assessment is to test all testable rooms within all testable buildings (Section 3.2.3 and Section 3.2.4) including applicable leased and international use agreement buildings (Section 2.9) at the installation or site. The only exception to this requirement is buildings proposed for demolition within the next 2 years. Within buildings proposed for significant modification (see definition of significantly modified) that would coincide with the radon testing, the testing should be deferred until after completion. The completion of a radon assessment is mandatory for all RPC 1 installation or sites. In addition, RPC 2 installation or sites may be included in assessments under specific circumstances (i.e., ≤31 buildings or < 1,000 rooms, or known elevated radon potential in the area, or cost considerations if the assessment costs are comparable to those of screening). In preparation for the assessment, a dated list of all testable buildings needs to be compiled, including the estimated number of testable rooms per building (Section 3.2.4). Buildings previously tested may be excluded from

the proposed assessment provided all testable rooms in the building have valid radon test data and the testing was performed within the last 5 years. However, consideration should be given to retesting buildings that meet these criteria if they have been significantly modified or if they have been damaged by events such as earthquakes or storms since the previous radon test. If these buildings cannot be included in the assessment, then they will need to be tested later under radon monitoring (Section 2.7).

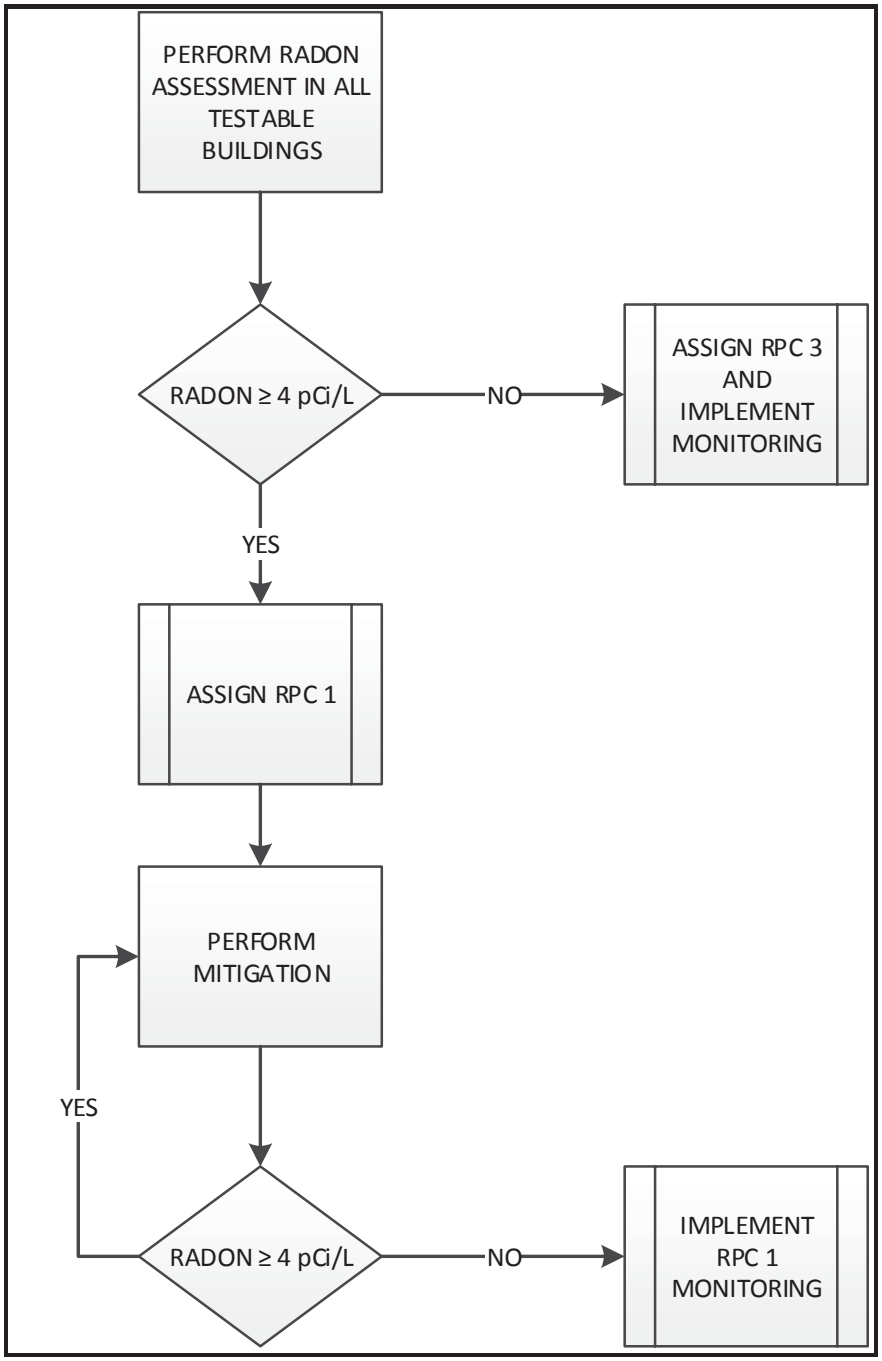
Unlike certain types of screening in which all the testing (e.g., detector placement and retrieval) needs to be performed during the same time period, assessment testing at an installation or site can be performed over extended time periods (e.g., months or years) if needed, provided the minimal testing duration requirements are met (Section 3.2.1).

For assessment testing, the selected detectors (Section 3.2.2) must have ≤25% measurement error (accuracy and precision information is available from the manufacturer), and long-term exposure (i.e., >90 days, with 1 year preferred) is recommended. However, under certain circumstances, short-term testing (e.g., 2 to 90 days) can be used under very stringent testing conditions (Section 3.2.1).

If the assessment is being performed at an RPC 2 installation or site, at the conclusion of the testing (assuming all data quality objectives of the survey are met; see Section 3.5), the appropriate RPC (RPC 1 or 3) is assigned to the installation or site (if applicable) based on the highest single average radon result (e.g., RPC 3 monitoring if the highest single average result is <4 pCi/L and RPC 1 monitoring if the highest single average result is ≥4 pCi/L). Future action is taken as required based on the assigned RPC (Section 2.4).

By design, under normal circumstances, an RPC 1 installation or site is assessed only once. Once the assessment phase has been completed, the installation or site transitions to the monitoring phase (Section 2.7) in which additional testing is performed and actions are taken to ensure that radon levels are maintained <4 pCi/L for all buildings. However, in cases where most of the buildings have been tested, and in particular where mitigation has already occurred, consideration should be given to transitioning to the monitoring phase, with emphasis given to testing the remaining buildings.

Flowchart 4 provides an overview of the assessment phase. Additional information on radon testing, data validation, and other testing considerations is presented in Chapter 3.



Flowchart 4. Overview of the assessment phase.

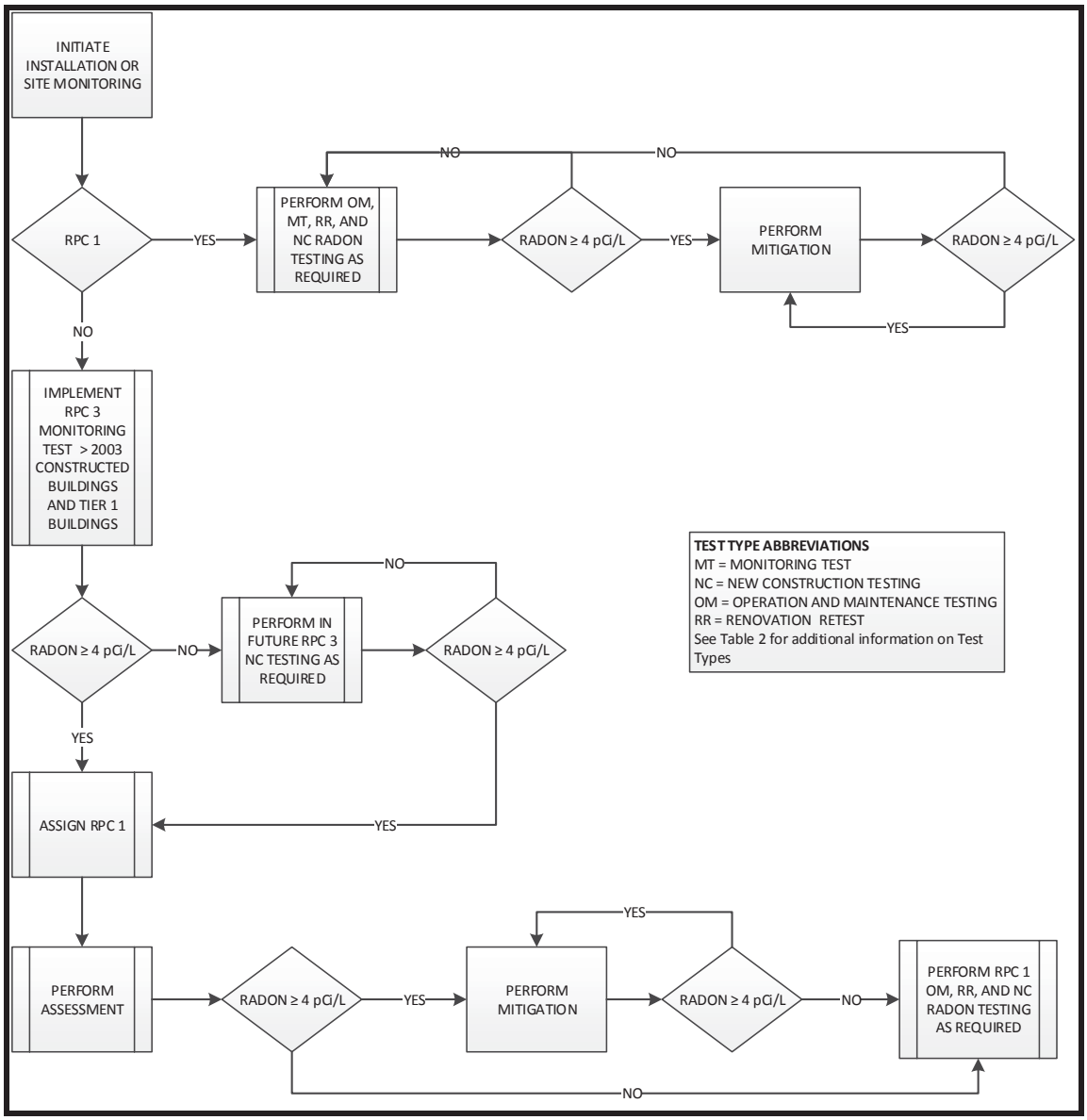
2.7 RADON MONITORING

As was stated in Section 2.4, the purpose is to transition all Navy and Marine Corps installations into a monitoring phase after screening and if applicable assessment has been successfully completed. Because radon emanates from soil and geological formations under the building, unlike the risks associated with lead-based paint or asbestos, the risk from radon exposure can never be removed. It can only be managed by taking appropriate, ongoing measures, including further radon testing at installations or sites with no known potential for radon (see below).

Under NAVRAMP, installations or sites that were successfully screened and were found to have no elevated radon are automatically placed into the monitoring phase and assigned a RPC 3 monitoring designation. However, those that are known to have elevated radon and that have successfully completed assessment are designated RPC 1 monitoring. Because the radon potentials are different (i.e., one has known elevated radon potential and the other does not), each of these monitoring subcategories (i.e., RPC 1 and RPC 3) has its own specific testing requirements (Sections 2.7.1 and 2.7.2, respectively). It is important to note that if the site option is used at the installation, it is not a requirement that the testing requirements for other sites at the installation be completed for a qualifying site to be incorporated into the monitoring phase.

For monitoring testing, the selected detectors (Section 3.2.2) must have ≤25% measurement error (accuracy and precision information is available from the manufacturer), and testing can be either short-term (i.e., <90 days) or long-term exposure (i.e., >90 days). Unless otherwise specified, radon testing within individual testable buildings shall be performed in all testable rooms with the noted exception of diagnostic, postmitigation, and operations and maintenance (O&M) testing (see Section 3.2.1, Table 2, for descriptions of test types). For RPC 3 sites, reassignment to RPC 1 is required if monitoring determines elevated radon potential at the site (e.g., valid, confirmed radon results ≥4 pCi/L). Similar to testing in the screening and assessment phases, all testable rooms are tested in the building (excluding diagnostic, postmitigation, and O&M testing, see Section 3.2.1, Table 2). Flowchart 5 provides an overview of the monitoring phase.

Unlike certain types of screening in which all testing needs to be performed during the same time period, monitoring testing at an installation or site can be implemented by building on an as-needed basis or performed over several years for a larger numbers of buildings. Additional information on radon testing, data validation, and other testing considerations is provided in Chapter 3.



Flowchart 5. Overview of the monitoring phase.

2.7.1 Types of Monitoring at RPC 1 Installations or Sites

Because elevated radon potential is known at an RPC 1 monitoring installation or site(s), periodic monitoring is mandated for all buildings as follows.

- Perform radon assessment (Section 2.6) in any untested, testable building,
- Retest all testable buildings
  - after every renovation (e.g., weatherization, whole building replacement, addition),
  - after every HVAC modification or replacement,
  - after damage by any event such as an earthquake or storm that would alter the building envelope, **<u>or</u>**

- simply retest every 5 years.
- In buildings with mitigation systems, retest the affected rooms (i.e., those that were identified as having elevated radon and mitigated) at least every 2 years.
- Test all newly acquired buildings before occupancy or within 5 years of occupancy.

2.7.2 Types of Monitoring at RPC 3 Installations or Sites

Because a successful screening has indicated that low radon potential exists at a RPC 3 monitoring installation or site(s), the primary purpose of this type of monitoring is to ensure that Tier 1 buildings (e.g., hospital, bachelor quarter, school, child-care center, brig) are tested, and that all testable building constructed after 2003 are tested to ensure that no elevated radon levels are present. Testing Tier 4 buildings is also recommended because of the above average frequency of elevated radon found within these types of buildings. Because this is not a recurring radon test, the results collected for these buildings as part of previous testing projects (e.g., screening, pre-occupancy clearance testing) can be used to meet this requirement provided they meet or exceed NAVRAMP testing standards (Section 3). In addition, these buildings do not need to be retested after every renovation, HVAC adjustment, and the like. With respect to future new construction, although EPA recommends testing before occupancy, studies have shown that the best time to test is actually 2–3 years later to allow more time for the concrete to settle and dry. Therefore, testing of newly acquired buildings can be performed at any time up to a maximum of 5 years after the occupancy date. However, in recognition of the fact that radon is dynamic, optional (i.e., not required) radon testing may be performed as part of an expanded monitoring program at RPC 3 installations or sites as specific circumstances as defined by the installation dictate. Examples for expanding the radon monitoring program at the installation would include, but would not be limited to, the following circumstances:

1. An existing building or group of buildings was significantly modified in such a way that they are different from the general building population at the installation.
2. Medical or health concerns exist about the indoor air quality within an existing building or buildings.
3. The radon data for selected buildings is >5 years old and there are reasons to suspect that the results are no longer representative of the indoor radon concentration.

For RPC 3 sites, a reassignment to RPC 1 is required if monitoring determines elevated radon potential at the site (e.g., valid, confirmed radon results ≥4 pCi/L).

2.8 INSTALLATION REVIEW OF NAVRAMP TESTING STATUS

As was discussed in Section 2.4, COMNAVFACENGCOM assigned all installations with shore facilities an initial RPC (see Appendix B; if your installation is not listed, assume an RPC 2 initial assignment). In making the initial assignments, all valid, historical and current radon data on file were used (residential and nonresidential collected from 1989 through May 2015). Also taken into consideration was the overall sample density at the installation and within particular buildings based on information provided in iNFADS (e.g., did an installation test a minimum of 31 buildings or at least 31 units per neighborhood, see Section 2.2, 2.5, and 2.6). It is important to note that because of DON installation consolidation, and radon testing performed since the decentralization of NAVRAMP in 1994, the totals in Appendix B may differ from those in official correspondences sent to the installation by ORNL in 1994 and those reported in the NAVRAMP final project report (DOE 1994).

Briefly, the RPCs (Section 2.4) are:

- RPC 1: One or more valid, confirmed radon results ≥4 pCi/L was present at the installation.
- RPC 2: Based on past and present radon policies, insufficient data exist to project the current radon potential for the nonresidential buildings at the installation (this would also include billeting, lodges, and transient quarters).
- RPC 3: Sufficient radon data (including family housing data) exist to conclude that the installation has a low radon potential.

It is also important to note that the RPC (a unique term developed by COMNAVFACENGCOM for NAVRAMP) is not related to the EPA radon map potential zones (http://www.epa.gov/radon/zonemap.html), which are similarly numbered. RPCs are assigned based on actual Navy/Marine Corps radon test data collected at the installation. The EPA radon map zones are based on limited data collected over large geographical areas and lack the resolution needed for Navy and Marine Corps monitoring applications. However, the EPA Zone designation may be used as a justification to skip installation screening and perform assessment if the installation is located in an EPA Zone 1 or Zone 2 area or its host nation's equivalent (Section 2.5).

In the initial part of the installation review, a decision needs to be made whether to implement NAVRAMP as an installation-wide program or as a series of sites (Section 2.4.1). This decision need not be based solely on distance and geological and structure details but can also be based on potential health concerns (e.g., was this area sampled sufficiently) and administrative issues [e.g., a different DoD agency in a joint base–type arrangement, qualifying leased and international use agreement buildings (Section 2.9)]. In addition, from a program management perspective, sites are managed akin to "mini installations" with their own RPCs, testing requirements, and schedules (Section 2.5 to 2.7). Therefore, the use of this option may provide the installation greater flexibility in getting more buildings into the monitoring phase (Section 2.7) in the shortest period of time.

After the site issue has been decided, the next step is to confirm or revise the installation RPC value and, if applicable, assign values to individual sites. The following are suggested steps.

- Consult all the radon data on file for the installation (data for family housing and other residential structures and nonresidential data can be used).
- If needed, consult building inventory information in iNFADs.
- In cases where only screening has been performed, consult installation maps to ensure that the testing had an adequate footprint.
- If the initial RPC is RPC 1, verify that the results ≥4 pCi/L were valid (Section 3.5) and were not collected in atypical buildings.
- If the initial RPC is RPC 2, using the data on file (there may be additional data that were not on file during the review), determine if screening has been completed (Section 2.5).
- If the initial RPC is RPC 3, verify that sufficient screening was performed.
- Assign updated RPCs as appropriate based upon your review.
- Document these findings and conclusions in the installation RMP (Section 2.10) or in a memo to file.

It is also important to note that radon mitigation of one or more buildings at an installation or site does not reduce the radon potential for all other buildings (e.g., mitigating a building does not alter the geological potential, it only controls the radon levels in that particular building or room). Therefore, RPC 1 would still apply.

Examples and rationales for appropriate installation RPC changes at an installation without elevated radon would include, but are not limited to, the following.

1. Changing an RPC 3 to an RPC 2
   a. The screening data were insufficient to arrive at a defensible testing conclusion at this installation.
   b. The screening data were collected at a different site or location from this installation.
   c. The screening data summarized in Appendix B were not collected at this UIC.
   d. The screening data are outdated and the buildings screened are no longer representative of the types of buildings at the installation.
2. Changing an RPC 2 to an RPC 3
   a. Additional valid radon test data that were not included in the COMNAVFACENGCOM database were identified and are sufficient to arrive at a defensible testing conclusion at this installation.
   b. The installation radon program could be better managed as an RPC 3 monitoring installation.
   c. Screening was performed successfully (Section 2.5) and no elevated radon was found.

However, for RPC 1 installations (elevated radon has been detected), the rationale needs to be more specific and defensible, since elevated radon results have already been reported. Therefore, the installation must review the radon data more closely and make a determination based on the elevated results. The following are examples of rationales that would be defensible reasons to disqualify an elevated radon measurement.

1. Valid, confirmation, follow-up, or diagnostic measurements support the absence of elevated radon (historical or more recent).
    a. To be considered as defensible, these subsequent tests must have been performed in the same room and, if the room is >2000 ft^2, at the same location.
        1) If room and location are in doubt, retest the entire building.
    b. The EPA average (Section 3.2.10) was applied to the initial and follow-up measurements and the average was <4 pCi/L.
2. The elevated result is at a location (Section 2.4.1) that is no longer controlled or owned by the Navy or Marine Corps.
    a. Data collected in a former Navy or Marine Corps family housing area that has since been privatized cannot be disqualified unless the neighborhood could be considered a separate site (Section 2.4.1).
3. More recent radon screening (Section 2.5) or assessment (Section 2.6) at the installation found no elevated radon.
4. The elevated results in question were collected within an atypical type room or building (Section 2.4.1).
    a. In this case, the room or building would still be managed as an RPC 1 site, but the overall installation RPC could be changed.

The next step in the installation review is to determine the most appropriate NAVRAMP testing phase (Section 2.2) for the installation or site(s). As was illustrated in Flowchart 2, the objective of NAVRAMP is to transition all naval installations worldwide into the monitoring phase of the program (Section 2.7). Doing so requires that screening and assessment (if applicable) be completed. However, all RPC 3 installations or sites are by default already considered to be in the monitoring phase. Therefore, the only required action is to implement RPC 3 monitoring as needed (Section 2.7.2). Likewise RPC 2 installation or sites are by default considered to be in the screening phase. Therefore, screening (Section 2.5) must be completed, and, if required, assessment (Section 2.6) before the monitoring phase can be implemented. However, RPC 1 installations or sites can be either in the assessment testing phase, meaning that most of the buildings still require testing, or the monitoring phase, which means that most if not all of the testing has been completed. However, in cases in which only a few buildings remain to be tested, particularly where mitigation has already occurred, consideration should be given to transitioning to the monitoring phase with emphasis given to testing the remaining untested buildings.

2.9 IMPLEMENTATION OF NAVRAMP WITHIN LEASED BUILDINGS

Navy (Chapter 25, Section 3.2. Section c of OPNAV M-5090.1 [US Navy 2014]) and Marine Corps policy (MCO P5090.2 [US Marine Corps 2013]) affords the same protection from radon exposure to Navy or Marine Corps personnel (includes military, civilian, and dependents) who are occupying testable buildings that are not Navy or Marine Corps owned. In consultation with appropriate legal counsel, installations must evaluate all current and future lease agreements to determine who has the main responsibility for radon testing and mitigation (if applicable). This requirement also applies to buildings used at overseas facilities under international use agreements, and to public–private ventures. If it is determined that the Navy or Marine Corps is responsible, then those buildings shall be tested and mitigated in accordance with all applicable NAVRAMP requirements. If it is determined that the lessor or host government is responsible, then the installation shall work with these parties to ensure that the buildings are tested and mitigated if required. If the responsibility cannot be determined, then the lease or agreement shall be renegotiated to empower the Navy or Marine Corps to implement NAVRAMP within these buildings. With respect to the construction of new buildings for long-term leases (e.g., leases, limited partnerships, and international use agreements), the naval installation shall consider the incorporation of RRNC features (Section 4.3) if the Navy or Marine Corps will be responsible for implementing NAVRAMP after construction has been completed.

For naval installations located at a non-Department of the Navy Joint Base, it should be determined if the host is in compliance with their respective service radon program. If not, then the installation should consult higher headquarters for further instruction.

2.10 RADON MANAGEMENT PLAN

All installations regardless of radon potential should develop and sustain an RMP. The primary purpose of an installation RMP is to serve as the primary document of the oversight mechanism for the entire radon control program. In addition, the document serves as a major means of maintaining program credibility and provides a quick reference for those who are new to or outside of the radon program at the installation. The RMP should be reviewed and updated every 5 years or as needed to ensure that the information within the document is current.

The following minimal outline is provided to facilitate RMP development; however, additional information or topics may be added by the installation as needed for further clarity.

Section 1: Introduction

- Date finalized
- Name and title of the preparer
- RMP coverage (e.g., all buildings, plus housing)
- Name and title of radon technical lead at the installation
- Suggested optional subsection: overview of roles and responsibilities for potential team members, for example
  - installation maintenance (periodic inspections, maintenance and repair of mitigation systems)
  - installation medical authority (to assist with health questions)
  - engineering design (new construction)
  - contracting (new construction)
  - safety office
  - legal and or public affairs (for release of radon data)
- Suggested optional subsection identifying possible stakeholders
  - family housing (government owned or privatized)
  - DoD Dependents Schools (DoDDS) or DoD Education Installation (DoDEA)
  - representatives of non-Navy or non–Marine Corps tenants at the installation

Section 2: Radon Data Analysis

- Brief overview of past radon surveys at the installation
  - Summary of radon surveys at the installation (e.g., number of buildings, rooms tested, highest results)
- Overall testing conclusions
  - Overall installation RPC
    - If site option is used,
      - RPC 1 if one site has elevated radon
      - RPC 2 if one site has not been screened
      - RPC 3 if all sites have been screened and no elevated radon was detected
  - Site RPCs (if applicable)
    - Include a brief rationale for each site
  - List of any leased or international use buildings at installation (Section 2.9)
    - Document who is responsible for testing and mitigation
  - List of atypical buildings (if applicable)
    - Include a brief justification for each atypical building
- A command-approved procedural plan for the release of radon results to stakeholders

Section 3: Mitigation

- List of mitigation systems by type of mitigation, room, and building at the installation

Section 4: Projects or Items Needing to be Addressed during the Next 5 Years

- List all projects that are required or proposed to meet NAVRAMP (funded and unfunded) over the next 5 years

2.11 HEALTH RISK COMMUNICATION

Under existing federal law (OSHA Hazard Communication Standard, 29 CFR 1910.1200 [CFR 2012]), military personnel, civil service employees, and subcontractors have the right to know the results of radon testing within their respective workplaces or residences. It is therefore in the Navy's and Marine Corps' best interest to be open and transparent about radon testing (see example handout in Appendix C). Prior to the initiation of radon testing, it is recommended that each installation develop a risk communication plan (RCP) and include it in the RMP (if applicable). The purpose of this RCP is to ensure that all stakeholders are informed and understand the installation's purpose for initiating radon testing, what the process is, and what to expect in terms of sharing results and other actions that may be necessary based on those results. This plan should include the procedures for the release of current survey data but also any historical data on file at the installation upon request by legitimate stakeholders. In the early stages of developing a risk communication plan, typically one or more of the following are consulted:

- command authorities
- installation medical office
- public affairs office
- installation legal office

Examples of stakeholders are

- occupants of the buildings
- DoDDS and DoDEA personnel (if schools are involved)
- installation medical support staff who are involved in primary care

Examples of methods by which to release the information include but are not limited to

- notices for building managers to distribute or post
- websites or a radon hotline
- town meetings or building-specific meetings
- base newspaper, all-hands emails

Another type of data dissemination that should be addressed in the RCP are requests through proper channels (e.g., higher headquarters, installation command, or public affairs office) from state, local, federal agencies, or host government officials; educational and research institutions; and news organizations.

3. NAVRAMP RADON TESTING PROCEDURES

3.1 OVERVIEW OF RADON TESTING PROCEDURES

As outlined in Section 2.2, NAVRAMP consists of three types of radon testing (screening, assessment, and monitoring), each with its own unique objective. Consequently, the types of detectors and the required quality assurance and quality control (QA/QC) procedures for each of the tests are different as well. This chapter outlines those requirements and, where possible, provides standardized procedures and specifications for all three testing categories. For all testing categories, whenever testing is required or performed within a structure, it is assumed that all occupied or potentially occupiable rooms are tested within the building. The only exceptions would be within buildings with installed radon mitigation systems where only the affected rooms would be tested (specifically diagnostic measurement, postmitigation, and O&M testing).

Under NAVRAMP, all installations or sites are required to complete screening and, if applicable, assessment. Once these are completed, installations or sites move into an ongoing monitoring phase to ensure that certain types of building changes or modifications do not result in rooms with radon concentrations ≥4 pCi/L. Because these changes or modifications can result in totally different actions at installations or sites with varying radon potential, COMNAVFACENGCOM has assigned initial RPCs (Section 2.4) to all installations responsible for shore facilities (Appendix B). These initial RPCs can be changed by the installation as circumstances dictate and are intended to be used for guidance as to how to conduct monitoring at the installation or site (if applicable).

Briefly, the testing requirements are as follows.

- For RPC 1 installations and/or sites
  - Ensure that radon testing is conducted in all occupied buildings (Section 2.6).
    - Retest all testable buildings
      - after every renovation (e.g., weatherization, whole building replacement, addition),
      - after every HVAC modification or replacement,
      - after damage by any event such as an earthquake or storm that would alter the building envelope, **or**
      - simply retest every 5 years.
  - Test all new buildings before occupancy or within 5 years of occupancy.
  - Test all mitigated rooms at least every 2 years.
- For RPC 2 installations and/or sites
  - Perform required screening (Section 2.5).
  - Based upon the survey findings, assign either an RPC 1 or RPC 3 designation.
- For RPC 3 installations and/or sites
  - Test all untested buildings constructed after 2003.

    - The rationale for testing all buildings constructed after 2003 is that some energy-saving features (primarily lower volumes of fresh makeup air and tighter building envelopes) typically incorporated after 2003 have been shown to increase the probability of elevated radon levels.
  - Test all recently acquired untested buildings (e.g., newly constructed, or through transfer of ownership) before occupancy or within 5 years of occupancy.
  - Test all Tier 1 buildings (e.g., hospitals, bachelors quarters schools, child-care centers, and brigs) that have not been tested previously.

3.1.1 Basis of the NAVRAMP Testing Protocol

At the inception of NAVRAMP, the stated overall objective was to screen all naval installations worldwide using a sampling protocol that would ensure an overall 95% statistical confidence that no single facility would have elevated radon potential. Since that time, the focus has shifted from an installation screening program to an ongoing environmental program in which the primary focus is the individual building. Because most radon testing in the United States is performed in single-family housing, EPA has focused considerable effort on the development of residential testing protocols. The underlying premise in these protocols is that the resident is genuinely motivated by either health concerns or the desire to sell a house and will do what is required to achieve a defensible testing conclusion. Consequently, the ability to perform a successful short-term radon measurement under the prescribed closed-building conditions presumably is simplified (for short-term tests of <4 days, closed building conditions must be initiated at least 12 h prior to the placement of the detectors and maintained for the duration of the test). With respect to nonresidential buildings, the only available EPA guidance document, *Radon Measurement in Schools* (EPA July 1993), does not adequately address the reality of testing a large population of buildings using its multiple measurement strategy. Consequently, in consultation with EPA and other subject matter experts, the Navy developed its own large building sampling protocol that blends applicable portions of the following EPA documents into a testing protocol:

- *A Citizen's Guide to Radon* (EPA 2012)
- *Home Buyer's and Seller's Guide to Radon* (EPA 2006)
- *Radon Measurement in Schools Revised Edition* (EPA July 1993)
- *Technical Support Document for the 1992 Citizen's Guide to Radon* (EPA May 1992)
- *Indoor Radon and Radon Decay Product Measurement Device Protocols* (EPA July 1992)

3.2 NAVRAMP TESTING PROTOCOL

The following testing procedures apply to all radon measurements performed within Navy and Marine Corps owned, leased, and international agreement buildings (excludes family housing) and for all testing phases (e.g., screening, assessment, and monitoring). For questions about testing family housing, please consult *Navy Radon Assessment and*

Mitigation Program Guidance Document for Navy Family Housing (US Navy 2002) for guidance.

3.2.1 When to Test and Testing Duration

Numerous studies (Appendix E, Section 1.3.2) have shown that indoor radon levels have not only day-to-day variation but also season-to-season variation. Consistent with EPA recommendations, under NAVRAMP, a 1 year test (tests ranging in duration from 325 to 395 days are considered 1 year tests) is required for all types of screening measurements (Section 2.5) and is the preferred method for assessment (Section 2.6) and periodic monitoring (Section 2.7) measurements. However, if 1 year tests are not practical, measurements >180 days are the preferred second choice. For testing of ≤180 days (the third choice), the testing should include the entire season of the year in which the building is under the longest period of closed-building conditions (i.e., typically winter for installations in the northern latitudes and summer for installations in southern latitudes). At installations that experience seasons (e.g., fall, winter, spring, and summer) during which 1 month or more elapses during the mechanical system changeover between heating and cooling configurations, the long-term test should span only one of these transitional seasons during the measurement period. In cases in which this cannot be determined with a high degree of certainty, a 1 year test should be performed.

However, in cases of possible health concerns, limited time, or financial considerations or at sites or installations at which significant elevated radon potential has been demonstrated (e.g., historical, validated radon data have identified rooms ≥20 pCi/L or the installation or site is RPC 1), short-term measurements (e.g., 2–90 days) can be used for assessment and for all periodic monitoring measurements provided that specific conditions are met during the entire test period (see also Section 3.5.6):

1. closed-building conditions
    a. For short-term tests of <4 days, closed building conditions must be initiated at least 12 h prior to the placement of the detectors and maintained for the duration of the testing period.
2. normal HVAC operation
3. testing is not performed during abnormal weather conditions

If one of these conditions was not met, then the short-term test data should be disqualified and the building retested. Validated short-term measurements that do meet these criteria are termed “representative” and are considered suitable for further evaluation (Section 3.5.6).

It is also important to note that testing for >1 year (e.g., 1.5 years) does not enhance or improve the quality of the long-term radon measurement. The sole intent of a 1 year test is to integrate the day-to-day and seasonal variations in radon concentrations found within most buildings to afford a good representation of the annual average (the risk upon which radon exposure is based). Extending the sample period of a 1 year test for more than 30 days (e.g., >395 days) may bias the result (higher or lower) and could impact the

overall measurement confidence. Table 2 summarizes the types of radon testing and recommended test durations performed under NAVRAMP.

Table 2. NAVRAMP radon measurement testing types and codes

Type of radon measurement	Testing code	NAVRAMP testing phase	Preferred test type	Description of the test
Screening	SG	Screening (Section 2.5)	Long-term (1 year)	Measurement performed as part of project to determine radon potential at a site or installation
Supplemental screening	SU	Screening (Section 2.5)	Long-term (1 year)	Measurement repeated as a replacement for lost detectors during screening
Assessment	AS	Assessment (Section 2.6)	Long-term [a] (>90 to ≤365 days)	Measurement performed to identify buildings or rooms at a site or installation with elevated radon
Supplemental assessment	SA	Assessment (Section 2.6)	Long-term [a] (>90 to ≤365 days)	Measurement repeated as a replacement for lost detectors during assessment
Confirmation	CN	All phases	Short or long-term	Measurement used to confirm a single elevated radon measurement
Follow-up test	FT	All phases	Short or long-term	A retest of the room where the results are averaged with the pervious radon measurements to reach a conclusion
New construction	NC	Monitoring (Section 2.7)	Short or long-term	A radon test performed in a new building before occupancy or within 5 years of acquisition
Significantly modified or HVAC replacement or modification retest	RR	Monitoring (Section 2.7)	Short or long-term	A retest of a room or building in which weatherization, whole building replacement, additions, HVAC modification or replacement, or damage by any events such as earthquakes and storms that would alter the building envelope has occurred

Table 2 (cont.)

Type of radon measurement	Testing code	NAVRAMP Testing Phase	Preferred test type	Description of the test
Operation and maintenance	OM	Monitoring (Section 2.8)	Short-term	A mitigation performance test performed at least every 2 years within the affected rooms.
Monitoring test	MT	Monitoring (Section 2.8)	Short or long-term	Radon testing performed after the screening and assessment phases have been performed to ensure that levels are <4 pCi/L
Diagnostic measurement	DM	Mitigation	Short-term	A radon test performed as part of a mitigation diagnostic or under exactly known conditions within a room or building of interest
Postmitigation	PM	Mitigation	Short-term	Radon test after radon mitigation within the affected rooms

[a] Under certain circumstances (Section 3.2.1), short-term measurements can be substituted for long-term measurements. See also Section 3.5.6.

3.2.2 Radon Detector Selection

The selection of the most appropriate radon detector for a particular application depends on many factors, such as the type of radon test, the cost of the device, the highest expected radon result, and the logistics of getting the detector analyzed. For testing in Navy and Marine Corps buildings, three types of detectors are approved for short-term measurements (charcoal, electret, and continuous radon monitor [CRM]) and two types of detectors for long-term measurements (alpha track detector [ATD] and electret). It is important to note that NAVRAMP policy does not specify a particular detector manufacturer but does require that the following technical specifications be met:

- The detectors and analysis laboratory must be National Radon Proficiency Program (NRPP) or National Radon Safety Board (NRSB) approved.
- The CRM must be NRPP or NRSB listed.
- The detectors or CRM must be used in accordance with the manufacturer's, NRPP, and NRSB published specifications.
- The data collected must meet minimum NAVRAMP data quality objectives.
- The detector should have an upper reportable limit of at least 30 pCi/L for the projected exposure period.

All detectors used for screening must have ≤15% measurement error, whereas all other detectors (for assessment and monitoring) must have ≤25% (accuracy and precision information is available from the manufacturer).

Another consideration in the selection of the detectors is overall suitability. Most radon detectors are designed for typical indoor environments and have published lower and upper temperature and humidity limits. Testing outside these limits will result in poor data quality and in some cases will be invalidated by the manufacturer (note that not all manufacturers do so). Maximum testing duration is another consideration. Some detectors have extremely short exposure periods (e.g., 2–3 days) which, if exceeded, invalidate the radon measurements. Others (electrets, ATDs) have upper reportable limits because of technological or calibration issues (similar to overexposing a photo). In addition, some detectors have short holding times (the time elapsed between retrieval and analysis of the detectors) which, if exceeded, would invalidate a radon measurement. Therefore, obtaining this information from the manufacturer and examining return shipment options should be a prerequisite in the planning stages of any survey, and testing duration should be adjusted accordingly.

Although EPA, NRPP, and NRSB protocols allow for the reporting of radon results in either picocuries per liter, becquerel per cubic meter (Bq/m^3), or working level months (WLM), uncertainties in particulate concentrations (a key assumption in WLM measurements) within Navy and Marine Corps buildings make using WLM difficult. Therefore, only testing methods that measure radon gas concentration directly in picocuries per liter are permitted. For additional information on WLM see Appendix E Section 2.1.2. Note that gas detectors measuring radon concentrations in international

units (Bq/m^3) are allowed provided the laboratory converts the results into pCi/L before reporting (1 pCi/L = 37 Bq/m^3).

3.2.3 Building Testing Requirements

For a building to be considered testable (referred to throughout the document as a testable building), it must first be enclosed, in ground contact (e.g., slab on grade, crawlspaces, basements), occupied or easily occupiable, and not proposed for demolition within the next 2 calendar years. Also included in this category of testable buildings are leased and international use agreement buildings in which it has been determined that the Navy or Marine Corps is responsible for the implementation of NAVRAMP (Section 2.9).

Exceptions to these testing requirements are buildings proposed for renovation, HVAC replacement, or other project or installations that would result in the building being more open than in typical usage. Testing for these buildings should be performed after these occurrences have been completed.

3.2.4 Room Testing Requirements

Within a building selected for radon testing (e.g., screening, assessment, and selected types of monitoring; see Sections 2.5–2.7), all ground-contact rooms (wall, floor, or ceiling) over a crawlspace or directly over a basement space not being tested are considered potentially testable rooms or areas. Selected measurement types (Table 2) excluded from this requirement are postmitigation, diagnostic, O&M, replacement for lost or damaged detectors, follow up, and confirmation testing. In these cases, the option exists to test only the individually impacted room or room of interest.

For a room or area to be considered for radon testing, it should be occupied for ≥4 h/day or easily occupiable (e.g., vacant bachelor quarter room, vacant office, or space that could easily be converted into occupied space). In addition, conference rooms, classrooms, and break areas should be included. Occupied service bays (e.g., motor transport buildings) should be tested only if the bay doors are closed for ≥4 h/day while occupied. Additional rooms for testing at the installation's discretion would include ground-contact hallways, stairwells, and other types of common areas. Rooms that should not be tested (unless for diagnostic purposes) include but are not limited to bathrooms, gear lockers, utility closets, dedicated storage rooms, elevator shafts, and unoccupied mechanical rooms.

3.2.5 Number of Sample Locations per Room

All radon testing using passive detectors shall be performed using 100% collocated duplicate detectors (e.g., two detectors placed side-by-side at the same location). The use of the second detector is not a requirement for CRMs.

Within testable rooms that are <10,000 ft^2, testing shall be performed at a frequency of one testing location per 2,000 ft^2 of floor area. In single testable rooms ≥10,000 ft^2 with a high volume of people usually present (e.g., commissary or exchange sales rooms, gymnasiums), testing locations shall be at an interval of one per 5,000 ft^2 up to a

maximum of 50 sampling locations (to the best extent possible, evenly distributed throughout the room). However, for testable rooms ≥10,000 ft^2 with a low density of occupants (e.g., hangar bays, warehouse or storage bays, high-bay repair shops), testing locations shall include all areas (one sampling location per 2,000 ft^2) where the occupants spend the most time (e.g., counter, desk areas, or break areas) plus the less frequently used areas of the room (a maximum of five evenly distributed sampling locations for these infrequently used areas). In addition, all individual, testable rooms within these large rooms shall be tested as independent rooms (i.e., these sampling locations do not count toward the 5 or 50 location maximum for the room).

A noted exception to this testing requirement is cases in which family housing buildings (not including high-rise buildings) have been converted to other uses (e.g., billeting, lodges, transient quarters, offices). In this case, only one centrally located room (former living room or hallway) is tested.

3.2.6 Selecting a Testing Location within a Room

After the rooms for radon testing have been selected, to the best extent possible, the detectors should be placed in accordance with applicable portions of *Indoor Radon and Radon Decay Product Measurement Device Protocols* (EPA July 1992) and *Protocols for Radon and Radon Decay Product Measurements in Homes* (EPA May 1993). Specifically, the following guidelines should be observed.

- Select a testing location that reduces the probability that the device will be disturbed.
- Do not place the devices within 3 ft of drafts caused by fans or heating, air-conditioning, or other ventilation systems.
- Do not place or hang the detectors on light or fire sprinkler fixtures.
- Do not put the detectors inside drawers or cabinets.
- Place the devices between 2 and 8 ft from the floor, 4 in. from other objects, at least 3 ft from exterior doors and windows, and 1 ft from an outside wall.
- Place collocated duplicate detectors (i.e., two detectors per test location), within 4 to 6 in. of each other.

In addition to those requirements, all recommendations provided by the device manufacturer should be followed (e.g., do not use in direct sunlight or in areas of high humidity or temperature).

After the detectors are placed, a sticker bearing the following information should be attached either to the detectors or adjacent to them on the wall:

DO NOT DISTURB
RADON TESTING IN PROGRESS
CALL: (contact phone number)

At the time of detector placement, a handout containing information about radon, the testing device, and so on should be left with the occupant (an example handout is included in Appendix C).

3.2.7 Testing Documentation

After the radon detectors have been placed, specific information needs to be recorded on a data sheet. At a minimum, the following information should be collected:

- placement technician
- building number
- building name
- detector numbers
- types of radon detectors (e.g., ATD, electret, CRM)
- type of radon test (Table 2)
- date placed
- time placed (if applicable)
- room in which placed
- location placed in the room
- comments

In addition, rooms that require radon testing but that, for a valid reason, could not be accessed during detector placement should be recorded and the reason documented.

During detector retrieval, the following information should be collected or verified and recorded on the data form:

- date retrieved
- time retrieved (if applicable)
- detector number
- room and location
- any evidence of tampering
- any evidence of significant modification to the building that could have an impact on the radon level
- whether closed-building conditions were maintained during the test period (short-term only)

After the detectors have been retrieved, they should be returned to the manufacturer for analysis and reporting. Because different devices have different field holding times (the time between detector retrieval and analysis), manufacturer recommendations shall be strictly adhered to at all times. In addition, the QA detectors (blanks and spikes) should be returned at the same time as the field detectors. In surveys in which more than one shipment is required, the QA detectors should be distributed proportionally with each shipment.

3.2.8 Detector Losses and Missed Rooms

For planning purposes, in nonresidential radon surveys, one can usually anticipate detector losses of about 0.5 to 1% per month of the total number of rooms tested. Therefore, during a 6 month, 1,000-room survey, one would expect to lose detectors in between 30 and 60 rooms. Studies have identified the following three major reasons for these losses:

1. An occupant threw the detector away for some reason (15%).
2. Uniformed painters or cleanup crews threw the detector away (75%).
3. The detector fell and was disposed of (10%).

To counter these causes for detector loss, the following precautions should be taken.

1. Affix warning stickers to the detectors with a local number to call for additional information and provide information handouts during detector placement.
2. Inform contractors and base personnel working in the buildings that radon testing is in progress and the testing devices are not to be disturbed.
3. Place detectors in out-of-the-way locations within the room to ensure that they will not be bumped during the test period, and instruct occupants during placement to reattach the detectors if they accidentally fall.

If warranted, rooms in which detectors were lost and rooms that could not be accessed during detector placement can be retested using either long-term (preferred) or short-term measurement devices. However, short-term testing can be performed only if it can be done during nominal closed-building conditions. It is recommended that all rooms without radon results be retested within 1 calendar year of the previous survey's retrieval date. The noted exception is for buildings in which one or more rooms had radon results ≥4 pCi/L. In this case, testing shall be completed as soon as possible so that mitigation planning and implementation can proceed in a timely manner. For all other buildings in which the highest result was <4 pCi/L, retesting in the rooms with missing data should be considered only if losses exceed 20% of the total testable rooms within the building.

3.2.9 Testing Errors

During the test period, things may happen that would have an impact on the validity of the radon measurement. Certain types of these events would result in the test's being classified as invalid or not reportable (commonly referred to as "catastrophic" errors). For example, EPA recommends, as does NAVRAMP, that short-term test data be invalidated if one or more of the following is true:

- Testing was not performed during closed-building conditions.
- HVAC operation during the testing period was not "typical" (e.g., building mechanicals were off or malfunctioning).
- Testing was conducted during periods of abnormal weather conditions.

Typical problems that would invalidate long-term measurements include these:

- significant modifications to the building or HVAC replacement
- nonachievement of the minimum manufacturer's recommended exposure time for the device

Examples of catastrophic errors that would apply to both types of measurements are

- damage to detectors (e.g., vandalism, water, smoke, paint)
- device tampering
- relocation of the detectors to other rooms

For these types of errors, the result is not reported (i.e., the attempted measurement is documented without the radon result and with the error description listed under comments), and retesting is recommended. However, other types of errors need only be recorded and reviewed to see if the resulting error is significant. Examples of these types of conditional errors are

- One or both the detectors fell down (not significant if both results are <2 pCi/L).
- Placement and/or retrieval dates are missing (not significant if substituting the last placement date and/or the first retrieval date for the project yields results of <2 pCi/L).
- Results exceed the maximum reportable limit.

If those qualifying conditions for the conditional error are true, then the result accompanied with the error may be reported. However, if the qualifying conditions for the error are not met, then retesting is required if one or more rooms in the building has elevated radon or if problems were encountered with >20% of the testable rooms.

3.2.10 Follow-up Testing vs. Retesting

Under EPA radon testing protocols and guidance documents, follow-up measurements (defined as measurements performed with the same device, at the same location, under similar testing conditions, and, if applicable, identical HVAC settings) are recommended for all measurements ≥4 pCi/L. The conclusion to take corrective action is then based upon the numeric average of the initial and follow-up measurements (e.g., (initial result + follow-up result)/2). However, under this guidance, any initial measurement ≥8 pCi/L would mathematically require mitigation (e.g., (8.0 pCi/L + 0 pCi/L)/2 = 4 pCi/L). For this reason, under NAVRAMP, the automatic use of the EPA follow-up measurement protocol is not recommended. Under NAVRAMP, if the data set has been validated (i.e., all QA/QC objectives were met) and the measurement was confirmed (e.g., collocated duplicates have a relative percent difference [RPD], Eq. 1, of <36% or other elevated radon was present in the building), it is assumed that the elevated result is valid and representative (Section 3.5.1) of the radon levels within the room or building. More simply stated, from a programmatic level, elevated radon was present within the room during the test period; therefore, if additional testing is required, diagnostic

measurements (a series of radon tests performed under known and specifically controlled conditions) are the preferred method to reach a defensible testing conclusion.

$$\textbf{Relative percent difference} = \frac{\textbf{(Highest pCi/L – Lowest pCi/L)} \times \textbf{100\%}}{\textbf{Mean}}$$

Equation 1. Relative percent difference
(Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I, EPA 600/9-76-005 [EPA 1984])

3.3 TESTING QUALITY ASSURANCE AND QUALITY CONTROL

The objective of radon measurement QA is to ensure that data are scientifically sound and of known precision and accuracy. This is accomplished with project QC using unexposed detectors (blanks), collocated duplicates, and controlled exposures (spikes). Additional elements of QA involve using only devices accredited for radon measurements of the type being performed and the use of qualified staff during the field execution phase.

As part of these QA programs, procedures for attaining the defined QA objectives and a system for recording and monitoring should be established. In validating and analyzing a data set (defining a data set as a group of measurements performed at the same time using the same devices by the same organization), all exceptions must be noted and reported and their impact noted in the data report. In addition, the QC measurements shall be permanently linked with the data set to afford independent analysis in the future.

Because, in most NAVRAMP surveys, large number of measurements are performed within a short period of time, plotting daily control charts (Appendix E, Section 2.1.4) would be of only minimal benefit. Instead, NAVRAMP uses an individual measurement tripwire using the EPA control limits (see the second bullet item, for "duplicates," in the following list). Under NAVRAMP, the QC requirements for all passive radon measurements are the following.

- Blanks: Blanks should be at or below the manufacturer's published lower level of detection (LLD).
- Duplicates: Collocated detectors in which both measurements are >4 pCi/L should have an RPD of <36% (see Eq. 1). For collocated detectors in which the measurements are >2 pCi/L and <4 pCi/L, an RPD of <67% is considered acceptable.
- Spikes: Spike results should be within ±25% of the known value (Eq. 2).

To the best extent possible, the blanks and spikes should be returned to the laboratory at the same time as the field detectors. In addition, they should be intermingled with and undistinguishable from the field detectors.

3.3.1 Passive Measurement Quality Assurance and Quality Control

Before a data set can be reported, it must first be validated to ensure that it meets specific QA requirements. Failure to meet any of the minimum QA requirements will require specific reporting actions and, depending on the severity of the failure, possibly retesting. The following sections detail the requirements, analysis procedures, and corrective actions to be taken if needed. Under NAVRAMP, the level of QC for passive detectors (ATDs, charcoal canisters, and electrets) depends upon the type of testing (i.e., screening, assessment, or monitoring) and the number of locations (e.g., rooms) being tested at a given time. The minimum QC levels follow.

- <10 locations:
  - one blank detector and
  - 100% collocated duplicates
- 10 to <33 locations:
  - three blank detectors,
  - 100% collocated duplicates, and
  - three spike detectors at four times the number of days of the projected exposure (e.g., for a 365 day exposure, the spike should be 1460 pCi/L-days)
- ≥33 locations:
  - blank detectors: 3% of the total number of locations tested, or up to 30 blanks (2/3 field blanks, 1/3 laboratory blanks), whichever quantity is less;
  - 100% collocated duplicates; and
  - spike detectors: 5% of the total number of locations tested or up to 50 spikes, whichever quantity is less; spike concentration of four times the number of days of the projected exposure (e.g., for a 365 day exposure, the spike should be 1460 pCi/L-days)

For screening using the enhanced statistical method option (Section 2.5.2), there are no upper limits for the number of blanks and spikes.

For blank ATDs, an acceptable blank measurement would be any reported measurement ≤60 pCi/L-day. For charcoal canisters, an acceptable blank measurement would be any reported measurement ≤1 pCi/L-day. For electret-based detectors, an acceptable blank measurement would be any measurement ±3 V from the original measurement

Under NAVRAMP, all spikes must be performed in an NRPP- or NRSB-accredited chamber or within a US governmental calibration chamber. NAVRAMP requires that the mean spike result (the average of all spike results at a given concentration) be ±25% of the known concentration (Eq. 2). With respect to ordering spikes from the private accredited chambers, it is highly recommended that contractual arrangements be made with the laboratory prior or shortly after the initiation of detector placement.

$$\text{Relative percent Error} = \frac{(\text{Measured Value} - \text{Reference Value}^{a}) \times 100\%}{(\text{Reference Value})}$$

([a] Reference value can be in either pCi/L-days or pCi/L)

Equation 2. Individual relative error.

Reference: (EPA 1997)

In all cases in which one or more of the QC requirements are not met, the testing contractor shall first inform the laboratory of the problem(s). If the laboratory can correct the problem, then the corrected results for the data set shall be resubmitted by the laboratory. However, if the laboratory is unwilling or unable to correct the QC problem(s), then the installation shall perform an in-depth analysis of the impact of the QC failure on the radon measurements. At a minimum, the impact analysis shall address the overall measurement uncertainty at 4 pCi/L and the likelihood of false positive and/or negative measurements. Using these measurement uncertainties, a review of the individual field measurements should be performed and all measurements in which the conclusion (e.g., the need to perform mitigation) is in question should be identified. For these individual measurements, retesting would be required. Individual measurements that fall outside the range of interest should be documented, and retesting would be at the discretion of the Navy or Marine Corps. It is important to note that EPA testing guidelines do not permit the end user to compensate or correct for laboratory identified QC deficiencies (e.g., blanks or spikes out of compliance) in the survey, these corrections can only be made by the laboratory (see also Section 3.5.1).

3.3.2 Precision Calculations for Passive Detectors

All radon testing currently performed under NAVRAMP using passive radon detectors is performed using 100% collocated duplicates. To determine if a data set meets overall precision requirements, the RPD for each measurement is calculated (Eq. 1) and then the results are sorted into two ranges based upon the average radon concentration of the measurement (>2 pCi/L and <4 pCi/L, and ≥4 pCi/L). No RPD requirement is needed for radon measurements for which both collocated results are <2 pCi/L.

The arithmetic average of the RPDs of each range is then calculated. A data set (i.e., a group of radon measurements performed at approximately the same time using identical detectors, the same QC, and so on) is considered to have acceptable precision if both of the following requirements are met:

- an average RPD of <67% is achieved for all average radon results >2 pCi/L and <4 pCi/L
- an average RPD of <36% is achieved for all average radon results ≥4 pCi/L

However, if one or both of the RPD precision requirements are not met, then further analysis is required using the following steps:

Average radon measurements >2 pCi/L and <4 pCi/L with RPD ≥67%

- Using Student's *t*-test or other appropriate statistical method, eliminate all statistical outliers and recalculate the average RPD.
  - If the average RPD without the statistical outliers is <67%, then the abbreviated data set is considered to have acceptable precision in the lower range.
    - Retesting of the rooms that failed the RPD test is not required.
  - If after the exclusion of the statistical outliers, the average RPD is >67%, then the laboratory should be consulted to see if the problem can be corrected.
    - If the problem cannot be corrected, then retesting should be considered for all rooms with RPDs ≥67%.

Average radon measurements ≥4 pCi/L with RPD ≥36%

- Using Student's *t*-test or other appropriate statistical method, eliminate all statistical outliers and recalculate the average RPD.
  - If the average RPD without the statistical outliers is <36%, then the abbreviated data set is considered to have acceptable precision in the upper range.
    - For the statistical outliers excluded from the RPD analysis, retesting is recommended for results with an arithmetic average ≥4 pCi/L to <20 pCi/L, and not recommended for statistical outliers where both measurements are ≥20 pCi/L.
- If after the exclusion of the statistical outliers, the average RPD is >36%, then the RPD should be recalculated excluding all outliers and measurements in which both radon results are ≥10 pCi/L.
  - If the average RPD is <36%, then the abbreviated data set is considered to have acceptable precision in the upper range.
    - For the results excluded from the RPD analysis, retesting is recommended for those in which both results are <10 pCi/L, and not recommended for those in which both results are ≥10 pCi/L.

If both methods using the abbreviated data set fail to achieve a <36% RPD using the abbreviated data sets, then the rooms should be confirmed before mitigation.

3.3.3 Continuous Radon Monitor Quality Assurance and Quality Control

At a minimum, all CRMs used under NAVRAMP must have ±10% resolution at 2 pCi/L and be able to record the levels hourly. The device used in the field must have a current manufacturer's calibration certificate and shall be maintained in accordance with manufacturer specifications. For every tenth radon measurement performed, a duplicate measurement performed with another CRM or an approved electret or charcoal canister shall be performed. The acceptance criterion for the CRM is that the result be within ±25% of the collocated duplicate measurement.

If this condition is not met, then the test should be repeated using either collocated duplicate passive detectors or collocated duplicate CRMs. If the CRM is found to be in error, then all rooms previously tested by the CRM since the last performance check should be retested.

3.4 RADON MEASUREMENT REPORTING REQUIREMENTS

For all radon testing conducted, a report shall be generated and submitted to the designated NAVRAMP point of contact. It shall contain at a minimum the following information:

Contractor information

- contractor name
- address and phone number
- contract number
- NRPP or NRSB testing certification number

Device information

- manufacturer's name, address, and phone number
- device type and model number
- manufacturer's NRPP and/or NRSB certification number

The following information should be submitted by building and room tested:

- report date
- site, if applicable
- building name
- sample room and location
- type of detector
- type test (short-term or long-term)
- detector identification number
- duplicate identification number
- date placed and retrieved
- measured radon concentration in picocuries per liter
- duplicate radon concentration in picocuries per liter
- average radon concentration in picocuries per liter
- occupied rooms that could not be tested
- testing exceptions and losses and comments

For each building tested, a summary listing should include the following:

- number of measurements completed
- number of detectors lost

- list of rooms in which testing was unsuccessful
- number of rooms 0 to <4 pCi/L
- number of rooms 4 to <20 pCi/L
- number of rooms 20 to <200 pCi/L
- number of rooms ≥200 pCi/L or greater
- highest measurement in picocuries per liter
- rooms requiring radon mitigation
- recommendations for future actions

Depending on the size, complexity, and needs of the project, additional deliverables (e.g., electronic format, maps, and local geological conditions) may also be requested.

3.5 DATA ANALYSIS

3.5.1 Data Set Validation

When a radon measurement data set is received, the data must be validated before any conclusions are drawn. All deficiencies in the data set need to be documented and corrective actions taken, if warranted. For QA detectors, the following acceptance criteria should be verified:

- The appropriate number of blanks were used (Section 3.3.1), and all blanks are at or below the reported manufacturer LLD.
- RPD calculations (a measure of precision) were done for all duplicate measurements and met the requirements listed in Section 3.3.2.
- The appropriate number of spikes were used, were exposed at the correct concentration (Section 3.3.1), and are within ± 25% of the known concentration.

Data sets that meet these QA criteria are considered validated and are suitable for further processing. However, for data sets with QA deficiencies, further analysis is required.

For all QA deficiencies, the manufacturer of the testing devices should be consulted to determine if corrections can be performed. In cases in which corrections cannot be performed, or the corrections still do not meet NAVRAMP QA requirements, two options exist: redo the radon survey or perform an error impact analysis. For small radon surveys, retesting will probably be the option of choice. However, for larger surveys, time, funding, and logistics may preclude retesting. The objective of error impact analysis is to determine if a defensible conclusion can be reached for measurements at or near the action level using conservative assumptions. The conclusions reached using these methods can be reported provided that the appropriate disclaimer is provided. For example, in cases in which the blanks are above the LLD but all radon test results are <4 pCi/L, the impact is minimal. The overall conclusion, no elevated radon is present, can be reached and results reported. Conversely, in cases of significantly elevated results, a conclusion can also be reached (e.g., elevated radon is present) provided the difference between the reported measurement and the background is ≥4 pCi/L. However,

in cases for which the background correction yields a result between 3 and 5 pCi/L, the rooms should be retested.

Conclusions as to accuracy can be reached provided that the data set has acceptable precision (Section 3.3.2). For example, if the bias is ±2 pCi/L and the highest measured result is 1.0 pCi/L, the overall conclusion that no elevated radon is present can be reached. However, in cases in which the bias could result in some individual results being ≥4 pCi/L, or some marginally elevated results being <4 pCi/L, retesting should be performed. The same is also true for significantly elevated radon results for which subtracting the bias still provides a result of ≥4 pCi/L and the conclusion that radon is elevated is evident.

However, poor precision is much more difficult to work around within the area of interest. For example, if the average RPD for results for all survey data <4 pCi/L is twice the NAVRAMP limit (e.g., 134%), any result over 1.7 pCi/L is potentially above the action level. Therefore, redoing the survey is warranted. Conversely, an elevated result of 5.6 pCi/L is also potentially suspect if its RPD is twice the NAVRAMP >4 pCi/L limit (e.g., 72%). Therefore, confirmation measurements are needed. At higher radon concentrations (e.g., >10 pCi/L), poor precision does not alter the conclusion that elevated radon is present; therefore, confirmation testing is not needed.

3.5.2 Data Set Quality Factor

Historically, within the Navy and Marine Corps, tens of thousands of individual radon results have survived in one form or another for decades. However, when they are reviewed decades later (Section 2.4), in a significant number of cases, the blank and spike data are incomplete or missing, creating the possibility of having to retest tens of thousands of rooms. To assist future reviewers of the data—who may not have the benefit of process knowledge of a particular survey—at the conclusion of each data set validation, a data set quality factor (DSQF) is assigned. These values will provide future reviewers of the data some insight into the data set quality and ensure that the validation process need not be repeated. The DSQF values and meanings follow.

- **DSQF 1: Meets NAVRAMP Criteria**
  - The data set meets or exceeds all historical or current NAVRAMP data quality requirements. Data sets with this assignment can be used or cited without further qualifications. However, NAVRAMP confirmation rules for elevated results must be followed as applicable for each measurement before taking correction action.
- **DSQF 2: Meets EPA Criteria**
  - The data set did not have sufficient blanks or spikes to meet the applicable NAVRAMP requirements in force at that time. However the data set has at least 10% duplicates, and the duplicates are within the acceptable RPD range provided by EPA. Data sets with this assignment can be cited; but in cases in which single radon measurements are ≥4 pCi/L, the result must contain the statement "Pending Confirmation." In addition, before corrective action is taken, all single elevated results must be confirmed. The sole exception is if

the elevated measurement was performed using collocated duplicates and the measurement had an acceptable RPD. In this case, mitigation could proceed without confirmation.

- **DSQF 3: Data Set Quality Is Unknown**
  - The data set has insufficient QC to make a determination. All elevated results, including those with collocated duplicates, must be confirmed before corrective action is taken. All citations of the data ≥4 pCi/L should include the comment "Pending Confirmation."
- **DSQF 4: Unusable Data**
  - The data set has sufficient QC to determine that it does not meet NAVRAMP or EPA data set quality standards. The data set or individual result should not be cited or distributed, and the entire survey should be repeated. In addition, no conclusions should be drawn from the data with respect to the absence or presence of elevated radon at the installation or site.

3.5.3 Data Set Completeness

The overall objective of NAVRAMP testing is to test all testable rooms (Section 3.2.4) within a building. However, detector losses, inaccessible areas, and other errors will inevitably result in some rooms not having radon data. The necessity of retesting these rooms depends upon many factors, such as the total number of rooms in which data are available, the potential for elevated radon at the installation or site, and the highest result in the building. Within each building tested, a check should also be performed to ensure that all occupied areas required to be tested under NAVRAMP actually were tested (Section 3.2.4). Any areas or rooms that were missed should be documented and reasons provided for their being missed. Under NAVRAMP, retesting of testable rooms with missing data (not the entire building) shall be performed for any building in which a confirmed elevated measurement was found. For all other buildings in which the highest result was <4 pCi/L, retesting in the rooms with missing data should be considered only if losses exceed 20% of the total testable rooms.

3.5.4 Elevated Radon Results

The objective of this section is to reach a defensible testing conclusion for each room tested using a validated data set following standardized procedures. Because EPA and NAVRAMP guidelines require that any measurement ≥4 pCi/L be confirmed before corrective action is taken, the measurements need to be segregated by room into two types of measurements: those performed individually and those performed using collocated duplicates.

For rooms tested with a single long-term measurement (e.g., only one detector was used), results ≥4 pCi/L are considered confirmed if one or more of the following is true:

- One or more rooms in the building are ≥4 pCi/L.
- Prior testing in the room has been ≥4 pCi/L.
- The average of sequential measurements employing similar test devices for a similar duration in the room is ≥4 pCi/L.

For all other rooms, a single measurement of ≥4 pCi/L will need to be confirmed by independent measurement using either long-term or short-term devices before corrective action is taken.

For measurements performed using collocated duplicates, results in which the arithmetic average is ≥4 pCi/L are individually reviewed to determine if confirmation is required. The measurement is considered confirmed if one or more of the following is true:

- The RPD is <36%.
- One or more rooms in the building are confirmed as ≥4 pCi/L.
- Prior testing in the room has been ≥4 pCi/L.
- The average of sequential measurements employing similar test devices at a similar duration in the room is ≥4 pCi/L.

For the remaining cases, the single ≥4 pCi/L measurement will need to be confirmed by independent measurement using either long-term or short-term devices before corrective action is taken.

The only exception to these rules is for cases in which both radon results are >30 pCi/L. For both technical and business reasons, all commercially available radon measurement devices have upper limits for radon exposure. After those limits are exceeded, precision and accuracy tend to widen and drift, respectively. In such cases, the device manufacturer should be consulted. In cases of high radon concentrations, obtaining a measurement within the NAVRAMP control limits is a secondary concern to mitigation.

In some cases, the detectors may have been exposed to higher levels of radon than can be accurately reported by the laboratory. (This should not be confused with exceeding the exposure duration of the detector, in which case retesting is warranted.) Typically, these results are coded by the manufacturer and reported as "measurement exceeds upper limit" or the result is greater than or equal to some value. Although the conclusion is self-evident (elevated radon is present, mitigation is needed), attempts should be made to work with the manufacturer to determine if the result could be over the respective NAVRAMP threshold timelines (in Table 1, for example is the result >20 pCi/L or >200 pCi/L). In cases in which the result cannot be bracketed by the manufacturer, mitigation should be performed as soon as practical.

With respect to elevated, confirmed short-term tests, the following must be true for the entire test period:

1. The entire test was performed during nominal closed-building conditions.
   a. For short-term tests of <4 days, closed building conditions must be initiated at least 12 h prior to the placement of the detectors and maintained for the duration of the test.
2. HVAC operation was as normal.
3. Testing was not performed during abnormal weather conditions.

At a minimum, if these three conditions cannot be met or maintained during the proposed test period, then the testing should not be performed at that time. If the testing was performed and one of these conditions was not met, the data should be disqualified and the building retested. Measurements that do meet these criteria are termed by NAVRAMP "representative radon measurements" and can be used for further evaluation.

3.5.5 Averaging Sequential Radon Measurements

Under the EPA testing protocol, sequential measurements (sometimes referred to as sequential duplicates) are performed as a means to judge the variability of the indoor radon concentration at different test conditions (e.g., different seasons or HVAC settings). To perform sequential averaging, the results to be averaged must all be from the same category (e.g., all long-term or all short-term). When similar types of radon measurements are averaged, the average of each individual measurement event is calculated first and then the average of these results is calculated. In the example shown in Table 3, over a 1 year period, a room had three short-term testing events, each performed with collocated duplicate detectors. The average result and RPD of each measurement event were calculated. Because all of the RPDs were within acceptable limits, the overall average of all three measurement events was then calculated. The result, 3.5 pCi/L, indicates that mitigation would not be required in this room. However, if one of the three measurement events had an unacceptable RPD, it would be discarded, the average of the two remaining results would be taken, and a conclusion would be drawn from the result.

Table 3. Sequential testing averaging example

Measurement	Detector 1 (pCi/L)	Detector 2 (pCi/L)	Average (pCi/L)	RPD (%)
1	3.9	4.5	4.2	14.3
2	2.0	2.4	2.2	18.2
3	3.8	4.3	4.1	12.3
Average			**3.5**	

In some buildings, seasonal HVAC settings may have a direct impact on the radon concentration. Examples include variation in the volume of makeup air, physically turning the HVAC off during transient seasons, and changes in the supply air volume, to name a few. In these cases, a time-weighted-average method can be employed to determine if mitigation is required. For this determination, detailed HVAC operational information is required—specifically, when the changes occur and for what duration—in addition to representative, good-quality radon measurement data collected during these periods. To perform the time-weighted average, the number of days is first estimated for each specific HVAC condition found throughout the year. The individual estimated days are then multiplied by their respective radon results (pCi/L) for this period. The pCi/L-days are then summed and the sum divided by the total number of days (ideally, 360 to 365 days). The result in pCi/L would be an estimate of the annual average for the building (see Table 4 for examples).

In cases where the estimated annual average is ≤2 pCi/L, mitigation is not recommended. For an annual average, ≥4 pCi/L, mitigation should be performed in accordance with the NAVRAMP timeline (Table 1). However, for estimated results >2 and <4 pCi/L, retesting using a 1 year measurement should be considered.

Table 4. Examples of time-weighted averaging

Example 1	**Winter (HVAC on)**	**Spring (HVAC off)**	**Summer (HVAC on)**	**Fall (HVAC off)**	**Total**
Number of days	120	60	120	60	360
Radon level (pCi/L)	8.0	1.0	4.0	0.5	N/A
pCi-L-days	960	60	480	30	1530
Average radon level	4.3				
Conclusion	Mitigate				
Example 2	**Winter (HVAC on)**	**Spring (HVAC off)**	**Summer (HVAC on)**	**Fall (HVAC off)**	**Total**
Number of days	180	N/A	180	N/A	360
Radon level (pCi/L)	8.0	N/A	0.1	N/A	N/A
pCi-L-days	1440	N/A	18	N/A	1458
Average radon level	4.1				
Conclusion	Mitigate				
Example 3	**Winter (HVAC on)**	**Spring (HVAC off)**	**Summer (HVAC on)**	**Fall (HVAC off)**	**Total**
Number of days	90	90	90	90	360
Radon level (pCi/L)	6.0	0.5	0.8	0.5	N/A
pCi-L-days	540	45	72	45	702
Average radon level	2.0				
Conclusion	Mitigation is not required, but 1 year testing should be considered				

3.5.6 Analysis of Short-Term Radon Data

Under NAVRAMP, if 1 year tests are not practical, radon tests of >90 days are preferred for assessment and supplemental assessment measurements rather than short-term measurements (e.g., 2–90 days). However, in cases of possible health concerns, limited time, or financial considerations, or at sites or installations at which significant elevated radon potential has been demonstrated (e.g., historical, validated radon data has identified rooms ≥20 pCi/L or a RPC 1 site or installation), short-term measurements (e.g., 2–90

days) can be used for assessment and supplemental assessment measurements provided that specific conditions are met during the entire test period (Section 3.2.3).

Unlike long-term tests (e.g., 91–365 days), short-term measurements can be biased (higher or lower) by episodic and seasonal weather (Appendix E, Fig. 6). Consequently, extra care must be taken to document periods of heavy rain or high winds during the test period and the HVAC conditions of the building (e.g., is the HVAC operating normally; if applicable, what are the seasonal settings; are there any setbacks for nights and weekends). For these reasons, a validated, elevated short-term result is treated differently under NAVRAMP from a long-term result of similar quality. For example, under NAVRAMP, if an elevated 1 year measurement has been validated and confirmed, mitigation should proceed without additional testing. Conversely, validated and confirmed, representative elevated short-term measurements require a review of the indoor testing conditions and may require additional radon testing before mitigation is considered.

In large buildings, radon levels can be significantly affected (up or down) by the operation of the building's mechanical systems (e.g., HVAC and exhaust blowers). Under the expedited testing protocol, all rooms with validated, confirmed, representative elevated radon are treated initially as "rooms of interest," meaning that the possible impact of the building HVAC system should be evaluated before recommending mitigation. Specifically, what needs to be determined is whether any seasonal adjustments were made during the year (e.g., fresh-air dampers opened and closed, heating and cooling cycles turned off for certain times of the year). If any of these has occurred, then the overall potential impact of these adjustments or cycles on the building's ventilation rate needs to be determined. This information can typically be obtained by consulting the installation's HVAC maintenance group or contractor.

In cases where seasonal changes in HVAC condition would not reduce or significantly change the ventilation rate, or in cases where there is no mechanical contribution (e.g., buildings with split systems with no allowance for fresh air, radiator heater/cooling, and so on), Table 5 should be consulted to extrapolate the radon levels needed for the remainder of the year to provide an estimated <4 pCi/L/year. Consideration should be given to periods of possible open-building conditions during transition seasons (e.g., spring and fall). For radon results between 4 and 6 pCi/L, or if the extrapolation is uncertain, consideration should be given to performing a short-term test during the opposite season and then doing a time-weighted estimated annual average (Flowchart 6). However, in cases where no significant change in radon concentration is expected, mitigation within the NAVRAMP guidelines should proceed.

However, for cases in which seasonal HVAC fresh-air volume adjustments are made, it should be determined whether the changes might reduce the radon levels either through dilution or pressurizing the building. To determine if retesting is needed, the first step is to estimate the number of days/year on which these HVAC conditions are prevalent. Rounding off to the nearest pCi/L, consult Table 5 to determine what the radon concentration would need to average for the remaining days of the year to average to

3.9 pCi/L. For example, if the initial radon result was 20 pCi/L and the duration of the HVAC condition was 30 days, the radon level would have to average ≤2.5 pCi/L for the remaining 335 days for the integrated annual average to be ≤3.9 pCi/L. In this example, a short-term retest during the other HVAC condition would be recommended if the seasonal HVAC changes had the potential to pressurize the building or significantly increase the building ventilation rate. However, in this example, if the duration of the tested HVAC condition was 90 days, mitigation should proceed in accordance with the NAVRAMP recommended guidelines, since negative levels of radon are an impossibility. If a valid and representative retest was performed, then the time weighted average should be calculated using Flowchart 6.

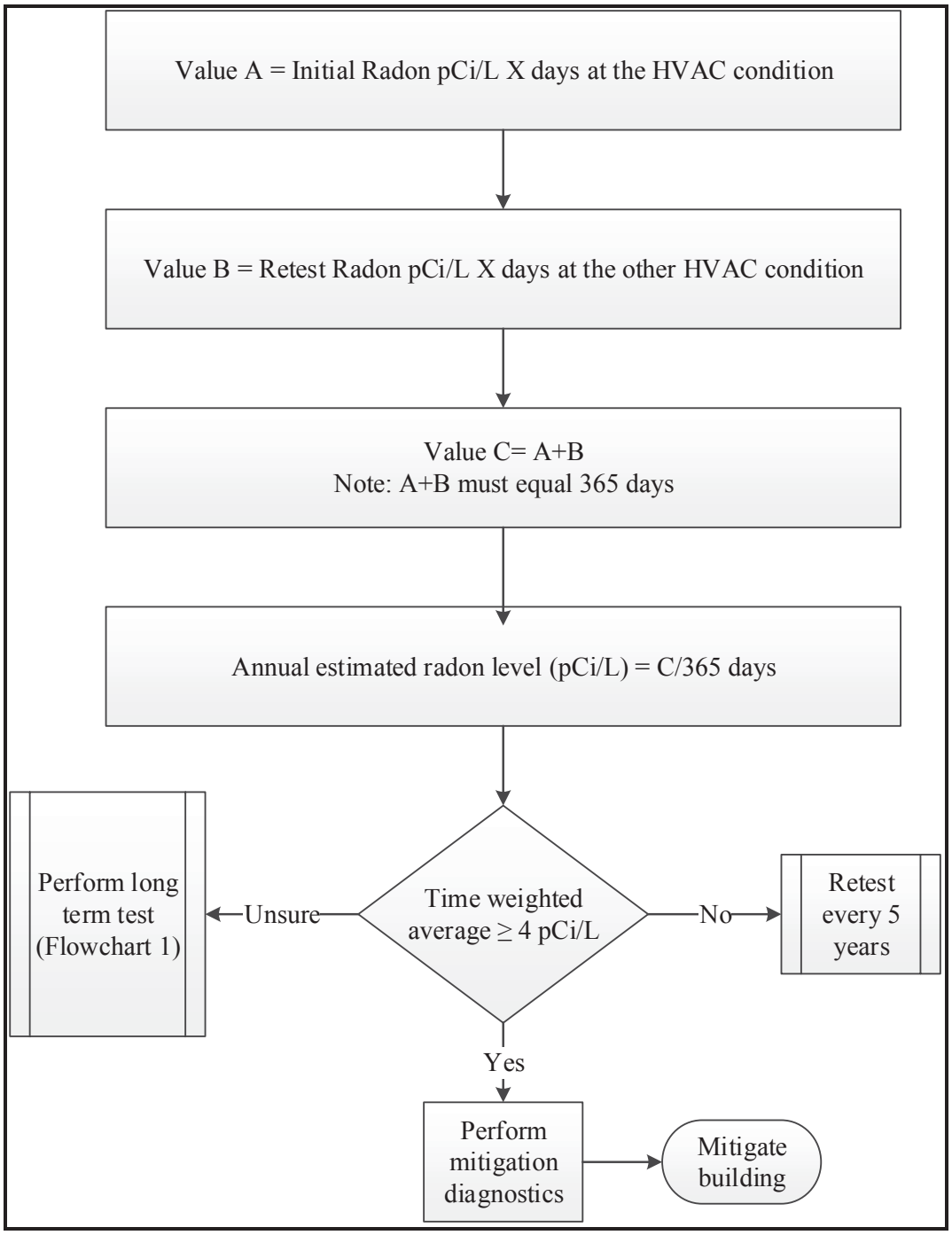
Table 5. Time-weighted averages to obtain annualized 3.9 pCi/L [a]

	30 days at HVAC or climate condition	**60 days at HVAC or climate condition**	**90 days at HVAC or climate condition**	**120 days at HVAC or climate condition**	**180 days at HVAC or climate condition**	**270 days at HVAC or climate condition**
Initial radon result (pCi/L)	**Average for remaining 335 days (pCi/L)**	**Average for remaining 305 days (pCi/L)**	**Average for remaining 275 days (pCi/L)**	**Average for remaining 245 days (pCi/L)**	**Average for remaining 185 days (pCi/L)**	**Average for remaining 95 days (pCi/L)**
4.0	3.9	3.9	3.9	3.8	3.8	3.6
5.0	3.8	3.7	3.5	3.4	2.8	0.8
6.0	3.7	3.5	3.2	2.9	1.9	–2.1
7.0	3.6	3.3	2.9	2.4	0.9	–4.9
8.0	3.5	3.1	2.6	1.9	–0.1	–7.8
9.0	3.4	2.9	2.2	1.4	–1.1	–10.6
10.0	3.4	2.7	1.9	0.9	–2.0	–13.4
15.0	2.9	1.7	0.3	–1.5	–6.9	–27.7
20.0	2.5	0.7	–1.4	–4.0	–11.8	–41.9
25.0	2.0	–0.3	–3.0	–6.4	–16.6	–56.1
30.0	1.6	–1.2	–4.6	–8.9	–21.5	–70.3
35.0	1.1	–2.2	–6.3	–11.3	–26.4	–84.5
40.0	0.7	–3.2	–7.9	–13.8	–31.2	–98.7
45.0	0.2	–4.2	–9.6	–16.2	–36.1	–112.9
50.0	–0.2	–5.2	–11.2	–18.7	–41.0	–127.1
100.0	–4.7	–15.0	–27.6	–43.2	–89.6	–269.2
200.0	–13.7	–34.7	–60.3	–92.2	–186.9	–553.4

[a] Radon levels < 0.0 pCi/L are an impossibility. The negative values were included for reference purposes only.

Another option is to perform a series of short-term, diagnostics radon measurements (radon measurements performed during radon mitigation diagnostics under known, precise conditions) at the different fresh-air settings. These measurements can be

performed using short-term passive detectors or CRMs, and the data can be processed using a similar time weighted process as illustrated in Flowchart 6.



Flowchart 6. Estimation of the annual average using two results.

3.5.7 Confirmation Measurements

Consistent with current EPA recommendations for follow-up testing, NAVRAMP requires that all rooms with a single reading (e.g., one detector) ≥4 pCi/L be confirmed by additional radon testing (short- or long-term) or by other means before mitigation. If NAVRAMP QA/QC has been followed and the data set validated (Section 3.5.1), then the likelihood of an erroneous radon measurement is very small. In cases in which seasonal weather patterns or cyclic HVAC operation is known or suspected to have caused an error, testing should be performed using sequential measurements (Section 3.5.5).

In all other cases using a valid data set, the only reasons to confirm an elevated measurement are

- The measurement in question failed to meet the RPD requirements (Section 3.3.2).
- The measurement was not performed using collocated duplicates.
- A specific event occurred during the testing that might have resulted in an elevated radon reading.

The perception of "testing until I find a result that I like" should be avoided at all times.

For a single, valid, elevated radon measurement (e.g., no collocated detector), retesting must be performed if there are no other results in the building ≥4pCi/L. If the initial measurement was short-term, then another short-term measurement can be used if similar test conditions can be obtained (e.g., if it is the same season). If not, then a long-term measurement will be required. If the retest of a short-term measurement is performed using short-term devices, under similar conditions, the initial measurement is considered confirmed if

- the average of the test and the retest is ≥4 pCi/L
- the average of the retest is <4 pCi/L but ≥50% of the initial measurement (e.g., a retest value of 2.0 pCi/L confirms 4.0 pCi/L).

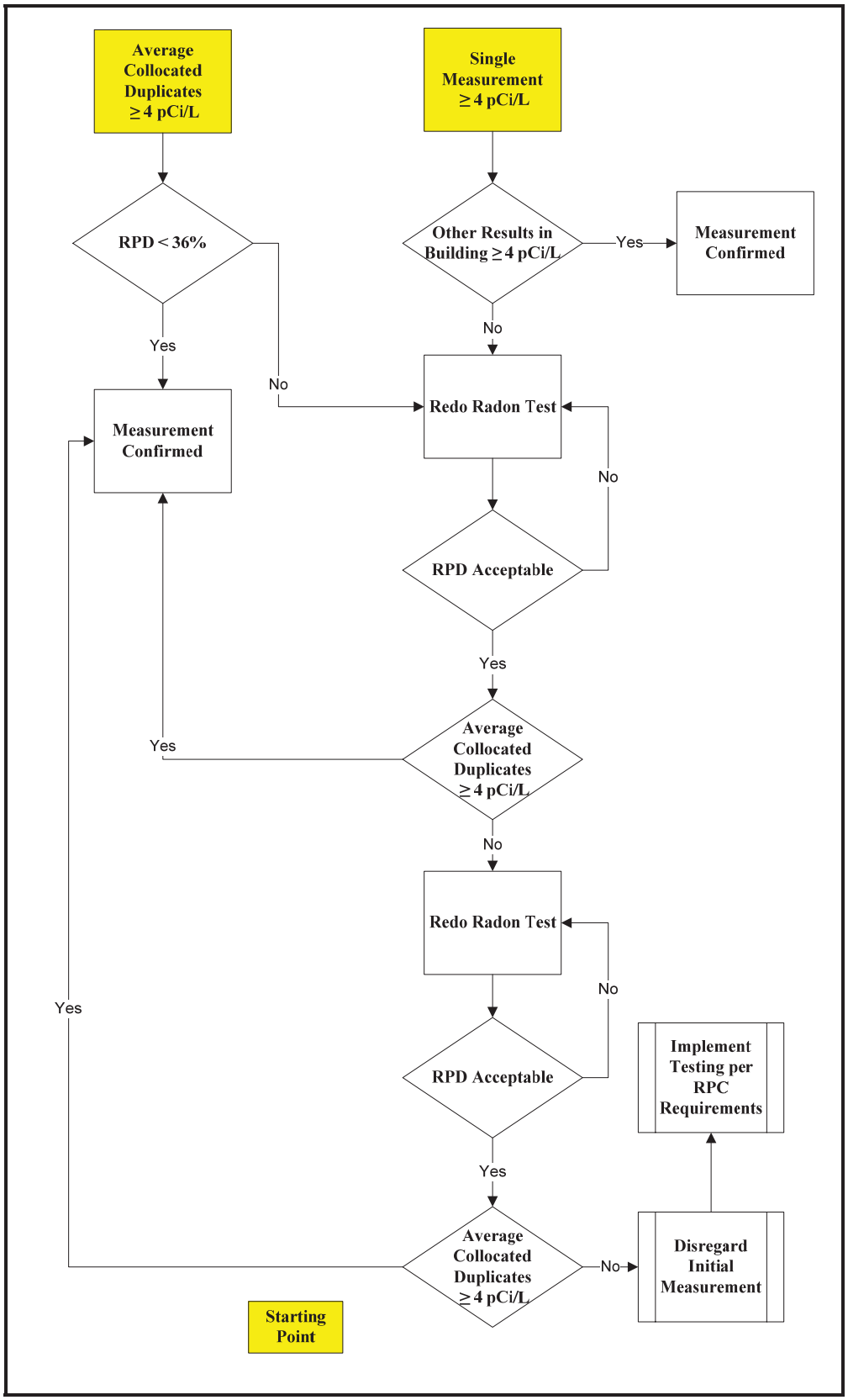
If the measurement is not confirmed, then a third test is employed using the same criteria as above. If the elevated measurement cannot be confirmed, it should be error-coded and not used.

Ideally, to confirm a long-term measurement, another long-term measurement would be performed during the same season. Unfortunately, time and/or financial considerations may require a follow-up test using a shorter measurement interval in a different season. Extrapolating from EPA guidance and programmatic lessons learned, a few general rules have been developed to assist in interpreting independently measured long-term tests and short-term data. The following is a summary of the confirmation algorithm:

1. If both the short-term and long-term measurements are ≥4 pCi/L, then the long-term result is considered confirmed (e.g., initial long-term = 4.0 pCi/L and average short-term confirmation = 30 pCi/L).

2. If the short-term measurement result is <4 pCi/L but >50% of the long-term result, then the long-term result is confirmed (e.g., initial long-term = 4.0 pCi/L and short-term confirmation = 2.0 pCi/L).

In cases of disagreement, a second confirmation measurement should be performed using either a short-term or long-term confirmation (the latter is preferred) during similar initial testing conditions. If the second follow-up measurement is >4 pCi/L, then the initial conclusion is kept (e.g., elevated radon is present). If the second follow-up agrees with the first follow-up measurement, then a new conclusion is reached based on the most recent short-term measurements. In addition, consideration should be given to any changes (usage, structural, or mechanical) that may have occurred since the initial long-term test was performed. The occurrence of any one of these events can cause significant increases or decreases in the radon levels. The confirmation algorithm is shown in Flowchart 7.



Flowchart 7. Elevated radon measurement confirmation process.

3.5.8 Postmitigation and O&M Measurements

For postmitigation testing, EPA requires only that the measurement be performed using an approved device/method and be conducted within 30 days of the mitigation installation (EPA 1994b). A successful mitigation is evident if the measurement is <4 pCi/L. Similar guidance is provided for O&M testing, with the exception that the test is to be performed at least every 2 years after mitigation. Under NAVRAMP, these measurements are performed using collocated duplicates (duplicates are not required for CRMs) and the results validated by calculating the RPD (Eq. 1). The measurement is considered valid if either of the following is true:

- An average RPD of <67% is achieved for average radon results >2 pCi/L and <4 pCi/L.
- An average RPD of <36% is achieved for average radon results ≥4 pCi/L.

RPD validation is not required if both results are <2 pCi/L.

3.5.9 Analysis of Radon Test Data from Other DoD Sources

Recently, as a cost savings measure, DoD combined separate DoD facilities into a common administrative entity to save on both administration and maintenance costs. At naval installations where joint basing has occurred and the Navy or Marine Corps has been designated as the administrative lead (e.g., implementation of NAVRAMP would be required for this population of buildings), a review of all available radon data for the acquired buildings will be required. Because of difference in the respective DoD radon testing programs, it will be very unlikely that the supplied data will meet all of the NAVRAMP requirements. Therefore, the data provided will need to be validated (Section 3.5.1) and then assigned a DSQF (Section 3.5.2) before an appropriate RPC can be assigned (Section 2.4). For data set analysis purposes, the provided data set should initially be processed as a separate site (Section 2.4.1) until an appropriate RPC has been determined for this population of buildings. However, if no individual radon test data are available (summary reports, sometimes referred to as circumstantial data, cannot be used), then RPC 2 shall be assigned to the site.

In the initial analysis step, determine if one or more of the following statements are **true** for the provided data set:

- The testing device information (e.g., manufacturer and type of testing device) was not provided or it is has been determined that they do not meet the minimal NAVRAMP requirements (Section 3.2.2).
  - Note: WLM or progeny measurements cannot be accepted under NAVRAMP.
- The measurements were **not** collected using the respective services radon testing program guidelines **or** one of the following standards were **not** followed.
  - *Protocols for Radon and Radon Decay Product Measurements in Homes*, (EPA May 1993),
  - *Radon Measurement in Schools* (EPA July 1993)

- *Protocols for Measuring Radon and Radon Decay Products in School and Large Buildings* (ANSI 2014a), or
- EPA testing requirements for federal agencies (Appendix E, Section 2.1.4).

- One or more of the following information is missing from the provided data set:
  - Detector id numbers,
  - placement and retrieval dates,
  - building numbers and tested room names, or
  - individual radon results for each room tested.

If any of the above statements are **true**, the data set should be assigned DSQF = 4, and the site RPC = 2. However, if the testing devices **do meet** the minimal NAVRAMP testing device requirements, and **at least one** of the testing guidelines listed above, then a review of the available QC data (duplicate, blank and spike results) should be performed and the appropriate DSQF assigned (Section 3.5.2).

For DSQF equal to 2 or 3 (if the data set was assigned a DSQF = 4, assign an RPC = 2 to the site), an RPC 1 is assigned to the site for any confirmed radon results ≥4 pCi/L (Flowchart 7) or if more than one result at the site was found to be ≥4 pCi/L. If confirmation testing is required, then the assignment of the RPC should be deferred until the confirmation or follow-up testing has been completed (Section 3.5.7). However, in this case, if expediency is desired for the RPC assignment, consideration can be given to other mitigating factors such as the main naval installation or other sites are known RPC 1.

If the data set is validated (e.g., DSQF 2 or 3) but the highest radon result is <4 pCi/L, a determination needs to be made whether sufficient testing has been performed. If at least 25% of the ground-contact occupied rooms at the site were tested, then an RPC 3 designation (Section 2.4) is assigned. However, if <25% of the rooms were tested, then an RPC 2 designation (Section 2.4) shall be applied.

After the initial RPC has been assigned to the site, the installation will need to decide as to whether to continue to manage this population of buildings as a separate site, integrate it into an existing naval site, or incorporate it into the existing population of buildings at the naval installation as a whole. If the decision is make to incorporate these buildings into the existing site, or the entire installation building population, then the RPC for the site or UIC as a whole would apply (Section 2.4) and any additional testing implemented as required (Section 2.4).

3.5.9.1 Analysis of Radon Test Data From Other Sources

Another source of radon data may be the current occupant of a building. Because of the availability and relatively low cost of "do-it-yourself" radon test kits, occupants may be tempted to perform the radon testing themselves. Under no circumstances are these data to be used to draw any testing conclusions.

3.5.10 Radon Testing Records Management

Under NAVRAMP, all installations are required to maintain a central data management system containing all valid data collected at the installation (this requirement includes current and former Navy/Marine Corps–owned family housing, and nonresidential buildings that are either owned or leased) that were tested under NAVRAMP. At a minimum, the information on file should contain the information specified in Section 3.4 and can be maintained in either hard copy or electronic format. Consistent with current EPA and BUMED recommendations, all radon test results collected under NAVRAMP shall be kept on file by the installation indefinitely, the rationale being that the manifestation of lung cancer after radon exposure can be decades. However, the installation is not required to maintain radon testing records from public private venture (PPV) housing collected by the partnering private company. Additional guidance on this subject will be provided by COMNAVFACENGCOM separately in the future.

3.6 RADON TESTING PROVIDER QUALIFICATIONS

For all field placement and retrieval activities, the radon team must be under the supervision of an on-site field supervisor. Qualifications of the field supervisor are

- Training: Radon testing training certified by NRPP or NRSB
- Experience: 3 years of documentable radon testing experience
- Certification: Current NRPP or NRSB certification

Personnel other than the on-site field supervisor who are placing and retrieving radon detectors are called "field technicians." Qualifications for the field technician are

- Training: Radon testing training certified by NRPP or NRSB
- Experience: 1 year of documentable radon testing experience
- Certification: Current NRPP or NRSB certification

Personnel who perform data analysis, validation, and certification of the radon testing results are called radon testing analysts. Qualifications for the radon testing analyst are

- Training: Radon testing training certified by NRPP or NRSB
- Experience: 5 years of documentable radon testing experience
- Certification: Current NRPP or NRSB certification

Under EPA guidelines for implementation of the IRAA, government employees and military personnel may perform the radon testing at their facilities without accreditation, although appropriate training is recommended. However, the remaining requirements for the testing (e.g., use of NRPP- or NRSB-listed devices and laboratories, testing locations, documentation) remain unchanged.

3.6.1 Testing Subcontractor Health and Safety Plan

Before any testing project begins, the subcontractor shall prepare a project health and safety plan. At a minimum, the plan shall list the expected potential hazards to the personnel performing the testing, the workers, and building occupants and the proposed measures to control the hazards.

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4. NAVRAMP RADON MITIGATION

Within tested and proposed new construction buildings, NAVRAMP requires the following.

- All buildings with valid radon test results ≥4 pCi/L shall be mitigated following a prescribed schedule (Table 1 of this document).
- Installed mitigation systems shall be periodically inspected and retested.
- RRNC shall be included where appropriate (Section 4.3).

This chapter provides the NAVRAMP installation specifications for the mitigation systems, RRNC, and mitigation system O&M. Additional information on these topics can be found in Chapter 4 in Appendix E.

4.1 NAVRAMP RADON MITIGATION SYSTEM REQUIREMENTS

The only mitigation techniques allowed under NAVRAMP are those that prevent radon gas from entering the building or those that dilute the gas by use of supplemental ventilation (see EPA August 1988 and EPA October 1993 for a complete list of mitigation techniques). Mitigation methods using HEPA filtration or progeny removal are not allowed (see EPA letter to Douglas County School Board in Appendix A). All ASD mitigation systems in existing building shall be in accordance with ASTM E2121-12 (ASTM 2012) and UFGS-31-21-13 (UFGS 2011) and shall be equipped with performance indicators and contact information to report system failure. In addition, all mitigation shall be performed by qualified personnel (Section 4.2.6). The schedule (Table 1) for corrective action (e.g., the mitigation clock) should generally be based upon the testing report date. In cases in which confirmation is required, the mitigation schedule should be based upon the report date of the initial test. In order to ensure protection of human health, specific mitigation schedules should be coordinated with command leadership, BUMED personnel, and others as appropriate. See also communication guidance provided in Section 2.11. In addition NAVRAMP requires the following.

- The installed mitigation system shall consistently maintain radon levels at <4 pCi/L when operating.
- Each active mitigation system regardless of type shall be equipped with a performance indicator and contact information to report system failure.
- All mitigation shall be performed by qualified personnel (Section 4.2.6).

4.2 RADON MITIGATION SPECIFICATIONS AND REQUIREMENTS

EPA divides radon mitigation into two basic categories: passive and active. Passive mitigation is defined as a nonmechanical means of radon abatement or control by the use of sealing cracks, balancing an existing mechanical system, installing a passive stack vent

pipe during construction, or increasing the natural ventilation rate of the building substructure (i.e., the crawlspace). The other category, active mitigation, entails using mechanical means, such as a fan or blower, to either dilute or control the entry of radon into the living area. Examples of active mitigation include, but are not limited to, SP, ERV, SSD, and SAM. For further information on these types of mitigation systems please consult Chapter 3 in Appendix E.

Because of the diversity in style and construction of naval installation buildings, a single mitigation approach for all buildings at an installation is highly unlikely. Therefore, building-specific mitigation diagnostics (measurements that assist in the selection of a mitigation system) should be conducted to ensure that a proper mitigation system selection is made. Mitigation method selection criteria always include costs (installation and O&M), probability of success, and direct impact on the building occupants. Other considerations might be

- energy consumption
- security concerns
- aesthetics
- noise generation
- loss of indoor functional space
- proposed and pending renovations
- projected remaining lifetime of the building
- understanding of the occupants' concerns
- life-cycle cost

As a general rule, because of their long-term cost-effectiveness, passive, SSD, and SAM should always be considered first. If these methods are not viable, then other mitigation methods (e.g., ERV, SP) should be considered. However, under no circumstances should HEPA systems or other methods that alter the radon decay product equilibrium be used, because their efficacy in reducing risk is uncertain.

Upon completion of a mitigation system installation, postmitigation radon testing shall be performed by the mitigation contractor to ensure that radon levels are <4 pCi/L. All postmitigation testing shall be short term and in accordance with NAVRAMP testing policies, guidelines, and procedures and EPA 402-R-92-004 (EPA July 1992). Postmitigation testing shall be performed no sooner than 24 h and no later than 30 days after system activation or, in the case of passive mitigation, completion. Within 30 days of the reporting of the postmitigation test results and at the discretion of the installation, an independent postmitigation test may be performed to verify that radon mitigation has indeed occurred. The extent and frequency of this follow-up postmitigation testing are at the sole discretion of the installation.

4.2.1 Passive Mitigation Specifications and QA

For existing construction, passive mitigation is divided into two categories: sealing and mechanical balance and repair. Although simple in concept (e.g., no moving parts), it

can in the long term be difficult to inspect passive mitigation measures and ascertain current system performance. EPA applies the same O&M inspection and testing criteria as for active systems (e.g., periodic inspection, retesting at least every 2 years).

In passive sealing, various sealants are applied to cracks, expansion joints, and other potential radon soil gas entry points in an effort to reduce radon entry or, ideally, eliminate it entirely. Passive sealing should be attempted as a mitigation means only if the repair would potentially last for >20 years. Therefore, the selection of the most appropriate sealant is critical. According to the American Adhesive and Sealant Council, the choice of a sealant should be based on the type and size of the opening, the opening substrate, the environment in which the sealant would be used, and the potential for deterioration, among other criteria. For most sealants on the market, specification and instruction sheets provided by the manufacturer are a good source of this type of information. In addition, the Material Safety Data Sheet should be consulted to see if any precautions need to be taken during installation and post-application curing.

Passive sealing is highly application-specific and thus does not easily fit a standard checklist for post-installation QA. Therefore, a customized QA checklist must be developed for each post-installation inspection and for future O&M checks. Questions that should always be included on the post-installation checklist are

- Was the use of this particular sealant appropriate for this application?
- Was the sealant applied according to the manufacturer's instructions?

In mechanical balance and repair, the building's mechanical systems (e.g., supply and exhaust) are modified or restored to the original design specifications. This includes, but is not limited to, replacing makeup air and exhaust components, adjusting supply and return air, adjusting the fresh-air and exhaust dampers, and modifying duct components that are in ground contact (e.g., subslab return or supply ducts). As with passive sealing, this technique is very much application-specific and does not easily fit into a standardized QA checklist. Therefore, a customized form must be developed for the post-installation check and future O&M inspections. Questions that should always be included on the post-installation check list are

- Did the adjustment, modification, or repair keep the building temperature and humidity within the design specifications?
- Did the adjustment, modification, or repair have any significant impact on occupant comfort?

Within 30 days of the passive mitigation installation, the installation or its designee should perform independent inspections of the passive mitigation installation to verify that the system meets the design requirements and was installed properly.

4.2.2 Shell Pressurization Specifications and QA

SP, although the oldest and best understood of all radon mitigation methods, should be considered the mitigation method of last resort. To be brief, compared with other forms of radon mitigation, SP has higher maintenance and energy costs and, depending upon the type of SP system installed, may be more expensive to install. SP systems consist of two basic types differentiated by how the required volume of outdoor air is supplied.

A Type 1 SP system uses either an existing or an installed fresh-air damper to supply the fresh air. In this design, the air is conditioned by the building's existing mechanical system before discharge into the building. Therefore, before the SP system is installed, it is necessary to evaluate the current mechanical system and calculate the load to determine if it could condition the added volume of air (e.g., heat, cool, and dehumidify). If the existing mechanical system lacks the capacity for conditioning the required makeup air, then a Type 2 SP system (an independent mechanical system to condition the outdoor air before it enters the structure) will be required. Load calculations must be performed to ensure that the unit will adequately condition the supply air year around.

Specifications for SP mitigation systems are building- and application-specific—the design for one building will not be readily interchangeable with another. Many considerations go into the design of an SP system to ensure that the current mechanical system(s) can handle the added conditioning load and that the possible increase in humidity would not place the building within the range for inducing mold growth (≥60% RH). Therefore, if SP is selected as the mitigation method, the design will need to be reviewed and approved by a qualified mechanical engineer before the mitigation system is installed. From this final design, a QA checklist can be generated for possible inspection. Examples of typical features and conditions to check after installation are

1. The quarters, room(s), or building is between (+) 4 and 8 Pa relative to the outdoors.
2. Installed filters have a minimum efficiency reporting value (MERV) rating of 8 or greater (ASHRAE 2007, 52.2-2007) and are accessible.
3. The relative humidity in the room(s) or building is ≤60% or meets the specific building requirements.
4. Wall penetrations to the exterior are sealed.
5. To the best extent possible, the system meets fresh-air intake requirements of *DoD Minimum Antiterrorism Standards for Buildings* (UFC October 2003, UFC 4-010-01, updated 22 January 2007).

Within 30 days of the mitigation installation, the SP system should be independently inspected to verify that it meets the design requirements and was installed properly. In addition, pressure, temperature, and humidity should be measured in the supply air and in the rooms or building to verify that the tolerances listed in the design were met.

4.2.3 Energy Recovery Ventilation Specifications and QA

ERV is a post-entry mitigation technique that reduces the indoor radon concentration by increasing the air exchange in the building or room(s). An ERV unit typically consists of two fans, one exhausting a known volume of indoor air and the second bringing in an equal volume. During operation, the two air streams (in separate compartments of the unit) pass over an inter-compartmental heat exchanger (for energy recovery) and a desiccant wheel (for humidity control). Although heat recovery is high for most units (ranging from 60 to 80%), the units are not well suited for use as dehumidifiers in climates with hot, humid summers. Consequently, as part of the mitigation design, it is necessary to evaluate the existing building mechanical system to determine if it can handle the added cooling and heating load and the increase in humidity. If that capability is in question, optional features (available on most commercial units) for conditioning the incoming outdoor air should be included.

The design specifications of all ERV systems for use within naval installation buildings must have been evaluated using either ASHRAE Standard 84-2008 (ASHRAE 2008) or AHRI Standard 1060-2005 (AHRI 2005).

The proposed ERV unit should have a rated capacity of at least 10% above the required cubic feet per minute to allow for some performance degradation between air filter changeouts. Also, the supply air volume should be at least 5% greater than the exhaust volume to prevent room depressurization. In addition, on average the unit should recover at least 70% of the conditioned temperature year round (as determined by either ASHRAE Standard 84-2008 [ASHRAE 2008] or AHRI Standard 1060-2005 [AHRI 2005]). The unit should be equipped with an insect screen and MERV 8 filters (ASHRAE 2007, 52.2-2007). In addition, unit operation should not cause room(s) or the building to exceed 60% RH or the specific building requirements for any extended period of time. Also, to the best extent possible, the system should meet fresh-air intake requirements *of DoD Minimum Antiterrorism Standards for Buildings* (UFC October 2003, UFC 4-010-01, updated 22 January 2007).

Within 30 days of the ERV installation, the installation should be independently inspected to verify that the system meets the proposed contract design requirements and was installed properly. In addition, temperature and humidity should be measured in the supply air and in the room(s) or building to verify that the tolerances listed in the design are met.

4.2.4 Supplemental Air Mitigation Specifications and QA

SAM is used to correct elevated radon problems in a single room by providing additional forced-air ventilation (Fig. 18). Although relatively easy to install and maintain (a typical SAM system consists of a blower, ductwork, and a switch), the technique is not widely employed because of its limited application. For example, the criteria for the room to be mitigated by SAM are that it must

- have radon levels <20 pCi/L
- be no larger than 3,500 ft^3
- have an ACH rate of <0.2
- be located near a large room or common area from which the desired volume of low-radon conditioned air can be withdrawn without a significant risk of depressurization

In addition to these criteria, particular attention must be paid to noise and occupant comfort. Because these systems are usually used in single or double offices, the noise generated by the discharge of the supply air may pose an inadvertent distraction to the occupant(s). Therefore, the supply diffuser, in addition to being aesthetically pleasing, must produce as little noise as possible. Another important consideration is the location of the discharge point. The discharge air velocity from a typical SAM system is comparable to that of a forced-air system. So to the best extent possible, the discharge needs to be in a location that would not appreciably increase the air velocity in the primary work area.

Within 30 days of the SAM installation, the system should be independently inspected to verify that the system meets the proposed contract design requirements and was installed properly.

4.2.5 Subslab Depressurization Specifications and QA

For SSD mitigation systems, minimum specifications are that the systems comply with

- *Radon Mitigation Standards for Schools and Large Buildings,* ANSI RMS-LB 2014 (ANSI 2014b)
- *Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings*, ASTM E2121-12 (ASTM 2012)
- *Radon Mitigation,* UFGS-31-21-13 (UFGS 2011)

In addition, the following requirements must be met:

1. All electrical work shall meet or exceed the most current National Electrical Code and installation requirements and shall use solid 12 AWG wire.
2. The electrical circuit for the radon fan shall be clearly labeled in the breaker panel.
3. All mitigation fans shall be hard-wired unless they are in an attic where corded fans (with cords shorter than 6 ft) are allowed.
4. A wet location–rated electrical switch shall be located within 6 ft of the fan unless it is an attic installation where corded fans are permitted.
5. All vent pipes and fittings shall be white 4 in. PVC Schedule 40.
6. All metal components of the system (e.g., fasteners, pipe straps, channel) shall be stainless steel or be corrosion resistant.
7. All fans shall be rated for exterior use and be designated by the manufacturer for use as radon mitigation fans.

8. Every vent stack shall be covered with a vent cap.
9. Every system shall have a performance indicator located within 6 ft of the primary slab penetration point. Instructions regarding how to read the indicator and a contact phone number shall be posted adjacent to the indicator.
10. Where applicable, all radon fans shall be covered by a fan cover attached to a fan cover base plate.
11. All exterior clamps and fasters shall be stainless steel, galvanized, or corrosion resistant.

Contractor-requested exceptions to these standards shall be submitted to the installation in writing for consideration at least 2 weeks before the mitigation installation.

Within 30 days of the mitigation installation project, an independent inspection should be performed on a randomly selected section of the radon system to verify that the system meets the proposed design specifications. The frequency of the random checks and the number of systems to verify are at the sole discretion of the installation. An example data form for SSD inspection is included in Appendix D.

4.2.6 Radon Mitigation Subcontractor Qualifications

For all field mitigation diagnostics and installation activities, the radon team must be under the direct supervision of an on-site field supervisor. Qualifications for the field supervisor follow.

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 3 years of documentable radon mitigation experience in nonresidential or other large buildings
- Certification: Current NRPP or NRSB certification

Personnel other than the on-site field supervisor who are involved in mitigation diagnostics or installation are called field technicians. Qualifications for the lead field technician follow.

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 1 year of documentable radon mitigation experience
- Certification: Current NRPP or NRSB certification

Personnel who perform mitigation design are called radon mitigation analysts. Qualifications for the radon mitigation analyst follow.

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 5 years of documentable radon mitigation experience in nonresidential or other large buildings
- Certification: Current NRPP or NRSB certification

Under EPA guidelines for implementation of the IRAA, government employees and military personnel may perform radon mitigation at their facilities without accreditation, although appropriate training is recommended.

4.2.7 Mitigation Subcontractor Health and Safety Plan

Before any mitigation project begins, the subcontractor shall prepare a project health and safety plan. At a minimum, the plan shall list the expected potential hazards to the mitigation personnel, workers, and building occupants and the measures to control the hazards.

4.3 RADON-RESISTANT NEW CONSTRUCTION REQUIREMENTS

As was discussed in Section 2.4, RRNC is required for all new construction at RPC 1 installations or sites and within the construction of new, long-term lease buildings (e.g., leases, limited partnerships, and international use agreements; see Section 2.9) in which the Navy/Marine Corps will be responsible for NAVRAMP implementation. The basic design considerations for buildings that will incorporate radon-resistant features in new construction are as follows.

- If possible, the aggregate bed under the slab should not be compacted.
- One riser should be installed for every 3,000–5,000 ft^2 of slab (see also ASTM E1465-08a).
- There should be provision for 3–4 ft of clearance in the attic to allow for easy access to install and maintain the fan.
- The electrical outlet should be located within 6 ft of the radon vent riser in the attic.

In addition to the requirements listed, the passive sealing portions of Unified Facilities Criteria (UFC) 3-490-04A (UFC May 2003) and the subslab gas collector specifications from ASTM E1465-08a should be incorporated.

4.3.1 RRNC Design Overview

For all new construction incorporating radon-resistant features, all gaps/joints and slab penetrations should be sealed. However, the installation of other RRNC features and components will depend upon the design of the building. It is recommended that to the best extent possible, one of the following three RRNC methods be incorporated into the building design:

- Method 1 uses a preinstalled vent pipe to route radon from under the slab to above the roof. This method is commonly referred to as “passive stack.”
- Method 2 uses a subslab soil gas collection piping network that is connected to a vent pipe that penetrates the roof. This technique is commonly referred to as “mitigation-ready passive stack.”
- Method 3 uses an identical subslab soil gas collection piping network, but the vent piping is stubbed out and capped in either the living area or the attic or on the

exterior of the building. This technique is commonly referred to as "mitigation ready."

Additional information about RRNC is included in Appendix E, Chapter 4.

4.3.1.1 Slab Sealing Specifications

All gaps/joints and all floor slab penetrations must be sealed to prevent air leakage into the building (EPA 402-K/11-002 [EPA 2012], ASTM E1465-08a [ASTM 2008], or UFC 3-490-04A, inactive with no replacement [UFC May 2003]). Gaps can be filled with polyethylene backer rod or comparable filler material as required and sealed with polyurethane caulk or other elastomeric sealant. Caulks and sealants shall be applied according to the manufacturer's instructions. All penetrations into the building exterior should be inspected to ensure they are watertight. All work should be coordinated with the contracting officer.

4.3.1.2 Method 1: Passive Stack (Option)

Operational Principle

This design uses an RRNC technique to potentially retard radon entry into the building by passively redirecting the radon soil gas from under the slab to a vent pipe.

Specifications

Just before the slab is poured, at an interval of one pipe for every 2,000 ft^2 of slab, a 4 in. Schedule 40 PVC vent pipe (or pipes) equipped with a tee will be inserted into a noncompacted aggregate bed (minimum 4 in. layer of clean coarse gravel [½–¾ in. mesh]). After the concrete has been poured, the gap around the pipe will be sealed with polyurethane caulk or another elastomeric sealant. The vent pipe will then be routed vertically through the building and through the roof in a manner that would not interfere with the daily operations and functions of the building occupants. The exhaust end of the pipe shall be left uncapped, and the vent stack pipe discharge location shall be as specified in ASTM E1465-08a (ASTM 2008).

Within 6 ft of the location of a proposed fan (the fan cannot be mounted in or directly under living or occupied space), an electrical outlet on a dedicated circuit shall be installed. If needed, multiple fans can be wired to the same dedicated circuit. All components of the radon system piping shall drain their condensed water vapor and collected rain completely to the ground beneath the slab. If the intent is to mount the proposed fan in the attic, then a minimum of 3–4 ft of vertical clearance will be required to allow for easy access to install and maintain the fan. To the best extent possible, the visibility of the system should be kept to a minimum, and all operating components should be accessible for maintenance and repair.

4.3.1.3 Method 2: Mitigation-Ready Passive Stack (Option)

Operational Principle

This design uses an RRNC technique to potentially retard radon entry into the building by passively redirecting the radon soil gas through a network of underground pipes to a vent pipe.

Specifications

A network of Schedule 40 perforated PVC pipes (Type 1 soil gas collector; flexible corrugated drain tile may be substituted) will be buried in a gas-permeable layer of crushed stone (minimum 8 in. layer of clean coarse gravel [½–¾ in. mesh]) and manifolded to effect coverage under all rooms. A tee assembly shall be positioned so that the suction-point pipe that attaches to it penetrates the slab in an unobtrusive place and so that the suction-point pipe can be attached to the vent stack (one riser for every 3,000–5,000 ft^2 of slab). Perforated, corrugated drain tile can be substituted for the Schedule 40 PVC provided it is inspected for deformations (e.g., crushing) and repaired just before the slab is poured. The radon system vent piping (4 in. Schedule 40; corrugated drain tile ***cannot*** be substituted) shall be routed so as not to interfere with the daily operations and functions of the building occupants. The exhaust end of the pipe shall be left uncapped, and the vent stack pipe discharge location shall be as specified in ASTM E1465-08a (ASTM 2008).

Within 6 ft of the location of a proposed fan (the fan cannot be mounted in or directly under living or occupied space), an electrical outlet on a dedicated circuit shall be installed. If needed, multiple fans can be wired to the same dedicated circuit. If the intent is to mount the proposed fan in the attic, then a minimum of 3–4 ft of vertical clearance will be required to allow for easy access to install and maintain the fan. All components of the radon system piping shall drain their condensed water vapor and collected rain completely to the ground beneath the slab. To the best extent possible, the visibility of the system should be kept to a minimum, and all operating components should be accessible for maintenance and repair.

4.3.1.4 Method 3: Mitigation-Ready (Option)

Operational Principle

This design uses a mitigation-ready approach to ensure that if elevated radon is found, mitigation can be successfully performed at a lower cost.

Specifications

A network of Schedule 40 perforated PVC pipes (Type 1 soil gas collector; flexible corrugated drain tile may be substituted) will be buried in the gas-permeable layer of crushed stone (minimum 8 in. layer of clean coarse gravel [½–¾ in mesh]) and manifolded to effect coverage under all rooms. In the design, allowances should be made

for one riser (see paragraphs below) for every 3,000–5,000 ft^2 of slab. If perforated, corrugated drain tile must be substituted for the Schedule 40 PVC soil gas collection network, it must be inspected for deformations (e.g., crushing) and repaired just before the slab is poured.

For interior risers, a tee assembly shall be positioned so that the suction-point pipe that attaches to the soil gas collection network penetrates the slab in an unobtrusive place and so that the suction point can be attached to the vent stack. The capped riser should extend a minimum 6 in. above the floor (proposed route of the optional vent pipe should be included in the building plans) and should be located in an area that is readily accessible (e.g., the capped end of the riser cannot be enclosed inside a wall).

For exterior-mounted risers, a branch of the soil gas collection network should extend through the foundation using 4 in. Schedule 40 pipe and should have a 90° elbow attached. From the top of the elbow, a minimum 6 in. section of 4 in. Schedule 40 pipe shall be attached and a cap installed on the end. The riser should be located in an area that is readily accessible, and the building plans should contain the proposed route of the optional vent pipe. In addition, the location of the riser and optional vent pipe should not interfere with the daily operations and functions of the building occupants.

Within 6 ft of the location (either type of riser) of a proposed fan (fan cannot be mounted in or directly under a living or occupied space), an electrical outlet on a dedicated circuit shall be installed. If needed, multiple fans can be wired to the same dedicated circuit. If the intent is to mount the proposed fan in the attic, then a minimum of 3–4 ft of vertical clearance will be required to allow for easy access to install and maintain the fan. All components of the radon system piping shall drain their condensed water vapor and collected rain completely to the ground beneath the slab. To the best extent possible, the visibility of the system should be kept to a minimum, and all operating components should be accessible for maintenance and repair.

4.3.1.5 Design Specification for Radon Fan Assembly

For all passive stack and mitigation-ready options, designs and specifications shall be provided for the installation of the radon fan. In addition, the proposed fan shall be installed in a vertical section of the vent stack pipe and in a vertical orientation to prevent condensed water and precipitation from accumulating in the fan. As a minimum, the design shall contain

- the proposed fan location and type of fan
- the proposed electrical hook-up and wiring specification
- the location and type of the system performance indicator
- any additional hardware needed for fan activation

4.3.1.6 Labeling of System

System components shall be labeled as specified in ASTM E1465-08a (ASTM 2008) for all passive stack and mitigation-ready options. This would include but not be limited to

labels that identify the vent piping as part of a radon reduction system in visible, inside walls and attics.

4.3.1.7 Radon Testing of Mitigation-Ready Building

Upon building completion or within 5 years of occupancy, an initial radon gas test shall be performed as specified in accordance with the NAVRAMP testing protocol.

4.3.1.8 Activation of Radon Mitigation-Ready System

If radon testing finds rooms within the building ≥4.0 pCi/L, then the mitigation fan and any remaining vent pipe should be installed per design and activated by a certified radon mitigator under the supervision of the responsible system designer. Upon completion of fan installation and activation, postmitigation testing shall be performed no sooner than 24 h after fan activation to ensure that radon levels in occupiable spaces are <4.0 pCi/L. All testing should be performed under closed-building conditions (for short-term tests of <4 days, closed building conditions must be initiated at least 12 h prior to the placement of the detectors and maintained for the duration of the test). In addition, all mechanical equipment that will be operating during normal human occupancy (normally, exhaust blowers and central air-conditioning system operating in a typical fashion) should be operating at least 24 h before an initial radon test is conducted. If elevated radon is still present, the contract officer should be consulted for further instruction.

4.3.2 Radon-Resistant New Construction Designer Subcontractor Qualifications

For all RRNC designs, the designer shall have as a minimum

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 5 years of documentable radon mitigation experience
- Certification: Current NRPP or NRSB certification

Personnel responsible for the installation, oversight, or activation of the RRNC system shall have as a minimum

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 1 year of documentable radon mitigation experience
- Certification: Current NRPP or NRSB certification

4.4 O&M OF RADON MITIGATION SYSTEMS

To maintain effective long-term radon control, radon systems will require periodic maintenance and retesting. Therefore, EPA recommends (EPA 402-R-93-078 [EPA 1994b]) that in addition to periodic performance checks, a detailed system inspection be performed at least every 2 years, followed by radon testing of the mitigated rooms. The following sections outline recommended O&M by system type.

4.4.1 O&M of Passive Mitigation Systems

Passive sealing is very much application-specific and thus does not easily fit a standard O&M checklist. Therefore, a customized O&M checklist must be developed. For passive mitigation involving mechanical balance and repair, the building mechanical system (e.g., supply and exhaust) is modified or restored to the original design specifications. This includes, but is not limited to, replacing makeup air and exhaust components, adjusting supply and return air, adjusting the fresh-air and exhaust dampers, and modifying duct components that are in ground contact (e.g., subslab return or supply ducts). Therefore, the O&M checklist should include those items. In addition, in cases where the repairs or adjustments involve bring in more fresh air, the building temperature and humidity should be included as well. In cases where sealing is involved, all joints should be inspected to verify that the caulk is still adhering to the substrate.

4.4.2 O&M of Shell Pressurization Systems

An SP system retards radon entry by mechanically introducing sufficient outdoor air to induce a positive pressure across the slab (typically 4 to 6 Pa) and into the soil. Applying pressure across the building shell reverses the natural flow of radon from the soil into the living area. Therefore, the air flows from the living area into the subslab, preventing radon entry. The downside of an SP system is that all windows and doors must be kept closed to maintain mitigation. Small openings, such as an entry door left ajar or a window left cracked open, will result in the radon levels reverting to their unmitigated levels. Also, as door and window seals deteriorate over time, additional fresh air must be drawn in to maintain mitigation.

The following routine maintenance is recommended for an air intake SP system on a quarterly basis or as required by the manufacturer:

1. Clean or replace the air intake grill air filter as needed.
2. Clean in-house return air filter.
3. After cleaning both filters, verify that shell pressure (indoor to outside) is between 4 and 6 Pa, using a digital micromanometer.

Table 6 lists troubleshooting techniques for air intake SP mitigation systems if, in the future, mitigation failure occurs or the building can no longer be pressurized to 4 Pa.

Table 6. Troubleshooting SP mitigation systems

Problem	Possible solutions
Building is <4 Pa shell pressure (indoor to outside)	1. Verify that the mechanical blower is running continuously and properly 2. Inspect intake grill for blockage 3. Clean intake grill air filter 4. Adjust air intake damper to increase outdoor airflow. 5. Inspect the mechanical collar for leakage. Repair leak as needed 6. Inspect shell for any significant leaks around windows and exterior doors. As appropriate, replace door seals or caulk any cracks around windows and doors
Building is >6 Pa pressure (indoor to outside)	1. Adjust air intake damper to decrease outdoor airflow 2. Clean central mechanical return air filter 3. Inspect mechanical collar for leakage. Repair leak as needed
Building is >4 pCi/L	1. Verify that the blower is running continuously and properly 2. Check shell pressure with digital micromanometer 3. Verify that occupants are not leaving windows and doors open for extended periods of time
Building is >4 pCi/L and shell pressure is between 4 and 6 Pa	1. Repeat differential pressure diagnostic for all major air exhaust systems. Discuss with occupants the frequency of usage of the exhaust systems. Increase airflow accordingly to compensate for largest and/or most frequently used air exhaust system

4.4.3 O&M of Energy Recovery Ventilation Mitigation Systems

ERV systems are commercially available package systems that reduce radon levels by increasing the natural ventilation rate in a building or room(s). Because of differences in design, installation, and materials, no two manufacturers' O&M requirements are exactly the same. Therefore, it is important to review the owner's manual and draft a system-specific O&M plan. Common O&M elements to address are

1. the frequency of changing the air filters and drive belts
2. lubrication of the drive and blow motors
3. maintenance of the desiccant wheel
4. the recommended frequency for checking the pressure balance of the system

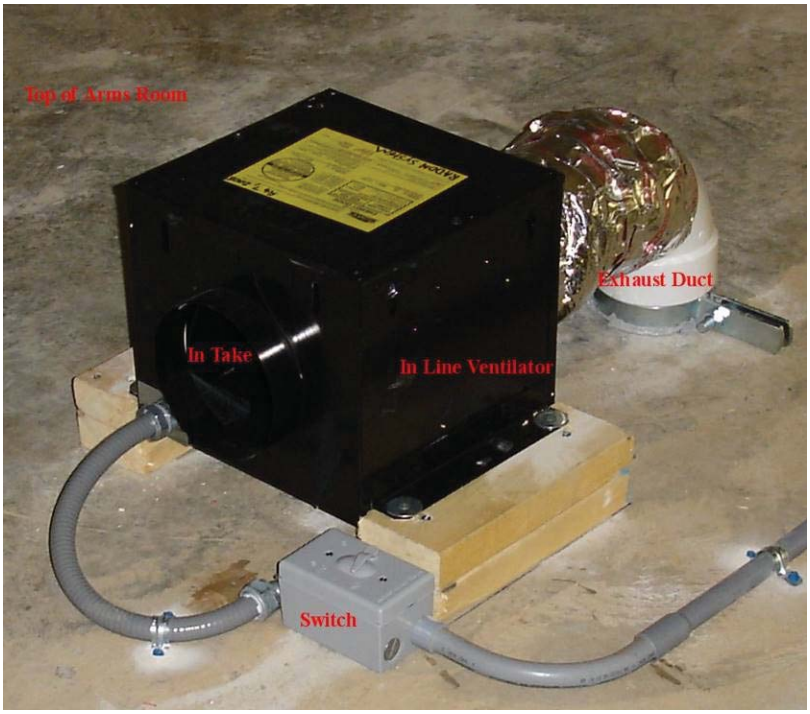
It is important to note that for ERV systems, O&M is not just a good idea—it is mandatory. For example, if the system filters are not changed, the building or room may become depressurized (i.e., the ERV exhausts more air than it is bringing in), resulting in

a potential increase in the room's radon levels. In addition, on some ERV models, lack of maintenance of the desiccant wheel could result in a sudden uncontrollable increase in the humidity of the supply air. This condition could result in a catastrophic condensation release followed by the onset of mold.

4.4.4 O&M of Supplemental Air Mitigation Systems

In general, SAM systems are easy to operate and maintain. The system consists of two basic parts, the electric fan and the duct, neither of which requires any scheduled maintenance. However, periodically, the intake (Pictures 1 and 2) should be inspected and cleaned and it should be confirmed that the unit is exhausting (e.g., smoke test, strip of paper). To determine if a SAM is working, an illuminated light box (Picture 3) can be installed. Fan operation is indicated by the green LED light (Picture 3).

Every 2 years, it is recommended that the exhaust rate of the blower be checked using a pitot tube, face velocity probe, or other suitable measuring device to confirm a minimum of 150 cfm of makeup air or the volume specified by the installer. If the air volume is found to be less, the blower should be replaced.



Picture 1. SAM components with box fan.

Picture 2. SAM components with centrifugal fan.

Picture 3. SAM performance indicator.

4.4.5 O&M of Subslab Depressurization Mitigation Systems

SSD mitigation uses a pipe inserted through the slab and connected to a fan (Fig. 1, Pictures 4 to 6). When the fan is activated, the area beneath the slab (subslab) is depressurized. The resulting depressurization prevents radon entry into the living area by redirecting the subslab radon into the pipe for discharge into the atmosphere, where it is harmlessly diluted. Generally speaking, an SSD system consists of two major components: the exhaust pipe and the mitigation fan. Of these two components, only the fan will normally need to be replaced during the remaining lifetime of the building. To determine if the fan is working properly, it is recommended that the occupant perform a monthly visual inspection of the U-tube on the fan. If the oil level reads between 0.3 and 4.0 on the scale, then the fan is operating properly (Fig. 2). If the oil level is reading 0, then the occupant should contact the phone number on the decal. A decal placed next to the U-tube provides detailed instructions and contact phone numbers. The only required maintenance of the U-tube is the infrequent addition of oil. If oil is needed, common cooking oil (e.g., Mazola® oil or the equivalent) may be used or the U-tube can be replaced. Petroleum-based oils or fluids should not be used because of the potential for poisoning small children. Before oil is added to the U-tube, the fan should be turned off either at the exterior switch or by tripping the circuit breaker. Using an eyedropper or plastic drinking straw, oil can then be added a drop at a time until the level equals 0, or the U-tube can simply be replaced. Pictures 7 and 8 show typical U-tube installations. The illuminated light box (Picture 9) relies on an electrical pressure sensor to trigger one of two LED lights (red indicating fan is off, and green indicating fan is on). Maintenance for an illuminated light box is limited to infrequent replacement of the 10-year LED bulbs and pressure sensor.

Depending upon the orientation of the building and the type of system installed, the U-tube can be mounted on the exterior of the building inside a manometer box (Picture 7) or mounted on the pipe near the floor penetration (Picture 8). An illuminated light box (Picture 9), on the other hand, can be located near the system or at a convenient location some distance from the system for remote viewing. In the private sector, routine maintenance of the mitigation system is the responsibility of the individual homeowner or building owner, and maintenance is usually performed by qualified personnel after system failure. Evaluation of the SSD systems installed at other military facilities identified several critical parts and components that should be checked on a regular interval. This maintenance is recommended to prevent water leakage into the building and loss of exterior components during high winds. With these considerations in mind, it is recommended that each component and part listed in Table 7 be inspected in accordance with the proposed schedule. To assist with the identification of the components, a “typical” SSD system has been broken into three assemblies (pipe, fan, and roof flashing) and is illustrated in Figs. 3, 4 and 5).

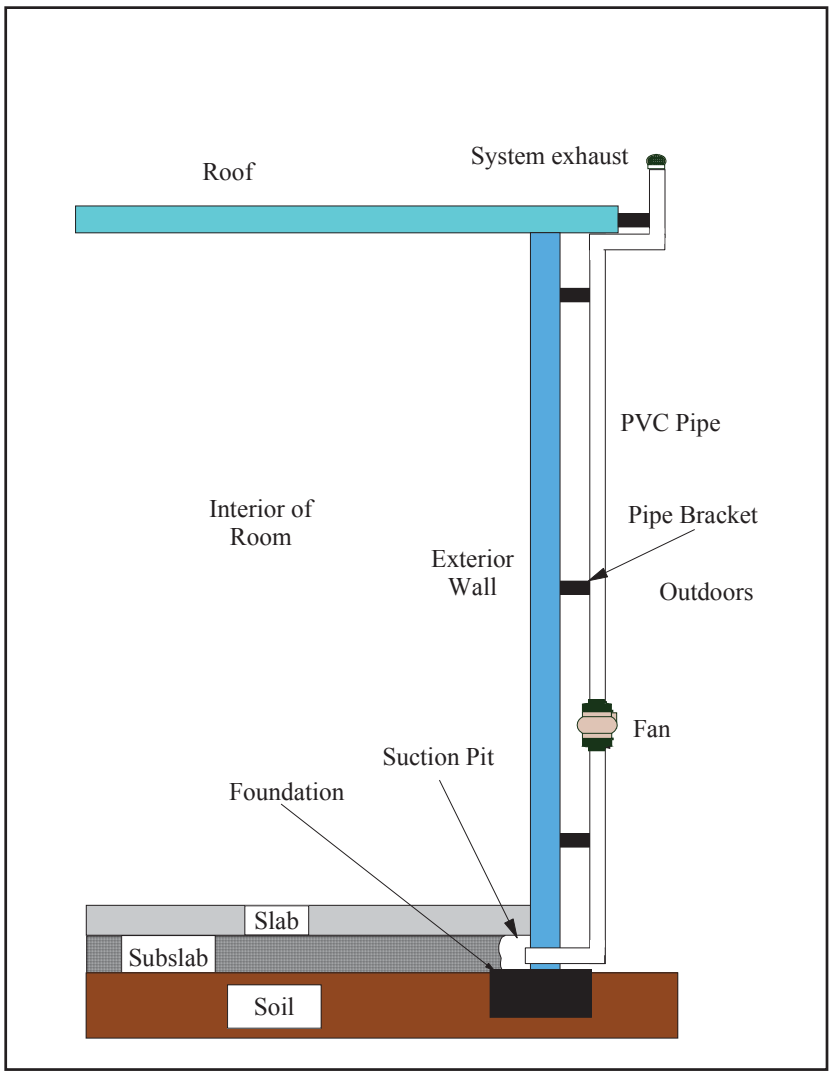
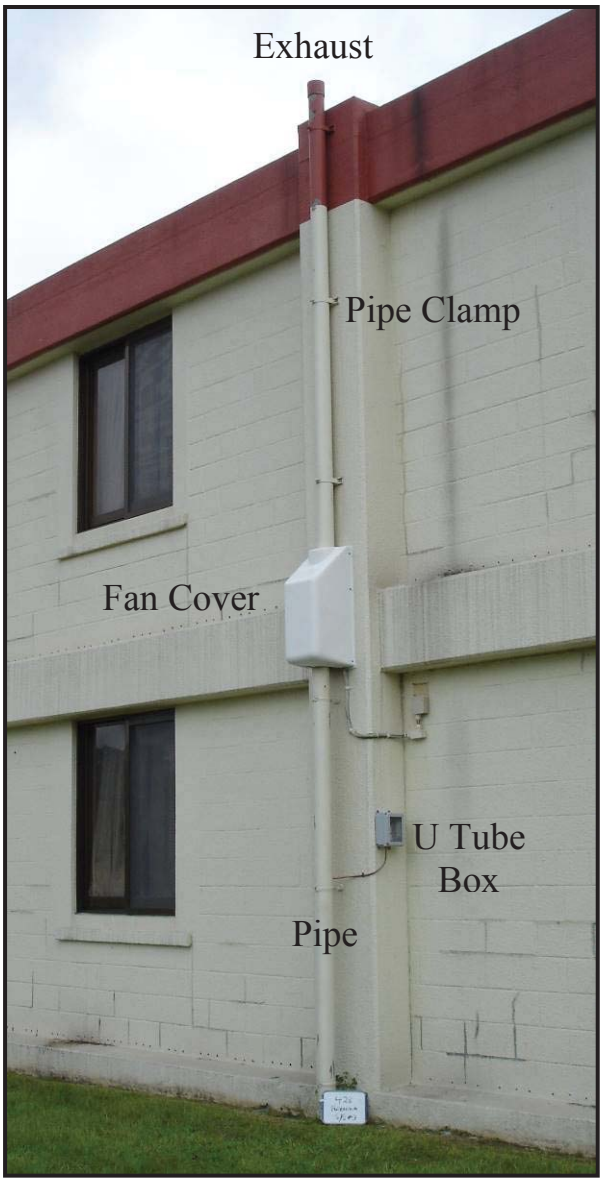
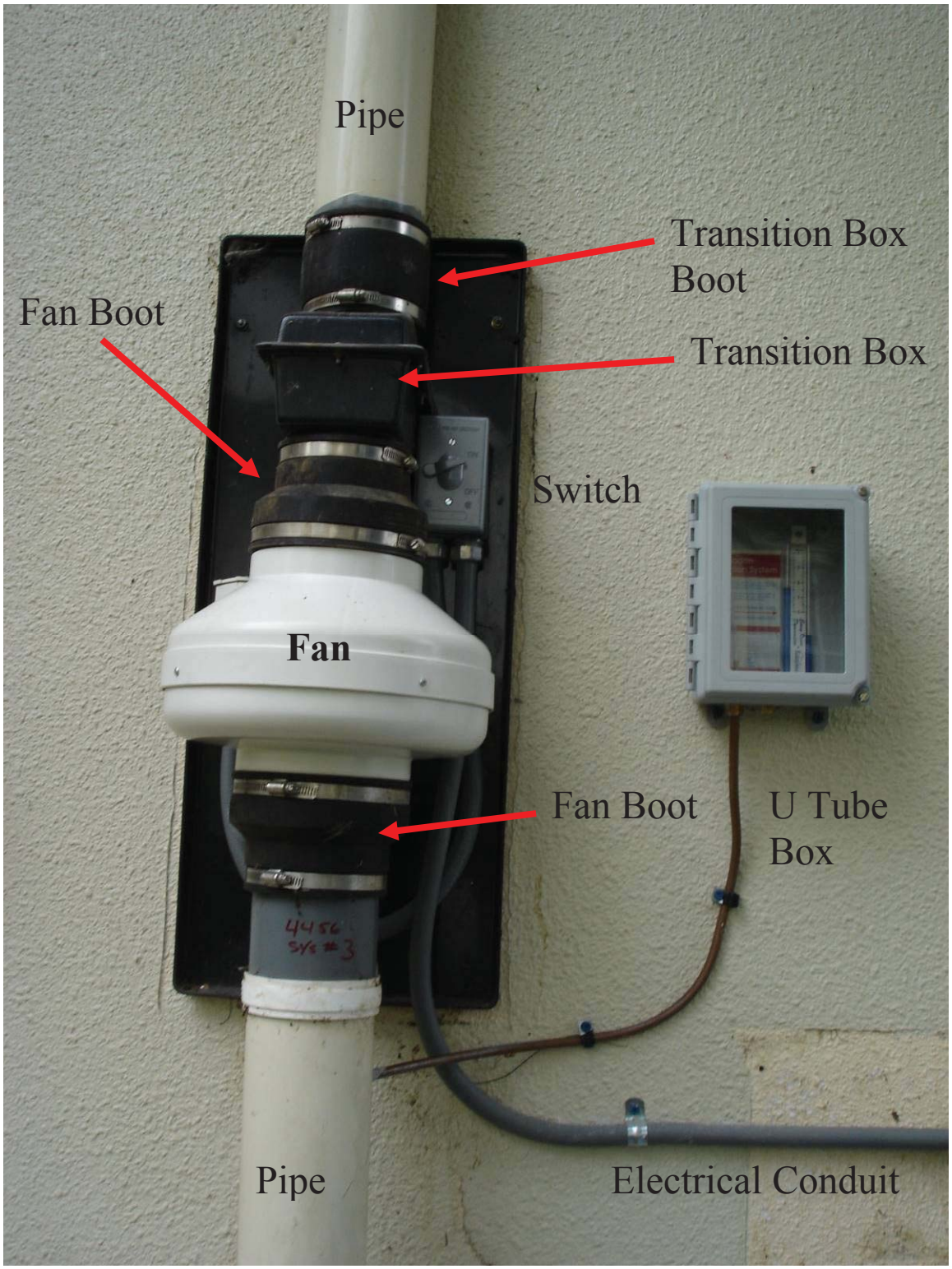


Fig. 1. Basic components of an SSD mitigation system.

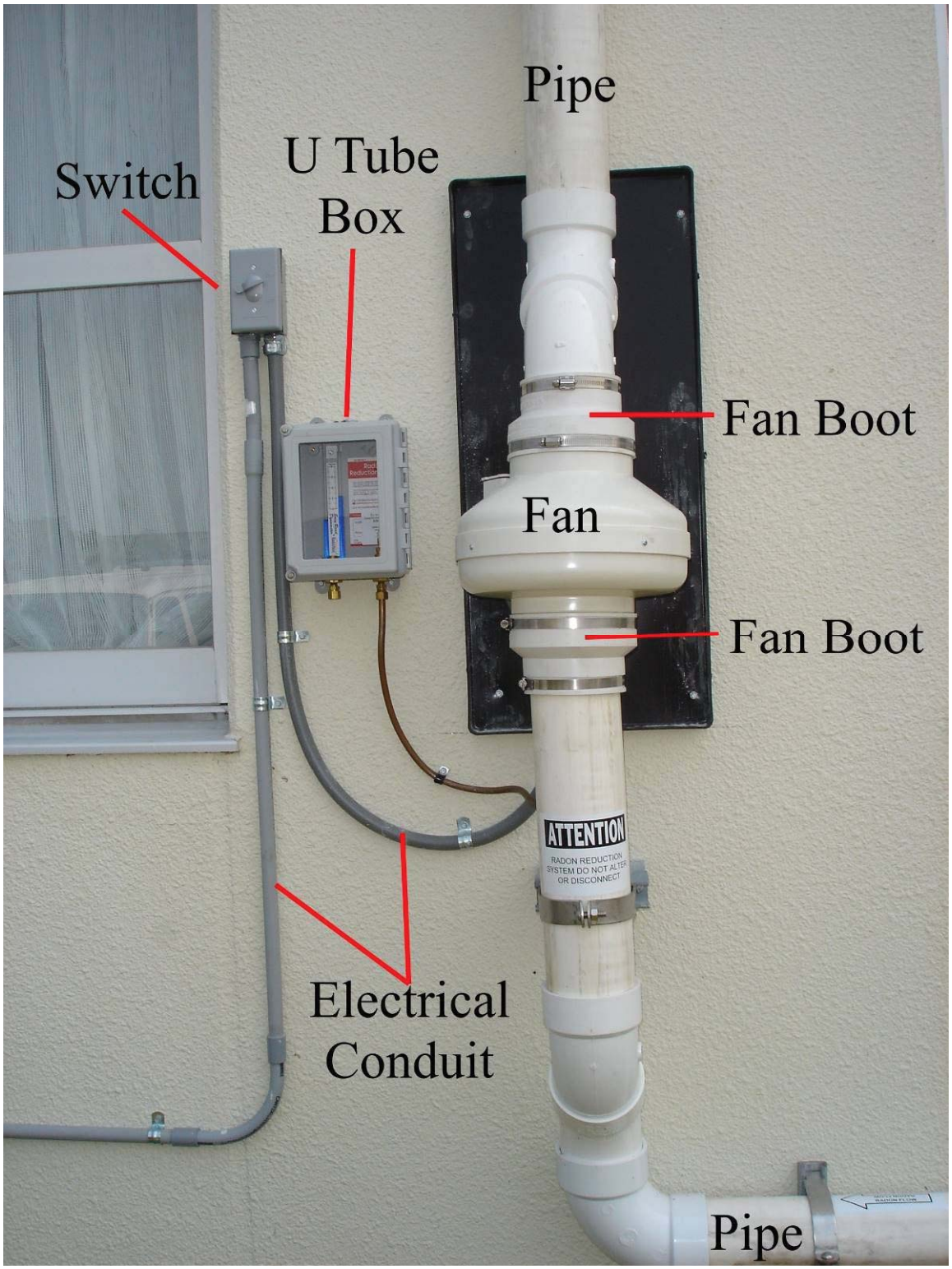
Problems in an SSD mitigation system generally are caused by failure of the mitigation fan or the loss of vacuum under the slab. Table 8 summarizes the most common problems and proposed corrective actions for SSD mitigation systems.



Picture 4. Typical SSD mitigation system.



Picture 5. SSD mitigation system with transition box.



Picture 6. SSD mitigation system without transition box.

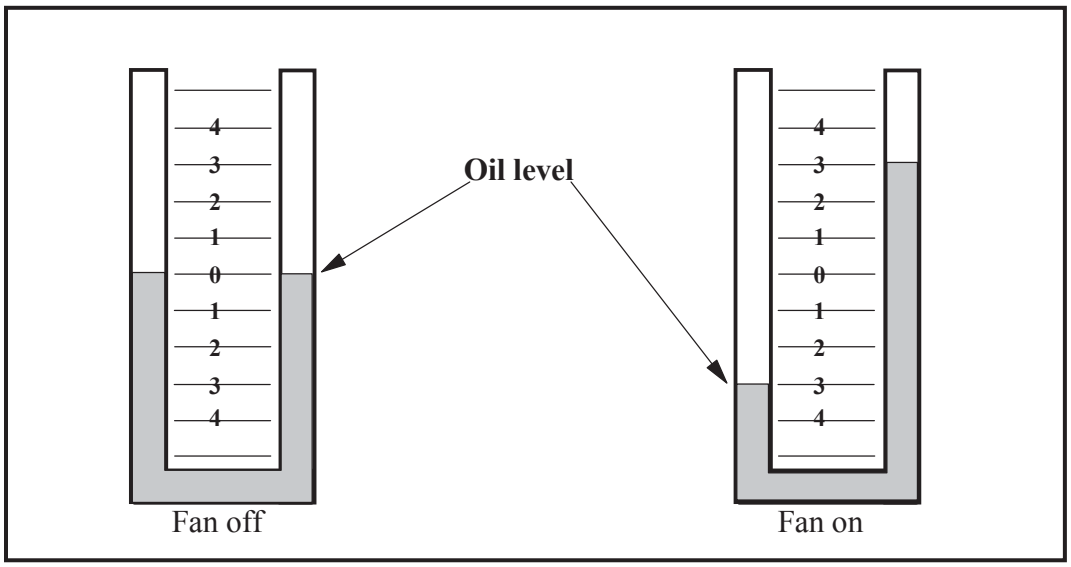


Fig. 2. Typical U-tube.

Picture 7. Typical external U-tube box.

Picture 8. Interior-mounted U-tube.

Picture 9. Typical illuminated light box.

Table 7. SSD components requiring routine inspection

Component	Check for	Corrective action	Recommended frequency of inspection
U-tube (Fig. 2)			
U-tube	Fan operation	Call Trouble Desk if fan is not operational	Monthly by occupant
U-tube	Oil level	Add oil	2 years
Pipe assembly (Fig. 3)			
Pipe/slab seal	Leakage	Apply additional polyurethane caulk	2 years
Interior wall/pipe seal	Leakage	Apply additional polyurethane caulk	2 years
Exterior wall/pipe seal	Leakage	Apply additional polyurethane caulk	2 years
Clamp nut	Tightness	Tighten nut	2 years
Pipe-mounted fan assembly (Fig. 4)			
Rubber boot	Cracking or sagging, fan seated level	Replace boot	2 years
Fan operation	Excessive noise, vibration, or not operating	Replace fan	2 years
Rubber boot/pipe seal	Leakage	Replace boot	2 years
Flex conduit electrical condition	Cracking of conduit and deterioration of liquid-tight connectors	Replace conduit and liquid-tight connectors	2 years
Switch and switch and switch cover gasket	Functional switch and seal of box gasket	Replace switch and gasket	2 years
Conduit C clamp	Tightness and corrosion	Tighten or replace C clamp	2 years
Hose clamp	Tightness	Tighten	2 years
Roof flashing (Fig. 5)			
Flashing	Water leaks and cracking	Replace flashing	2 years

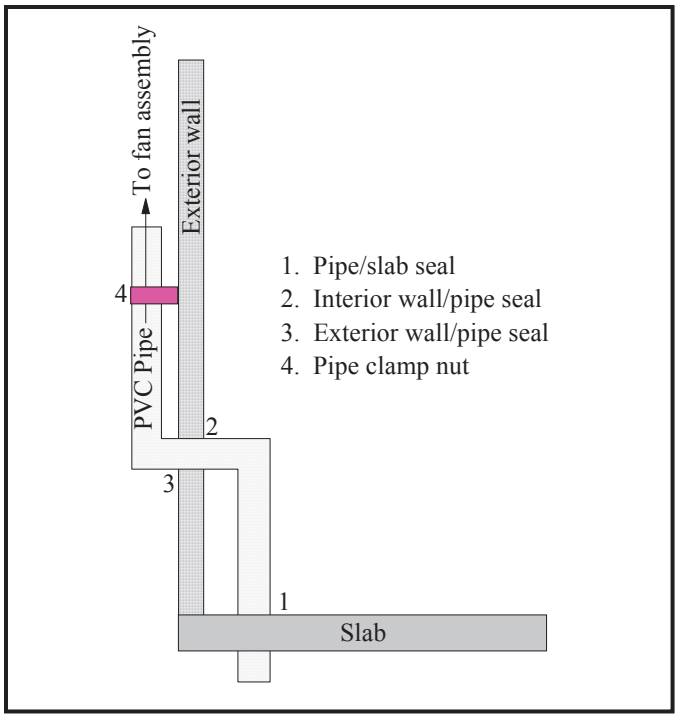


Fig. 3. Components to inspect in an SSD system pipe assembly.

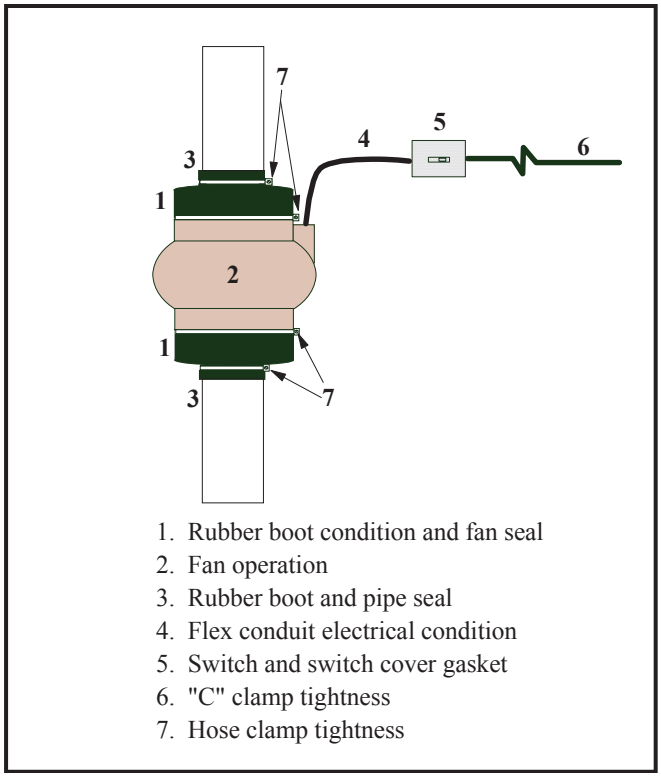


Fig. 4. Components to inspect in an SSD system pipe-mounted fan assembly.

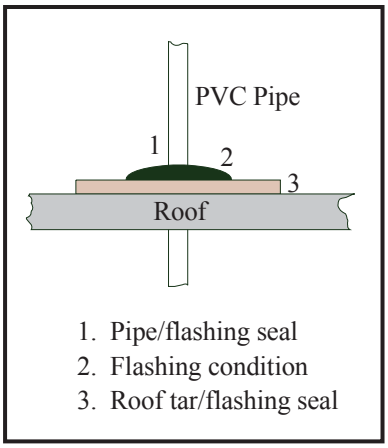


Fig. 5. Components to inspect in an SSD system roof flashing assembly.

Table 8. Troubleshooting SSD mitigation systems

Problem	Possible solution
Fan is not operating	1. Verify that the switch is on and the circuit breaker has not tripped 2. Check electrical connections from the switch box to the fan 3. Replace mitigation fan
Pipe has a noticeable vibration sound	1. Make sure that the fan is level 2. Verify that the base of the fan is not in contact with the pipe. If boot is sagging, replace boot 3. Replace fan
Fan is vibrating	1. Make sure that the fan is level 2. Replace fan
Fan is operating, but U-tube reads <1.5	1. Verify that additional oil is not needed in the U-tube 2. Inspect the U-tube and verify that it is connected to the pipe and that the tubing has not been crimped 3. Verify that no obstructions are present in the system exhaust 4. Inspect the boot/fan seals for air leaks 5. Check floor/pipe seals for air leakage 6. Inspect PVC pipe for holes 7. Replace mitigation fan

Table 8 (cont.)

Problem	Possible solution
Fan appears to be operating within normal parameters, but building/roomt is no longer <4 pCi/L	1. Verify that U-tube has sufficient oil 2. Verify that no obstructions are present in the system exhaust 3. Inspect the boot/fan seals for air leaks 4. Check floor/pipe seals for air leakage 5. Inspect PVC pipe for holes 6. Repeat radon test 7. Replace fan 8. Review repair and renovation history of building since the system was last verified to be functioning properly. Have renovations occurred that may have reduced the air change rate? Has a new air exhaust system been added? If the answer is yes to either question, a supplemental suction point may be required 9. Perform lateral field extension measurements to determine if vacuum gradient has changed. Install new suction point in area without vacuum
System has audible whistling sound while operating	1. Inspect pipe for holes 2. Inspect PVC joints for leakage 3. Inspect pipe/slab seal for leakage
During heavy rains, water leaks around pipe	1. Inspect wall/pipe seal for leakage 2. Inspect pipe/floor seal for leakage 3. Inspect flashing assembly for cracks or holes

Appendix D contains an example of a data form used for O&M inspection.

4.4.6 Qualifications of O&M Subcontractor

4.4.6.1 Subcontractor Qualifications for O&M Testing

For all field placement and retrieval activities, the radon team must be under the supervision of an on-site field supervisor. Qualifications of the field supervisor follow.

- Training: Radon testing training certified by EPA, NRPP, or NRSB
- Experience: 3 years of documentable radon testing experience
- Certification: Current NRPP or NRSB certification

Personnel other than the on-site field supervisor who are placing and retrieving radon detectors are called field technicians. Qualifications for the field technician follow.

- Training: Radon testing training certified by EPA, NRPP, or NRSB
- Experience: 1 year of documentable radon testing experience

- Certification: Current NRPP or NRSB certification

Personnel who perform data analysis, validation, and certification of the radon testing results are called radon testing analysts. Qualifications for the radon testing analyst follow.

- Training: Radon testing training certified by EPA, NRPP, or NRSB
- Experience: 5 years of documentable radon testing experience
- Certification: Current NRPP or NRSB certification

4.4.6.2 Subcontractor Qualifications for O&M Inspection

For all O&M inspection activities, the radon team must be under the direct supervision of an on-site field supervisor. Qualifications of the field supervisor follow.

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 5 years of documentable radon mitigation experience
- Certification: Current NRPP or NRSB certification

Personnel other than the on-site field supervisor who are involved in mitigation diagnostics or installation are called field technicians. Qualifications for the field technician follow.

- Training: Radon mitigation training certified by EPA, NRPP, or NRSB
- Experience: 1 year of documentable radon mitigation experience
- Certification: Current NRPP or NRSB certification

DEFINITIONS AND TERMS

Abnormal weather: Any type of severe weather (e.g., high wind, heavy rain or snow) that would be considered out of the ordinary while performing a short-term radon test. For long-term tests, examples of severe weather would be hurricanes, tropical cyclones, tropical storms and typhoons.

Assessment: The testing of all testable rooms at an installation or site for radon.

Atypical building: A building with unique construction that is different from all other buildings at the installation or site (e.g., underground command bunker).

Becquerel per cubic meter (Bq/m^3): The international unit of radon measure. 1 pCi/L = 37 Bq/m^3. See picocurie per liter (pCi/L) definition below.

Blank: A radon detector that is returned to the laboratory unexposed in order to measure the background of the device as part of NAVRAMP QA/QC.

Closed-building conditions: During the radon test, the building's windows and exterior doors are closed except for routine entrances and exits. For short-term tests of <4 days, closed building conditions must be initiated at least 12 h prior to the placement of the detectors and maintained for the duration of the test period.

Collocated: Radon test devices are placed within 12 in. of each other during a simultaneous measurement.

Duplicate: Radon measurements that are performed using two radon testing devices at the same time as part of NAVRAMP QA/QC.

Karst: Landscape underlain by limestone that has been eroded by dissolution, producing ridges, towers, fissures, sinkholes, and other characteristic landforms.

Mitigation: The corrective action taken in buildings or rooms that have been found to have radon levels ≥4 pCi/L.

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

Monitoring: Ongoing radon testing performed at an installation or site with known radon potential (low or elevated) which will alert the installation to any future elevated radon problems.

Nonresidential building: Simply put, a building that is not considered family housing. For the purposes of NAVRAMP and this document, other types of residential buildings

such as bachelor officer quarters/bachelor enlisted quarters, Navy/Marine Corps lodges, temporary lodging, and transient quarters are also included in this definition.

Normal building testing conditions: The building is occupied, and the building's mechanical systems (e.g., heating and cooling systems) are operating under typical seasonal conditions.

Occupied: A room or building in which one or more people spend >4 h/day on average per year.

Occupiable: A room not currently occupied but that could be occupied easily. Examples are bachelor quarter rooms, vacant offices, or offices currently used as storage rooms that could easily be converted to office space.

One year test: Under NAVRAMP, any radon test between 335 and 395 days duration is considered a 1 year test.

Picocurie per liter (pCi/L): A common unit of measurement of the concentration of radioactivity in a fluid (liquid or gas). A picocurie per liter corresponds to 0.037 radioactive disintegrations per second in every liter of fluid. For radon testing purposes, pCi/L is the unit of measure of radon gas. EPA and NAVRAMP have set an action level of 4 pCi/L.

Picocurie per liter per day (pCi/L-day): A measure of the detector dose; 1 pCi/L-day is the dose a detector receives if it is exposed to 1 pCi/L for 1 day.

Radon: A colorless, odorless, radioactive gas formed by the decay of uranium. It exists in varying amounts in all soils, rocks, and some groundwater supplies worldwide. Under certain conditions, it can infiltrate into and concentrate to unacceptable levels in buildings.

Radon potential category (RPC): A dynamic category assigned by COMNAVFACENGCOM, based on historical radon testing data to a naval installation or site which designates its potential for having elevated radon. Briefly the designations are

- RPC 1 means proven elevated radon potential exists
- RPC 2 means the potential is unknown
- RPC 3 means a low potential for elevated radon exists

Radon progeny: Radon particles that can be breathed into the lungs, where they continue to release radiation as they further decay. Also known as radon decay products or radon daughters.

Representative short-term radon measurement: A short-term radon measurement performed during closed-building conditions; normal HVAC system operation; and typical seasonal weather patterns.

Room of interest: a room with valid test data that indicate the presence of elevated radon.

Screening: Radon testing in a representative statistical subset of testable rooms at a site or installation.

Significantly modified: A building occupied or to be occupied, altered, or renovated either by changing mechanical systems (e.g., HVAC) or by making modifications (e.g., changing the original number or type of windows, doors, ground slabs, walls) in any manner that significantly changes the air change or flow into and within the building.

Site: The subdivision of an installation into smaller geographical areas based on geology, building types, or remoteness.

Spike: A radon detector exposed at a laboratory to a known radon concentration as part of NAVRAMP QA/QC. When used in conjunction with field testing, spikes measure the accuracy of the survey radon results.

Testable building: A building that is enclosed, occupied/occupiable, and in ground contact.

Testable room: An occupied or easily occupiable room in a testable building either in ground contact or over an unoccupied ground contact basement room or crawlspace.

Test type code: A two-letter code assigned to a specific radon measurement to document the reason why the radon test was performed (example: PM = postmitigation).

Tier 1 buildings: Includes all hospitals, bachelor quarters, schools, child-care centers, and brigs.

Tier 2 buildings: Includes all 24 h manned facilities, such as but not limited to command and communication facilities, fire stations, lodges, and security buildings.

Tier 3 buildings: Includes all offices and administrative buildings, exchanges, commissary, shops, recreational facilities (i.e., fitness centers, theaters), warehouses and other work areas.

Tier 4 buildings: Includes atypical buildings such as but not limited to armories, occupied magazines, underground facilities, and buildings with unique construction characteristics.

Valid radon test: Radon test that meets the requirements of NAVRAMP (e.g., type of radon detection device; sampling strategies, procedures, and intervals; QA and QC).

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APPENDIX A: EPA CORRESPONDENCE

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

December 1, 2011

Mr. David Wilson
Research Staff
Oak Ridge National Laboratory/Sobran
115D Flint Road
Oak Ridge, Tennessee 38731

Dear Mr. Wilson:

This letter is in response to your recent request for additional information pertaining to radon and the testing intervals, action levels and standards, filtration, and radon-resistant new construction. EPA's understanding is that this information is pertinent to the NAVFACENGCOM effort to complete an update of the U.S. Navy's Radon Testing and Mitigation Guidebook.

Radon is a highly localized phenomenon. Identical buildings (or dwelling units within a building) that are adjacent to one another can have very different radon levels. Geologic and soil conditions, building design and materials, operation and maintenance, and the aging of the building are key variables that affect the radon concentration. Atmospheric conditions also play a significant role temporally in determining a building's radon concentrations. Buildings should be tested in accordance with the appropriate and approved protocol.

1-Testing Interval for Buildings or Spaces Not Mitigated. Homes that initially test below 4pCi/L should be retested periodically. In addition to the regular testing required by OSHA, EPA and the radon community of practice believe it prudent to test residential buildings every five years, consistent with current consensus standards of practice.[1] Furthermore, a radon test should be conducted following any activity with the potential to affect the air dynamic of any building. Changing a building's air flow dynamic has the potential to affect the radon concentration. For example, upgrading or replacing the HVAC system or windows, or adding a family room to the building.

2-Testing Interval for Mitigated Buildings. All buildings, once mitigated, should be tested within 30 days to confirm the mitigation system's initial effectiveness. Periodic testing should be conducted to confirm the continuing effectiveness of the mitigation system. More specifically, previously mitigated spaces in schools and other large buildings should be retested annually or every two years, consistent with current consensus standards of practice.[2]

3-Testing in New Residential Construction. Test for radon after the building is completed and all systems are operating properly, and prior to occupancy or the issuance of an occupancy certificate. In the case of passive radon mitigation systems, a radon vent fan should be added when the test result exceeds the EPA action level of 4 pCi/L.

4-Radon Action Level and Workplace Standards. For homes, including multi-family buildings, and schools, we recommend that these buildings be mitigated when the measurement or test result is 4pCi/L or more. If non-residential buildings are workplaces, they would be subject to the DOL-OSHA standard,

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i.e., the Maximum Permissible Concentration (MPC) of 100pCi/L for an adult worker's exposure in 40-hours over a consecutive 7-day period (work week). In addition, OSHA has posting (notice) requirements for radon concentrations below the 100 pCi/L standard.

[For details see http://www.osha.gov/dts/sltc/methods/inorganic/id208/id208.html, and http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10098]

However, we strongly encourage you to consider a more protective approach to your workplaces. In Appendix A to its recent publication, *Indoor Air Quality in Commercial and Institutional Buildings* (OSHA 3430-04 2011), OSHA does note EPA's 4pCi/L action level. Presuming that the OSHA MPC is a minimum standard of protection, health & safety officers, and facility managers could as a matter of prudent policy choose to meet the more protective EPA action level.

5-High Efficiency Particulate Air (HEPA) Filtration. We don't recommend filtration or HEPA filtration as a radon control measure or mitigation technique. There is some evidence that filtration can reduce radon progeny concentrations. However, many factors can affect filtration's effectiveness in maintaining reduced progeny concentrations, including: (1) a potential increase in ultra fine particles available for progeny attachment and deposition in the lung; (2) a potentially larger percentage of progeny as an unattached fraction available to be deposited in the lung; (3) uncertainties with filter loading, consistency and cost of filter replacement, and maintaining a consistent air volume setting; (4) human interference with filtration device operation; and (5) the frequency (and cost) of radon progeny measurements needed to confirm that the desired progeny concentration is being maintained.

6-Pre-construction Radon Prediction. Soil flux measurements or measurement results from neighboring areas are not reliable methods for predicting a given building's radon level. Individual buildings should be tested in accordance with an appropriate and approved protocol.

7- Radon Resistant New Construction. We recommend that all homes, including multi-family buildings and schools, be built radon-resistant when located in high radon potential areas (Zone 1 on the EPA Map of Radon Zones). EPA also recommends that homes and schools built in medium radon potential areas (Zone 2 on the EPA Map of Radon Zones) consider using radon-resistant construction. Currently, the most appropriate standards are Appendix F of the ICC IRC, or ASTM E1465-08a.

We strongly encourage you to consider building non-residential buildings in accordance with a green building standard, e.g., the ICC International Green Construction Code (IgCC), or adapted from a closely relevant standard to offer occupants an increased level of protection from radon exposure and other health benefits. Please contact me (2020.343.9733, Long.Bill@epa.gov) or Phil Jalbert of my staff (202.343.9431, Jalbert.Philip@epa.gov) if you have questions regarding this letter.

Sincerely,

Bill Long

Bill Long, Director
Center for Radon and Air Toxics

cc: Philip Jalbert, EPA/ORIA/IED

[1]ANSI-AARST Protocol for Conducting Radon and Radon Decay Product Measurements in Multifamily Buildings (MAMF-2010; EPA 402-K-11-002).
2 MAMF-2010; EPA 402-K-11-002) - (see section II.G., page II:2.), and Reducing Radon in Schools: A Team Approach (EPA 402-R-94-008, April 1994) – (Section 9.1, page 9-1).

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
Office of Radiation and Indoor Air
Indoor Environments Division

March 6, 2008

Ms. Teri Jamin, President
Douglas County School Board
1638 Mono Avenue
P.O. Box 1888
Minden, Nevada 89423

Dear Ms. Jamin:

Thank you for your letter of February 19, 2008 requesting assistance in answering questions posed by you and Ms. Luna with regard to the Zephyr Cove Elementary School (ZCES). We also received additional information from Mr. Greg Felton. He provided the minutes of the School Board Meeting (February 12, 2008) and a detailed email (March 4, 2008) on his observations and five questions related to radon risk. We normally refer such requests to our Regional offices. However, in this case, the EPA Region 9 office (San Francisco) has asked us to respond directly to your request.

Please be aware that this response is based only on the information we have received. Therefore, in the absence of complete information or a site inspection, we've limited our response to several general observations and recommendations. Our response addresses measurement, risk, mitigation and technical assistance. EPA's policies on radon measurement and mitigation are necessarily conservative and protective, and based on many years of research and experience in a wide variety of buildings, including schools. EPA's guidance on radon is a prudent and cost-effective long-term approach to risk reduction that is protective of students and staff alike.

Radon measurement. EPA's recommended action level has always been primarily defined as a radon gas measurement, i.e., 4 picocuries per liter of air (pCi/L). The Fallon report incorrectly claims that EPA views working level (WL or progeny) measurements as equally acceptable to radon gas (pCi/L) measurements. Radon gas measurements should always be preferred, especially when the measurement result will be used in mitigation decisions.

Since the actual radon gas measurements from the ZCES are available, they should be used in mitigation decisions, provided the measurements were obtained in accordance with the EPA Radon Measurement in Schools Protocol (EPA 420-R-92-014, July 1993). The Schools protocol allows for initial short-term measurements to be conducted in every ground contact room. Measurement results at or above 4 pCi/L (e.g., 4-10 pCi/L) should be verified with follow-up measurements which can be long-term or short-term. Long-term measurements (90-days+) give a more accurate estimate of the average annual radon level.

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Making a good working level or progeny measurement is more difficult than making a radon gas measurement. Because of the uncertainties associated with progeny measurements, the state of New Jersey and the American Association of Radon Scientists and Technologists (AARST) do not recommend making mitigation decisions based on working level measurements. Working level (WL) measurements are mentioned very briefly in EPA documents. The main reason for their inclusion is that in the early years of EPA's radon program there were some devices being used in the market to measure working level (progeny). The use of WL devices has declined over time due to the difficulty and expense of making such measurements.

For the reasons above, EPA's recommendation is to base a mitigation decision on a gas measurement, which we consider a conservative and protective, as well as practical way to evaluate potential risk. More simply put, "no radon gas, no risk." Of course, there is rarely, if ever, "no" radon gas. Background concentrations of radon in outdoor air can vary from place to place and time of day. The available data suggest that the outdoor average is about 0.4 pCi/L, or 1/10th EPA's action level.

Radon health risk. To our knowledge, lung cancer is the only health effect from exposure to radon in air. There are no data to suggest that children are at greater risk from exposure to radon in air than are adults. Recent radon risk assessments confirm that the risk at relatively low levels of radon is significant. For this reason, EPA recommends that mitigation be considered at levels even below our action level of 4 pCi/L (and specifically between 2 and 4 pCi/L) for residential structures. As you know, the 2003 EPA risk assessment estimated 20,000 annual radon-related lung cancer deaths. It's important to remember that this estimate is based on exposure to 1.25 pCi/L, which is the average U.S. indoor radon level. It is for these reasons that the International Commission on Radiation Protection (ICRP) recommends that radon be reduced to a level as low as reasonably achievable (ALARA).

Mitigation. EPA's principal recommendation for mitigating radon levels in school buildings is to control the source, i.e., to minimize or prevent radon entry. The technique used most often and successfully is sub-slab or sub-membrane Active Soil Depressurization (ASD). From the Fallon report we reviewed, it appears that the existing ZCES ASD systems have not been adequately evaluated for their effectiveness.

A complete and thorough evaluation of the existing ASD systems should be conducted. The evaluation should identify needed upgrades to, or extensions of, the existing radon mitigation systems. Any upgrades or new systems should conform to EPA's guidance. We recommend that school ASD systems be operated continuously. For the school's slab-on-grade footprint not served by an existing ASD system, if measurement results warrant mitigation, additional diagnostics should be done to determine whether ASD can be employed. These evaluation/diagnostic activities should

be conducted by a qualified professional with experience in large, low-rise, slab-on-grade/crawlspace school/commercial buildings. Evaluations and diagnostics can be conducted independent of weather conditions and when convenient.

EPA does not recommend filtration as a radon control measure; the use of High Efficiency Particle Air (HEPA) filtration devices is not recommended as a mitigation technique. While there is evidence that filtration can reduce progeny concentrations, many factors can impinge on the effectiveness of filtration in maintaining reduced progeny concentrations with an attendant reduction in radon dose.

Some of these complicating factors include: a potential increase in ultra fine particles available for progeny attachment and deposition in the lung; a potentially larger percentage of progeny as an unattached fraction available to be deposited in the lung; maintaining a consistent air volume setting; human interference with filtration device operation; uncertainties with filter loading and progeny reductions; and the frequency of radon progeny measurements needed to maintain the target progeny concentration.

Technical assistance. Further technical assistance may be available to assist you in your ZCES deliberations. Radon professionals at EPA and the State of Nevada are available to support you through letters like this, via conference calls, etc. Also, onsite technical assistance may be available through the Conference of Radiation Control Program Directors (CRCPD). For such a request you should contact Adrian Howe with the Nevada State Radon Program (775-687-7531, ahowe@health.nv.gov).

We acknowledge the good offices of the State of Nevada Radon Program in addressing this issue to date. Thank you for the opportunity of joining in the effort to assist the Douglas County School District in resolving this important public health issue.

Sincerely,

Phil Jalbert [signed]
Radon Team Leader
202-343-9431
jalbert.philip@epa.gov

Gene Fisher [signed]
Health Physicist
202-343-9418
fisher.eugene@epa.gov

cc:
Ms. Holly Luna, Director, Business Services, Douglas County School District
Ms. Carol Lark, Superintendent, Douglas County School District
Dr. Susan Conrath, MPH, PhD, U.S. Public Health Service, EPA
Mr. Bill Long, Director, EPA Center for Radon and Air Toxics, EPA
Mr. Adrian Howe, State of Nevada Radon Program
Ms. Louise Hill, EPA Region 9 Radon Coordinator
Ms. Kelly Krolicki
Mr. Greg Felton

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

April 21, 2014

Mr. David Wilson
Research Staff
Oak Ridge National Laboratory/Sobran
115D Flint Road
Oak Ridge, Tennessee 38731

OFFICE OF
AIR AND RADIATION

Dear Mr. Wilson:

This letter is in response to your recent email request for information pertaining to radon and the Agency's recommended residential testing protocol. The Agency's policy and recommendations are that at a minimum, every ground contact dwelling unit be tested, whether it be a multi-unit residential building or a single-family home. This approach is consistent with standards of practice and consensus based standards.

The most relevant protocol for testing multi-unit residential buildings is the ANSI-AARST* *Protocol for Conducting Radon and Radon Decay Product Measurements in Multifamily Buildings* (MAMF-2010; EPA 402-K-11-002).

The most relevant protocol for testing single-family homes is *Protocols for Radon Measurement in Homes Standard* (MAH 9/2005), issued by AARST.

The protocol contained in Section 25-3.2.b.(1)(a) of OPNAV M-5090.1 (10-Jan 2014) for making screening measurements will almost certainly result in overlooking units within buildings or entire buildings that exceed the 4pCi/L action level. This result, and the attendant risk, is likely since radon is such a localized phenomenon. Adjacent buildings can have very different radon levels. Ground contact dwelling units within a building can have varying radon levels. Geologic and soil conditions, building design and materials, operation and maintenance, and the aging of the building are key variables determining the radon concentration. Atmospheric conditions also play a significant role temporally.

Please contact me with any questions you might have (202.343.9431, Jalbert.Philip@epa.gov). Thank you.

Sincerely,

Philip Jalbert†
Center for Radon and Air Toxics
Indoor Environments Division

*American National Standards Institute (ANSI), and American Association of Radon Scientists and Technologists (AARST)
†Executive Secretary, Federal Interagency Committee on Indoor Air Quality (CIAQ)

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APPENDIX B: RADON POTENTIAL CATEGORIES (RPCs) AT NAVAL AND MARINE CORPS INSTALLATIONS

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NAVY INITIAL RPCs

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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
BUMED	N44852	NAVMEDRSCHU SIX LIMA PE	0	0	N/A	2	Screening	FORMER NAVMEDRSCHCEN DET LIMA PERU
BUMED	N61751	NAVMEDRSCHU THREE CAIRO EGYPT	1	0	0.3	2	Screening	
EURAFSWA	N32960	FORMER NAVSUPPACT LA MADDALENA IT	363	69	12.5	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N3379A	CAMP LEMONNIER DJIBOUTI	0	0	N/A	2	Screening	
EURAFSWA	N57032	FORMER NAF MILDENHALL UK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N62585	FORMER NAVACT LONDON UK	107	2	4.0	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N62588	NAVSUPPACT NAPLES IT	1724	28	35.6	1	Monitoring	RADON DATA FROM 1989-1992 NOT INCLUDED IN TOTALS, ONLY 2013-2015 DATA.
EURAFSWA	N62590	NSA NAPLES	0	0	N/A	N/A	Does not apply	SEE N62588
EURAFSWA	N62745	FORMER OICC MED MADRID SP	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N62863	NAVSTA ROTA SP	274	0	2.6	3	Monitoring	
EURAFSWA	N62995	NAS SIGONELLA IT	21	0	2.7	3	Monitoring	
EURAFSWA	N63005	NAVSUPPACT BAHRAIN	81	0	1.9	2	Screening	FORMER ADMINSUPPU BAHRAIN
EURAFSWA	N63032	FORMER NAS KEFLAVIK IC	246	0	3.1	N/A	Does not apply	NO LONGER NAVY OWNED

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
EURAFSWA	N63073	FORMER NAVSECGRUACT EDZELL UK	325	11	6.3	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N63182	NCTAMS LANT DET ROTA SP	0	0	N/A	2	Screening	FORMER NAVCOMMSTA ROTA SP
EURAFSWA	N63395	FORMER NAVCOMSTA THURSO UK	2	0	0.7	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N64981	FORMER NAVWPNSFAC ST MAWGAN UK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N65995	FORMER NAVSUPPACT HOLY LOCK UK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N66096	NAVHOSP NAPLES IT	27	0	1.6	N/A	Does not apply	NEW HOSPITAL DATA IN N62588
EURAFSWA	N66101	NAVHOSP ROTA SP	2	0	0.8	2	Screening	
EURAFSWA	N66691	NAVSUPPACT SOUDA BAY GR	73	0	1.2	3	Monitoring	
EURAFSWA	N68165	FORMER NAVFAC BRAWDY WALES UK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
EURAFSWA	N70294	NAVCOMTELSTA NAPLES IT	0	0	N/A	N/A	Does not apply	SEE N62588
EURAFSWA	N70295	FORMER NAVCOMMSTA GREECE NEA MAKRI GR	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
Far East	N43666	NAVJNTSERVACT NS TOKYO JA	8	0	0.4	2	Screening	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Far East	N61054	COMFLEACT YOKOSUKA JA	120	0	3.7	3	Monitoring	MAIN BASE RADON STATUS BASED ON NFEC FE YOKOSUKA NWCF (UIC N65115) RADON DATA; OUTLYING AREAS - NO DATA; DATA FROM UIC N65115 MOVED TO THIS UIC
Far East	N61056	COMFLEACT OKINAWA JA	1548	343	98.1	1	Monitoring	DATA INCLUDES KADENA AND OUTLYING AREAS; FORMER UIC N62254 - DATA MOVED TO THIS UIC
Far East	N61057	NAF ATSUGI JA	242	0	2.9	3	Monitoring	FORMER UIC N62507; DATA MOVED TO THIS UIC
Far East	N61058	COMFLEACT SASEBO JA	1146	14	9.1	1	Monitoring	DATA INCLUDES MAIN BASE AND OUTLYING AREAS
Far East	N61060	NAF MISAWA JA	0	0	N/A	2	Screening	FORMER UIC N68212; DATA MOVED TO THIS UIC
Far East	N61078	FORMER NAVSUPPFAC DIEGO GARCIA IO	0	0	N/A	N/A	Does not apply	DATA LOCATED IN UIC N68539
Far East	N61581	NMC EAD DET YOKOSUKA JA	0	0	N/A	2	Screening	
Far East	N62254	NAVY MUNITIONS COMMAND EAD UNIT OKINAWA JA	0	N/A	N/A	N/A	Does not apply	DATA PART OF COMFLEACT OKINAWA UIC N61056

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Far East	N62507	NAVY MUNITIONS COMMAND EAD DET ATSUGI ANNEX	0	0	N/A	N/A	Does not apply	DATA PART OF COMFLEACT NAF ATSUGI UIC N61057
Far East	N62649	FISC YOKOSUKA JA	0	0	N/A	N/A	Does not apply	FORMER NSD YOKOSUKA; RADON STATUS BASED ON YOKOSUKA COMPLEX DATA
Far East	N62735	NAVY MUNITIONS COMMAND EAD DET SASEBO	0	0	N/A	N/A	Does not apply	PART OF COMFLEACT SASEBO UIC N61058; DATA PART OF COMFLEACT SASEBO
Far East	N62758	NAVSHIPREPFAC YOKOSUKA JA	0	0	N/A	N/A	Does not apply	RADON STATUS BASED ON YOKOSUKA COMPLEX DATA
Far East	N65115	NFEC FE YOKOSUKA JA NWCF	139	0	3.1	3	Monitoring	FORMER PWC YOKOSUKA
Far East	N66319	SHIP SUPPOFF HONG KONG	9	2	5.8	1	Assessment	
Far East	N68212	NAVY MUNITIONS COMMAND EAD DET MISAWA ANNEX	0	0	N/A	N/A	Does not apply	DATA MOVED TO NAF MISAWA UIC N61060
Far East	N68292	NAVHOSP YOKOSUKA JA	6	0	0.9	2	Screening	RADON STATUS BASED ON NFEC FE YOKOSUKA JA NWCF UIC N65115
Far East	N68470	NAVHOSP OKINAWA JA	932	34	28.4	1	Assessment	
Far East	N68539	NAVSUPPFAC DIEGO GARCIA IO	129	0	0.7	3	Monitoring	FORMER UIC N61078

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Far East	N70278	NAVCOMTELSTA FAR EAST	26	0	2.4	3	Monitoring	FORMER NAVCOMMSTA YOKOSUKA; RADON STATUS ALSO BASED ON UIC N65115 NFEC FE YOKOSUKA
Far East	N70284	FORMER NAVSECGRUACT HANZA OKINAWA JA	217	73	40.7	N/A	Does not apply	NO LONGER NAVY OWNED
Hawaii	N00311	NAVSHIPYD AND IMF PEARL HARBOR	164	0	0.7	3	Monitoring	FORMER NSY PEARL HARBOR
Hawaii	N00314	NAVSTA PEARL HARBOR HI	114	0	2.2	3	Monitoring	FORMER SUBASE PEARL HARBOR
Hawaii	N00334	FORMER NAS BARBERS PT	746	4	15.2	N/A	Does not apply	FORMER NAS BARBERS POINT HI
Hawaii	N00604	FISC PEARL HARBOR HI	133	2	11.7	1	Assessment	FORMER NSC PEARL HARBOR
Hawaii	N00950	NCTAMS PAC HONOLULU HI	558	1	5.6	1	Assessment	FORMER NAVCAMS EASTPAC HONOLULU
Hawaii	N0534A	PACMISRANFAC HAWAIIAN AREA	29	0	1.2	3	Monitoring	
Hawaii	N0545A	NAVEPVNTMEDU NO 6 PEARL HARBOR HI	23	0	0.2	3	Monitoring	
Hawaii	N43456	NAVY INFO OPERATIONS CMD HI	184	1	5.2	1	Assessment	FORMER NSGA KUNIA

RPC 1: Elevated radon potential exists
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RPC 3: Low radon potential
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N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Hawaii	N57026	NAVSEA INACTSHIPMAINTO PH HI	9	0	0.1	2	Screening	RADON STATUS ALSO BASED ON OTHER PEARL HARBOR DATA
Hawaii	N61064	CNIC PMRF BARKING SANDS HI	0	0	N/A	N/A	Does not apply	
Hawaii	N61449	NAVSTA PEARL HARBOR	2	0	0.1	2	Screening	FORMER COMNAVREG PEARL HARBOR HI; RADON STATUS ALSO BASED ON OTHER PEARL HARBOR DATA
Hawaii	N61845	NAVOPSPTCEN HONOLULU HI	42	0	0.5	3	Monitoring	FORMER NAVMARCORESCEN HONOLULU HI
Hawaii	N62363	NAVMARFCSTCEN PERAL HARBOR HI	0	0	N/A	2	Screening	FORMER NAVWESTOCEANCEN PEARL HARBOR; RADON STATUS BASED ON PEARL HARBOR DATA
Hawaii	N62707	DPS DET PEARL HARBOR HI	24	15	17.1	1	Assessment	FORMER NPPS PEARL HARBOR; DET IS LOCATED IN GUAM
Hawaii	N62755	NAVFAC HAWAII PEARL HARBOR HI	138	0	0.5	3	Monitoring	FORMER PWC PEARL HARBOR

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RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Hawaii	N62813	JBPHH PEARL HARBOR - NAVSTA PEARL HARBOR	21	0	0.8	2	Screening	FORMER NAVSTA PEARL HARBOR; RADON STATUS BASED ON PEARL HARBOR DATA
Hawaii	N68098	NAVMEDCLINIC PEARL HARBOR HI	0	0	N/A	N/A	Does not apply	RADON STATUS BASED ON PEARL HARBOR DATA
Hawaii	N68297	NAVY MUNITIONS COMMAND EAD DET PEARL HARBOR	498	19	14.3	1	Assessment	FORMER NAVY MAGAZINE PEARL HARBOR; ALSO FORMER WEST LOCH AND NAVMAG LUALUALEI
Korea	N32778	FLEET ACTIVITIES CHINHAE ROK	699	89	40.8	1	Monitoring	
Korea	N44990	COMNAVFORKOREA DET POHANG	17	0	3.3	3	Monitoring	
Marianas	N41557	NSA ANDERSEN GUAM	963	112	71.4	1	Assessment	ALSO KNOWN AS ANDERSEN AIR FORCE BASE
Marianas	N60872	NAVAL MUNITIONS GUAM	0	0	N/A	N/A	Does not apply	FORMER NAVMAG GUAM GQ. NOW PART OF NAVBASE GUAM N61755; DATA PART OF NAVBASE GUAM

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Marianas	N61119	FISC GUAM	0	0	N/A	N/A	Does not apply	FORMER NSD GUAM; NOW PART OR NAVBASE GUAM N61755; DATA PART OF NAVBASE GUAM
Marianas	N61577	AGANA GUAM NAS (CLOSED)	188	20	19.8	N/A	Does not apply	FORMER NAS AGANA GUAM; NOW PART OF NAVBASE GUAM N61755; INCLUDES MAIN BASE DATA; HOUSING DATA PART OF NAVBASE GUAM
Marianas	N61755	NAVBASE GUAM	9637	1705	230.0	1	Assessment	FORMER CNRM; DATA INCLUDES MAIN BASE AND OUTLYING AREAS
Marianas	N62328	BRDENCLINIC GUAM	0	0	N/A	N/A	Does not apply	FORMER NAVY DENTAL CLINIC GUAM; NOW PART OF NAVBASE GUAM N61755; DATA PART OF NAVBASE GUAM
Marianas	N62395	NAVFAC MARIANAS	0	0	N/A	N/A	Does not apply	FORMER PWC GUAM; NOW PART OF NAVBASE GUAM N61755; DATA PART OF NAVBASE GUAM
Marianas	N62586	NAVBASE GUAM MAIN BASE (FORMER SRF GUAM)	0	0	N/A	N/A	Does not apply	PART OF NAVBASE GUAM N61755; DATA PART OF NAVBASE GUAM

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Marianas	N66125	FORMER NAVFAC GUAM (RITIDIAN POINT)	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
Marianas	N68096	NAVHOSP GUAM	185	8	19.3	1	Assessment	HOUSING DATA PART OF NAVBASE GUAM N61755
Marianas	N69143	AGANA GUAM NAS CSO	0	0	N/A	N/A	Does not apply	CLOSED
Marianas	N70243	NAVAL TELECOMMUNICATIONS STATION GUAM	0	0	N/A	N/A	Does not apply	FORMER NAVCOMTELSTA GUAM; PART OF NAVSTA GUAM N61755; DATA PART OF NAVSTA GUAM
Mid-Atlantic	N00034	DEFENSE FINANCING & ACCOUNTING	0	0	N/A	2	Screening	FORMER NAVFINCEN CLEVELAND OH
Mid-Atlantic	N00101	NAS SOUTH WEYMOUTH MA	93	0	2.6	3	Monitoring	
Mid-Atlantic	N00102	PORTS NSYD PORTS NH (STU ONLY)	306	34	13.3	1	Assessment	FORMER NSY PORTSMOUTH NH
Mid-Atlantic	N00104	NSA MECHANICSBURG PA	N/A	N/A	N/A	N/A	Does not apply	DATA RELOCATED TO N32414 NAVSUPPACT MECHANICSBURG PA
Mid-Atlantic	N00105	NBHC PORTSMOUTH NH	0	0	N/A	2	Screening	FORMER NAVMEDCLINIC PORTSMOUTH NH
Mid-Atlantic	N00109	NMC DET YORKTOWN VA	425	2	6.2	1	Assessment	FORMER WPNSTA YORKTOWN VA
Mid-Atlantic	N00124	NAVWARCOL NEWPORT RI	0	0	N/A	2	Screening	
Mid-Atlantic	N00128	GREAT LAKES NAVAL STATION	0	0	N/A	2	Screening	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

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Mid-Atlantic	N00129	NAVSUBASE NEW LONDON CT	5665	90	26.4	1	Assessment	
Mid-Atlantic	N00151	PHILADELPHIA NAVAL YARD ANNEX	78	0	2.1	3	Monitoring	FORMER NSY PHILADELPHIA PA
Mid-Atlantic	N00158	NAS JRB WILLOW GROVE PA	397	3	9.0	1	Assessment	
Mid-Atlantic	N00163	FORMER NAVAIRWARCENACDIV INDIANAPOLIS	5	0	2.5	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N00164	NAVSURFWARCENDIV CRANE	63	16	6.6	1	Assessment	FORMER NAVWPNSUPPCEN CRANE IN
Mid-Atlantic	N00181	NSY NORFOLK VA	5	0	0.2	2	Screening	FORMER NSY PORTSMOUTH VA
Mid-Atlantic	N00183	NAVMEDCEN PORTSMOUTH VA	22	0	2.2	3	Monitoring	FORMER NAVHOSP PORTSMOUTH VA
Mid-Atlantic	N00188	NAS OCEANA AIR DET NORFOLK VA	0	0	N/A	2	Screening	FORMER NAS NORFOLK VA
Mid-Atlantic	N00189	NAVSUP FLC NORFOLK VA	0	0	N/A	2	Screening	FORMER FISC NORFOLK VA
Mid-Atlantic	N00197	FORMER NAVSURFWARCEN ORDSTA KY	6	0	1.9	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N00210	NSTC GREAT LAKES IL	2844	13	11.3	1	Assessment	FORMER NTC GREAT LAKES IL
Mid-Atlantic	N00211	NAVHEALTHCLINIC GREAT LAKES IL	474	0	2.6	3	Monitoring	FORMER NAVAL HOSPITAL GREAT LAKES IL

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Mid-Atlantic	N00274	NAF DETROIT MI	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N00275	NAVAIRESCEN CHICAGO	1202	2	4.2	1	Assessment	FORMER NAS GLENVIEW IL
Mid-Atlantic	N00281	TRASUPPCEN HAMPTON ROADS	28	0	0.4	3	Monitoring	FORMER FLECOMBATTRACENLANT DAM NECK VA
Mid-Atlantic	N00288	NASOPUBFORMCEN PHILADELPHIA PA	0	0	N/A	2	Screening	
Mid-Atlantic	N00383	NSA PHILADELPHIA	11	0	0.7	3	Monitoring	FORMER NAVICP PHILADELPHIA PA
Mid-Atlantic	N00702	NAVSECGRUACT WINTER HARBOR ME	308	7	8.6	1	Assessment	
Mid-Atlantic	N08912	NMCB 13 PEEKSKILL NY	0	0	N/A	2	Screening	FORMER RNMCB 13 PEEKSKILL NY
Mid-Atlantic	N30316	NAVSOC DET ALPHA PROS HB	13	0	1.1	3	Monitoring	
Mid-Atlantic	N30530	NOSC-MCRC COLUMBUS OH	0	0	N/A	2	Screening	FORMER NAVAIRESCEN COLUMBUS OH
Mid-Atlantic	N31188	NIOC SUGAR GROVE WV	252	1	6.8	1	Assessment	TO BE CLOSED IN 2015
Mid-Atlantic	N31260	NRLCHESBAYDET CHESAPEAKE BEACH MD	47	9	6.7	1	Assessment	

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Mid-Atlantic	N32185	NAVHLTHCLINIC NEW ENGLAND RI	234	8	8.6	1	Assessment	INCLUDES DATA FROM: NAVDENCLINIC NE NEWPORT RI UIC N66023 AND NAVAMBCARECEN NEWPORT RI UIC N68086
Mid-Atlantic	N32411	NAVAL STATION NEWPORT RI	96	19	7.8	1	Assessment	
Mid-Atlantic	N32414	NAVSUPPACT MECHANICSBURG PA	1988	597	33.2	1	Assessment	INCLUDES FORMER N00104 NSA MECHANICSBURG DATA
Mid-Atlantic	N32443	NSA NORFOLK NAVY SHIPYARD	0	0	N/A	2	Screening	
Mid-Atlantic	N32446	NSS PORTSMOUTH NAVY SHIPYARD	1200	23	19.3	1	Assessment	
Mid-Atlantic	N32510	BRMEDCLINIC NAVAL STATION NORFOLK SP	0	0	N/A	2	Screening	FORMER NAVMEDCLINIC NORFOLK VA UIC N68722
Mid-Atlantic	N3567A	CENTER FOR SURFACE COMBAT SYSTEMS (CSCS) DET EAST	0	0	N/A	2	Screening	FORMER STU FLETRACEN NORFOLK UIC N61797
Mid-Atlantic	N39029	AEGIS TECH REP	0	0	N/A	2	Screening	FORMER AEGIS CSEDS MOORESTOWN NJ; NOT PHYSICALLY LOCATED ON NAVAL WEAPONS STATION EARLE AND DOES NOT SUPPORT EARLE MISSION

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Navy Initial Radon Potential Categories

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Mid-Atlantic	N40085	NFEC MLANT NORFOLK VA	826	3	5.7	1	Assessment	FORMER PWC NORFOLK UIC N00187
Mid-Atlantic	N4148A	NEPMU FD 2 EAST DET	0	0	N/A	2	Screening	FORMER NAVENPVNTMEDU-2 UIC N63117
Mid-Atlantic	N50092	JNTEXPBASE LITTLE CREEK FS VA	0	0	N/A	2	Screening	
Mid-Atlantic	N57023	COMOPTEVFOR NORFOLK VA	0	0	N/A	2	Screening	
Mid-Atlantic	N57039	NAVFAC NANTUCKET MA	0	0	N/A	2	Screening	
Mid-Atlantic	N57041	NAVFAC CAPE HATTERAS NC	0	0	N/A	2	Screening	
Mid-Atlantic	N57095	NAVSUPPACT NORFOLK VA	0	0	N/A	2	Screening	FORMER LANTFLTHEADSUPPACT NORFOLK VA
Mid-Atlantic	N60087	NAS BRUNSWICK ME	498	2	5.3	1	Assessment	
Mid-Atlantic	N60138	NAVAL AIR SUPPORT EQUIPMENT FACILITY	16	1	7.9	1	Assessment	FORMER FISC CHEATHAM ANNEX
Mid-Atlantic	N60191	NAS OCEANA VA	108	0	1.1	3	Monitoring	

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Navy Initial Radon Potential Categories

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Mid-Atlantic	N60478	NMC DET EARLE NJ	596	0	3.5	3	Monitoring	FORMER WPNSTA EARLE COLTS NECK NJ; TENANT GEOGRAPHICALLY LOCATED ON NAVAL WEAPONS STATION EARLE; RADON STATUS BASED ON WEAPONS STATION EARLE UIC N69213
Mid-Atlantic	N61011	NSA SARATOGA SPRINGS NY	0	0	N/A	2	Screening	
Mid-Atlantic	N61018	NAVAL SUPPORT ACTIVITY CRANE	0	0	N/A	2	Screening	
Mid-Atlantic	N61174	NAVSTA NEW YORK NY	67	0	3.2	3	Monitoring	FORMER NAVSTA BROOKLYN NY
Mid-Atlantic	N61189	NAVSTA PHILADELPHIA PA	13	0	0.6	3	Monitoring	
Mid-Atlantic	N61414	NAVPHIBASE LITTLE CREEK VA	113	0	2.1	3	Monitoring	
Mid-Atlantic	N61797	CENTER FOR SURFACE COMBAT SYSTEMS DETACHMENT EAST	0	0	N/A	N/A	Does not apply	FORMER STU FLETRACEN NORFOLK; DATA MOVED TO NEW UIC N3567A CENTER FOR SURFACE COMBAT SYSTEMS (CSCS) DET EAST NORFOLK VA
Mid-Atlantic	N61801	NAVMARCORESCEN LAWRENCE MA	10	1	7.7	1	Assessment	
Mid-Atlantic	N61803	NAVRESCEN QUINCY MA	9	1	15.6	1	Assessment	

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Mid-Atlantic	N61804	NAVRESCEN PORTLAND ME	10	0	1.0	2	Screening	
Mid-Atlantic	N61805	NOSC BANGOR ME	0	0	N/A	2	Screening	FORMER NAVRESCEN BANGOR ME
Mid-Atlantic	N61808	NAVRESCEN NEW BEDFORD MA	0	0	N/A	2	Screening	
Mid-Atlantic	N61809	NAVOPSPTCEN MANCHESTER NH	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN MANCHESTER NH
Mid-Atlantic	N61814	NAVRESCEN PORTSMOUTH NH	0	0	N/A	2	Screening	
Mid-Atlantic	N61815	NAVOPSPTCEN WORCESTER MA	8	0	3.5	2	Screening	FORMER NAVMARCORESCEN WORCESTER MA
Mid-Atlantic	N61818	NAVRESCEN PITTSFIELD MA	9	0	0.8	2	Screening	
Mid-Atlantic	N61821	NAVOPSPTCEN NEWPORT RI	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN PROVIDENCE RI; LOCATED IN NEWPORT RI
Mid-Atlantic	N61822	NAVOPSPTCEN WHITE RIVER JCT	11	0	0.6	2	Screening	FORMER NAVRESCEN BURLINGTON VT
Mid-Atlantic	N61823	NAVRESCEN PERTH AMBOY NJ	7	0	1.0	2	Screening	
Mid-Atlantic	N61833	NAVRESCEN BINGHAMTON NY	0	0	N/A	2	Screening	
Mid-Atlantic	N61834	NAVOPSPTCEN HORSEHEADS NY	0	0	N/A	2	Screening	

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Mid-Atlantic	N61835	NAVOPSPTCEN PLAINVILLE CT	10	0	0.8	2	Screening	FORMER NAVMARCORESCEN PLAINVILLE CT
Mid-Atlantic	N61837	NAVRESCEN JAMESTOWN NY	10	0	1.3	2	Screening	
Mid-Atlantic	N61839	NAVOPSPTCEN ROCHESTER NY	66	1	6.3	1	Assessment	FORMER NAVMARCORESCEN ROCHESTER NY
Mid-Atlantic	N61842	NAVOPSPTCEN BUFFALO NY	11	0	1.0	2	Screening	FORMER NAVMARESCEN BUFFALO NY
Mid-Atlantic	N61843	NAVOPSPTCEN NEW YORK CITY NY	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN BRONX NY
Mid-Atlantic	N61844	NAVRESCEN WHITESTONE NY	0	0	N/A	2	Screening	
Mid-Atlantic	N61846	NAVMARCORESCEN NEW ROCHELLE NY	0	0	N/A	2	Screening	
Mid-Atlantic	N61848	NAVRESCEN POUGHKEEPSIE NY	10	0	1.8	2	Screening	
Mid-Atlantic	N61851	NAVOPSPTCEN FORT DRUM NY	0	0	N/A	2	Screening	FORMER NAVRESCEN WATERTOWN NY
Mid-Atlantic	N61860	NAVRESCEN WEST TRENTON NJ	0	0	N/A	2	Screening	
Mid-Atlantic	N61861	NAVOPSPTCEN ALBANY NY	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN ALBANY NY

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Mid-Atlantic	N61863	NAVOPSPTCEN SYRACUSE NY	8	0	0.7	2	Screening	FORMER NAVRESCEN SYRACUSE NY
Mid-Atlantic	N61864	NAVOPSPTCEN FRANKFORT NY	0	0	N/A	2	Screening	FORMER NAVRESCEN ROME NY
Mid-Atlantic	N61866	NAVOPSPTCEN NEW LONDON	9	0	0.6	2	Screening	FORMER NAVMARCORESCEN NEW HAVEN CT
Mid-Atlantic	N61868	NAVRESCEN FREEPORT NY	0	0	N/A	2	Screening	
Mid-Atlantic	N61869	NAVMARCORESCEN HUNTINGTON NY	0	0	N/A	2	Screening	
Mid-Atlantic	N61870	NAVRESCEN PHILADELPHIA PA	8	0	0.4	2	Screening	
Mid-Atlantic	N61876	NAVOPSPTCEN WILMINGTON DE	12	0	1.6	2	Screening	FORMER NAVMARCORESCEN WILMINGTON DE
Mid-Atlantic	N61878	NAVOPSPTCEN ERIE PA	10	0	1.2	2	Screening	FORMER NAVMARCORESCEN ERIE PA
Mid-Atlantic	N61880	NAVOPSPTCEN LEHIGH VALLEY PA	10	8	10.8	1	Assessment	FORMER NAVRESCEN LEHIGH VALLEY PA
Mid-Atlantic	N61881	NAVOPSPTCEN READING PA	2	0	1.5	2	Screening	FORMER NAVMARCORESCEN READING PA
Mid-Atlantic	N61882	NAVRESCEN ATLANTIC CITY NJ	0	0	N/A	2	Screening	

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Mid-Atlantic	N61883	NAVRESCEN ALTOONA PA	11	1	7.2	1	Assessment	
Mid-Atlantic	N61884	NAVMARCORESCEN FOLSOM PA	0	0	N/A	2	Screening	
Mid-Atlantic	N61886	NAVOPSPTCEN EBENSBURG PA	9	0	1.0	2	Screening	FORMER NAVMARCORESCEN EBENSBURG PA
Mid-Atlantic	N61889	NAVRESCEN MCKEESPORT PA	10	0	1.4	2	Screening	
Mid-Atlantic	N61893	NAVRESCEN WILLIAMSPORT PA	0	0	N/A	2	Screening	
Mid-Atlantic	N61897	NAVOPSPTCEN BALTIMORE MD	0	0	N/A	2	Screening	FORMER NAVRESCEN BALTIMORE MD
Mid-Atlantic	N61900	NAVOPSPTCEN RICHMOND VA	12	0	1.3	2	Screening	FORMER NAVMARCORESCEN RICHMOND VA
Mid-Atlantic	N61902	NAVRESCEN CUMBERLAND MD	1	0	1.2	2	Screening	
Mid-Atlantic	N61903	NAVOPSPTCEN ELEANOR WV	0	0	N/A	2	Screening	FORMER NAVRESCEN HUNTINGTON WV
Mid-Atlantic	N61904	NAVOPSPTCEN MOUNDSVILLE WV	9	0	1.3	2	Screening	FORMER NAVMARCORESCEN WHELLING WV
Mid-Atlantic	N61905	NAVOPSPTCEN ROANOKE VA	10	1	4.6	1	Assessment	FORMER NAVMARCORESCEN ROANOKE VA

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Mid-Atlantic	N61906	NAVRESCEN LYNCHBURG VA	0	0	N/A	2	Screening	
Mid-Atlantic	N61917	NAVOPSPTCEN CHARLOTTE NC	0	0	N/A	2	Screening	FORMER NAVRESCEN CHAROLTTE NC
Mid-Atlantic	N61920	NAVOPSPTCEN ASHEVILLE NC	10	0	0.7	2	Screening	FORMER NAVRESCEN ASHVILLE NC
Mid-Atlantic	N61921	NAVOPSPTCEN GREENSBORO NC	10	0	2.6	2	Screening	FORMER NAVRESCEN GREENSBORO NC
Mid-Atlantic	N61923	NAVOPSPTCEN RALEIGH NC	10	0	1.3	2	Screening	FORMER NAVRESCEN RALEIGH NC
Mid-Atlantic	N61989	NAVOPSPTCEN GREEN BAY WI	10	0	0.7	2	Screening	FORMER NAVMARCORESCEN GREEN BAY WI
Mid-Atlantic	N61996	NAVOPSPTCEN ROCK ISLAND	8	0	1.7	2	Screening	FORMER NAVMARCORESCEN ROCK ISLAND IL
Mid-Atlantic	N61999	NAVOPSPTCEN TOLEDO OH	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN TOLEDO OH
Mid-Atlantic	N62028	NAVMARCORESCEN WEST TRENTON NJ	56	0	2.0	3	Monitoring	
Mid-Atlantic	N62031	NAVOPSPTCEN INDIANAPOLIS IN	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN INDIANAPOLIS IN

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Mid-Atlantic	N62033	FORMER NAVRESCEN OSHKOSH WI	10	0	1.7	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62034	FORMER NAVMARCORESCEN DETROIT MI	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62035	NAVOPSPTCEN MILWAUKEE WI	9	0	3.3	2	Screening	FORMER NAVMARCORESCEN MILWAUKEE WI
Mid-Atlantic	N62037	NAVOPSPTCEN PEORIA IL	0	0	N/A	N/A	Does not apply	RADON DATA MOVED TO UIC PWC-GL
Mid-Atlantic	N62046	FORMER NAVRESCEN GARY IN	9	0	0.4	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62048	FORMER NAVRESCEN PORTSMOUTH OH	10	0	1.1	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62052	FORMER NAVRESCEN SHEBOYGAN WI	9	0	0.5	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62053	FORMER NAVRESCEN CADILLAC MI	10	0	0.7	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62055	FORMER NAVMARCORESCEN DAYTON OH	11	0	3.5	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62060	FORMER NAVMARCORESCEN DANVILLE IL	9	1	4.5	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62062	NAVOPSPTCEN DECATUR IL	0	0	N/A	2	Screening	FORMER NAVRESCEN DECATUR IL

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Mid-Atlantic	N62063	FORMER NAVRESCEN MANSFIELD OH	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62066	FORMER NAVOPSPTCEN LACROSSE WI	10	0	1.0	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62073	FORMER NAVMARCORESCEN FORT WAYNE IN	10	0	3.0	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62075	FORMER NOSC GRISSOM ARB IN	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62076	FORMER NAVRESCEN TERRE HAUTE IN	10	0	2.4	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62078	NAVOPSPTCEN LOUISVILLE KY	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN LOUISVILLE KY
Mid-Atlantic	N62080	NAVOPSPTCEN DETROIT MI	11	0	0.6	2	Screening	FORMER NAVRESCEN SOUTHFIELD MI
Mid-Atlantic	N62082	NAVOPSPTCEN GRAND RAPIDS	10	0	1.3	2	Screening	FORMER NAVMARCORESCEN GRAND RAPIDS MI
Mid-Atlantic	N62084	NAVOPSTCEN BATTLE CREEK MI	43	3	6.1	1	Assessment	FORMER NRC FORT CUSTER MI
Mid-Atlantic	N62085	NAVOPSTCEN LANSING MI	5	0	0.9	2	Screening	FORMER NAVMARCORESCEN LANSING MI

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Mid-Atlantic	N62086	FORMER NAVRESCEN MUSKEGON MI	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62088	NAVOPSPTCEN SAGINAW MI	10	0	0.5	2	Screening	FORMER NAVRESCEN SAGINAW MI
Mid-Atlantic	N62092	NAVOPSPTCEN AKRON OH	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN AKRON OH
Mid-Atlantic	N62094	NAVOPSPTCEN CINCINNATI OH	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN CINCINNATI OH
Mid-Atlantic	N62095	NAVOPSPTCEN COLUMBUS OH	10	1	4.2	1	Assessment	FORMER NAVMARCORESCEN COLUMBUS OH
Mid-Atlantic	N62098	NAVOPSPTCEN YOUNGSTOWN OH	10	0	0.9	2	Screening	FORMER NAVMARCORESCEN YOUNGSTOWN OH
Mid-Atlantic	N62100	NAVOPSPTCEN MADISON WI	10	0	0.2	2	Screening	FORMER NAVMARCORESCEN MADISON WI
Mid-Atlantic	N62153	NAVRESCEN FORT WADS S I NY	5	0	0.8	2	Screening	
Mid-Atlantic	N62268	NAVOPSPTCEN GLENS FALLS	9	0	0.2	2	Screening	FORMER NAVRESCEN GLENS FALLS NY
Mid-Atlantic	N62269	NAVAIRWARCENACDIV WARMINSTER	686	13	55.7	1	Assessment	

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RPC 3: Low radon potential
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N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Mid-Atlantic	N62276	NAVRESCEN STAUNTON VA	0	0	N/A	2	Screening	
Mid-Atlantic	N62364	NAVRESCEN AUGUSTA ME	9	1	9.2	1	Assessment	
Mid-Atlantic	N62367	NAVCLOTEXTRSCHFAC NATICK MA	0	0	N/A	2	Screening	
Mid-Atlantic	N62376	NAVAIRWARCENACDIV TRENTON NJ	96	0	2.0	3	Monitoring	FORMER NAVAIRPROPCEN TRENTON NJ
Mid-Atlantic	N62378	FORMER NAVOPSPTCEN CLEVELAND OH	9	0	0.3	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62578	CBC DAVISVILLE RI	182	12	8.8	1	Assessment	
Mid-Atlantic	N62661	OFF TRNG CMD NEWPORT	1697	15	10.0	1	Assessment	FORMER NETC NEWPORT RI
Mid-Atlantic	N62688	NAVSTA NORFOLK VA	6	0	2.3	3	Monitoring	
Mid-Atlantic	N62757	FORMER NAVOPSPTCEN FOREST PARK IL	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N62789	SUPSHIP GROTON CT	0	0	N/A	2	Screening	
Mid-Atlantic	N62793	SUPSHIPNEWPORT NEWS VA	0	0	N/A	2	Screening	
Mid-Atlantic	N62952	NAVOPSPTCEN PITTSBURGH PA	10	4	5.4	1	Assessment	FORMER NAVMARCORESCEN PITTSBURGH PA
Mid-Atlantic	N62986	NAVNUPWRTRAU BALLSTON SPA NY	0	0	N/A	2	Screening	
Mid-Atlantic	N62990	FORMER SUPSHIP NO DET STURGEON BAY WI	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Mid-Atlantic	N63038	NCTAMSLANT DET CUTLER	59	0	1.5	3	Monitoring	FORMER NAVCOMMU CUTLER ME
Mid-Atlantic	N63039	NAVOPSPTCEN ADELPHI MD	9	0	2.0	2	Screening	FORMER NAVRESCEN ADALPHI MD
Mid-Atlantic	N63063	AFEXPTRAACT CAMP PEARY VA	108	3	4.9	1	Assessment	
Mid-Atlantic	N63117	FORMER NEPMU FD 2 EAST DET	0	0	N/A	N/A	Does not apply	FORMER NAVENPVNTMEDU-2 NORFOLK VA; DATA LOCATED IN UIC N4148A NEPMU FD 2 EAST DET
Mid-Atlantic	N63159	NAVDAMCONTRACEN PHILADELPHIA PA	9	0	0.2	3	Monitoring	
Mid-Atlantic	N63238	NAVSURFWPNCENDET FT MONROE VA	0	0	N/A	2	Screening	
Mid-Atlantic	N63401	FORMER NASC SWM SITE	0	0	N/A	N/A	Does not apply	DATA LOCATED IN NEW UIC N66046 CNATTU NORFOLK VA
Mid-Atlantic	N63423	FORMER NAVMATDATSYSGRP MORGANTOWN WV	14	0	2.5	3	Monitoring	
Mid-Atlantic	N63438	NAVOPSPTCEN NORFOLK VA	7	0	0.1	2	Screening	
Mid-Atlantic	N63458	NAVRESFAC LOWER BURRELL PA	0	0	N/A	2	Screening	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

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Mid-Atlantic	N63465	NAVRESCEN PARKERSBURG WV	0	0	N/A	2	Screening	
Mid-Atlantic	N63500	FORMER NAVRESFAC STEVENS POINT WI	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N63891	NAVSECGRUACT NWEST CHESAPKE VA	92	0	3.3	3	Monitoring	
Mid-Atlantic	N64281	FORMER NAVUNSEAWARCEN DET NORFOLK VA	0	0	N/A	2	Screening	UNIT DOES NOT EXIST AT NORFOLK ANY LONGER
Mid-Atlantic	N64356	JFSC NAVADMINCOM NORFOLK	0	0	N/A	2	Screening	FORMER NAVADMINCOM AFSC NORFOLK VA
Mid-Atlantic	N65113	NFEC MW NWCF	1978	57	15.2	1	Assessment	FORMER PWC GREAT LAKES
Mid-Atlantic	N65540	NAVSURFWARCEN SHIPSYSENGSTA PA	0	0	N/A	2	Screening	FORMER NAVSSES PHILADELPHIA PA
Mid-Atlantic	N65908	NEX SCOTIA NY	6	0	2.5	2	Screening	FORMER RESALEACT SARATOGA SPRINGS NY (OR SCOTIA NY); CHANGED FROM SCOTIA TO SARATOGA SPRINGS
Mid-Atlantic	N66023	FORMER NAVDENCLINIC NE NEWPORT RI	0	0	N/A	2	Screening	NOW PART OF NAVAL HEALTH CLINIC NEW ENGLAND UIC N32185;
Mid-Atlantic	N66046	CNATTU NORFOLK VA	0	0	N/A	2	Screening	FORMER UIC N63401 NASC SWM SITE

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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Mid-Atlantic	N66094	NAVHEALTHCLINIC CHERRY POINT	2	0	0.9	2	Screening	FORMER NAVHOSP CHERRY PT NC
Mid-Atlantic	N66231	NAVOPSPTCEN CHICAGO IL	0	0	N/A	2	Screening	FORMER NAVRESCEN GREAT LAKES IL
Mid-Atlantic	N66315	NAVOPSPTCEN AVOCA PA	0	0	N/A	2	Screening	FORMER NAVRESCEN AVOCA PA
Mid-Atlantic	N66604	FORMER NAVUNSEAWARCENDIV NEWPORT RI	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC N68934
Mid-Atlantic	N68086	FORMER NAVAMBCARECEN NEWPORT RI	0	0	N/A	N/A	Does not apply	PART OF NAVAL HEALTH CLINIC NEW ENGLAND UIC N32185; DATA MOVED TO THAT UIC
Mid-Atlantic	N68093	NAVHOSP CAMP LEJEUNE NC	3	0	3.2	2	Screening	
Mid-Atlantic	N68101	FORMER NAVMEDCLINIC PHILADELPHIA PA	9	0	1.2	N/A	Does not apply	CLOSED AND DEMOLISHED
Mid-Atlantic	N68317	NAVSUPPU SARATOGA SPRINGS NY	36	0	2.2	3	Monitoring	FORMER NAVADMINU SARATOGA SPRINGS (OR SCOTIA NY); CHANGED FROM SCOTIA TO SARATOGA SPRINGS
Mid-Atlantic	N68329	FORMER NAVRESREDCOM REG 5 RAVENNA OH	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED

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Navy Initial Radon Potential Categories

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Mid-Atlantic	N68335	NAWCAD LAKEHURST NWCF	235	3	6.1	1	Assessment	FORMER NAVAIRENGCEN LAKEHURST NJ; NOT PART OF NAVAL WEAPONS STATION EARLE, LOCATED ON JOINT BASE MCGUIRE DIX LAKEHURST
Mid-Atlantic	N68524	FORMER NAVRESCEN BROOKLYN NY	0	0	N/A	N/A	Does not apply	DATA IS IN UIC N68527 NAVRESCEN BROOKLYN NY
Mid-Atlantic	N68527	NAVMARCORESCEN BROOKLYN NY	9	0	0.1	2	Screening	
Mid-Atlantic	N68722	FORMER NAVMEDCLINIC NORFOLK VA	0	0	N/A	N/A	Does not apply	DATA LOCATED IN NEW UIC N32510
Mid-Atlantic	N68759	DOD FAM HSG FAC NIAGARA NY	30	0	0.9	3	Monitoring	
Mid-Atlantic	N68777	NAVRESFAC LEWES DE	10	0	0.4	2	Screening	
Mid-Atlantic	N68815	FORMER NAVOPSPTCEN MARQUETTE MI	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Mid-Atlantic	N68846	NAVOPSPTCEN EARLE NJ	0	0	N/A	2	Screening	FORMER NAVRESCEN KEARNY NJ; RADON STATUS BASED ON NAVAL WEAPONS STATION EARLE UIC N69213
Mid-Atlantic	N68859	NAVRESCEN MANHATTAN NY	0	0	N/A	2	Screening	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Mid-Atlantic	N68934	NAVUNSEAWARCENDIV NEWPORT RI	1038	8	7.6	1	Assessment	FORMER NUSC NEWPORT RI UIC N66604
Mid-Atlantic	N69124	PHILADELPHIA PA NH CSO	0	0	N/A	N/A	Does not apply	CLOSED
Mid-Atlantic	N69126	DAVISVILLE RI CBC CSO	0	0	N/A	N/A	Does not apply	CLOSED
Mid-Atlantic	N69138	JAMESTOWN NY NRC CS	0	0	N/A	2	Screening	
Mid-Atlantic	N69139	PITTSFIELD MA NRC CS	0	0	N/A	2	Screening	
Mid-Atlantic	N69148	PHILADELPHIA PA NS CSO	0	0	N/A	N/A	Does not apply	CLOSED
Mid-Atlantic	N69160	WARMINSTER PA NAWC-AD CSO	0	0	N/A	N/A	Does not apply	CLOSED
Mid-Atlantic	N69170	SOUTH WEYMOUTH MA NAS CSO	0	0	N/A	N/A	Does not apply	CLOSED
Mid-Atlantic	N69212	NAVAL WEAPONS STATION YORKTOWN	0	0	N/A	2	Screening	
Mid-Atlantic	N69213	NAVAL WEAPONS STATIN EARLE NJ	24	0	1.8	2	Screening	MAIN INSTALLATION
Mid-Atlantic	N70272	NCTAMS LANT NORFOLK VA	0	0	N/A	2	Screening	FORMER NAVCAMSLANT NORFOLK VA
Mid-Atlantic	N70310	FORMER NAVRADSTA /R/ SUGAR GROVE	0	N/A	N/A	N/A	Does not apply	CLOSED 10/1/1992, DATA MOVED TO N31188
Mid-Atlantic	N90691	NIROP ROCHESTER NY	0	0	N/A	2	Screening	
Mid-Atlantic	N90845	NWIRP BETHPAGE NY	0	0	N/A	2	Screening	
Mid-Atlantic	N91041	NIROP PITTSFIELD MA	0	0	N/A	2	Screening	

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N/A: Not applicable
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Mid-Atlantic	N91571	ALLEGANY BALLISTICS LAB	169	0	2.7	2	Screening	FORMER NIROP CUMBERLAND MD; INSTALLATION GEOGRAPHICALLY LOCATED IN ROCKET CENTER WV
Mid-Atlantic	N91780	ORD RESEARCH LAB UNIV PARK PA	0	0	N/A	2	Screening	
Mid-Atlantic	N92782	NWIRP BLOOMFIELD CT	65	0	0.7	3	Monitoring	
Mid-Atlantic	N93880	NWIRP BEDFORD MA	29	0	1.0	2	Screening	
Mid-Atlantic	N94151	KNOLLS APL SCHENECTADY NY	0	0	N/A	2	Screening	
Mid-Atlantic	N96095	NWIRP CALVERTON NY	0	0	N/A	2	Screening	
Mid-Atlantic	PWC-GL	FORMER PWC GREAT LAKES IL	32	12	7.3	1	Assessment	FORMER UIC N62037
N/A	N00651	FORMER NSD SUBIC BAY RP	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N00927	FORMER NAVCOMTELSTA CUBI PT RP	14	0	0.8	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N30851	FORMER DJAKARTA NMRD	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N55418	FORMER NAVANTARCTICSUPU CHRISTCHURCH	2	0	1.4	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N57075	FORMER NAVFAC ARGENTIA NFLD CANADA	31	0	1.2	N/A	Does not apply	NO LONGER NAVY OWNED

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Navy Initial Radon Potential Categories

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N/A	N61552	FORMER NAVSTA SUBIC BAY RP	28	0	1.2	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N62494	FORMER NAF MIDWAY ISLAND	116	0	0.2	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N62770	FORMER NAVSHIPREPFAC SUBIC BAY RP	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N62807	FORMER NAVMAG SUBIC BAY RP	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N62808	PWC SUBIC BAY PHILIPPINES	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N62814	NAVMEDRSCHUNIT TWO PACIFIC	0	0	N/A	N/A	Does not apply	
N/A	N62864	OICC SOUTHWEST PAC MANILA	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N62876	FORMER NAS CUBI POINT RP	1	0	1.5	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N63427	NAVCOMMSTA HE HOLT EXMOUTH AS	1	0	1.5	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N65491	FORMER NAVHOSP SUBIC BAY	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
N/A	N91982	FORMER JHU APPLIED PHYSIC LAB	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
NDW	N00014	CHIEF OF NAVAL RESEARCH ARLINGTON VA	0	0	N/A	2	Screening	
NDW	N00161	USNA ANNAPOLIS MD	139	11	8.9	1	Assessment	

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NDW	N00162	NAVHEALTHCLINIC ANNAPOLIS	2	0	1.5	2	Screening	FORMER NAVMEDCLINIC ANNAPOLIS MD
NDW	N00166	NAF WASHINGTON DC	75	0	0.5	3	Monitoring	
NDW	N00167	NATNAVMEDCEN BETHESDA MD	145	5	8.3	1	Assessment	FORMER DTNSRDC BETHESDA MD
NDW	N00168	COMNAVDIST WASHINGTON DC	14	0	3.6	3	Monitoring	FORMER NAVMEDCOMNATCAPREG BETHESDA
NDW	N00171	NRL WASHINGTON DC	2	0	0.5	2	Screening	FORMER COMNAVDIST WASHINGTON DC
NDW	N00173	NRL WASHINGTON DC	130	1	6.0	1	Assessment	
NDW	N00174	NAVSURFWARCENDIV INDIAN HEAD	44	0	3.5	3	Monitoring	FORMER NAVORDSTA INDIAN HEAD MD
NDW	N00178	NAVSURFWARCENDIV DAHLGREN VA	13	0	1.6	3	Monitoring	
NDW	N00231	NAVHEALTHCLINIC QUANTICO VA	228	0	1.1	3	Monitoring	
NDW	N00421	NAVAIRWARCENACDIV PATUXENT MD	181	0	3.6	3	Monitoring	FORMER NAVAIRTESTCEN PATUXENT RIVER MD
NDW	N00424	NOLSC FORT BELVOIR VA	0	0	N/A	2	Screening	FORMER NAVPETOFF ALEXANDRIA VA
NDW	N00693	HPS SITE DAHLGREN	0	0	N/A	2	Screening	FORMER NTC BAINBRIDGE MD

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NDW	N00788	NAVCOTELSTA DET CHELTENHAN	87	0	2.4	3	Monitoring	FORMER NAVCOMMU WASHINGTON DC
NDW	N0417A	NAVSUPPFAC THURMONT MD	21	0	2.3	3	Monitoring	
NDW	N08863	NMCB 23 FT BELVOIR VA	0	0	N/A	2	Screening	
NDW	N33355	NAVSUPPACT BETHESDA MD	0	0	N/A	2	Screening	
NDW	N35328	RADTRANF ANNAPOLIS MD	33	0	1.3	3	Monitoring	
NDW	N47608	NAVAL AIR STATION PAX RIVER	0	0	N/A	2	Screening	
NDW	N60921	NAVSUFWARCEN WHITE OAK DET MD	247	2	9.9	1	Assessment	FORMER NSWC DAHLGREN VA
NDW	N61142	JBAB ANACOSTIA BOLLING	0	0	N/A	2	Screening	
NDW	N61150	NSA NORTH POTOMAC	0	0	N/A	2	Screening	
NDW	N61151	NSA SOUTH POTOMAC	0	0	N/A	2	Screening	
NDW	N61152	NAVSUPPACT ANNAPOLIS	0	0	N/A	2	Screening	
NDW	N61533	NAVSURFWARCEN DET ANNAPOLIS MD	5	3	4.3	1	Assessment	FORMER NSRDC ANNAPOLIS MD
NDW	N61894	FORMER NAVMARCORESCEN WASHINGTON DC	8	0	0.2	2	Screening	
NDW	N62285	NAVOBSY WASHINGTON DC	112	8	48.6	1	Assessment	
NDW	N62477	FORMER NAVFAC EFA CHESAPEAKE	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED

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NDW	N63138	NAVSPACESURCEN DAHLGREN VA	0	0	N/A	2	Screening	FORMER NAVSPACESURSYS S DAHLGREN VA
NDW	N68469	NAVAL SUPPORT ACTIVITY WASH	0	0	N/A	2	Screening	
NDW	N70092	FORMER NAVSECSTA WASH DC	112	0	2.7	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N00251	NAVSHIPYD PUGET SOUND WA	4	0	0.3	2	Screening	
Northwest	N00253	NAVUNSEAWARCENDIV KEYPORT WA	3	0	0.9	2	Screening	
Northwest	N00255	NAVSTA PUGET SOUND WA	15	0	0.6	3	Monitoring	
Northwest	N00276	FORMER NAS TWIN CITIES MN	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N00406	FISC PUGET SOUND BREMERTON WA	96	0	0.3	3	Monitoring	FORMER NSC PUGET SOUND BREMERTON WA
Northwest	N00620	NAS WHIDBEY ISLAND WA	184	0	1.7	3	Monitoring	
Northwest	N30178	NAVOPSPTCEN HELENA MT	22	0	1.4	3	Monitoring	FORMER NRC HELENA MT
Northwest	N30315	NAVSPACECOM DET BRAVO VANDENBG	26	0	2.0	3	Monitoring	FORMER ASTROGRPDET B ROSEMOUNT MN
Northwest	N30531	NAVOPSPTCEN MINNEAPOLIS MN	95	0	2.8	3	Monitoring	FORMER NAVRESCEN TWIN CITIES MN
Northwest	N32013	FORMER NAVMAG INDIAN ISLAND WA	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N57055	NAVFAC COOS HEAD OR	20	0	0.3	3	Monitoring	

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Northwest	N57056	FORMER NAVFAC PACIFIC BEACH WA	43	0	0.7	3	Monitoring	
Northwest	N57099	NAVAL OCEAN PROCESS FAC ADAK AK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
Northwest	N60462	FORMER NAF ADAK AK	261	0	0.7	N/A	Does not apply	NO LONGER NAVY OWNED
Northwest	N61066	CNI NAVMAG INDIAN ISLAND	0	0	N/A	2	Screening	
Northwest	N61987	FORMER NAVOPSPTCEN CEDAR RAPIDS IA	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N61998	NAVOPSPTCEN OMAHA NE	10	0	1.2	2	Screening	FORMER NAVMARCORESCEN OMAHA NE
Northwest	N62042	NAVMARCORESCEN WATERLOO IA	33	4	8.9	1	Assessment	
Northwest	N62043	FORMER NOSC SIOUX CITY IA	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62044	NAVOPSPTCEN DES MOINES IA	5	0	1.5	2	Screening	FORMER NAVMARCORESCEN DES MOINES IA
Northwest	N62047	FORMER NAVOPSPTCEN DUBUQUE IA	10	1	4.3	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62057	NAVOPSPTCEN DULUTH MN	10	0	2.0	2	Screening	FORMER NAVRESCEN DULUTH MN

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Northwest	N62058	FORMER NAVMARCORESCEN ST PAUL MN	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62068	NAVOPSPTCEN SIOUX FALLS SD	0	0	N/A	2	Screening	FORMER NAVRESCEN SIOUX FALLS SD
Northwest	N62069	FORMER NAVOPSPTCEN LINCOLN NE	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62091	NAVOPSPTCEN FARGO ND	0	0	N/A	2	Screening	FORMER NAVRESCEN FARGO ND
Northwest	N62134	FORMER NAVRESCEN SEATTLE WA	22	0	0.8	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62135	FORMER NAVOPSPTCEN TACOMA WA	26	0	0.9	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62138	NAVOPSPTCEN BILLINGS MT	38	1	4.5	1	Assessment	FORMER NAVMARCORESCEN BILLINGS MT
Northwest	N62139	NAVOPSPTCEN BOISE ID	26	0	2.2	3	Monitoring	FORMER NAVMARCORESCEN BOISE ID
Northwest	N62142	NAVOPSPTCEN CHEYENNE WY	10	0	0.7	2	Screening	FORMER NAVRESCEN CHEYENNE WY
Northwest	N62143	NAVRESFAC BUTTE MT	10	3	4.9	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62144	NAVOPSPTCEN EVERETT WA	26	0	0.4	3	Monitoring	FORMER NRC EVERETT WA

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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Northwest	N62145	NAVOPSPTCEN PORTLAND OR	36	0	2.3	3	Monitoring	FORMER NAVMARCORESCEN PORTLAND OR
Northwest	N62146	NAVOPSPTCEN SPOKANE WA	66	0	3.3	3	Monitoring	FORMER NAVMARCORESCEN SPOKANE WA
Northwest	N62182	DAVID TAYLOR RESCEN BAYVIEW ID	11	10	50.2	1	Assessment	
Northwest	N62250	FORMER NAVMARCORESCEN SALEM OR	10	1	4.4	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N62298	NAVOPSPTCEN SPRINGFIELD OR	54	0	1.0	3	Monitoring	FORMER NAVMARCORESCEN EUGENE OR
Northwest	N63402	SWFPAC BANGOR WA	105	0	0.7	3	Monitoring	
Northwest	N63533	NAVOPSPTCEN BANGOR WA	24	0	0.3	3	Monitoring	FORMER NAVRESCEN BANGOR WA
Northwest	N63538	NAVRESCEN GREAT FALLS MT	11	1	4.7	1	Assessment	
Northwest	N63543	FORMER NAVOPSPTCEN CENTRAL POINT OR	20	0	1.4	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N63545	NAVRESCEN MISSOULA MT	0	0	N/A	2	Screening	
Northwest	N63548	FORMER NAVRESCEN RICHLAND WA	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED

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Navy Initial Radon Potential Categories

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Northwest	N63550	FORMER NAVOPSPTCEN POCATELLO ID	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N63886	NAVSECGRUACT ADAK AK	2	0	0.5	N/A	Does not apply	NO LONGER NAVY OWNED
Northwest	N65198	FORMER NAVADMINU IDAHO FALLS ID	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N65226	FORMER NAVARCLAB BARROW AK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
Northwest	N66135	NAVOPSPTCEN ANCHORAGE AK	26	1	4.0	1	Assessment	FORMER NAVRESCEN ANCHORAGE AK
Northwest	N68095	NAVHOSP BREMERTON WA	66	0	0.5	3	Monitoring	
Northwest	N68328	NAVREG NW RCC EVERETT	14	0	0.8	3	Monitoring	FORMER REDCOM22 EVERETT WA
Northwest	N68349	FORMER NAVRESREDCOMREG16	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N68436	NAVAL BASE KITSAP BREMERTON WA	0	0	N/A	2	Screening	FORMER SUBASE BREMERTON WA
Northwest	N68437	TRITRAFAC BANGOR WA	164	0	1.3	3	Monitoring	
Northwest	N68438	NAVIMFAC BANGOR WA	115	0	0.5	3	Monitoring	FORMER TRIREFFAC BANGOR WA
Northwest	N68660	NCTAMS PAC DET PUGET SOUND WA	0	0	N/A	2	Screening	FORMER NAVCOMMSTA PUGET SOUND SUBSE
Northwest	N68967	NAVSTA EVERETT WA	0	0	N/A	2	Screening	

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N/A: Not applicable
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Northwest	N69169	CSO NAF ADAK AK	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
Northwest	N70273	NCTS PAC DET PG/NRS TJC OSO WA	2	0	0.9	3	Monitoring	FORMER NAVRADSTA/T/JIM CREEK WA
Northwest	N81997	MIUW UNIT 101	0	0	N/A	2	Screening	
Northwest	N91192	NIROP MINNEAPOLIS MN	0	0	N/A	2	Screening	
Northwest	N91741	FORMER NIROP ST PAUL MN	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Northwest	N94166	APPLIED PHYSICS LAB SEATTLE WA	0	0	N/A	2	Screening	
Singapore	N61077	SINGAPORE AREA COORDINATOR/NAVREGCEN SINGAPORE	338	3	8.6	1	Monitoring	FORMER NRCC SINGAPORE UIC N68047
Singapore	N68047	NAVREGCEN SINGAPORE	0	0	N/A	2	Screening	FORMER NRCC SINGAPORE; DATA IN UIC N61077
Southeast	N00065	COMNAVMETOCCOM STENNIS SPACEN	0	0	N/A	2	Screening	FORMER COMNAVMETOCCOM BAY ST LOUIS MS
Southeast	N00153	AF RET HOME GULFPORT	0	0	N/A	2	Screening	FORMER NAVAL HOME GULFPORT MS
Southeast	N0017A	FORMER LANTFLTWPNTRAFAC ROOS RDS PR	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N00191	NSY CHARLESTON SC	140	1	7.3	1	Assessment	

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Southeast	N00193	NMC DET CHARLESTON SC	7	0	2.2	2	Screening	FOMER WPNSTA CHARLESTON SC
Southeast	N00196	NAS ATLANTA GA	13	0	2.8	2	Screening	
Southeast	N00203	NAVHOSP PENSACOLA FL	5	0	0.2	2	Screening	
Southeast	N00204	NAS PENSACOLA, FL	6	0	0.6	2	Screening	
Southeast	N00205	FORMER NSA NEW ORLEANS LA	109	1	4.7	1	Assessment	FORMER NAVSUPPACT NEW ORLEANS LA
Southeast	N00206	NAS JRB NEW ORLEANS LA	76	0	2.3	3	Monitoring	FORMER NAS NEW ORLEANS
Southeast	N00207	NAS JACKSONVILLE FL	57	0	1.5	3	Monitoring	
Southeast	N00213	NAS KEY WEST FL	425	0	3.5	3	Monitoring	
Southeast	N00215	NAS DALLAS TX	24	5	6.7	1	Assessment	
Southeast	N00216	NAS CORPUS CHRISTI TX	69	0	0.6	3	Monitoring	
Southeast	N00232	NAVHOSP JACKSONVILLE FL	0	0	N/A	2	Screening	
Southeast	N00267	NAVMEDCLINIC KEY WEST FL	3	0	1.5	2	Screening	
Southeast	N00285	NAVHEALTHCLINIC CORPUS CHRISTI	3	0	0.1	2	Screening	FORMER NAVHOSP CORPUS CHRISTI TX
Southeast	N00306	NAS GUANTANAMO BAY	0	0	N/A	2	Screening	
Southeast	N00389	FORMER NAVSTA ROOSEVELT ROADS PR	58	0	1.1	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N00612	FISC JAX DET CHARLESTON	0	0	N/A	2	Screening	FORMER NSC CHARLESTON SC

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Southeast	N00639	NAVSUPPACT MIDSOUTH MEMPHIS TN	609	1	9.1	1	Assessment	FORMER NAS MEMPHIS TN
Southeast	N00743	FORMER NAVCOMMSTA ROOSEVELT ROADS RQ	65	0	2.7	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N08864	NMCB 24 HUNTSVILLE AL	0	0	N/A	2	Screening	FORMER RNMCB 24 HUNTSVILLE AL
Southeast	N08868	NMCB 28	5	0	0.2	2	Screening	FORMER RNMCB 28 BARKSDALE AFB LA
Southeast	N08914	NMCB 15 RICHARDS-GEBOUR AFB	0	0	N/A	2	Screening	
Southeast	N30924	FORMER NAVAIRESCEN OLATHE KS	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N40003	NAVAL ACTIVITY PUERTO RICO	0	0	N/A	2	Screening	
Southeast	N40282	CNI NAVAL METOC	0	0	N/A	2	Screening	NEW UIC REPLACING N68462 NRL DET STENNIS SPACE CTR MS
Southeast	N42237	SUBASE KINGS BAY GA	63	0	3.3	3	Monitoring	
Southeast	N44466	TRIREFFAC KINGS BAY GA	0	0	N/A	2	Screening	
Southeast	N45610	NAVAL CON BRIG CHARLESTON SC	4	0	0.1	2	Screening	
Southeast	N45719	NCFSU THREE FT JACKSON SC	0	0	N/A	2	Screening	FORMER NRCF UNIT THREE CHARLESTON SC
Southeast	N50173	NAVSUPPFAC BEAUFORT SC	0	0	N/A	2	Screening	

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Southeast	N57038	NAVOCEANPROFAC DET BERMUDA	0	0	N/A	2	Screening	FORMER NAVFAC BERMUDA
Southeast	N57049	NSF ANTIGUA, WEST INDIES	17	0	3.6	3	Monitoring	FORMER NAVSUPFAC ANTIGUA AC
Southeast	N60002	BR MED CLINIC MILLINGTON TN	6	0	0.9	2	Screening	FORMER NAVHOSP MILLINGTON TN
Southeast	N60200	FORMER NAS CECIL FIELD FL	69	0	1.0	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N60201	NAVSTA MAYPORT FL	146	0	2.1	3	Monitoring	
Southeast	N60241	NAS KINGSVILLE TX	63	0	1.4	3	Monitoring	
Southeast	N60376	NAS CHASE FIELD TX	4	0	1.1	2	Screening	
Southeast	N60508	NAS WHITING FLD MILTON FL	263	0	2.9	3	Monitoring	
Southeast	N60514	NAVSTA GUANTANAMO BAY	78	0	2.2	3	Monitoring	
Southeast	N61006	FORMER NAVAL SUPPORT ACTIVITY ATHENS	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N61007	NAVAL SUPPORT ACTIVITY ORLANDO	0	0	N/A	2	Screening	
Southeast	N61008	NAVAL SUPPORT ACTY PANAMA CITY	0	0	N/A	2	Screening	

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Southeast	N61035	NAVOPSPTCEN NEW ORLEANS	9	0	0.3	2	Screening	OLD UIC N61954; NEW UIC FORMED WITH MERGER OF NAVY AIR RESERVE AND NAVAL RESERVE CENTER; MAIN ELEMENTS PHYSICALLY LOCATED AT NAS JRB NEW ORLEANS UIC N00206
Southeast	N61165	NAVSTA CHARLESTON SC	4	0	0.9	2	Screening	
Southeast	N61331	NAVSURFWARCENDIV PANAMA CITY FL	25	0	0.9	3	Monitoring	FORMER NAVCOASTSYSCEN PANAMA CITY FL
Southeast	N61337	NAVHOSP BEAUFORT SC	98	1	4.0	1	Assessment	
Southeast	N61339	NAVAIRWARCEN TSD (N-NWCF) ORLA	97	0	0.9	3	Monitoring	FORMER NAVTRASYSCEN ORLANDO FL
Southeast	N61564	NAVHOSP GUANTANAMO	0	0	N/A	2	Screening	
Southeast	N61910	NAVOPSPTCEN AUGUSTA GA	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN AUGUSTA GA
Southeast	N61911	NAVOPSPTCEN CHARLESTON SC	9	0	0.7	2	Screening	FORMER NAVRESCEN CHARLESTON SC
Southeast	N61912	NAVOPSPTCEN COLUMBIA SC	10	0	0.3	2	Screening	FORMER NAVMARCORESCEN CLOUMBIA SC
Southeast	N61913	NAVRESCEN MACON GA	10	0	0.9	2	Screening	

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Southeast	N61915	NAVMARCORESCEN ATLANTA GA	0	0	N/A	2	Screening	
Southeast	N61919	NAVOPSPTCEN COLUMBUS GA	8	0	0.7	2	Screening	FORMER NAVRESCEN COLUMBUS GA
Southeast	N61926	NOSC-MCRC JACKSONVILLE FL	10	0	2.3	2	Screening	FORMER NAVMARCORESCEN JACKSONVILLE FL
Southeast	N61927	NAVOPSPTCEN MIAMI FL	0	0	N/A	2	Screening	FORMER NAVRESCEN MIAMI FL
Southeast	N61929	NAVOPSPTCEN ORLANDO FL	10	0	1.5	2	Screening	FORMER NAVMARCORESCEN ORLANDO FL
Southeast	N61930	NAVOPSPTCEN ST PETERSBURG FL	10	0	1.6	2	Screening	FORMER NAVRESCEN ST PETERSBURG FL
Southeast	N61931	NAVOPSPTCEN WEST PALM BEACH FL	10	0	0.6	2	Screening	FORMER NAVRESCEN WEST PALM BEACH GARDENS FL
Southeast	N61933	NAVOPSPTCEN TAMPA FL	76	1	5.6	1	Assessment	FORMER NAVRESCEN TAMPA FL
Southeast	N61934	NAVOPSPTCEN CHATTANOOGA TN	8	0	0.2	2	Screening	FORMER NAVMARCORESCEN CHATTANOOGA TN
Southeast	N61935	FORMER NAVRESCEN GULFPORT MS	10	0	0.2	2	Screening	

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Southeast	N61937	NAVRESCEN FORT SMITH AR	10	0	0.5	N/A	Does not apply	FORMER NAVRESCEN FORT SMITH AR, NO LONGER NAVY OWNED
Southeast	N61938	NAVOPSPTCEN TULSA OK	10	0	0.5	2	Screening	FORMER NAVMARCORESCEN BROKEN ARROW OK
Southeast	N61940	NAVOPSPTCEN BATON ROUGE LA	2	0	0.1	2	Screening	FORMER NAVMARCORESCEN BATON ROUGE LA
Southeast	N61942	NAVOPSPTCEN BESSEMER AL	6	0	2.0	2	Screening	FORMER NAVMARCORESCEN BESSEMER AL
Southeast	N61944	NAVOPSPTCEN SHREVEPORT LA	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN SHREVEPORT LA
Southeast	N61945	NAVOPSPTCEN MOBILE AL	8	0	0.7	2	Screening	
Southeast	N61947	NAVMARCORESCEN MONTGOMERY AL	0	0	N/A	2	Screening	
Southeast	N61948	NAVOPSPTCEN KNOXVILLE TN	10	1	5.1	1	Assessment	FORMER NAVMARCORESCEN KNOXVILLE TN
Southeast	N61949	FORMER NAVRESCEN PENSACOLA FL	0	0	N/A	2	Screening	
Southeast	N61951	NAVRESCEN WICHITA FALLS TX	0	0	N/A	2	Screening	

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Southeast	N61954	NAVOPSPTCEN NEW ORLEANS LA	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN NEW ORLEANS LA
Southeast	N61955	NAVOPSPTCEN MERIDAN MS	10	0	0.6	2	Screening	FORMER NAVRESCEN JACKSON MS
Southeast	N61956	FORMER NAVRESCEN KINGSPORT TN	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N61958	FORMER NAVRESCEN STILLWATER OK	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N61959	NAVOPSPTCEN AMARILLO TX	14	0	0.5	3	Monitoring	FORMER NAVMARCORESCEN AMARILLO TX
Southeast	N61962	NAVOPSPTCEN MEMPHIS TN	1	0	0.5	2	Screening	FORMER NAVRESCEN MEMPHIS TN
Southeast	N61967	NAVMARCORESCEN LAFAYETTE LA	0	0	N/A	2	Screening	
Southeast	N61968	NAVOPSPTCEN HOUSTON TX	19	0	0.4	3	Monitoring	FORMER NAVMARCORESCEN HOUSTON TX
Southeast	N61971	NAVOPSPTCEN NASHVILLE TN	10	4	12.9	1	Assessment	FORMER NAVRESCEN NASHVILLE TN
Southeast	N61972	NAVRESCEN EAST GADSDEN AL	10	0	1.1	2	Screening	
Southeast	N61973	NASRESFAC ALEXANDRIA LA	1	0	0.2	2	Screening	

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Southeast	N61979	FORMER NAVRESCEN DALLAS TX	6	0	0.3	2	Screening	
Southeast	N61980	NAVOPSPTCEN EL PASO TX	7	0	0.3	2	Screening	FORMER NAVMARCORESCEN EL PASO TX
Southeast	N61982	NAVOPSPTCEN SAN ANTONIO TX	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN SAN ANTONIO TX
Southeast	N61988	FORMER NAVOPSPTCEN CAPE GIRARDEAU MO	10	0	0.6	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N61992	NAVOPSPTCEN ST LOUIS MO	10	1	5.5	1	Assessment	FORMER NAVMARCORESCEN ST LOUIS MO
Southeast	N62032	FORMER NAVRESCEN HUTCHINSON KS	10	0	2.0	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N62039	FORMER NAVRESCEN JOPLIN MO	2	0	0.6	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N62040	NAVOPSPTCEN WICHITA KS	11	0	0.3	2	Screening	FORMER NAVRESCEN WICHITA KS
Southeast	N62041	FORMER NAVMARCORESCEN TOPEKA KS	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N62054	NAVOPSPTCEN KANSAS CITY MO	10	0	0.9	2	Screening	FORMER MANVARCORESCEN KANSAS CITY MO

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Southeast	N62090	FORMER NAVRESCEN ST JOSEPH MO	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N62154	NAVMARCORESCEN SAVANNAH GA	10	0	1.1	2	Screening	
Southeast	N62190	NAVUNSEAWARCEN DET	0	0	N/A	2	Screening	FORMER NRL UWS REF DET ORLANDO FL
Southeast	N62247	NAVRESCEN HUNTSVILLE AL	0	0	N/A	N/A	Does not apply	FORMER NAVRESCEN HUNTSVILLE AL, NO LONGER NAVY OWNED
Southeast	N62248	NAVOPSPTCEN LUBBOCK TX	11	1	4.5	1	Assessment	FORMER NAVMARCORESCEN LUBBOCK TX
Southeast	N62257	NAVMARCORESCEN ABILENE TX	8	0	0.4	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N62306	NAVOCEANO STENNIS SPACE CNTR	0	0	N/A	2	Screening	FORMER NAVOCEANO BAY ST LOUIS MS
Southeast	N62375	NAVOPSPTCEN GREENVILLE SC	9	4	10.0	1	Assessment	FORMER NAVMARCORESCEN GREENVILLE SC
Southeast	N62481	NAS BERMUDA	474	8	12.2	N/A	Does not apply	BRAC
Southeast	N62604	CBC GULFPORT MS	41	0	0.7	3	Monitoring	
Southeast	N62681	FORMER SUPSHIP SAN JUAN PR	0	0	N/A	N/A	Does not apply	DIS-ESTABLISHED

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Southeast	N62701	NAVSUFWARCEN DET DANIA NWCF	2	0	0.2	3	Monitoring	FORMER NAVSURFWPNCENDET FT LAUDERDALE
Southeast	N62741	NAVSCSCOL ATHENS GA	509	12	6.7	1	Assessment	NAVY SUPPLY SCHOOL MOVED TO NEWPORT RI
Southeast	N62748	NAVOPSPTCEN WACO TX	10	1	7.6	1	Assessment	FORMER NAVMARCORESCEN WACO TX
Southeast	N62795	FORMER SUPSHP PASCAGOULA MS	146	0	1.5	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N62841	NAVORDTESTU CAPE CANAVERAL	0	0	N/A	2	Screening	FORMER NAVORDTESTU PATRICK AFB FL
Southeast	N62892	NAVSECGRUACT HOMESTEAD FL	1	0	1.8	3	Monitoring	
Southeast	N63028	SWFLANT DET CHARLESTON SC	0	0	N/A	2	Screening	
Southeast	N63043	NAS MERIDIAN MS	57	0	2.4	3	Monitoring	
Southeast	N63082	CENINFODOM CORRY STA PCOLA FL	2	0	0.2	2	Screening	FORMER NAVTECHTRACENCRST PENSACOLA FL
Southeast	N63248	NAVRESFAC FAYETTEVILLE AR	10	0	1.1	N/A	Does not apply	FORMER NAVRESFAC FAYETTEVILLE AR
Southeast	N63249	FORMER NAVRESCEN HARLINGEN TX	6	0	0.1	2	Screening	
Southeast	N63257	NAVRESCEN MONROE LA	0	0	N/A	2	Screening	

RPC 1: Elevated radon potential exists
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RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southeast	N63267	FORMER NAVRESCEN TYLER TX	11	0	0.3	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N63322	SUBTRAFAC CHARLESTON SC	0	0	N/A	2	Screening	FORMER FLEBALMISUBTRACEN CHARLESTON SC
Southeast	N63425	NCTS JACKSONVILLE DET K WEST	0	0	N/A	2	Screening	FORMER NAVCOMMU KEY WEST FL
Southeast	N63482	NAVOPSPTCEN TALLAHASSEE FL	10	0	0.7	2	Screening	FORMER NAVMARCORESCEN TALLAHASSEE FL
Southeast	N63821	NAVUNSEAWARCENDET AUTEC ANDROS	149	0	1.8	3	Monitoring	FORMER NUSCDETAUTEC ANFROS ISL BF
Southeast	N65114	PWC JACKSONVILLE DET PENSACOLA	190	0	1.0	3	Monitoring	FORMER PWC PENSACOLA FL
Southeast	N65236	SPAWARSYSCEN ATLANTIC	59	1	5.1	1	Assessment	FORMER NAVELEXCEN CHARLESTON SC
Southeast	N65492	NAVHOSP ORLANDO FL	5	0	1.0	2	Screening	
Southeast	N65928	NTC ORLANDO FL	908	0	2.9	3	Monitoring	
Southeast	N65980	FORMER NISEEAST DET	116	0	2.1	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N66754	FORMER NAVSECGRUACT SABANA SECA PR	88	0	1.4	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N66833	NAVSTA PANAMA CANAL RODMAN PN	90	0	0.8	3	Monitoring	

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N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southeast	N66863	NAVBIODYNLAB NEW ORLEANS LA	0	0	N/A	2	Screening	
Southeast	N66898	NAVAMBCARECEN NEW ORLEANS LA	0	0	N/A	2	Screening	FORMER NAVMEDCLINIC NEW ORLEANS LA
Southeast	N68084	NAVHEALTHCLINIC CHARLESTON SC	6	0	1.0	2	Screening	FORMER NAVHOSP CHARLESTON SC
Southeast	N68305	PUBLIC WORKS DEPT ORLANDO	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC NCELPH
Southeast	N68322	NETPDTC PENSACOLA FL	1	0	0.9	2	Screening	FORMER NAVEDTRANCEN PENSACOLA FL
Southeast	N68378 (HIST-ORICAL)	FORMER PWC SAN FRANCISCO	192	0	3.7	3	Monitoring	NAVFAC MIDLANT DET MECH PA HAS ADMIN CONTROL OF THIS FORMER INSTALLATION
Southeast	N68449	NAVOPSPTCEN ORANGE TX	9	0	0.3	2	Screening	FORMER NAVMARCORESCEN ORANGE TX
Southeast	N68462	FORMER NRL DET STENNIS SPACE CTR MS	0	0	N/A	N/A	Does not apply	DATA IN NEW UIC N40282 CNI NAVAL METOC
Southeast	N68701	TRITRAFAC KINGS BAY GEORGIA	0	0	N/A	2	Screening	
Southeast	N68702	FORMER NAVRESCEN CALL BOX SAN JUAN PR	10	0	0.1	2	Screening	
Southeast	N68709	NAS MAYPORT FL	116	0	1.4	3	Monitoring	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southeast	N68733	SWFLANT KINGS BAY GA	21	4	5.5	1	Assessment	
Southeast	N68836	FISC JACKSONVILLE FL (NWCF)	0	0	N/A	2	Screening	FORMER NSC JACKSONVILLE FL
Southeast	N68889	FORMER NAVSTA MOBILE AL	59	0	0.6	3	Monitoring	
Southeast	N68890	FORMER NS PASCAGOULA MS	140	0	1.4	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N68891	NAVSTA INGLESIDE TX	0	0	N/A	2	Screening	
Southeast	N69175	ORLANDO FL NTC CSO	0	0	N/A	N/A	Does not apply	CLOSED
Southeast	N69177	CECIL FIELD FL NAS CSO	0	0	N/A	N/A	Does not apply	CLOSED
Southeast	N69214	NAVAL WEAPONS STATION CHASN	0	0	N/A	2	Screening	
Southeast	N70283	NAVSECGRUACT GALETA IS PN	14	0	0.3	3	Monitoring	
Southeast	N83447	NAS JRB FT WORTH TX	902	50	75.3	1	Assessment	
Southeast	N91662	APPLIED RESEARCH LAB AUSTIN TX	0	0	N/A	2	Screening	
Southeast	N94307	FORMER NWIRP BRISTOL TN	59	0	1.2	N/A	Does not apply	DIS-ESTABLISHED
Southeast	N95918	NWIRP MCGREGOR TX	0	0	N/A	2	Screening	
Southeast	UNKNOWN	FORMER FLEMINEWARTRACEN CHARLESTON SC	0	0	N/A	2	Screening	FORMER MINEWARTRACEN SAN DIEGO UIC N62603

RPC 1: Elevated radon potential exists
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RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N00221	FORMER NSY MARE ISLAND VALLEJO CA	2252	3	7.7	N/A	Does not apply	BRAC
Southwest	N00228	FORMER FISC OAKLAND CA	135	0	1.0	N/A	Does not apply	BRAC
Southwest	N00236	FORMER NAS ALAMEDA	0	0	N/A	N/A	Does not apply	BRAC
Southwest	N00244	FISC SAN DIEGO CA	0	0	N/A	2	Screening	FORMER NSC SAN DIEGO CA
Southwest	N00245	NAVBASE SAN DIEGO	7	0	2.0	2	Screening	
Southwest	N00246	NAVBASE CORONADO	0	0	N/A	2	Screening	FORMER NAS NORTH ISLAND SAN DIEGO CA
Southwest	N00247	FORMER NTC SAN DIEGO CA	3	0	1.3	N/A	Does not apply	BRAC
Southwest	N00259	NAVMEDCEN SAN DIEGO CA	543	0	3.0	3	Monitoring	FORMER NAVHOSP SAN DIEGO CA
Southwest	N00296	FORMER NAS MOFFETT FIELD CA	747	7	6.1	N/A	Does not apply	BRAC
Southwest	N00619	FORMER NAVHOSP OAKLAND CA	151	0	1.5	N/A	Does not apply	
Southwest	N00849	FORMER NAVSECGRUACT SKAGGS IS CA	0	0	N/A	N/A	Does not apply	BRAC
Southwest	N00886	NAVCOMTELSTA DIXON	78	1	4.1	1	Assessment	NOW GOES BY DIXON RATHER THAN STOCKTON
Southwest	N00948	FLEASWTRACENPAC SAN DIEGO	0	0	N/A	2	Screening	

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N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N08915	FORMER NMCB 16 LOS ALAMITOS CA	0	0	N/A	N/A	Does not apply	NO LONGER NAVY OWNED
Southwest	N47609	NAWS CHINA LAKE	0	0	N/A	2	Screening	
Southwest	N47615	NMC CWD UNIT SEAL BEACH CA	112	0	2.5	3	Monitoring	FORMER WEAPONS SUPPORT FACILITY SB - UIC N60701
Southwest	N47822	FORMER NAVMEDCOM OAKLAND CA	23	0	0.2	3	Monitoring	
Southwest	N55262	SWRMC SAN DIEGO CA	307	0	1.6	3	Monitoring	FORMER SUPSHIP SAN DIEGO CA - UIC N62791 AND FORMER SIMA SAN DIEGO CA - UIC N65918
Southwest	N57053	NAVSUPPACT MONTEREY CA	20	0	1.6	N/A	Does not apply	FORMER NAVFAC CENTERVILLE BEACH CA - DECOMMISSIONED 1993
Southwest	N60028	NAVSTA TREASURE ISLAND CA	6	0	0.6	N/A	Does not apply	BRAC
Southwest	N60036	FORMER NAVWPNSTA SEAL BCH DET CONCORD	35	0	1.5	N/A	Does not apply	NOW RUN BY ARMY
Southwest	N60042	NAF EL CENTRO CA	753	0	1.8	3	Monitoring	
Southwest	N60258	FORMER NSY LONG BEACH CA	116	0	0.9	N/A	Does not apply	BRAC
Southwest	N60259	MCAS MIRAMAR CA	305	0	2.2	3	Monitoring	FORMER NAS MIRAMAR
Southwest	N60285	NAVHOSP CAMP PENDLETON CA	231	0	1.1	3	Monitoring	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N60495	NAS FALLON NV	315	1	4.3	1	Assessment	
Southwest	N60530	FORMER NAVAIRWARCENWPNDIV CHINA LAKE	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC N68937 NAWS CHINA LAKE
Southwest	N60701	FORMER WEAPONS SUPPORT FACILITY SB	0	0	N/A	N/A	Does not apply	DATA LOCATED IN UIC N47615 NAVWPNSTA SEAL BEACH
Southwest	N61014	NAVSUPPACT MONTEREY CA	1844	328	9.9	1	Assessment	
Southwest	N61065	NAVWPNSTA SEAL BEACH	0	0	N/A	2	Screening	
Southwest	N61665	FLEET COMBAT TRAINING CENTER SAN DIEGO	123	0	3.2	3	Monitoring	FORMER NPDC TRNG SUPP SITE SAN DIEGO - PART OF NAVBASE POINT LOMA AND PHYSICALLY ADJOINING MAIN BASE, SEPARATED BY PUBLIC ROAD
Southwest	N61762	NAVSURFWARCEN DET WHITE SANDS	4	1	5.5	1	Assessment	FORMER NAVORDMISTESTSTA WHITESANDS NM
Southwest	N62021	NAVPHIBASE CORONADO SDIEGO CA	4	0	0.6	2	Screening	
Southwest	N62102	NAVOPSPTCEN LOS ANGELES CA	55	0	0.5	3	Monitoring	FORMER NAVMARCORESCEN LONG BEACH CA

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N62103	NAVMARCORESCEN LOS ANGELES CA	0	0	N/A	2	Screening	
Southwest	N62105	NAVOPSPTCEN PORT HUENEME CA	26	0	0.4	3	Monitoring	FORMER NAVRESCENDET PT HUENME CA
Southwest	N62106	NAVOPSPTCEN SAN DIEGO	43	0	0.6	3	Monitoring	FORMER NAVMARESCEN SAN DIEGO CA
Southwest	N62107	NAVOPSPTCEN TUCSON AZ	49	0	1.2	3	Monitoring	FORMER NAVMARCORESCEN TUCSON AZ
Southwest	N62109	NAVOPSPTCEN PHOENIX AZ	45	0	2.7	3	Monitoring	FORMER NAVMARCORESCEN PHOENIX AZ
Southwest	N62111	NAVMARCORESCEN BAKERSFIELD CA	54	0	1.8	3	Monitoring	
Southwest	N62114	NAVOPSPTCEN MORENO VALLEY	55	0	0.9	3	Monitoring	FORMER NAVMARCORESCEN MORENO VALLEY CA
Southwest	N62115	FORMER NAVRESCEN SAN FRANCISCO CA	10	0	0.3	2	Screening	
Southwest	N62116	NAVOPSPTCEN ALAMEDA, CA	85	0	1.5	3	Monitoring	FORMER NMCRC ALAMEDA CA
Southwest	N62117	NAVRESCEN STOCKTON CA	0	0	N/A	2	Screening	
Southwest	N62118	FORMER NAVRESCEN VALLEJO CA	10	0	1.3	2	Screening	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N62119	NAVOPSPTCEN SACRAMENTO CA	56	0	0.8	3	Monitoring	FORMER NMCRC SACRAMENTO CA
Southwest	N62121	NAVOPSPTCEN LEMOORE CA	52	0	3.1	3	Monitoring	FORMER NAVRESCENAFRC FRESNO CA
Southwest	N62123	NAVRESCEN COLORADO SPRINGS CO	0	0	N/A	2	Screening	
Southwest	N62124	NAVRESCEN OGDEN UT	11	0	1.4	3	Monitoring	FORMER NRC OGDEN UT
Southwest	N62125	NAVRESCEN PUEBLO CO	0	0	N/A	2	Screening	
Southwest	N62126	NAVOPSPTCEN SALT LAKE CT UT	36	0	1.6	3	Monitoring	FORMER NAVMARCORESCEN SALT LAKE CT UT
Southwest	N62127	NAVOPSPTCEN RENO NV	25	0	2.8	3	Monitoring	FORMER NMCRC RENO NV
Southwest	N62128	NAVOPSPTCEN SAN JOSE CA	66	0	2.7	3	Monitoring	FORMER NMCRC SAN JOSE CA
Southwest	N62130	NAVOPSPTCEN DENVER CO	9	0	0.6	2	Screening	FORMER NAVMARCORESCEN DENVER CO
Southwest	N62180	NAVRESCEN SANTA ANA CA	0	0	N/A	2	Screening	
Southwest	N62241	NAVOPSPTCEN LAS VEGAS NV	0	0	N/A	2	Screening	FORMER NAVMARCORESCEN AFRC LAS VEGAS NV
Southwest	N62267	NAVRESCEN PACIFIC GROVE CA	10	0	1.0	2	Screening	

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RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N62271	FORMER NAVAL POST GRADUATE SCHOOL	0	0	N/A	N/A	Does not apply	DATA MOVED TO UIC N61014 NAVSUPPACT MONTEREY CA
Southwest	N62474	FORMER NAVFAC EFA W DALY CITY CA	109	0	0.8	N/A	Does not apply	BRAC
Southwest	N62583	FORMER NFELC PORT HUENEME CA	119	0	2.1	3	Monitoring	FORMER NFELC PORT HUENEME CA IS NOW PART OF NAVBASE VENTURA CITY PT MUGU CA UIC N69232
Southwest	N62603	MINEWARTRACEN SAN DIEGO CA	68	0	1.0	3	Monitoring	
Southwest	N62654	NAVAIRWARCENWPNDIV ALBUQUERQUE	0	0	N/A	2	Screening	FORMER NAVWPNEVALFAC ALBUQUERQUE NM
Southwest	N62738	NAWPNCENCORONA DET NORCO CA	0	0	N/A	2	Screening	
Southwest	N62791	SUPSHIP SAN DIEGO CA	0	0	N/A	N/A	Does not apply	SUPSHIP SAN DIEGO CHANGED NAME TO SWRMC SAN DIEGO (UIC N55262; DATA LOCATED IN THIS UIC) BUT IS PHYSICALLY LOCATED ON NAVBASE SAN DIEGO UIC N00245
Southwest	N62818	NAVRESCEN POMONA CA	10	0	1.5	2	Screening	

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N/A: Not applicable
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Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N62887	ONRDET MONTEREY CA	0	0	N/A	2	Screening	CONTACT AT NAVSUPPACT MONTEREY HAD NO KNOWLEDGE OF THIS ORGANIZATINO OR UIC
Southwest	N63042	NAS LEMOORE CA	9	0	2.9	2	Screening	
Southwest	N63126	FORMER NAVAIRWARCENWPNDIV PT MUGU CA	792	2	10.2	1	Assessment	NAS PT MUGU IS NOW PART OF NAVBASE VENTURA CTY PT MUGU CA N69232
Southwest	N63243	NAVRESFAC CARLSBAD NM	0	0	N/A	2	Screening	
Southwest	N63387	NAVFAC SOUTHWEST SAN DIEGO CA PWC DEPARTMENT	372	0	2.8	3	Monitoring	FORMER PWC SAN DIEGO CA
Southwest	N63394	FORMER NAVSURFWARCENDIV PORT HUENEME	0	0	N/A	2	Screening	NOW NAVBASE VENTURA CTY PT MUGU CA N62583; NAVSURFWARCENDIV IS LOCATED ON PORT HUENEME
Southwest	N63406	NAVBASE POINT LOMA	497	9	14.5	1	Assessment	FORMER SUBASE SAN DIEGO CA
Southwest	N65584	NISE-WEST SAN DIEGO CA	34	0	0.5	3	Monitoring	FORMER NAVELEXSYSENGCEN SAN DIEGO CA
Southwest	N65913	NAVSEACENPAC SAN DIEGO CA	0	0	N/A	N/A	Does not apply	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N65918	SIMA SAN DIEGO CA	0	0	N/A	N/A	Does not apply	NOW SWRMC SAN DIEGO UIC N55262 AND THE DATA IS LOCTED IN THIS UIC. IT IS PHYSICALLY LOCATED ON NAVBASE SAN DIEGO.
Southwest	N66001	SPAWARSYSCEN PACIFIC SAN DIEGO	245	3	9.6	1	Assessment	
Southwest	N66890	FORMER NAVSTA MARE ISLAND CA	4	0	1.4	N/A	Does not apply	BRAC
Southwest	N68090	FORMER NAVHOSP LONG BEACH CA	7	0	1.2	N/A	Does not apply	BRAC
Southwest	N68174	NAVOPSPTCEN ENCINO CA	67	0	3.1	3	Monitoring	FORMER NAVMARCORESCEN ENCINO CA
Southwest	N68311	FORMER NAVSTA LONG BEACH CA	7	0	1.1	N/A	Does not apply	BRAC
Southwest	N68318	NAVMARCORESCEN SAN BRUNO CA	56	0	1.5	3	Monitoring	
Southwest	N68937	NAWS CHINA LAKE	81	0	3.2	3	Monitoring	DATA MOVED TO HERE FROM OLD UIC N60530
Southwest	N69127	CSO HUNTERS POINT ANNEX	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69141	CSO NS LONG BEACH CA	0	0	N/A	N/A	Does not apply	CLOSED

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N69152	CSO NSY MARE ISLAND CA	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69161	CSO NAS ALAMEDA CA	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69162	CSO NTC SAN DIEGO CA	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69165	CSO NSY LONG BEACH CA	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69168	CSO NS TREASURE ISLAND CA	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69174	CSO PWC SAN FRANCISCO CA	0	0	N/A	N/A	Does not apply	CLOSED
Southwest	N69232	NAVBASE VENTURA CTY PT MUGU CA	0	0	N/A	2	Screening	
Southwest	N70240	NAVCOMTELSTA SAN DIEGO, CA	0	0	N/A	2	Screening	FORMER NAVCOMMSTA SAN DIEGO CA
Southwest	N91285	NIROP SUNNYVALE CA	149	0	3.0	3	Monitoring	
Southwest	N91726	CAL INST OF TECH PASADENA CA	0	0	N/A	2	Screening	NAVY OWNS BLDGS AT THE UNIVERSITY
Southwest	N91947	INST OF MINING/TECH SOCORRO NM	0	0	N/A	2	Screening	NAVY OWNS BLDGS AT THE UNIVERSITY
Southwest	N91961	NWIRP DALLAS TX	0	0	N/A	2	Screening	
Southwest	N92625	U OF CAL SAN DIEGO LA JOLLA CA	0	0	N/A	2	Screening	NAVY OWNS BLDGS AT THE UNIVERSITY
Southwest	N93055	NIROP POMONA CA	0	0	N/A	2	Screening	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

Navy Initial Radon Potential Categories

Navy Region	UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
Southwest	N94750	NIROP MAGNA UT	0	0	N/A	2	Screening	
Southwest	N95137	NIROP SACRAMENTO CA	0	0	N/A	2	Screening	
Southwest	NCELPH	FORMER NAVCIVENGRLAB PORT HUENEME CA	160	0	2.4	3	Monitoring	FORMER UIC N68305

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015

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MARINE CORPS INITIAL RPCs

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Marine Corps Initial Radon Potential Categories

UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
M00146	MCAS CHERRY POINT NC	279	0	3.9	3	Monitoring	
M00243	MARCORPRCUITDEP SAN DIEGO CA	10	0	1.2	3	Screening	
M00262	MCAF QUANTICO VA	0	0	N/A	2	Screening	
M00263	MCRD/BEAUFORT PI SC	197	0	1.9	3	Monitoring	
M00264	MARINE CORPS BASE QUANITCO VA	3482	39	8.9	1	Assessment	
M00318	MCB HAWAII KANEOHE	1255	1	5.6	1	Assessment	DATA INCLUDES MAIN BASE, CAMP SMITH, AND MANANA AREAS
M00526	FORMER USMCRC WYOMING PA	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC M03035
M00540	FORMER NAS SOUTH WEYMOUTH MA	0	0	N/A	N/A	Does not apply	DATA LOCATED IN UIC N00101 NAS SOUTH WEYMOUTH MA
M00681	MCB CAMP PENDLETON CA	3565	2	10.8	1	Assessment	
M01139	SITE SUPPORT - FRESNO CA (FORMER USMCRC FRESNO CA)	0	0	N/A	N/A	Does not apply	DATA MOVED TO UIC M03040 SITE SUPPORT FRESNO CA
M01199	FORMER MSMCRC JOHNSTOWN PA	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC M03045
M03029	4TH LAAD MAW	0	0	N/A	N/A	Does not apply	UIC was formerly assigned to USMCRC Pasadena CA
M03035	SITE SUPPORT WYOMING PA	49	1	9.0	1	Monitoring	FORMER USMCRC WYOMING PA UIC M00526

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015.

Marine Corps Initial Radon Potential Categories

UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
M03040	SITE SUPPORT - FRESNO CA	98	0	2.6	3	Monitoring	FORMER USMCRC FRESNO CA UIC M01139
M03045	SITE SUPPORT JOHNSTOWN PA	36	0	1.5	3	Monitoring	FORMER MSMCRC JOHNSTOWN PA UIC M01199
M14069	FORMER USMCRC LAFAYETTE LA	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC M84286
M14120	USMCRC PASADENA CA	128	0	1.9	3	Monitoring	Former UICs sampled at this installation include M03029 and M14121
M14167	FORMER USMCRC PERRYSBURG OH	60	0	3.3	3	Monitoring	
M14170	FORMER USMCRC CHICAGO IL	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC M85225 SITE SUPPORT CHICAGO IL
M14231	FORMER USMSRC BROOKPARK OH	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC M81225 SITE SUPPORT BROOK PARK OH
M14314	FORMER USMCRC PICO RIVERA CA	25	0	0.3	3	Monitoring	
M14333	USMCRC WEST TRENTON, NJ	0	0	N/A	2	Screening	
M14633	USMCRC HUNTSVILLE, AL	0	0	N/A	2	Screening	DATA LOCATED IN UIC M83185
M14703	USMCRC WINDY HILL GA	50	0	1.1	3	Monitoring	
M20810	CAMP MUJUK REPUBLIC OF KOREA	174	1	9.7	1	Monitoring	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015.

Marine Corps Initial Radon Potential Categories

UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
M21443	FORMER USMCRTC YAKIMA WA	53	0	3.6	3	Monitoring	
M21445	USMCRC TWENTY-NINE PALMS CA	56	0	0.8	3	Monitoring	UNIT PHYSICALLY LOCATED ON MCAGCC TWENTY-NINE PALMS
M21833	USMCRC JACKSONVILLE FL	54	0	0.7	3	Monitoring	
M29060	FORMER USMCRTC NEWPORT NEWS, VA	0	0	N/A	N/A	Does not apply	RADON DATA MOVED TO NEW UIC M61896 MCRC NEWPORT NEWS VA
M29062	FORMER EASTOVER, SC	40	0	1.2	3	Monitoring	
M29074	USMCRTC OMAHA NE	62	2	5.1	1	Monitoring	
M33610	FORMER MARMTNTRANCEN BRIDGEPORT, CA	0	0	N/A	2	Screening	
M38450	USMC BICMD JACKSONVILLE FL	43	0	0.5	3	Monitoring	
M45271	SITE SUPPORT FOLSOM PA	24	0	1.3	3	Monitoring	FORMER USMCRC FOLSOM PA UIC M81229
M60050	MCAS EL TORO SANTA ANA CA	185	0	3.4	N/A	Does Not Apply	Decommissioned, No Longer USMC Owned
M60169	MCAS BEAUFORT SC	2690	8	7.7	1	Assessment	
M61896	MCRC NEWPORT NEWS VA	56	0	1.2	3	Monitoring	FORMER USMCRTC NEWPORT NEWS VA UIC M29060
M62204	MCLB BARSTOW CA	1539	1	11.5	1	Monitoring	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015.

Marine Corps Initial Radon Potential Categories

UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
M62535	MCAS TUSTIN CA	2	0	1.6	2	Screening	
M62613	MCAS IWAKUNI	521	7	5.9	3	Assessment	
M62974	MCAS YUMA AZ	223	0	3.2	3	Monitoring	
M67001	MCB CAMP LEJEUNE NC	357	0	3.6	3	Monitoring	
M67004	MCLB ALBANY GA	2511	53	5.5	1	Assessment	
M67011	MARCOPS DIST 1 GARDEN CITY NY	0	0	N/A	2	Screening	
M67021	HDQTRS 4TH MAW NEW ORLEANS LA	0	0	N/A	2	Screening	
M67029	MARBKS WASHINGTON DC	7	0	1.6	3	Screening	
M67353	HQBN HQMC ARLINGTON VA	185	2	5.0	1	Assessment	
M67385	MCB HAWAII CAMP HM SMITH	0	0	N/A	N/A	Does not apply	DATA PART OF MCB HAWAII KANEOHE UIC N00318
M67386	MCSPTACT KANSAS CITY MO	0	0	N/A	2	Screening	
M67391	MARFORLANT CAMP ELMORE NORFOLK VA	2	0	1.3	2	Screening	
M67399	MCAGCC TWENTYNINE PALMS CA	563	0	3.4	3	Monitoring	
M67400	MCB CAMP SD BUTLER OKINAWA	10,211	944	79.1	1	Monitoring	DATA INCLUDES VARIOUS CAMPS
M67443	DFAS-KANSAS CITY CTR-PERS ONLY	306	42	8.7	1	Assessment	FORMER MARFINCEN KANSAS CITY MO
M67604	MCAS CAMP PENDLETON CA	0	0	N/A	N/A	Does Not Apply	PART OF MCB CAMP PENDLETON CA
M67695	MCSF BLOUNT ISLAND	18	0	0.5	2	Screening	
M67861	MARCORRESFOR NEW ORLEANS LA	0	0	N/A	2	Screening	
M67865	MCAS MIRAMAR	702	4	6.2	1	Assessment	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015.

Marine Corps Initial Radon Potential Categories

UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
M68479	HDQTRS 4TH MARDIV NEW ORLEANS	0	0	N/A	2	Screening	
M71778	FORMER USMCRTC DAYTON OH	0	0	N/A	2	Screening	
M81225	SITE SUPPORT BROOK PARK OH	46	0	1.1	3	Monitoring	FORMER UIC M14231
M81229	FORMER SITE SUPPORT FOLSOM PA	0	0	N/A	N/A	Does not apply	DATA MOVED TO NEW UIC M45271
M81247	SITE SUPPORT (DAYTON OH)	123	8	43.9	1	Monitoring	FORMER USMCRTC DAYTON OH
M82220	SITE SUPPORT BALTIMORE MD	66	0	2.3	3	Monitoring	FORMER USMCRTC BALTIMORE MD
M82221	SITE SUPPORT LYNCHBURG VA	44	0	3.5	3	Monitoring	FORMER USMCRC LYNCHBURG VA
M83185	SITE SUPPORT HUNTSVILLE AL	34	1	5.0	1	Monitoring	
M83227	SITE SUPPORT CHARLESTON, SC	33	0	2.0	3	Monitoring	FORMER USMCRC CHARLESTON SC
M83263	SITE SUPPORT MEMPHIS TN	41	0	0.5	3	Monitoring	FORMER USMCRC MEMPHIS TN
M83304	SITE SUPPORT ROME GA	27	1	5.7	1	Monitoring	FORMER USMCRC ROME GA
M84237	SITE SUPPORT TEXARKANA TX	48	1	4.0	1	Monitoring	FORMER USMCRC TEXARKANA TX
M84267	SITE SUPPORT GALVESTON TX	30	0	0.6	3	Monitoring	FORMER USMCRC GALVESTON TX
M84286	SITE SUPPORT LAFAYETTE LA	127	0	2.2	3	Monitoring	FORMER USMCRC BROUSSARD LA
M85220	SITE SUPPORT SELFRIDGE ANGB	36	1	5.7	1	Assessment	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015.

Marine Corps Initial Radon Potential Categories

UIC	UIC Name	Total Number Radon Measurements	Number of Measurements at UIC ≥ 4 pCi/L	Highest Radon Result at UIC	Radon Potential Category	Radon Testing Phase	Comments
M85225	SITE SUPPORT CHICAGO IL	42	0	1.5	3	Monitoring	
M95429	CMC HQ MARCORPS ARLINGTON VA	0	0	N/A	2	Screening	

RPC 1: Elevated radon potential exists
RPC 2: Radon potential is unknown
RPC 3: Low radon potential
If UIC is not listed, assume RPC 2 (Screening).
N/A: Not applicable
Radon data summary includes residential and nonresidential data collected from 1989 through 2015.

APPENDIX C: EXAMPLE OF RADON TESTING HANDOUT

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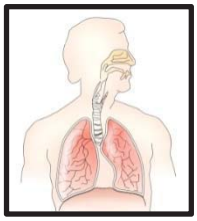
NOTE: This handout is provided as an example and can be used "as is" by simply editing the highlighted areas. However, as circumstances dictate, the handout can be modified in whole or part by the installation to meet their specific needs or replaced entirely with an installation specific handout.

What Is Radon?

Radon is a colorless, odorless, tasteless gas that is produced by the breakdown (radioactive decay) of naturally occurring uranium. Outdoors, radon is harmlessly diluted by the atmosphere. However, in enclosed places like homes and buildings, radon can accumulate to unacceptable levels.

Is There A Health Risk?

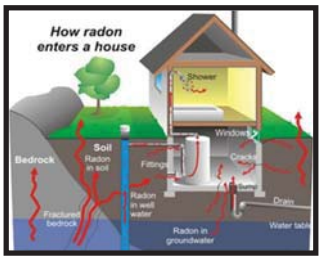


Radon gas decays into radioactive particles that can become trapped in your lungs. As these particles break down further, they release small bursts of energy that can damage lung tissue. Many years of exposure to elevated radon levels can lead to an increased risk of lung cancer.

How Common Is Radon?

The EPA has estimated that 14% of all homes in the United States have elevated levels of radon. Elevated radon has also been found in almost every country in the world as well. No area in the world is considered radon free.

How Does Radon Enter a Building?



Radon gas comes from uranium in the soil and bedrock. Wherever air and moisture seep in through drains, joints, cracks, and pores in the foundation and exterior walls, radon can enter your building. If the building shell is tight, the radon cannot escape.

Am I being Exposed to Radon?

The only way to know if elevated level radon is present is to test.

Why Is the Navy Testing For Radon?

The health of its military personnel, their dependents, and employees is a primary concern of the Navy. When various medical studies showed that radon could be a potential health risk, the Navy developed a program called the Navy Radon Assessment and Mitigation Program (NAVRAMP) to identify and manage radon at all naval installations worldwide.

How Is The Navy Going To Test?

For this radon testing project, the Navy has selected the Alpha Track Radon detector. This detector emits no noise, emits no harmful chemicals, and requires no special attention. It only needs to be left undisturbed. If the detector is moved or falls down during the test period, please return it to its original location.

How Long Will The Test Period Last?

Depending on the local climate, the test could last up to 1 year.

How Soon Will the Navy Fix the Problem?

If a problem is found, the Navy will take corrective action in accordance with NAVRAMP and published US Environmental Protection Agency (EPA) guidelines. Depending on the radon concentration, EPA recommends corrective action be taken within a few months to a few years.

What Can I Do?

Provide the Navy access to your residence or work place for testing. Leave the radon detectors undisturbed. Inform your local Environmental Office if any issues arise.

Whom Do I Call For More Information?

For more information about radon, please contact your local Environmental Office at Phone Number.

APPENDIX D: EXAMPLE OF RADON MITIGATION SYSTEM INSPECTION FORM

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New Subslab Depressurization System Inspection Form (Pg 1 of 2)

Building Number: _____ **Building Name:** _____

Date: _____ **Inspectors:** _____

General System Description

System Number: Number Suction Points:	Suction Point Locations	Room(s) System Fixes
Fan Make and Model	Fan Location Interior_____ Exterior_____ Attic_____ Roof_____	System Design Ext. (Type 1) ___ Int. w egress (Type 2) ___ Int. w/o egress (Type 3) ___
Performance Indicator Type	Performance Indicator Location	Performance Indicator Reading
Breaker/Panel Number	Switch Location	Electrical Tap Location
Comments		

Drawings/Notes

New Subslab Depressurization System Inspection Form (Pg 2 of 2)

Component	Specification	Findings	Comments
Vent Pipe	4 in, PVC, SCH 40, White	**Pass Fail**	
	Fittings and connections appear to be airtight, properly joined/sealed	**Pass Fail**	
	10 ft above grade, at least 12 in. above eave/roof and at least 10 ft from any opening to conditioned space	**Pass Fail**	
	Vent exhaust cap present	**Pass Fail**	
	Fire collar/damper present if fire rated wall is penetrated	**Pass Fail** **Not Applicable**	
	Sealing around vent pipe penetrations through slab, wall and floor is intact	**Pass Fail**	
	Pipe is strapped at least every 6 ft on horizontal runs and every 8 ft on vertical runs	**Pass Fail**	
	All exterior fasteners are stainless steel, galvanized, or corrosion resistant	**Pass Fail**	
Performance Indicator	A performance indicator is present, visible, operating and accessible.	**Pass Fail**	
	Pressure tubing is sealed and intact	**Pass Fail**	
	Instructions on how to use the indicator are present and a contact phone number is provided	**Pass Fail**	
Mitigation Fan	Mounted in a vertical section of pipe and level	**Pass Fail**	
	Fan is **not** located in or below conditioned space	**True False**	
	Vacuum within manufacturers performance range	**Pass Fail**	
	Fan not vibrating	**Pass Fail**	
Does System Meet EPA/ASTM/FTC Standards	Any negative findings above circle, No	**Yes No**	
Additional Comments			

O&M Subslab Depressurization System Inspection Form

Building Number: _____ **Building Name:** _____

Date: _____ **Inspectors:** _____

System Number: _____ **Fan Make/Model:** _____

Item	P	F	NA	Comments	Corrected
Fan Cover					
Cover Screws					
Fan Operation				Replacement Fan: _____	
Fan Boots					
Fan Mounting					
System Decals					
Vacuum Indicator				Reading: _____	
Vacuum Tubing					
Pipe					
Pipe/Wall/Slab Seals					
Pipe Clamps					
Clamp Anchors					
Roof Cap					
Flex					
Flex Connectors					
Switch Operation					
Conduit					
Conduit Clamps					
Electrical Tap Seal					
Roof Seal					

Comments:

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APPENDIX E: REFERENCE DOCUMENTS FOR GUIDEBOOK

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REFERENCE DOCUMENT FOR

NAVY RADON ASSESSMENT AND MITIGATION PROGRAM GUIDEBOOK

FOR

NAVAL SHORE INSTALLATIONS

June 6, 2015

prepared for
NAVAL FACILITIES ENGINEERING COMMAND, PACIFIC
Environmental Compliance Product Line
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ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ACH	air change per hour
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
ATD	alpha track detector
BEIR	Biological Effects of Ionizing Radiation (Committee on)
CDC	Centers for Disease Control
cfm	cubic foot per minute
cm	centimeter
CRM	continuous radon monitor
DOE	US Department of Energy
EIC	electret ion chamber
EPA	US Environmental Protection Agency
EpCi/L	equivalent picocurie per liter
ER	equilibrium ratio
ERV	energy recovery ventilation
FT	foot
GAC	granular activated carbon
h	hour
h^{-1}	per hour
HEPA	high-efficiency particulate air
HVAC	heating, ventilating, and air-conditioning
IRAA	Indoor Radon Abatement Act
L	liter
LFE	lateral field extension
MPC	Maximum Permissible Concentration
NAVFAC	Naval Facilities Engineering Command
O&M	operation and maintenance
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
pCi	picocurie
pCi/h	picocurie per hour
pCi/L	picocurie per liter
ppm	parts per million
QA/QC	quality assurance/quality control
RDP	radon decay product
RPD	relative percent difference
RRNC	radon-resistant new construction
SAM	supplemental air mitigation
SMD	submembrane depressurization
SP	shell pressurization
SSD	subslab depressurization

TSCA	Toxic Substances Control Act
USGS	US Geological Survey
WHO	World Health Organization
WL	working level

EXECUTIVE SUMMARY

Radon is a known Class 1 human carcinogen, and many studies have shown that radon exposure is the second leading cause of lung cancer deaths in the United States. Although in the early 1980s it was hypothesized that indoor elevated radon would be found only in areas high in uranium or along geological faults, data collected over the last 30 years have shown elevated radon in every state and almost every county in the United States. Although a precursor for the presence of elevated radon is some concentrations of uranium and thorium in the soil or rock formations under a building, structures with low ventilation have been found to have elevated radon in areas where uranium and thorium are at or below the detection limits of most standard radiological assessment methods. Although analytical methods exist to measure the radon surface flux and radon soil gas concentrations at a building site, the uncertainties in estimating the radon infiltration rate through the soil/building interface and its retention within the building shell bring into question the overall reliability of these methods as a prognostication tool. It is for these reasons that the Environmental Protection Agency (EPA) and US Geological Survey recommend that all buildings be tested for radon.

Although EPA protocols allow for radon measurements to be performed in as little as 48 h, it is a well-established fact that the concentration can vary significantly because of the season, episodic weather conditions, and occupant lifestyle. For these reasons, EPA recommends that a single radon test be performed for as long as possible or a multi-test strategy be employed (separate short-term tests during different seasons). If the conclusion of the testing is that elevated radon is present (currently defined as radon ≥4 pCi/L), EPA recommends that the mitigation be performed as soon as possible. EPA recommends retesting after every renovation in which changes have been made in the soil/building interface or to the shell ventilation rate. Also, in light of the fact that radon generation is permanent, and buildings change over time (e.g., use, settling, interior modifications), retesting should be performed in the future as well.

In nonresidential buildings, studies have shown significant variation in the room-to-room radon concentration. The causes for this are varied (e.g., type of forced air system, structural features, pressure imbalances) but are considered too complex and unreliable to model. For these reasons, EPA recommends testing all ground-contact rooms that are routinely occupied.

In selecting a mitigation method, techniques using active soil depressurization have proved to be the most economical and reliable over time. However, other considerations (e.g., structural, ventilation, and aesthetic) may override these considerations. Therefore, mitigation diagnostics (scientific tests that help with the selection of the most appropriate mitigation method) are recommended before selecting a mitigation method. Regardless of the mitigation method installed, periodic inspection of the system components is recommended, and retesting is recommended every 2 years to ensure that the system is still working.

In new construction, in particular at sites with known elevated radon potential (EPA Radon Zone 1, http://www.epa.gov/radon/zonemap.html), EPA recommends that radon-resistant features be incorporated into the building design. Although these features will not guarantee that elevated radon will not be present upon building completion or at some time in the future, they will (if installed properly) ensure that mitigation will be predictable, effective, and lower in cost than installing a system from scratch. However, in marginal radon potential areas (EPA Zones 2 and 3), the potential savings are not as clear.

INTRODUCTION

This document was developed in support of the Naval Facilities Engineering Command Pacific, (NAVFAC Pacific) under US Department of Energy (DOE) Proposal 2172-S515-A1 for the performance of radon technical support. DOE assigned the project to its Oak Ridge National Laboratory (ORNL) Building Technologies Research and Integration Center, managed by UT-Battelle, LLC, to assist with this agreement with NAVFAC Pacific.

This document has been designed to be used as a technical reference document for "*Navy Radon Assessment and Mitigation Program Guidebook for Naval Shore Installations*" March 4, 2015. The information contained within this document is suitable for both internal and public dissemination, and it can be used as a stand-alone document as circumstances dictate.

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1. OVERVIEW OF RADON

1.1 WHAT IS RADON

Radon is a naturally occurring, odorless, colorless, radioactive gas caused by the breakdown of uranium (Fig. 1). Because uranium is a common substituent found in soil and rock matrixes throughout the world (on average about 3 g of natural uranium per ton), detectable quantities of radon can be measured everywhere. However, within certain rock formations (limestone, granite, shale, phosphate, and pitchblende), higher levels of uranium and its decay product radon are present. When radon is generated, it immediately begins diffusing toward the surface. In the outdoors, radon rarely reaches concentrations of concern; however, within enclosed spaces, such as buildings, radon can accumulate to levels in excess of federally mandated exposure limits for radiation workers (CFR 29 1910.1096[b]). Because these geological formations are fairly common within the United States and worldwide, measurable quantities of radon have been detected and reported in all 50 states and in most countries as well. In fact, the US Environmental Protection Agency (EPA) has estimated that 1 in every 15 homes has elevated radon levels (EPA September 1994, *A Citizen's Guide to Radon*, Fourth Edition). Because of the prevalence of indoor elevated radon, radon exposure represents over half of the average annual radiation exposure for the typical US citizen (Fig. 2) and most people worldwide (WHO 2009). Currently the EPA has set an action level of any result ≥4 pCi/L (EPA May 2012, EPA 402-K-12-002).

1.1.1 The Isotopes of Radon

There are 33 known isotopes of radon; however only 2 [radon-220 (^{220}Rn) and radon-222 (^{222}Rn) are typically found indoors. Radon-220, typically called thoron, comes from the thorium-232 (^{232}Th) decay chain and is also a common substituent found in soil and rock matrixes throughout the world. However, because of its short half-life (55.6 seconds) its diffusion potential through soil and rock is limited; and if it is found indoors at any appreciable concentration, it is usually linked to a source inside the building (e.g., water supply or building material). The other isotope, ^{222}Rn which is part of the uranium-238 decay chain (Fig. 1) has a radioactive half-life of 3.82 days, which does allow it sufficient time to diffuse from its matrix and come in contact with building components that contact the soil. For this reason, ^{222}Rn is considered the primary isotope responsible for the radiation dose throughout the world (WHO 2009).

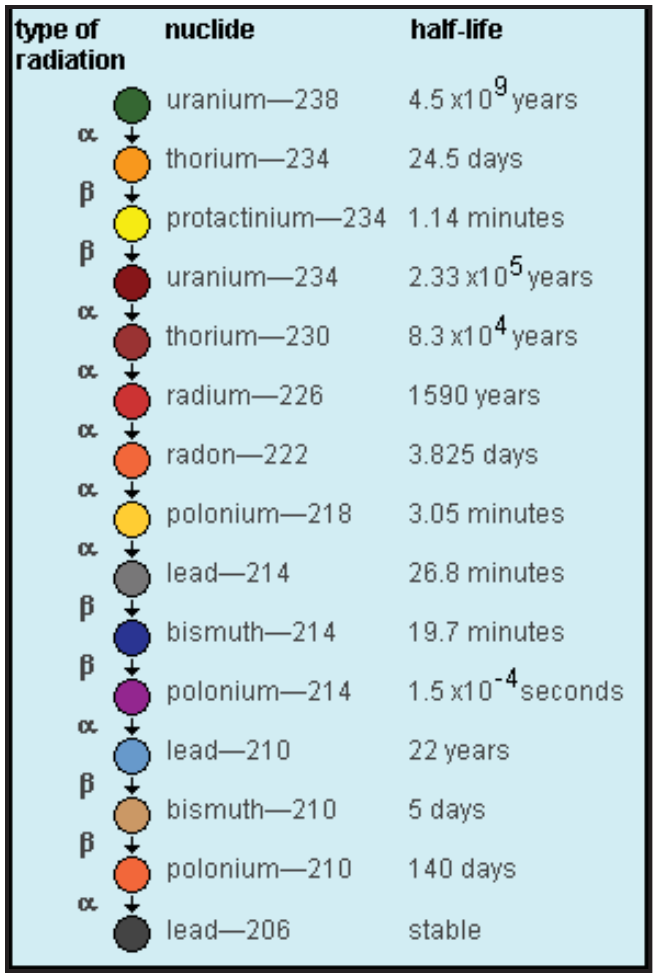


Fig. 1. The uranium decay series.

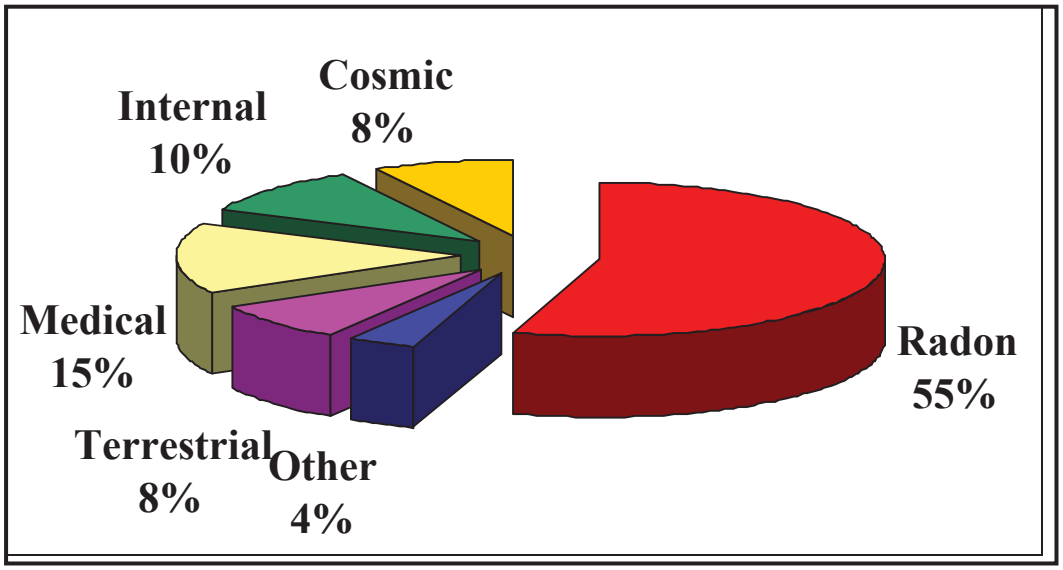


Fig. 2. Sources of radiation exposure for the average US citizen.

1.2 RADON AND GEOLOGY

In 1995, the US Geological Survey (USGS) in cooperation with EPA published a series of reports (USGS 1993, Open File Reports 93-292-A through K) that generalized radon potential within specific EPA regions. The evaluation and conclusions were based upon available USGS geological data and soil survey data collected by the Soil Conservation Service and included radon data collected by EPA during the 1986–1987 national residential radon survey. Practically speaking, one would expect that a precursor for elevated radon would be the presence of appreciable amounts of surface uranium concentrations (Fig. 3). Although the correlation was good between high indoor radon levels and significant levels of uranium and thorium in the soil, it was noted that similar levels of radon were also found in areas of the country with only trace levels of these elements. In addition, some areas that were known radiological "hot spots" exhibited a significantly lower than expected percentage of buildings with elevated radon. After further review and study, the conclusion was reached that the geologic radon potential was only part of predicting radon levels in a particular area. Factors such as the type and state of the geological formation (e.g., solid, layered, or fractured); local building codes; soil moisture content, depth, and permeability; and weather all played a contributing role. Therefore, in 1993, the EPA and USGS included with the release of the radon potential map a disclaimer that the map should not be used as an indicator whether to test and recommended that all homes and buildings be tested regardless of geographic location.

1.2.1 National Radon Potential Map

In the early 1980s, little was understood about the mechanisms of radon transport and its retention inside buildings. The key assumption made at that time was that for a building to have an indoor radon problem, a significant uranium source needed to be close at hand. It was therefore postulated that a radiological potential map showing uranium deposits would greatly assist in identifying areas of the United States that would require radon testing. Limited studies conducted in Colorado and Pennsylvania in the mid-1980s tended to support this hypothesis. However, these studies were performed mostly in areas with high levels of uranium covered with moderately to highly permeable soils. Because of this assumed correlation between geology and radon potential, the Indoor Radon Abatement Act (IRAA) of 1988 (Public Law 100-551a and b, Sections 307 and 309) directed the EPA to identify areas of the United States and its territories that have the potential to produce harmful levels of indoor radon. These characterizations were to be based on both geological data and indoor radon levels in homes and other structures. To assist with the geological requirements of the law, EPA entered into an Interagency Agreement with the USGS. From 1989 through 1992, EPA and USGS reviewed existing radiological maps, performed radon and geological surveys, and summarized all available radon data sets. The culmination of this effort was the publication in 1993 of the first EPA Map of Radon Zones (a more recent updated edition of the map is shown in Fig. 4 and can be downloaded at http://www.epa.gov/radon/zonemap.html). On the radon map, each county was placed into one of 3 categories:

- Zone 1 High Potential (red): counties that have a predicted average indoor radon concentration >4 picocuries per liter (pCi/L).
- Zone 2 Moderate Potential (orange): counties that have a predicted average indoor radon concentration between 2 and 4 pCi/L.
- Zone 3 Low Potential (yellow): counties that have a predicted average indoor radon concentration <2 pCi/L.

A common misunderstanding by the public and others in interpreting the map was the use of the word "average," which brought into question the need to test buildings in Zone 2 and 3 counties. Later, EPA clarified the meaning of "average" to mean that if all the homes in this county were tested, the average results of all the homes tested would be expected to fall within those ranges. In addition, EPA stated that some homes in Zone 2 and 3 counties would test >4 pCi/L, and **the only way to know the radon level of a particular building is to test it.**

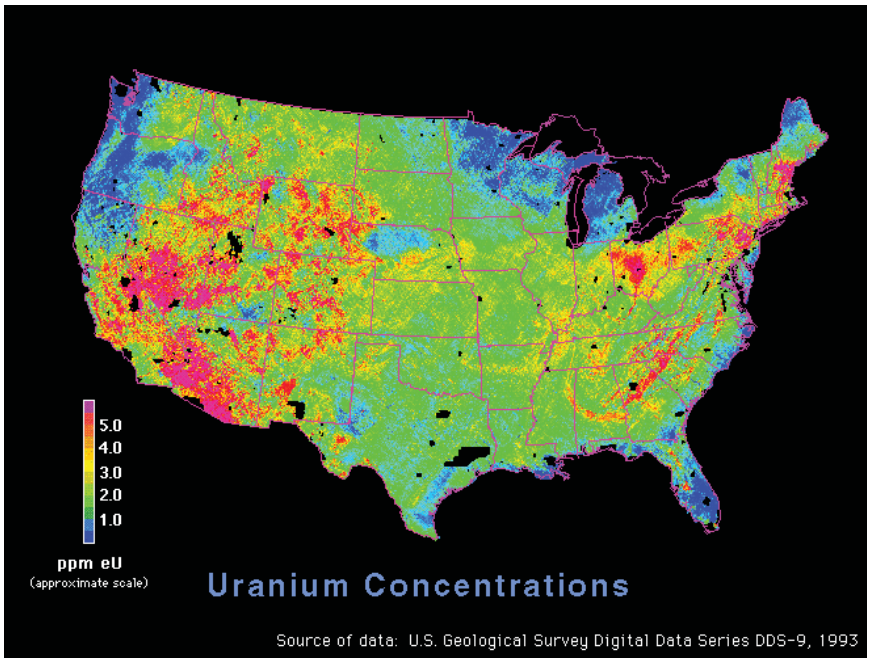


Fig. 3. Uranium concentrations within the United States.

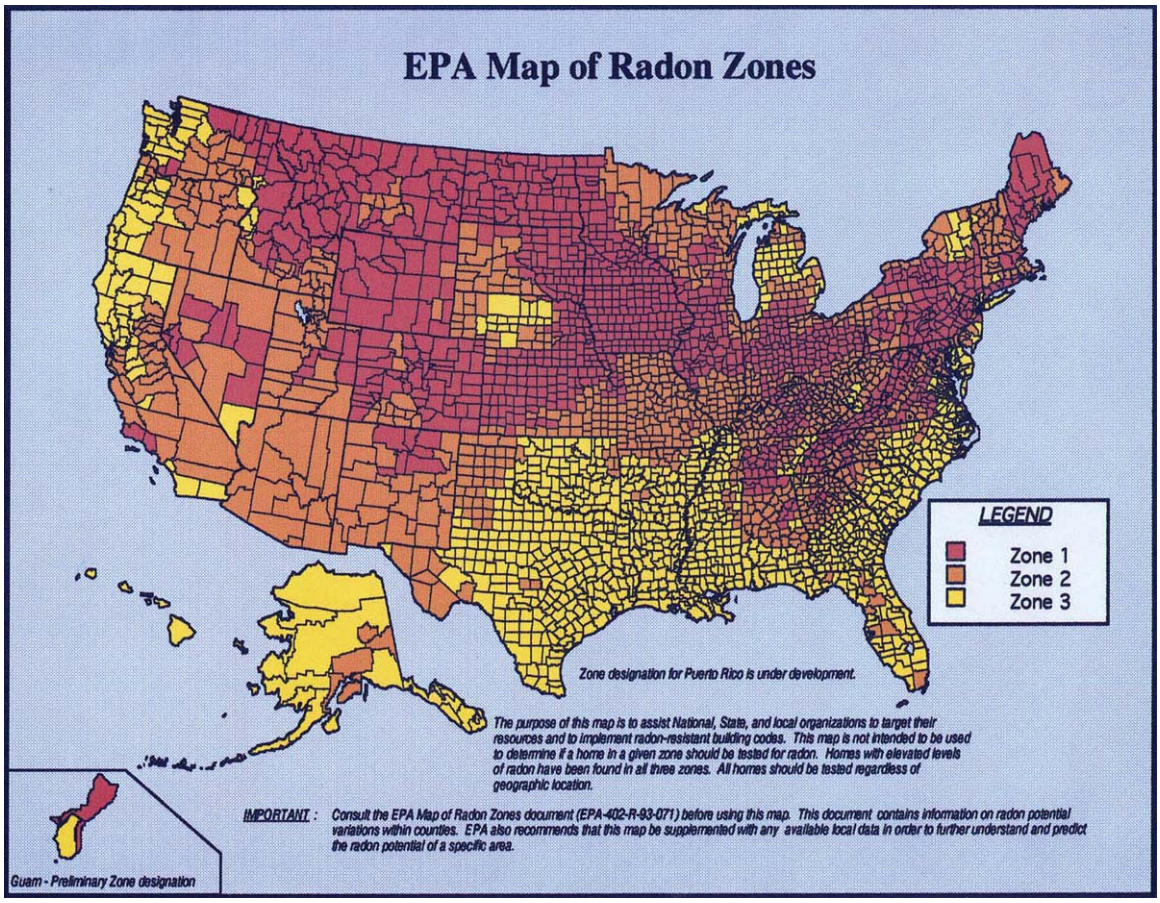


Fig. 4. United States radon potential map.

1.2.2 Radon Emanation within Rock and Soil

Radon is a naturally occurring, odorless, colorless, radioactive gas caused by the breakdown of uranium. In nature, uranium is found in varying amounts throughout the earth's crust, primarily in the mineral form of tyuyamunite [$Ca(UO_2)_2(VO_4)_2 \cdot 6(H_2O)$]. However, certain rock formations—primarily light-colored volcanic rocks, granites, dark shales, sedimentary rocks that contain phosphate, and metamorphic rocks derived from these rocks—contain higher than average uranium content [e.g., >3 parts per million (ppm) of natural uranium per ton]. Because soil is essentially weathered rock mixed with organic matter, tyuyamunite is also found in soil at the same concentration as in the rock from which the soil was derived.

Because radon is a gas, it has much greater mobility than uranium and radium, which are fixed in the solid matrix of rocks and soils. However, for radon to be a concern, it has to migrate (diffuse or flow) from the rock or soil and become entrapped within a building. The term "radon emanation efficiency" refers to the overall ease with which radon moves from its natural matrix into the environment by a diffusion and/or flow mechanism. This efficiency is dependent upon the density of the matrix, the degree of fracture, the size of the pore spaces between the grains, and the moisture content. In addition, the efficiency

is time-sensitive, because the most common isotope of indoor radon (^{222}Rn) has a relatively short half-life of 3.8 days. Therefore, in most cases, if radon is going to make a measurable contribution to the indoor levels, it must escape from the matrix and enter the building within fewer than five half-lives (USGS 1988, *Relationships Between Geology, Equivalent Uranium Concentration, and Radon in Soil Gas, Fairfax County, Virginia*). If radon is generated within a dense rock with minimal pore sizes, at most it could migrate only a few centimeters (Tanner 1964). Therefore, in this type of rock, only radon generated within the top few centimeters of the surface could escape and potentially migrate into a building. Conversely, if the rock has a low density and a large pore size and is fractured, the migration of radon can be on the order of hundreds or thousands of feet (Akerblom 1984; Sextro 1987).

Regardless of the primary source of radon (e.g., rock or soil grain), before radon can enter a building, it usually must past through a layer of soil. The method (e.g., flow or diffusion) and speed of radon movement through soils are controlled by the amount of water present in the pore space (the soil moisture content), the percentage of pore space in the soil (the porosity), and the interconnectedness of the pore spaces, which determines the soil's ability to transmit water and air (Otton et al. 1993). The term "soil permeability" refers to the overall air flow characteristics of a particular soil and is an indicator of the relative ease with which radon moves from its natural matrix into the environment by a diffusion and/or flow mechanism. As with radon transport through rock, extremely dense, nonporous soils (e.g., low-permeability soils, <1.5 cm/h) can significantly reduce the amount of radon available for incorporation into a building. Likewise, if radon is able to move easily in the pore space (e.g., high-permeability soils, >15 cm/h), then it can travel a greater distance before it decays, and it is more likely to collect in high concentrations inside a building (Nagada 1994; Otton et al. 1993).

In summary, the presence of high levels of uranium in the soil and/or rock is not the sole precursor of elevated indoor radon potential. Radon must first emanate from the rock or soil grain and find a pathway through the soil to the building. In dense rock and nonporous compacted soils, the reservoir of radon available for transport into a building can be limited to just the first few inches of rock and/or soil under a building. However, in high-emanation-efficiency rock and/or soil matrixes in contact with a permeable soil, even negligible levels of uranium can produce a high soil gas concentration.

1.2.3 Geological Features that Enhance Radon Transport

In addition, certain geological features, such as karst topography, have demonstrated the capacity for seasonal variation (Gammage et al. 1992). "Karst" is a term used to describe a topography in which surface water or groundwater has dissolved sedimentary rock such as limestone. The result of the erosion is a subterranean network of shafts, tunnels, cavities, and caves (Mammoth Cave in Kentucky is a good example). Also, in most cases, the shafts, tunnels, and cavities connect to the surface (Fig. 5). In solid rock, radon can at most diffuse a few centimeters (Tanner 1964). Therefore, for all practical purposes, radon availability is limited to the surface of the rock. However, a karst network greatly increases the surface area of a given formation, resulting in much greater emanation efficiency. The network of caves, tunnels, and shafts then serve as a means to

both concentrate the radon and transport it from considerable depths to the surface. Another characteristic of karst networks is that they breathe: whenever the ambient outdoor temperature is different from the ground temperature, the network will exhaust air or draw it in. The driving force is simply that warm air rises and cool air sinks. In flat karst areas, winter levels of indoor radon average 2–3 times those observed in the summer months. However, in cases in which a karst network is inside a hill, ridge, or mountain, the effect is even more enhanced by the stack or chimney effect. For example, a building built on the top of a hill connected to a karst network will see an order-of-magnitude increase in indoor radon concentration in the winter. Those located at the bottom of the hill will have a similar order-of-magnitude increase, but only in the summer months. Other geological types with similar features include lava tubes, layered basalts and volcanic tuff, weathered granite, and coquina.

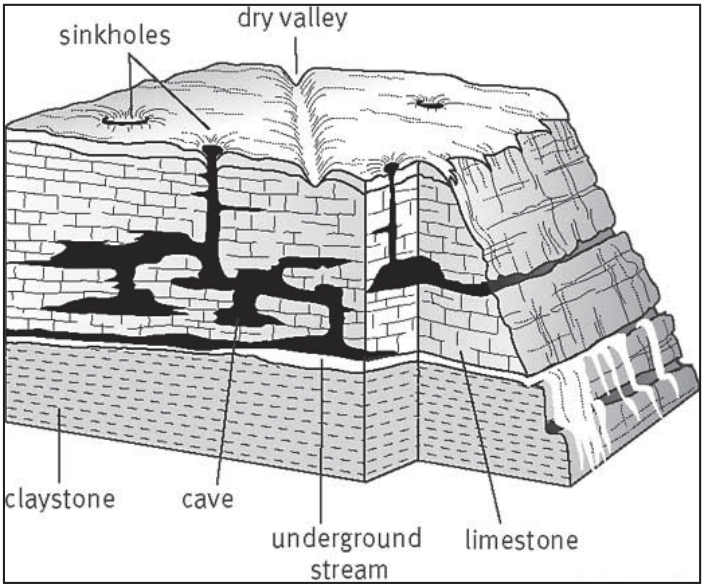


Fig. 5. Typical features found in karst topography.

Another example of a geological feature that causes seasonal variation and higher than expected indoor radon levels is sheared fault zones (common in the Appalachian region of the eastern United States). Like karst, these faults result in higher radon emanation from the uranium-bearing formation (rocks with cracks have more surface area than solid rocks) and allow the radon to migrate from considerable depths (upward of 1,000 ft.) and distances (several miles).

In soils, certain types of glacial deposits also enhance the indoor radon concentrations. Many areas of the United States underlain by soils derived from continental glacial deposits generate elevated indoor radon levels (>4 pCi/L). For example, Iowa (71%), North Dakota (63%), and Minnesota (46%) have some of the highest percentages of homes with elevated indoor radon levels in the State/EPA Residential Radon Survey. Determining the radon potential of glaciated areas is complicated by several problems:

1. Surface radioactivity is generally uncharacteristically low in glaciated areas and does not appear to correlate well with indoor radon values.
2. Because glaciers redistribute the bedrock they override and entrain, the composition and physical properties of till soils do not necessarily reflect those of the underlying bedrock (transport distances were much further for the continental glaciers of the Great Plains and Great Lakes regions than for glaciers in New England or for valley glaciers.
3. Where glacial cover is thin, the radon potential may be a complex product of the glacial cover and the underlying bedrock. Crushing and grinding of rocks by glaciers increases the mobility of uranium and radium in the resulting tills, allowing them to move readily downward through the soil profile with other mobile ions as the soils are leached.

Because of these day-to-day and seasonal variations, the Committee on Biological Effects of Ionizing Radiation (BEIR) VI (BEIR VI 1998) conceded that although all exposure to radon increases the risk of contracting lung cancer, the need for corrective action should be based on an integrated 1 year average, not on short-term excursions.

1.3 HOW RADON ENTERS A BUILDING

Radon, a gas at ambient temperatures and pressures, migrates from the surrounding soil into buildings through cracks in concrete slabs and basement foundation blocks, through pores in concrete masonry units, and through air spaces around pipes (ASHRAE 2010, *Indoor Air Quality Guide*). It can also collect in crawlspaces and then flow into living and work areas. The flow of radon into the living area of a building is caused by both natural diffusion and pressure-assisted flow. However, natural diffusion usually contributes only a small amount of radon within a building; in most cases, radon above ambient levels can be attributed to pressure-assisted flow.

The process of pressure-assisted flow can be either natural or man-made. The rising and exiting of warm air within a building causes natural pressure-assisted flow, or thermal stack effect. As warm air rises, makeup air is pulled into the building through slab and wall imperfections. If the imperfections are in contact with soil, the building radon concentration increases. Man-made enhancement of radon entry is primarily the result of negative pressure created by the operation of a furnace, air-conditioning system, ventilation fan, or air exhaust system.

The physics of radon transport and retention in a building are very complex. The radon source term is the total quantity of radon entering the structure per unit of time (pCi/h). Studies by EPA and DOE have identified more than ten variables that contribute to the source term (e.g., radium content of the soil, emanation efficiency of the soil matrix, soil permeability, soil water content, various temperatures, and shell and subslab pressures). After radon has entered a structure, many other variables either enhance or dilute it. The term relative air change) refers to the rate at which outdoor air infiltrates into the building shell and inside air is exhausted (for both natural and man-made causes). Generally

speaking, if the radon source term is greater than the relative air change, then elevated radon will result. Because of these variables, there is no certain way to predict the radon level of a particular building. The only sure way to know if a room/building has elevated indoor radon levels is to test.

1.3.1 Indoor Radon Retention

Although radon diffusing through and, in rare cases, from concrete (e.g., wall, floors, piers, beams) can contribute to the indoor radon level, the main driving force for most buildings is the pressure differential caused by the stack effect (the rising and escape of warm air in a building through the upper floors) and the negative pressures caused by the operation of mechanical exhaust systems within a building (e.g., bathroom exhausts, fume hoods, combustion furnaces). In addition, episodic weather conditions, such as wind and rain, can induce a pressure differential that results in transient increases in the building radon level.

Although the physics of radon transport into and retention in a building are complex (more than ten variables have been identified to date), it can be approximated as a simple dilution ventilation problem using a source term (pCi/h) into a fixed volume (ft^2), with a known ventilation rate (h^{-1}). Because the volume of a structure is fixed, the equation can be further simplified to demonstrate that elevated radon in a building is strongly linked to the overall ventilation rate of the building, meaning that buildings with high ventilation rates have lower elevated radon potential. Conversely, buildings with lower ventilation rates have higher elevated radon potential. However, the relationship between ventilation rate and radon concentration is not 1 to 1; at a constant source term, halving the ventilation rate doubles the radon concentration (EPA 1988a, *Radon Reduction Techniques for Detached Housing*, EPA 1988a, 625/5-87/017). This variable, air-change per hour (ACH), is a function of how tightly the building was constructed and is regulated by the requirements of local building and energy codes. Nationally, the ACH ranges for residential and nonresidential construction are from 0.25 h^{-1} in colder (e.g., Minnesota) or hot and humid (e.g., Florida) climates to over 1.5 h^{-1} in the temperate tropical areas (e.g., Hawaii). The significance of the relationship between indoor radon levels and a building's ACH is as follows. Assume for a source term that you have 500 pCi/L of soil gas (average for most parts of the United States) under a slab that results in a 2 pCi/L radon level (the approximate indoor national average) for a house with an ACH of 1 h^{-1} (typical for homes built in Hawaii). The same home in Tennessee, under identical conditions but with a typical ACH of 0.5 h^{-1}, would have a radon level of 4 pCi/L. However, if the home were located in the upper Midwest, with a typical ACH of 0.25 h^{-1}, the home would have 8 pCi/L. Therefore, when considering elevated indoor radon potential, in addition to the geological variables found in soil and rock, local building practices must be taken into account.

As can be seen in Fig. 6, a rain event that lasted only a few hours resulted in an order-of-magnitude increase in the radon concentration. The time required for the dissipation of such a radon spike depends mostly upon the ventilation rate of the building. For example, if the building has an air change rate of 0.5 h^{-1}, the spike would usually

dissipate within 6 h (assume in this example that three air volumes are required to remove a gas pollutant). However, in some cases (e.g., buildings with tight envelopes or buildings with fresh-air makeup greatly reduced), the radon spike may require days or even weeks to fully dissipate. As a result, the integrated concentration in the room over time would vary significantly depending upon the frequency (how often) and quantity (how much) of rainfall within a certain time period.

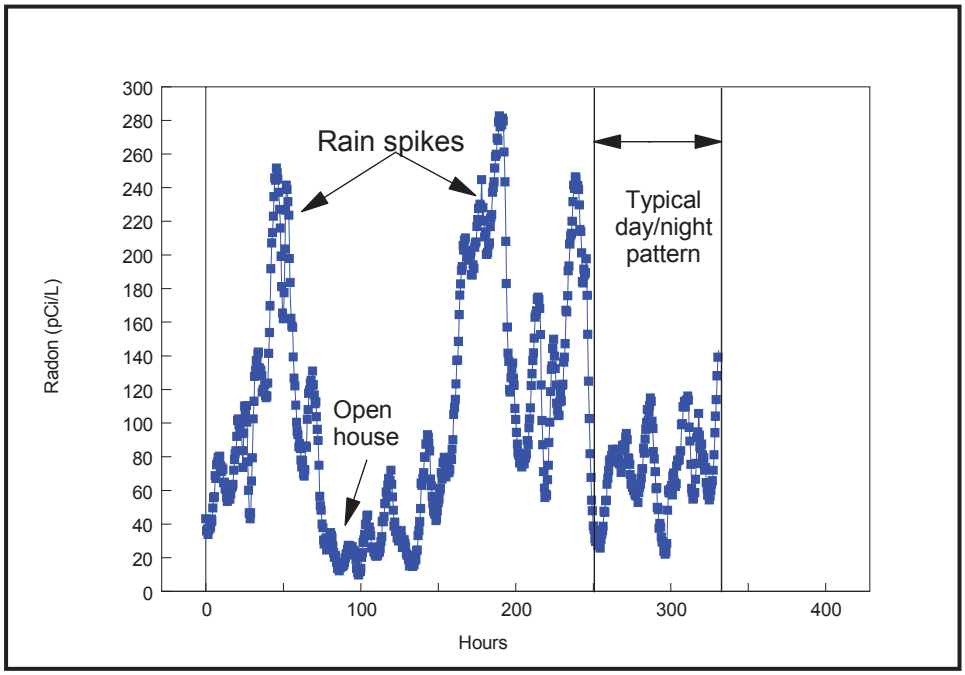


Fig. 6. Example of short-duration events on radon concentration.

1.3.2 Episodic Events that Impact Indoor Radon Levels

Unlike other common indoor environmental concerns (e.g., lead-based paint and asbestos), indoor radon concentration can vary significantly from day to day and from season to season. The day-to-day variation in radon concentration is usually caused by episodic weather events such as rain and wind but can also be caused by actions of the building occupants (e.g., leaving doors or windows open; see Fig. 6). For these reasons, EPA recommends that all short-term testing (testing for <90 days) be performed during normal weather patterns and under closed building conditions (e.g., windows and doors are closed except for routine entrances and exits). With respect to seasonal variation (e.g., heating vs. cooling season), the range observed is dependent upon the geographical region and climate. For example, in the northeastern United States, radon concentrations are typically 50% higher than normal in the winter, vs. 25% higher in the Southeast. Other studies (Lin et al. 1999) have found that a single short-term measurement is typically within a factor of 1.8 of the long-term measurement. Opinions vary as to why this is observed (e.g., increased stack effect in the winter, prolonged periods of closed building conditions, ground freeze, and snow cover), but most experts agree it results from a combination of many things and not just a single cause.

1.3.3 Distribution of Radon within Nonresidential Buildings

Residential studies by EPA have shown that on the same level, the radon concentration does not vary significantly from room to room in most homes. It is for these reasons that, other than recommending that the test be performed on the lowest occupied level, EPA protocols do not specify which rooms to test (EPA May 1993, 402-R-92-003). However, unlike in residential buildings, the distribution of radon within nonresidential buildings does vary significantly from room to room. In fact, studies by DOE have found that for buildings >2000 ft^2 with elevated radon, over 95% of the time, only one in four rooms tested positive (Wilson et al. 1991b). With respect to using statistical means to estimate the extent of elevated radon potential in large buildings, statistical analysis of large nonresidential data sets (Wilson et al. 1991b.) has found that over 70% of the time, the elevated result(s) would not have been predicted at a 95% confidence level. Further modeling of the radon data, the objective of which was to predict the presence of one room with elevated radon in a building, found with 95% confidence that 95% of the rooms needed to be tested. It is for all these reasons that EPA recommends the testing of all occupied ground-contact rooms in its nonresidential testing protocol (EPA July 1993, 402-R-92-014).

There are many accepted reasons for this disparity in room-to-room concentration. For one, slabs in nonresidential buildings are larger, meaning a greater volume of radon can accumulate in the fill area under the slab. In addition because of higher load considerations, large buildings typically have more internal footings and expansion joints per unit area of slab than does residential construction. Also, large buildings tend to have more numerous floor penetrations for water, sanitary, electrical, and communications purposes. Another difference is interior design: to prevent the spread of smoke during a fire, floor-to-ceiling fire walls are typically used throughout a large building. This design feature tends to isolate rooms and areas from one another within the building by reducing the natural flow of air from one zone to another. Finally, large buildings have larger mechanical systems, which move significant volumes of air. If these systems are not balanced, certain areas of the building may become depressurized relative to the soil beneath it. If openings are present within the slab in those rooms, the concentration of radon soil gas entering those rooms will increase significantly. In fact, DOE studies have found that in nonresidential buildings with elevated radon, only about one-third of the higher radon concentration is directly attributed to the elevated radon. Another third was attributed to a combination of mechanical and building design features.

In summary, the distribution of room-to-room radon concentrations in large buildings is different from the distribution in residential buildings simply because the buildings are designed and conditioned differently. For that reason, all occupied, ground-contact rooms need to be tested to determine if the occupant is at risk.

1.3.4 Surface Radon Potential and Indoor Radon Levels

In the late 1980s and 1990s, USGS, EPA, and DOE expended considerable effort in attempting to correlate radon soil gas concentrations and indoor radon levels (Tanner 1986 and 1992). The primary hypothesis of these studies was that if the radon flux at the surface could be measured accurately, the number of homes in a given area with elevated radon could be estimated. If true, this correlation would assist state and local governments in coordinating their respective radon programs and determining if radon-resistant features in new construction were needed. Unfortunately, during these studies, many variables at the surface/building interface were identified which proved difficult to estimate in advance (e.g., estimating the total leakage surface area of the slab for all cracks, joints, and plumbing fixture openings). In addition, order-of-magnitude changes in the radon soil gas concentration were observed at some of the sites because of variations in microgeology. Estimating a building's shell natural ventilation rate and the stack effect of the structure proved difficult as well. In light of all these uncertainties, EPA concluded that radon surface flux or soil gas measurements at a given location did not provide sufficient assurance whether indoor elevated radon would be present. In addition, the costs of such measurements were orders of magnitude higher than simply incorporating radon-resistant features into new construction and testing afterward.

1.3.5 Radon from Building Materials

The precursors for radon—uranium, radium, and thorium—are found naturally in all geological formations. Therefore, in any building where concrete (processed limestone) or decorative stone (e.g., marble, granite, shale) is present, radon is being emitted. In the case of concrete, in the 1970s, homes located in Durango and Grand Junction, Colorado, were found to contain high levels of radon in addition to high radiation levels. The source of the radon and radiation was later determined to be processed uranium mill tail sand that had been used as aggregate in the concrete and cement block in the homes. In response to the health hazards posed by this exposure, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978. This Act established two programs to protect the public and the environment from uranium mill tailings and prohibited the use of uranium mill tailing sands in building construction. In the 1980s similar problems with radon and elevated radiation were also found in the southeastern United States, where processed phosphate slag had also been used as an aggregate within concrete and cement block manufacturing. A series of environmental regulations were then enacted which prohibited the use of these materials in building construction as well.

For concrete that came from gypsum, fly ash, and limestone, studies by EPA in the late 1980s found minimal contribution to the indoor radon level. With respect to decorative stone, a series of news articles in 2008 indicated that high levels of indoor radon were linked to granite countertops. Studies by the decorative stone and radon industry and by EPA concluded that this claim was false for almost all granites on the commercial market.

More recently, however, the issue of elevated indoor radon linked to building materials has emerged within buildings that have had significant weatherization upgrades or in new construction with high energy-efficiency ratings. The common denominator in all cases observed thus far has been extremely low ventilation rates (<0.1 h^{-1}) within buildings made of concrete (floor, walls, and ceilings). Although the emanation rate of radon from the concrete was found to be low (buildings at the same site made from the same concrete but without weatherization upgrades tested extremely low for radon), the low ventilation rate allowed the radon to concentrate (empirically speaking, if you halve the air change rate, you double the radon concentration). These findings, although rare (>99% of all elevated indoor radon is directly linked to radon soil gas), are predicted to become more common in the future as building codes require tighter buildings to address climate change concerns.

Another example of elevated radon levels from nontraditional sources is cases in which radon is emanating from materials stored within the building. For example, a storage facility containing approximately 1,000 tons of river sand (radon activity 0.07 pCi/g) gave rise to 8.5 pCi/L within the occupied areas of the building. Another facility that warehoused thorium lantern mantels was found to have elevated radon levels as well. Although these cases were extremely rare, the cause—substandard ventilation—was the same.

1.3.6 Radon from Groundwater Sources

The ^{222}Rn concentration in groundwater is due to the decay of ^{226}Ra contained within the rock and soil surrounding the aquifer. As radon gas is generated, it diffuses through the soil and rock and then percolates through the water. Because radon is soluble in water (230 cm^3/kg at 20°C), it can concentrate to levels much higher than that of the dissolved ^{226}Ra. Release of the radon into the indoor environment occurs at point sources wherever the water is used (showers, sinks, clothes washers) and from hot water heaters. According to EPA, approximately 10,000 pCi/L of radon in water is needed to increase the indoor radon level by 1 pCi/L. Because the average waterborne radon level in public groundwater supplies is 353 pCi/L (EPA 1985, 520/5-85-008), radon in water is not considered a major contributor to airborne radon exposure. However, according to the Centers for Disease Control (CDC), 30 to 1,800 deaths per year are attributed to the ingestion of radon in water. Because of these health concerns, Congress included radon in the 1996 Amendments to the Safe Water Drinking Water Act. To address this concern, EPA made available a multimedia mitigation program to address radon risks in indoor air and from drinking water. This option affords states the opportunity to develop enhanced state programs to address the health risks from radon in indoor air, while individual water systems reduce radon levels in drinking water to 4,000 pCi/L or lower. Currently, EPA is encouraging states and sister agencies to adopt this option because it is the most cost-effective way to achieve the greatest radon risk reduction.

1.4 RADON EXPOSURE RISKS

For many years, radon was not considered a health problem in residential buildings; however, in 1984, private homes in the Reading Prong area of Pennsylvania were discovered to have levels of radon in excess of federally mandated exposure limits for radiation workers. Nero et al. (1986) estimated that about one million American homes have radon levels in excess of 8 pCi/L. In 1988, studies by the National Research Council and BEIR found that excessive exposure to radon progeny resulted in a higher-than-predicted number of deaths from lung cancer in mining populations (BEIR VI 1988). Based on this and other information, the EPA estimated that from 5,000 to 20,000 lung cancer deaths per year are attributable to radon exposure (EPA 1986, *A Citizen's Guide To Radon*, OPA-86-004). In 1996 the World Health Organization (WHO) acknowledged that worldwide, radon exposure was the second leading cause of lung cancer, behind smoking (WHO April 1993). More recently, BEIR VI (1999) reinvestigated the health risks associated with radon exposure. Using information from previous studies and supplementing it with information from more recent laboratory studies, the committee estimated that approximately 11,000 lung cancer deaths per year were attributable to exposure to radon (BEIR VI 1998). These mortality estimates make exposure to radon the second-leading cause of lung cancer, behind smoking. However, statistically speaking, an individual's lifetime risk of dying from radon lies between the risks of being killed by a drunk driver and drowning (Fig. 7). Individual relative risk from radon exposure is summarized in Table 1. These findings were borne out by other studies noted by WHO in 2009 (WHO 2009). However, corrective actions (i.e. mitigation, see Chapter 3) greatly reduce these lifetime lung cancer risks (EPA May 2012, EPA 402/K-12/002).

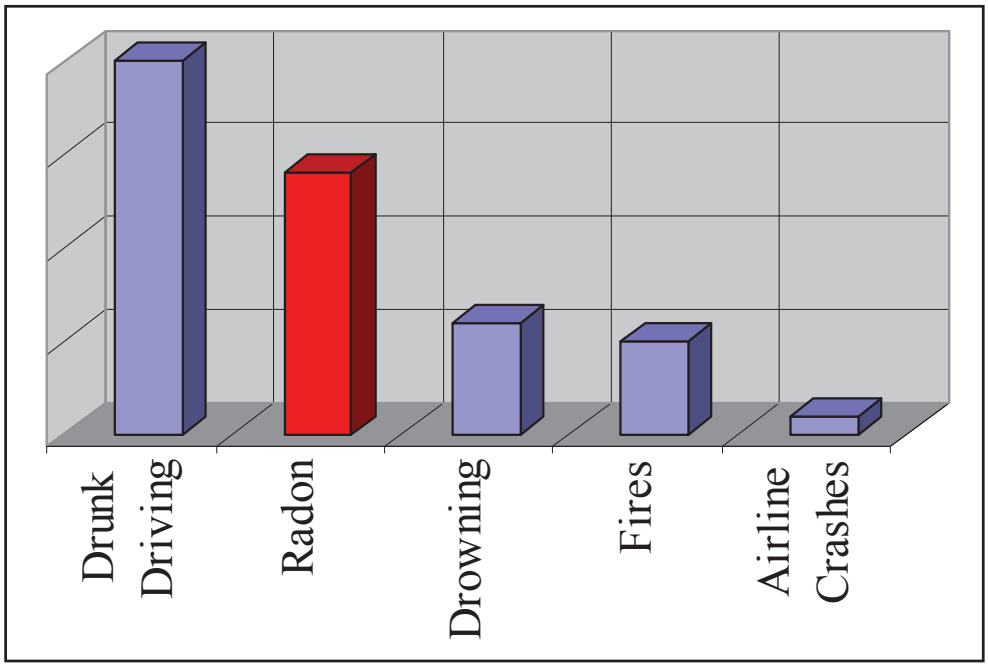


Fig. 7. Lifetime relative risks to radon exposure.

Table 1. Lifetime radon exposure risk

Radon level (pCi/L)	Number of lung cancer deaths per year per 1000 people	Comparable risks
200	440–770	More than 60 times the lung cancer risks of nonsmokers
		Four packs/day smoker
100	270–630	
		20,000 chest x-rays per year
40	120–380	
		Two pack/day smoker
20	60–120	
		One pack/day smoker
10	30–120	
		Five times non-smoker risks
4	13–50	
		200 chest x-rays per year
2	7–30	
		Nonsmoker risk of lung cancer
1	3–13	
0.2	1–3	20 chest x-rays per year

Source: EPA, *A Citizen's Guide to Radon,* OPA-86-004, 1986.

1.4.1 Impact of Radon Exposure on Lung Tissue

The subsequent radioactive decay products of ^{222}Rn, more commonly referred to as radon progeny, consist of four short-lived radon progeny (polonium-218 [^{218}Po], lead-214 [^{214}Pb], bismuth-214 [^{214}Bi], and polonium-214 [^{214}Po]) (Fig. 1)] and three long-lived radon progeny (lead-210 [^{210}Pb], bismuth-210 [^{210}Bi], and polonium-210 [^{210}Po]). Of these seven, typically only the short-lived progeny are considered a health risk. Unlike radon, which is chemically inert, radon progeny are chemically reactive metals that can attach to walls, floors, and airborne particles or combine with water vapor and other gases in the air. The portion of the radon progeny attached to particles in the ambient atmosphere is called the "attached fraction," whereas "unattached fraction" refers to suspended individual atoms or ultrafine particle clusters. Radon progeny that attach to walls or other surfaces are considered to be "plated out" and therefore removed from the

air, so they can no longer be inhaled. When the short-lived radon progeny (attached or unattached) are inhaled, a portion of them can attach to the lining on the bronchioles of the lungs. Because of their short half-lives, the lung cannot clear itself of these materials before they undergo radioactive decay. Of particular importance are ^{218}Po and ^{214}Po, which emit highly energetic alpha particles. These alpha particles can strike sensitive cells in the bronchial tissue and cause damage that could lead to lung cancer. It is these two polonium radionuclides that produce the bulk of the radiation dose to the lung and create the greatest source of risk of lung cancer from exposure to radon and radon progeny (EPA May 1992, 400-R-92-011; EPA 1993a, 402-K-93-008). Additional information about the health risk associated with attached and unattached progeny is also provided in Section 2.1.2.

1.4.2 Radon-related Lung Cancer vs. Other Types of Cancer

Compared with other types of cancer, the National Cancer Institute's 2010 Surveillance, Epidemiology, and End Results study identified deaths from lung cancer due to radon as number 3, just behind deaths from leukemia and lymphoma (Fig. 8.). A copy of the study is available at http://seer.cancer.gov/csr/1975_2007/results_single/sect_01_table.01.pdf . Additional information can be obtained at http://www.cancer.gov/.

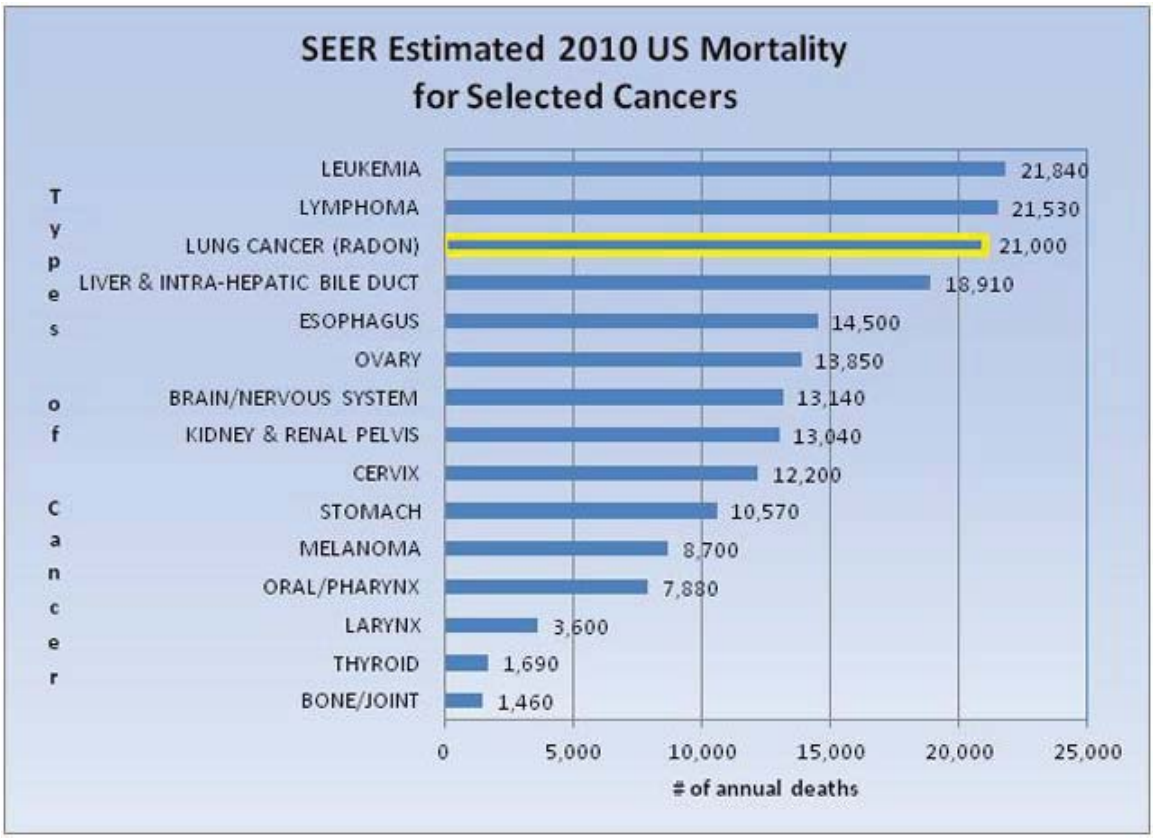


Fig. 8. Surveillance, Epidemiology, and End Results (SEER) 2010 findings.

1.5 EPA CORRECTIVE ACTION GUIDELINES

In 1986 EPA published the first of five subsequent editions of *A Citizen's Guide to Radon* (EPA 1986, 1994, 2007, 2009, 2012). Unlike other EPA publications, the follow-up editions did not supersede or replace previous editions; they only provided additional information and, in the case of subsequent editions (the most recent is EPA May 2012, 402-K-12-002), a more user-friendly format. The key points in these documents are as follows:

1. There are no safe levels of radon. Exposure to the average outdoor level found in the United States is roughly equivalent to 20 chest x-rays per year.
2. Because of the cost of reducing the radon levels in homes, EPA established a guideline of 4 pCi/L as an action level based on reducing the radon risk to the general population at a reasonable cost.
3. In the subsequent editions, the significantly increased risks of radon exposure and smoking were also included.

In the 1986 edition of *A Citizen's Guide to Radon*, EPA provided a recommended timeline for corrective action (Table 2). This timeline, although excluded from later editions, is still a useful guide in determining when to take corrective action. However, EPA currently recommends that corrective action be taken as soon as possible (EPA May 2012, 402-K-12-002).

Table 2. A Citizen's Guide to Radon corrective action schedule

EPA radon action levels (pCi/L)	Recommended actions
0 to <4	No action required
4 to <20	Mitigate within a few years
20 to <200	Mitigate within a few months
≥200	Mitigate within several weeks

Source: US Environmental Protection Agency, *A Citizen's Guide To Radon,* OPA-86-004, 1986.

In comparison, the WHO (WHO 2009) has recommend that the action level for industrialized countries be set at 100 Becquerel per cubic meters (Bq/m^3, 1 pCi/L= 37 Bq/m^3) or 2.7 pCi/L. Note that Bq/m^3 is the international unit of radon measure.

1.6 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION AND RADON

In December 2002, the Occupational Safety and Health Administration (OSHA) acknowledged that radon in the workplace within a structure controlled by the employer would fall under CFR 29 1910.1096 (OSHA December 23, 2002). Therefore, occupational exposure to radon would fall under Department of Labor-OSHA standards. Under this standard, a Maximum Permissible Concentration (MPC) of 100 pCi/L for an adult worker during a 40 hour, 7 day period would be allowed. However, if this standard is applied in the workplace, additional measures must also be taken to ensure that the MPC is not being exceeded (e.g., airborne radiation hazard placarding, maintaining individual dose records, rad worker training, etc.). More details can be found at www.osha.gov. In lieu of this requirement, in 2011 OSHA suggested that the EPA 4 pCi/L guideline could be used (OSHA 2011, 3430-04-2011).

2. OVERVIEW OF RADON TESTING

2.1 RADON MEASUREMENT

As defined by EPA, radon measurements are of two distinct types: short term (2 to 90 days) and long term (91 to 365 days). The advantage of short-term measurements is that radon data can be collected quickly. In addition, because detectors are in the field for less time, the potential for field attrition is much lower. With respect to accuracy and cost, both types of measurements are comparable. However, unlike the levels of most pollutants, indoor radon levels are constantly changing. Studies by EPA and DOE have found that indoor radon levels can vary by as much as a factor of 10 from one season to another. Other studies have shown that the indoor concentration of radon can increase by a factor of 2 to 10 during short-duration weather events (e.g., rain, periods of high winds, and cold snaps; see Fig. 6). Because of these variations, EPA bases the health risks of radon exposure on an integrated annual average. When a short-term test is performed, EPA recommends that the measurement be performed under closed building conditions, which means that in a heating climate, the test should be performed ideally at the season midpoint with the building closed (e.g., windows and doors kept closed at all times) and not during periods of abnormal weather conditions. In addition, if the test is <4 days in duration, the house must be closed for at least 12 h before the placement of the testing device.

A long-term measurement offers the advantage of integrating the impact of short-duration weather effects over a longer period of time. Also, a long-term measurement can be performed during normal living conditions, thus minimizing the impact of radon testing on either work or living activities.

Because of these and other considerations, EPA recommends that any radon test be performed for as long as possible to provide the most accurate representation of the annual average. Because corrective action can be expensive, EPA recommends that follow-up measurements be performed in cases where elevated radon was detected and, in particular, in cases when abnormal weather occurred during the test period. Generally speaking, the higher the initial radon result, the more confidence one has that elevated radon is present. For example, if the initial radon result is ≥8 pCi/L, EPA recommends immediate short-term measurements be performed or mitigation performed (EPA January 2009, 402/K-09/001).

2.1.1 Types of Radon Gas Detectors

EPA divides short-term measurement devices into two categories, continuous and integrating. Continuous radon monitors (CRMs) typically measure radon gas or radon decay products in air. These measurements are performed in real time, meaning that the radon concentration can be measured and studied at fixed time intervals. To measure radon, room air is either pumped or diffused into a counting chamber that detects the ion

particles generated by the radioactive decay of radon and its progeny. The counts per unit of time measured by the detector are then transmitted to a recording device (electronic or printer), where they are converted into picocuries per liter. Detection methods for CRMs include ion-trap, pulse ion-chamber, scintillation cell, or silicone integrated circuit detector. The typical exposure period for CRMs, as for most short-term devices, is 2 to 7 days. However, the chief advantage of CRMs over passive devices is the ability to "see" what is occurring by recording radon concentration as a function of time. When the instrument is downloaded and the data plotted, the impact of episodic weather events and other nonstandard tests (e.g., doors and windows left open) can be measured and quantified (Fig. 9). If used properly, CRMs are the most accurate of all short-term radon measurement devices. For example, most commercially available instruments are typically within 5% of the true radon concentration (vs. 15 to 25% for integrating devices). However, the disadvantage is the high initial purchase cost, $500 to $25,000 per CRM. Also, CRMs must be maintained and require periodic calibration.

Integrating devices average the radon exposure by absorption, physical damage to a film, or the loss of surface electrical potential. A key difference between integrating devices and continuous devices is that after the measurement has been performed, integrating devices are analyzed in an off-site laboratory. If integrating devices are used in high-priority, short-term measurements (e.g., real estate transactions or confirmation measurements), EPA recommends that the measurement be performed with collocated duplicate detectors (EPA May 1993, 402-R-93-003). Common examples of integrating radon detectors for short-term measurements are charcoal canisters and electrets.

A charcoal canister consists of an airtight container with a known quantity of activated carbon. To sample radon, the carbon is exposed to the area tested (typically, by removing the lid) for a period of 2 to 7 days. During the exposure period, the radon in the air is absorbed into the charcoal granules. At the end of the sampling period, the canister is sealed and returned to the laboratory for gamma spectroscopy analysis. After analysis, the corrected gamma counts per minute divided by the time of exposure are proportional to the radon concentration. The main advantage of using charcoal is its low unit cost. In large quantities, charcoal test kits can be obtained for under $5 per measurement (price includes canister and analysis). However, certain technical and logistical considerations can negate this cost advantage. Because charcoal permits the continual absorption and desorption of radon, this device does not give a true, integrated measurement over the exposure time. This means that the reported result may be significantly biased by either episodic or random events during the last 8 to 12 h of exposure. Another consideration is that all charcoal-based radon detectors have a maximum exposure limit. Because absorption sites within the charcoal granules are not specific, water and certain organic vapors compete with radon. Over time, these active absorption sites become irreversibly saturated with water, preventing further radon absorption. If water saturation occurs, the test must be repeated. Another consideration is holding time. At the laboratory, gamma spectroscopy analysis measures the quantity of radon presently absorbed in the charcoal. Because ^{222}Rn (the most common isotope of radon) has a half-life of 3.8 days, it is imperative that the canister be read within 2 weeks of the conclusion of sampling.

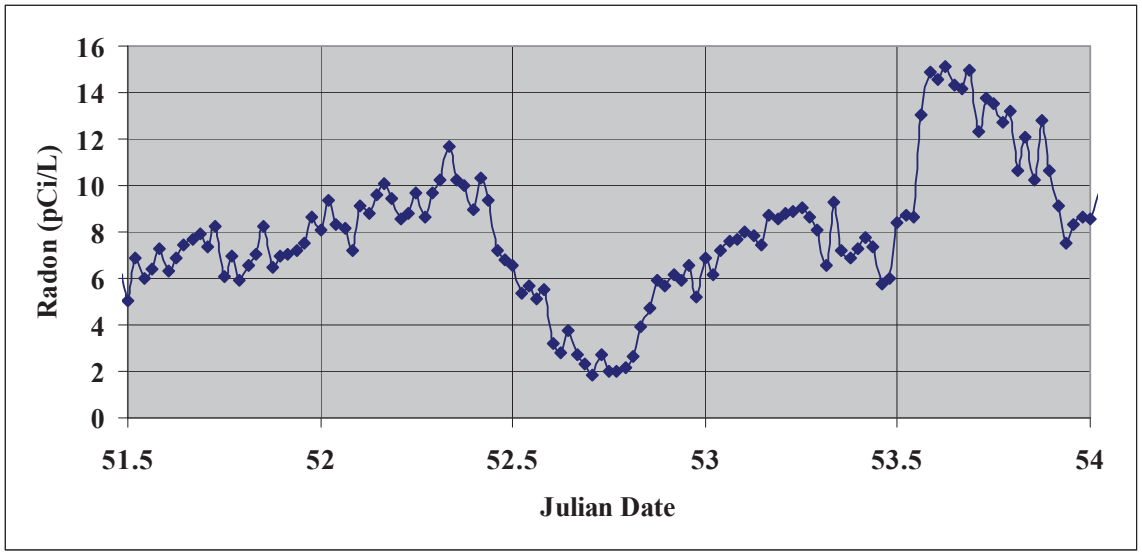


Fig. 9. Example of a continuous radon measurement.

Electret-based radon detectors consist of two distinct parts: the ion chamber and the electret (Fig. 10). The ion chamber is a specially designed holder for the electret, which is made of electrically conducting plastic. This feature permits the uniform discharge of any static energy generated by the decay of radon or radon daughters in the air inside the chamber. An electret consists of an electrically charged wafer of Teflon that has been treated to hold a stable electrostatic potential. This potential attracts oppositely charged ions that collect on the electret surface, thus neutralizing the surface charge and reducing the electrostatic potential. The surface potential is measured before and after exposure, using a specially designed voltage reader. The decrease in surface potential during exposure is proportional to the concentration of radon integrated over time. When new, the voltage of an electret is between 700 and 750 V, and the electret can be reused until the voltage drops below 200 V. The discharge rate, or volts per unit of time per radon concentration, depends on the volume of the ion chamber and on the sensitivity of the electret. High-sensitivity electrets discharge at a rate 11 times that of low-sensitivity electrets. For short-duration tests, such as 90 day tests, a higher discharge rate is needed for better accuracy. For example, a 90 day measurement conducted at 1 pCi/L of radon with a low-sensitivity electret would yield only a 6 V drop, whereas a high-sensitivity electret would yield a 66 V drop. The higher voltage drop results in an accuracy increase of about 50% in this example. Conversely, for longer exposures, such as 240 days, the drop in voltage for the high-sensitivity electret would be 176 V, or 35% of the usable voltage for the electret. The lower-sensitivity electret would drop by only 16 V, losing only 3% of its usable voltage.

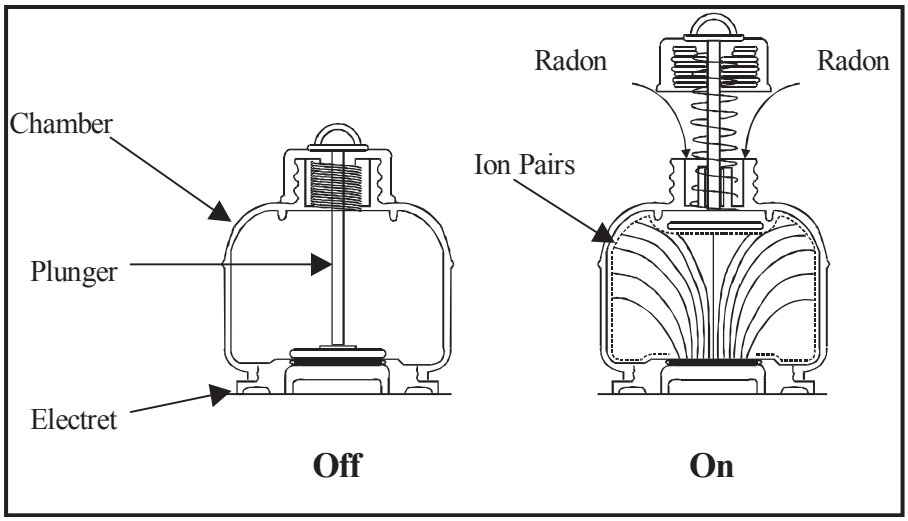
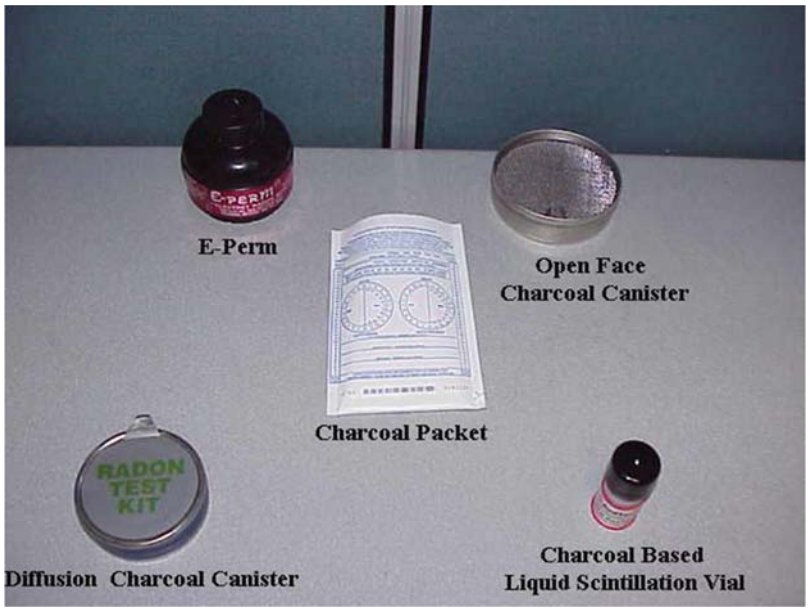


Fig. 10. E-Perm® electret-based radon detector.

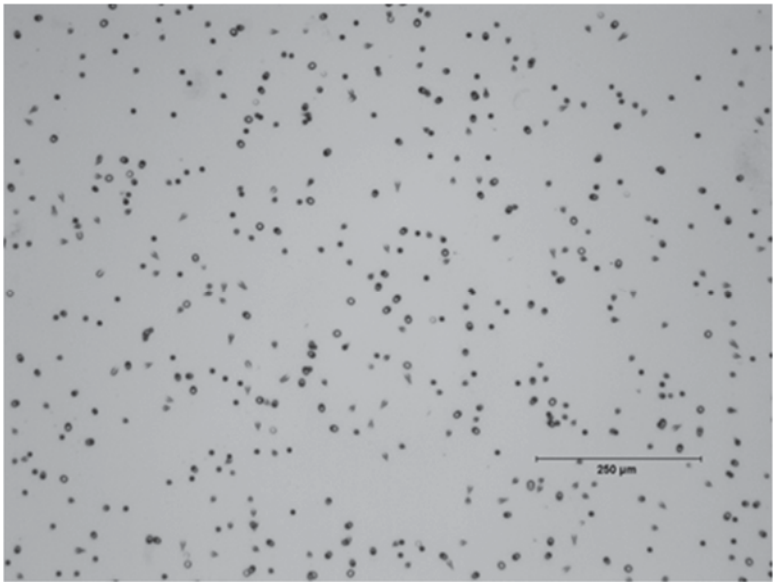
As with charcoal, one of the major advantages of electret-based radon measurements is the low cost per measurement. Because electret-based detectors are reusable, electret measurements also can be performed for less than $5 (excluding field labor). Unlike charcoal canisters, electrets can be placed for more than 7 days and are insensitive to water and organic vapors. In addition, electrets are true integrating devices, meaning they are not dependent upon the last 8 to 12 hours of exposure. The total voltage discharge is proportional to the average radon concentration during the exposure period. Most important, electret readers are field portable; that is, detector analysis can be performed at the job location. However, unlike charcoal, an electret does have an upper limit for radon exposure. For new electrets, the maximum usable dose is approximately 250 pCi/L-days (1 pCi/L-day = 1 pCi/L exposure for 1 day). Therefore, each time an electret is used, care must be taken to ensure that sufficient usable voltage remains to perform the measurement. Typical short-term test kits are shown in Picture 1.

For long-term measurements (>90 days), using CRMs is generally not considered cost-effective. Instead, either electrets or alpha track detectors (ATDs) are used. ATDs, the oldest and best understood of long-term measurements, work on the principle of counting physical damage (tracks) to an acrylic chip (CR-39) caused by alpha particles generated during the radioactive decay of radon (Picture 2). During the deployment of an ATD, radon diffuses through a filtered membrane (in the most common type of ATD). If radon undergoes radioactive decay while in the holder, the subsequent radon daughters are attracted to the CR-39. If the daughters deposit on the surface of the CR-39, subsequent alpha decay will leave a submicroscopic track on the surface of the CR-39. After the ATD is retrieved, it is returned to the laboratory for development and analysis. This is performed by disassembling the ATD, removing the CR-39 chip from the holder, and placing the CR-39 chip in a heated caustic solution (potassium or sodium hydroxide) for about 12 to 24 h (depending on the vendor). The caustic development or etching enlarges the alpha tracks so that they can be viewed and counted under a microscope. The tracks per unit of area (track density) as a function of time (days) are proportional to the radon

concentration (pCi/L). Picture 3 shows typical ATDs by different manufacturers. Table 3 provides a summary comparison of the most common types of passive detectors.



Picture 1. Typical short-term test kits



Picture 2. Typical tracks (dark spots) on a developed ATD chip

Picture 3. Typical ATD by different manufactures

Table 3. Summary comparison of passive radon detectors

Detector Type	Passive/ active	Typical uncertainty a [%]	Typical sampling period
Alpha-track detector (ATD)	Passive	10 – 25	1 – 12 months
Activated charcoal detector (ACD)	Passive	10 – 30	2 – 7 days
Electret ion chamber (EIC)	Passive	8 – 15	5 days – 1 year
Electronic integrating device (EID)	Active	~ 25	2 days – year(s)
Continuous radon monitor (CRM)	Active	~ 10	1 hour – year(s)
Uncertainty expressed for optimal exposure durations and for exposures 5.4 pCi/L (200 Bq/m ^{3})			
Source: Table 6, WHO Handbook on Indoor Radon (2007)			

2.1.2 Measurement of Radon Decay Products

Although measuring radon gas in air is the most common method used today by radon testing companies within the United States, another method measures the radiological activity of radon progeny that have become attached to particles suspended in air. To perform this measurement, the equilibrium ratio (ER) must either be determined or assumed. Simply speaking, the ER is the percentage of radon daughters attached to particles that are suspended in air. The ER is calculated by dividing the total concentration of radon decay products (RDPs) present by the concentration that would exist if the RDPs were in radioactive equilibrium with the radon gas concentration present. Therefore, at equilibrium (i.e., at an ER of 1.0), one working level (WL) of RDPs would be present when the radon concentration was 100 pCi/L. However, because of ventilation and plate-out (the attachment of RDPs to the walls, floors, or objects within the room), the ratio can never be 1.0. Residential studies performed by EPA found typically an average ER of 50% (the range was from 30 to 70%) for typical residential structures with average air recirculation rates.

In most nonresidential buildings, however, the ERs are consistently lower, ranging from 5 to 30% with an average ER of 25%. The exact reasons for the lower average ER are subject to debate. But most nonresidential buildings are nonsmoking, do not have pets, have more efficient heating and air-conditioning filters, and are usually cleaned more frequently. Therefore, for the most part, the common sources for residential particles in air are absent.

To convert from units of WL to equivalent gas concentration in pCi/L, the WL is multiplied by 100 and then divided by the ER (Eq.[1]). For example, 0.02 WL (RDPs) × 100/0.5 (50% ER assumed) would equal an equivalent gas concentration of 4.0 pCi/L. It is important to note that if the ER is assumed, the gas concentration should be identified as "equivalent gas concentration" to avoid confusion. Table 4 shows equivalent gas concentration in picocuries per liter at various WL concentrations and ER at a 4 pCi/L gas concentration.

$$\textbf{Radon (pCi/L)} = \frac{\textbf{WL} \times \textbf{100}}{\textbf{ER}}$$

Equation 1. Conversion from gas to WL

For many years EPA set the action level for measuring RDP at 0.02 WL (EPA May 1993, 402-R-92-003, and EPA November 2006a, 402-K-06-093), which is equivalent to a 4.0 pCi/L gas concentration at an ER of 0.5 (the default value recommended by EPA if the ER is unknown). But in 2007 EPA lowered the action level from 0.02 to 0.016 WL (the gas concentration action level remained unchanged at 4.0 pCi/L) and decreased the assumed ER to 0.4 (EPA May 2007, 402-K-07-009). However, in the most recent *Citizen's Guide*, testing options using RDP were not included (EPA January 2009, 402/K-09/001). Instead, only radon gas measurement options were provided.

Table 4. Equivalent gas concentrations at 4 pCi/L for various equilibrium ratios

Equilibrium ratio	Working level	Equivalent gas concentration (EpCi/L)
0.05	0.002	0.4
0.1	0.004	0.8
0.2	0.008	1.6
0.3	0.012	2.4
0.4	0.016	3.2
0.5	0.02	4.0
0.6	0.024	4.8
0.7	0.028	5.6

For many years EPA set the action level for measuring RDP at 0.02 WL (EPA May 1993, 402-R-92-003, and EPA November 2006a, 402-K-06-093), which is equivalent to a 4.0 pCi/L gas concentration at an ER of 0.5 (the default value recommended by EPA if the ER is unknown). But in 2007 EPA lowered the action level from 0.02 to 0.016 WL (the gas concentration action level remained unchanged at 4.0 pCi/L) and decreased the assumed ER to 0.4 (EPA May 2007, 402-K-07-009). However, in the most recent *Citizen's Guide*, testing options using RDP were not included (EPA January 2009, 402/K-09/001). Instead, only radon gas measurement options were provided.

The most common WL measurement devices are CRMs or electrets that consist of a pump, filter paper, and detector. The basic principle of operation is that dust particles with the RDPs attached become trapped on the filter paper. The detector then measures the alpha particles emitted by ^{218}Po and ^{214}Po as a function of time and flow rate. Studies have shown that even common occurrences within buildings can change the ER and, in turn, affect the WL measurement. For example, simple routine occurrences such as smoking, lighting a candle, cooking, dusting, or vacuuming have resulted in doubling the response of the WL meter. Conversely, increasing the amount of air movement within a building by turning on a ceiling fan or the heating and air-conditioning blower can reduce the response of the WL meter by up to 1 order of magnitude.

The generally accepted theory for why routine activities such as cooking or vacuuming affect the measurement is that they generate additional airborne particles, increasing the number of sites suitable for RDP attachment and their subsequent capture on the instrument's filter paper. This results in an increase in measured WL. The reasons why a ceiling fan or heating system blower cause a decrease in instrument response are not as clear. As a result, two divergent but viable theories have been proposed. In the first theory, it is assumed that the RDPs, once adhered to an airborne particle, become irreversibly attached. As these particles (including the attached RDP) collide with a fixed object in the room, they become "stuck" and are removed from the breathing zone. For RDPs that are not attached to particles, the increase in air velocity increases the probability that they will also collide with a fixed object in the room and become irreversibly attached. However, the second theory assumes that some of the RDPs are not irreversibly attached to airborne particles. Increasing the air velocity in the room also increases the frequency and the energy of collisions between air molecules and attached

RDPs. As a result, some of the attached RDPs are dislodged and become unattached once again. Because these unattached RDPs (more accurately visualized as molecules) are small enough to pass through the filter paper on the WL meter and not become trapped, the instrument would not be able to measure the emitted alpha particles.

The importance of what exactly is happening with the unattached RDPs is not academic. It has a direct bearing on the dose and hence the risk of contracting lung cancer. It is generally acknowledged that the respiratory system filters out a significant number of RDPs attached to large particles in the nose and throat. The greater risk comes from the RDPs attached to smaller particles that manage to get past the body's natural defenses and penetrate deeper into the lung. In addition, it is well known and accepted that unattached RDPs have a 20–30 times greater efficiency in delivering a dose to lung tissue. Therefore, any increase in unattached RDP concentration, no matter how small, in the breathing zone would significantly increase the dose to lung tissue.

Because of the higher risk associated with ERs >50% (an ER of 3 pCi/L at 0.65 is equivalent in risk to 4 pCi/L), EPA rationalized that WL measurements should continue to be listed as a viable testing method. However, these measurement uncertainties (in particular when the ER is unknown or highly variable) and the difficulty in interpreting the data were the primary reasons that WL measurements generally fell out of favor with the radon testing industry.

2.1.3 EPA Radon Testing Protocols for Nonresidential Buildings

Although considerable information is available for testing within family housing, the only document published by EPA for radon testing in nonresidential building is for schools (EPA July 1993, 402-R-92-014). In this protocol, EPA states that because of room-to-room variation in radon concentrations, the only way to know if an individual room or area has a high level of radon is to test. As a result, EPA recommends that all frequently occupied rooms in contact with the ground or over a crawlspace be tested for radon. In addition, rooms with walls in ground contact and rooms directly above a basement space that is not frequently occupied should be tested. Large open areas should be tested at an interval of one testing location for every 2,000 ft^2. Areas such as restrooms, hallways, stairwells, elevator shafts, utility closets, and storage closets need not be tested. More recently, the American National Standards Institute (ANSI), in conjunction with the American Association of Radon Scientists and Technologists, has published MALB 2014, an updated set of testing standards for schools and other large buildings (ANSI 2014.). EPA has classified this standard as a "Current Standards of Practice" (see http://www.epa.gov/radon/pubs/index.html) and recommends its application.

2.1.4 EPA Radon Testing Requirements for Federal Agencies

In response to the requirements in the 1988 IRAA, EPA released an updated version of the *Citizen's Guide* (and provided to its sister agencies additional guidance on how to conduct a radon testing program. This guidance also included minimum criteria for quality assurance and quality control (QA/QC) for radon testing within federal buildings

(most of these recommendations were eventually incorporated in EPA July 1993, 402-R-92-014). Specifically the document called for each building tested to have

- blanks (5% or 25, whichever was smaller)
- collocated duplicates (10% or 50, whichever was less)
- spikes (no limits were provided, but 3% was recommended in the reference document)

For analysis of the QC data, EPA stated that the procedures presented in *Indoor Radon and Radon Decay Product Measurement Device Protocols* (EPA-520/1-89-009) should be used. However, in 1992, this document was superseded by EPA 402-R-92-004 (EPA July 1992).

For blanks, EPA requires monitoring of the background exposure that may have accumulated during shipment and storage of the testing devices. Because each type of radon testing device (e.g., ATD, charcoal, or electret ion chamber) responds differently to background exposure, the EPA protocol provides device-specific corrective action if a reading is found to be significantly greater than the lower level of detection. For example, for electret ion chambers (EICs), EPA requires that 5% of the EICs or 10, whichever number is smaller, be set aside to track voltage drift. Over a 3 week test period for the EICs, any voltage loss found in the control EICs of more than 1 V per week should be investigated. In addition, because EICs are sensitive to background gamma radiation, a correction must be multiplied by the gamma radiation level at the site (in μR/h) and the product (in equivalent pCi/L) subtracted from the apparent radon concentration. If the gamma radiation at the site is unknown, then a measurement would need to be performed directly using appropriate radiation detection instruments.

The objective of performing simultaneous or duplicate measurements is to assess the precision error of the measurement method, or how well two side-by-side measurements agree. This precision error is the "random" component of error (as opposed to the calibration error, which is systematic). The precision error, or the degree of disagreement between duplicates, can be composed of many factors. These include the error caused by the random nature of counting radioactive decay, slight differences between detector construction (for example, electret chamber volume), and differences in handling of detectors. With respect to collocated duplicates, EPA recommends using the relative percent difference (RPD, Eq. [2]) as the best indicator of overall precision in radon measurements.

$$\textbf{Relative percent difference} = \frac{\textbf{(Highest pCi/L} - \textbf{Lowest pCi/L)} \times \textbf{100\%}}{\textbf{Mean}}$$

Equation 2. Relative percent difference

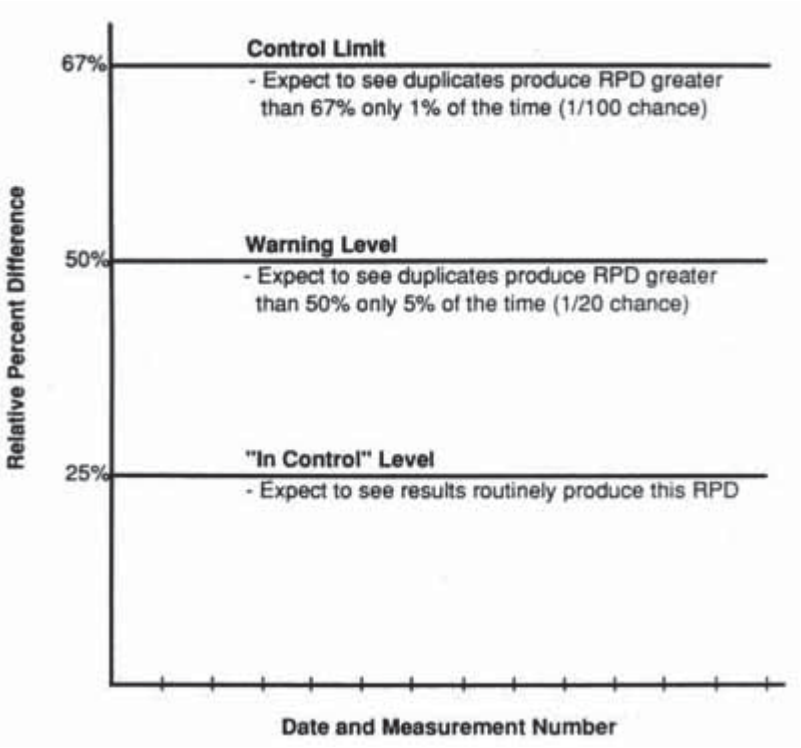
(from *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I,* EPA 600/9-76-005 [EPA 1984])

Ideally, the results of duplicates should be assessed in a way that allows for determining the level of chance associated with a particular difference between duplicates. This will allow for the predetermination of limits for the allowable differences between duplicates before the cause of large differences is investigated. For example, the warning level, or the level of discrepancy between duplicates that triggers an investigation, may be set at a 5% probability. This level is a difference between duplicates that is so large that, when compared with previous precision errors, should be observed only 5% of the time. A control limit, at which further measurements should cease until the problem is corrected, may be set at 1% probability.

A control chart for duplicates is not as simple as a control chart used to monitor instrument performance, as for a check source. This is because the instrument's response to a check source should be fairly constant with time. Duplicates are performed at various radon concentrations, however, and the total difference between two measurements is expected to increase as radon levels increase. Because of the difficulties in measuring radon at low levels, EPA guidelines recommend that the acceptance criteria be based on the average of the two results relative to 4 pCi/L. After the RPD is calculated, its value is plotted on one of the two applicable control charts by date and average radon concentration (Figs. 11 and 12). Over time, the RPDs are evaluated based on the overall number of results within the respective ranges (i.e., in control, warning level, and control limit). If the number of data points exceeds what would be predicted at the warning level, then investigation into the cause of the problem is warranted. If however, a significant number of data points are at or beyond the control limit, then measurements should cease until the problem has been identified and corrected.

EPA provides a statistical table (Table 5) for determining what constitutes a significant number of RPD warnings and failures. The required action is based upon the number of failures and the total number of data available. For example, if two sets of duplicates had RPDs outside the warning level, and between 2 and 7 sets of data were within the control limit, EPA would recommend that analysis stop until the problem had been identified and corrected. However, if between 8 and 19 sets of acceptable data had been obtained, it would be necessary only to investigate the problem.

Control Chart* for Relative Percent Difference (RPD)
Based on an "In Control" Level of 25% (=COV of 18%)
(For duplicates where average <4 pCi/L or 0.02 WL)



RPD=difference between two measurements divided by their average

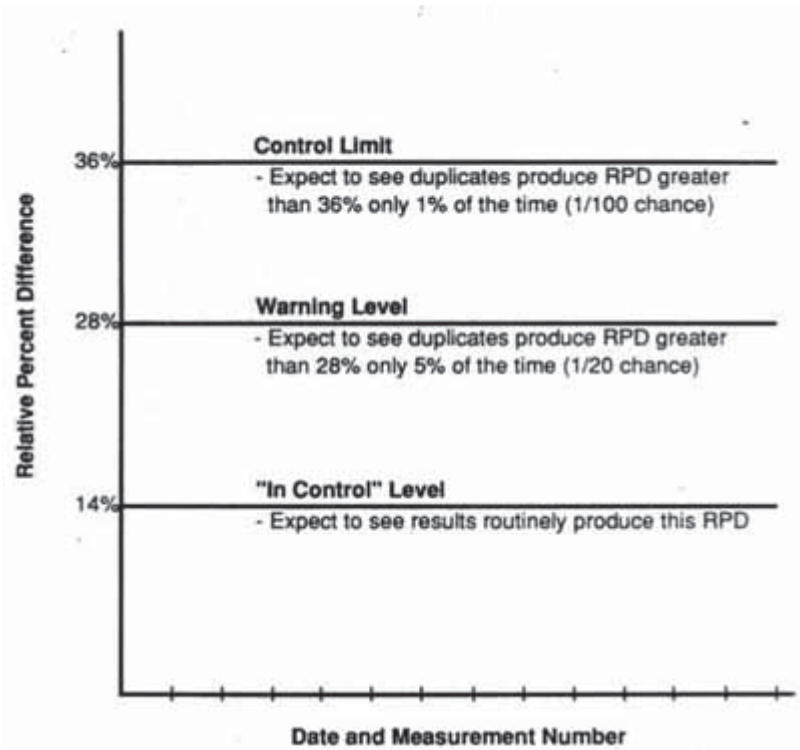
Example: Detector A=2 pCi/L, B=3 pCi/L, RPD=40%

If RPD exceeds the *control limit*—cease measurements until the problem is identified and corrected.

If RPD exceeds the *warning level*—follow guidance in *Section B.3* and see Exhibit B-5 within *Protocols for Radon and Radon Decay Product Measurements in Homes* (EPA 1993, 402-R-93-003)

Fig. 11. Control chart for RPD for average radon results <4 pCi/L.
(*Protocols for Radon and Radon Decay Product Measurements in Homes* [EPA May 1993])

Control Chart* for Relative Percent Difference (RPD)
Based on an "In Control" Level of 14% (=COV of 10%)
(For duplicates where average ≥ 4 pCi/L or 0.02 WL)



RPD=difference between two measurements divided by their average

Example: Detector A=5 pCi/L, B=6 pCi/L, RPD=18%

If RPD exceeds the *control limit*—cease measurements until the problem is identified and corrected.

If RPD exceeds the *warning level*—follow guidance in *Section B.3* and see Exhibit B-5 within *Protocols for Radon and Radon Decay Product Measurements in Homes* (EPA May 1993, 402-R-93-003)

Fig. 12. Control chart for RPD for average radon results >4 pCi/L.
[*Protocols for Radon and Radon Decay Product Measurements in Homes* (EPA May 1993, 402-R-93-003)]

Table 5. Criteria for taking action for measurements outside the warning levela

Number of duplicate results outside the warning level	Total number of duplicates	
	Investigate, but continue operation A	Stop operation until problem is corrected B
2	8–19	2–7
3	17–34	8–16
4	29–51	17–28
5	41–67	29–40
6	54–84	41–53
7	67–100	54–66

[a]Modified from Goldin (Goldin 1984) and based upon cumulative probability tables of the binomial distribution.

Protocols for Radon and Radon Decay Product Measurements in Homes (EPA May 1993, 402-R-93-003).

EPA addresses spikes by requiring laboratories (organizations that read electrets are considered laboratories) to maintain a performance ratio (Eq. [3]) between 0.75 and 1.25. If the performance ratio is outside the range, EPA recommends that the measurement cease until the problem has been identified.

$$\textbf{Performance Ratio} = \frac{\textbf{(Mean Measured Value)}}{\textbf{Target Value}}$$

Equation 3. Performance ratio

2.1.5 Radon in Water

EPA has recommended two methods for routine measurement of radon in water. The emanation method, in which radon is degassed from the water and transferred into a Lucas scintillation cell, has a detection limit of approximately 0.05 Bq/L (1 pCi = 0.037 Bq) for a sample volume of 100 mL (Crawford 1989). In the liquid scintillation method, the water is injected directly into a scintillation solution and counted in an automated liquid scintillation device; this method has a detection limit of about 0.4 Bq/L using a sample volume of 10 mL (Prichard and Gesell 1977) and EPA Method 913 (EPA June 1991, Report EMSL/LV). All methods require careful sampling because of the rapid loss of radon from the water when it is agitated and open to the atmosphere. The EPA [EPA 1991, *Fed. Regist.* **56**(138): 33050] estimated a practical quantization limit for radon in water (based on the ability of laboratories to measure radon within reasonable limits of precision and accuracy) at about 10 or 11 Bq/L (1 pCi/L = 37 Bq/m^3).

3. OVERVIEW OF RADON MITIGATION

3.1 EPA RADON MITIGATION SYSTEM CATEGORIES

EPA divides radon mitigation into two basic categories: passive and active. Passive mitigation is defined as a non-mechanical means of radon abatement or control. Examples of passive mitigation include sealing cracks, balancing an existing mechanical system, or increasing the natural ventilation rate of the building substructure (i.e., crawlspace). For the remaining lifetime of the building, passive radon techniques are generally considered the most cost-effective means of radon control. Typically, installation costs for a passive system are less than half those of an active system, and a passive system has no operation and maintenance (O&M) costs (i.e., energy for operation). Unfortunately, successful passive mitigation has proved difficult because all radon entry pathways within the room or building must be identified and negated. However, noted success has been observed in buildings with drainage sumps, French and perimeter drains, and major openings exposed to soil (e.g., wall pipe penetrations and beam pockets). For buildings in which these significant soil gas conduits are not present, the effectiveness of passive mitigation measures is greatly reduced. Another form of passive mitigation is the restoration of a building's mechanical systems (heating, ventilation and air-conditioning [HVAC]) and exhaust to the original design specifications. This would include rebalancing the building's conditioned air supply, return air, fresh-air and exhaust air volumes.

Active mitigation entails the use of mechanical means, such as a fan or blower, to control radon entry into the living area. Generally speaking, all active mitigation methods can be grouped into two categories: pre-entry and post-entry mitigation. Pre-entry mitigation is a technique that retards radon entry into the living area. Common examples of this type are shell pressurization (SP) and active soil depressurization. Post-entry mitigation involves the treatment of the radon-laden air inside the room or building. Examples are energy recovery ventilation (ERV), supplemental air mitigation (SAM), and high-efficiency particulate air (HEPA) filtration (currently not supported by EPA, see Appendix A).

3.1.1 Shell Pressurization Mitigation

SP, the oldest radon mitigation method, retards radon entry by mechanically introducing sufficient outdoor air to the building to induce a positive pressure (typically ≥4 Pa) across the slab and into the soil (Fig. 13). The two basic designs (with minor variations) are

- Type 1 SP: Uses the building's existing mechanical system to condition the required volume of outdoor air (Fig. 13).
- Type 2 SP: Uses an independent mechanical system to condition the outdoor air before its discharge into the structure (Fig. 14).

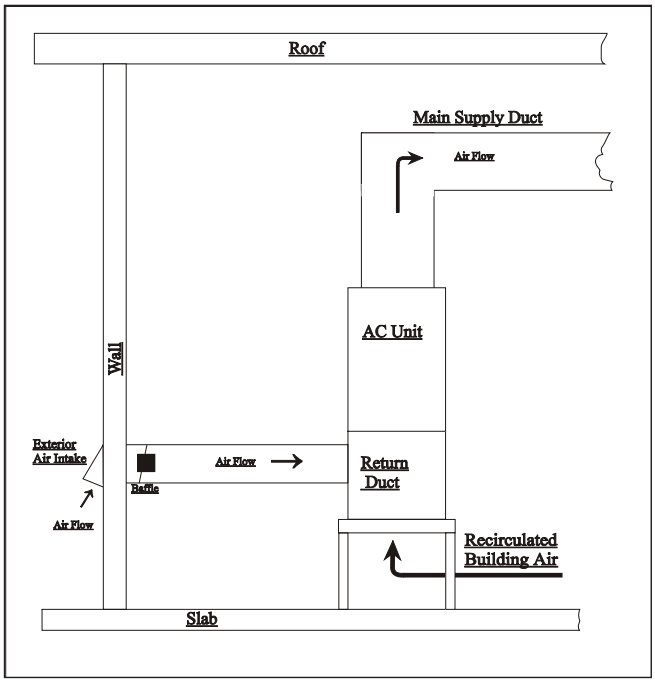


Fig. 13. Example of a Type 1 SP system.

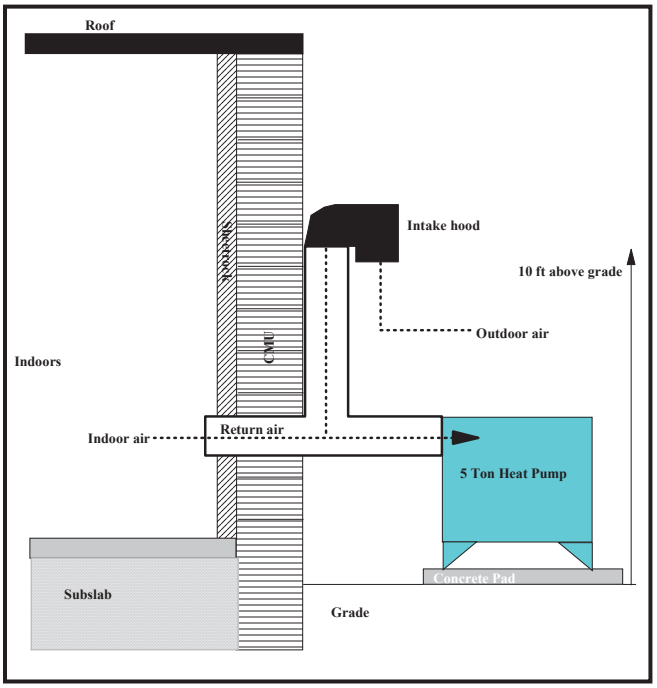


Fig. 14. Example of a Type 2 SP system.

The deciding factor for the selection of a Type 1 or Type 2 SP system is the ability of the existing mechanical system to condition the added volume of outdoor air. Although this information is readily available on the as-built design drawings or the unit itself, with older equipment (e.g., ≥5 years old) performance degradation may be an issue that needs investigation before Type 1 SP mitigation is attempted. Assuming that the HVAC unit

has sufficient capacity to condition the additional outdoor volume, the existing fresh-air duct (from the exterior intake to the return air box) is replaced with a larger duct and a higher-capacity damper. A popular cost savings option in this case is the addition of an inline blower fan to the existing air intake duct in lieu of replacement. For buildings without existing intake air ductwork, an appropriately sized duct is run from the exterior to the return box of the unit.

For Type 2 SP mitigation, there are many varieties of commercially available units which can condition the required outdoor air volume. Selection of the most appropriate unit is based mainly on the volume of outdoor air and the year around climate conditions. Common examples are

- single-pass HVAC or heating/air-conditioning units that bring in 100% fresh air (i.e. there is no return air)
- desiccant makeup air units
- split units with a dedicated air makeup
- specially modified heating/air-conditioning units

Although a highly effective radon mitigation technique, SP is extremely vulnerable to occupant interaction. The technique works only as long as the building is under positive pressure. Therefore, all windows must be kept closed year around and doors opened only for normal entrances and exits. In addition, all the pre-filters (bug screens) and system filters must be cleaned or replaced frequently (e.g., weekly or monthly) to ensure that the required volume of fresh air is being supplied. The energy penalty (e.g., the energy cost to condition the outdoor air before it is discharged into the building) is also quite high. For all these reasons, SP mitigation is generally considered the last mitigation alternative.

3.1.2 Active Soil Depressurization Mitigation

Active soil depressurization consists of two main types of mitigation techniques, subslab depressurization (SSD) and submembrane depressurization (SMD). For buildings with slabs or basements, SSD is the most common means of radon control within the United States. This method uses a pipe inserted through the slab and a fan connected to the pipe (Fig. 15). When the fan is activated, the area beneath the slab (subslab) is depressurized. The resulting depressurization prevents radon entry into the living area by redirecting the subslab radon into the pipe for discharge into the atmosphere, where it is harmlessly diluted. However, the overall effectiveness of SSD is limited by pre-existing conditions under the slab that can impede the extension of the vacuum field (e.g., compacted fill, presence of grade beams, enclosed utility vaults, and interior foundations are common conditions that reduce the vacuum field extension). Slab size is another consideration. Under ideal conditions (e.g., noncompacted fill, no grade beams or other structures impeding vacuum) a single SSD system with a 4 in. vent duct (the most common size) can typically depressurize between 2,000 and 5,000 ft^2 of subslab. Systems with vent ducts larger than 4 in. can depressurize up to 10,000 ft^2; however, they typically cost more to install than multiple 4 in. duct systems. Therefore, in larger buildings, the use of two or more independent systems is not uncommon.

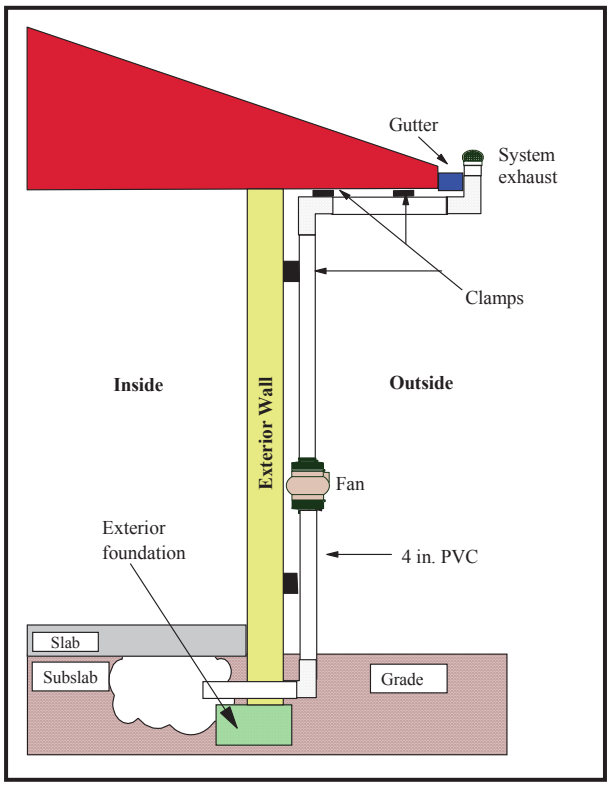


Fig. 15. Type 1 SSD system.

The three basic designs (with minor variations) are

1. Type 1 SSD: an externally mounted pipe/fan system with an exterior penetration (Fig. 15)
2. Type 2 SSD: an externally mounted pipe/fan system with an internal penetration (Fig. 16)
3. Type 3 SSD: an interior pipe penetration with a roof- or attic-mounted fan (Fig. 17)

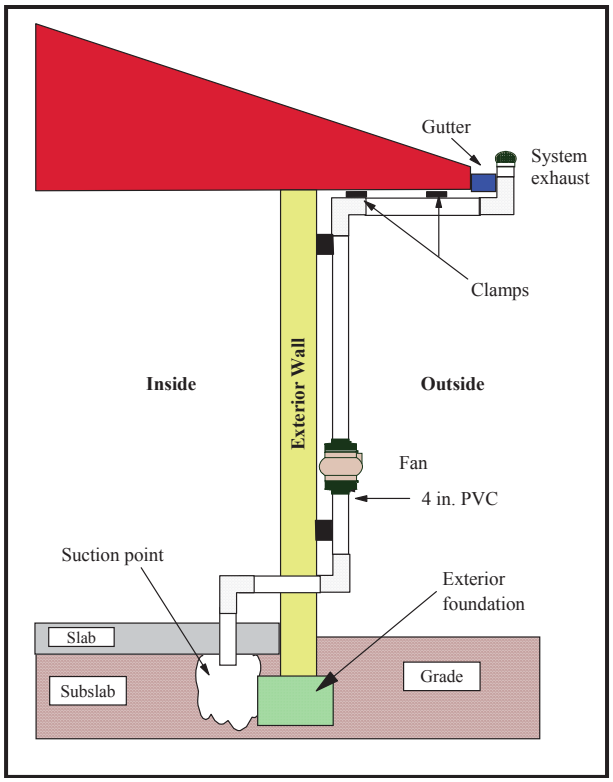


Fig. 16. Type 2 SSD system.

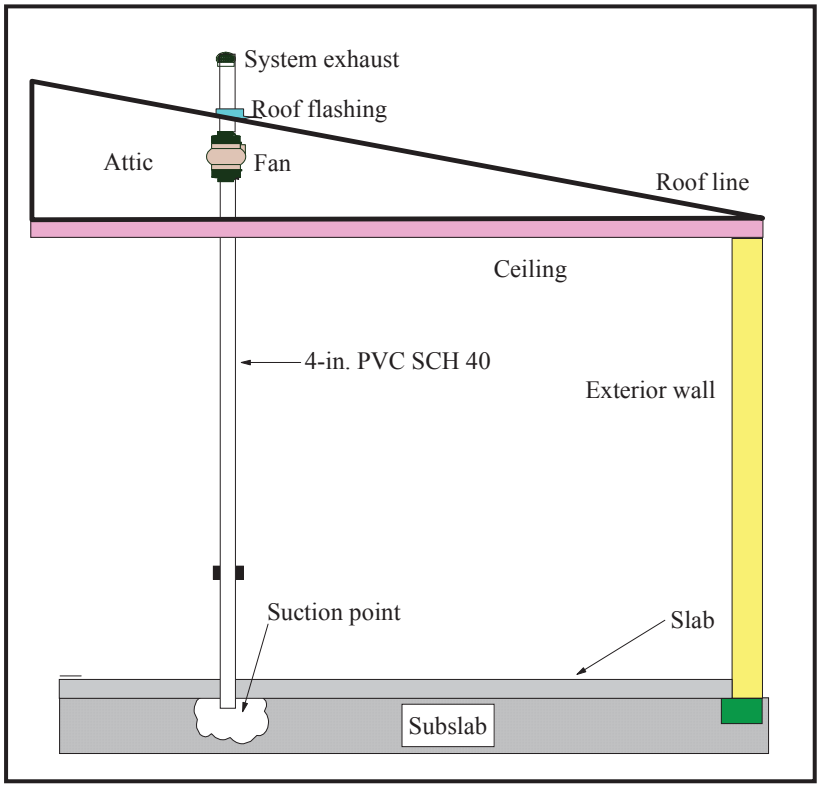


Fig. 17. Type 3 SSD system.

Another consideration in selecting an SSD design is planning for future O&M of the radon system. Although SSD systems do not require any specific routine maintenance, some system components will need to be replaced eventually because of failure or as part of a preventive maintenance schedule. In addition, to verify that the system is working, EPA recommends periodic checks of the system performance indicator in addition to inspecting the system every 2 years.

Although the time required for these checks and repairs is minimal (typically just a few minutes), gaining access to the interior of the building can be a time-consuming process. For example, studies conducted by ORNL within Department of Defense nonresidential buildings have found that one-third to one-half of the time expended for Type 3 SSD repairs and inspections was used arranging for access. Conversely, minimal interaction was required for Type 1 and 2 SSD systems. Another consideration is nonresidential roofing. Commercial buildings usually have complex roofing systems that are warranted or bonded by the contactor for a fixed number of years. Installing a pipe through this roof without the support or permission of the contractor would void the warranty for not only the area where the penetration occurred but also potentially the entire roof.

EPA, the American Society for Testing and Materials (ASTM), and ANSI (EPA 1994, 402-R-93-078; ASTM E2121-13; and ANSI 2014, RMS-LB 2014) require that SSD system performance indicators be simple to read or interpret and be located where they are easily seen or heard by building occupants and protected from damage or destruction. The simplest and most common performance indicator, the manometer, deflects a volume of oil in a U-tube. Others rely on an electrical pressure sensor to trigger either a warning light or audible alarm.

For buildings with crawlspaces, SMD is usually used. Placing a polymeric membrane, such as a plastic sheet (typically ≥ 10 mil in thickness, 1 mil = 0.001 in.), on the floor of the crawlspace and depressurizing underneath the membrane with a fan channels the radon into a vent pipe and discharges it into the atmosphere above the roofline of the building.

3.1.3 Energy Recovery Ventilation Mitigation

ERV mitigation works solely on the principal of indoor volume dilution. This is accomplished by the use of a commercially available unit (Fig. 18) that exchanges a fixed volume of indoor air with an equal volume of outdoor air (units range in capacity from 100 to 100,000 cfm). Selection of the correct size unit is critical and is based on the cubic volume of the room or building being ventilated, the current ventilation rate (measured in ACH), and the initial radon concentration. Empirically speaking, doubling the ACH in the room or building will reduce the radon levels by 50%.

Although ERV is a proven mitigation technique, installation and operational costs (e.g., routine maintenance on filters, drive belts and motors, and desiccant wheel) are significantly higher than for SSD mitigation (Section 1.6.7). Furthermore, because of

conditioned air loss during the exchange process (most units typically recover 80%), the energy penalty can be quite high for high-capacity units. This energy deficit may become problematic if the existing HVAC system lacks the capacity to make up for the loss.

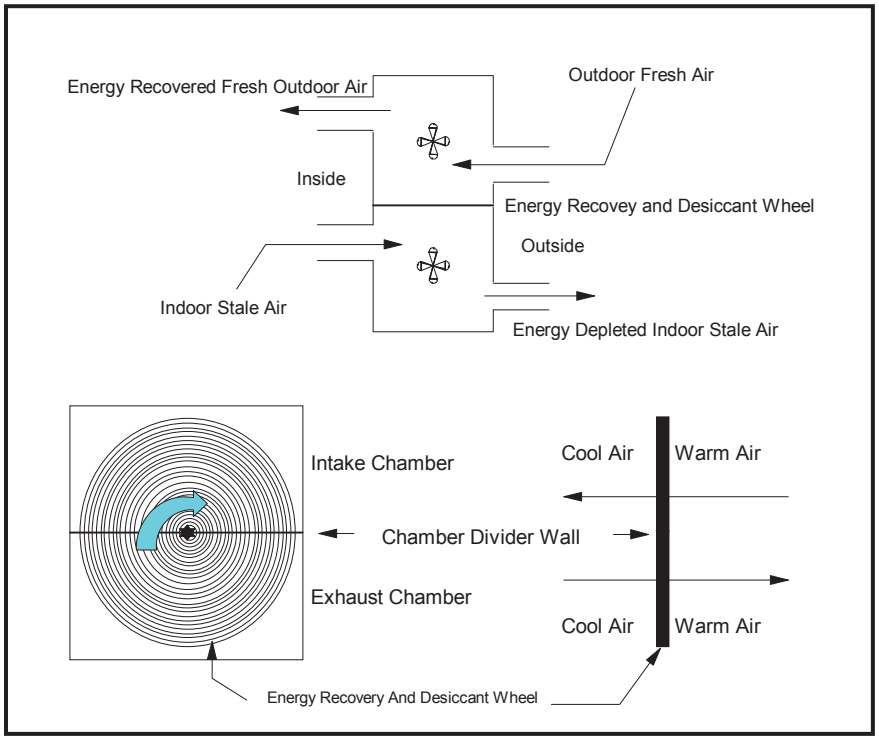


Fig. 18. Energy recovery ventilation overview.

3.1.4 Supplemental Air Mitigation

For individual room mitigation, a SAM system can be installed to control radon by increasing a room's ventilation rate. Typically a SAM system draws 75 to 500 cfm of conditioned air from an adjoining hallway or large room known to have low levels of radon and discharges it into the room (Fig. 19). Unconditioned air from outdoors or from within the building should never be used as the source air for this mitigation technique.

Although a SAM system is the least complex of all active mitigation systems (i.e., typically it only has a fan and two short pieces of ductwork), for it to work properly, significant pre-mitigation planning must be employed. To design a SAM system, one must first estimate or preferably measure the room's ACH rate and then perform a series of calculations that include the room's volume and its current radon level (EPA 1988b, 625/5-87/019). From these calculations, the appropriate duct size and capacity for the in-line ventilator can be ascertained.

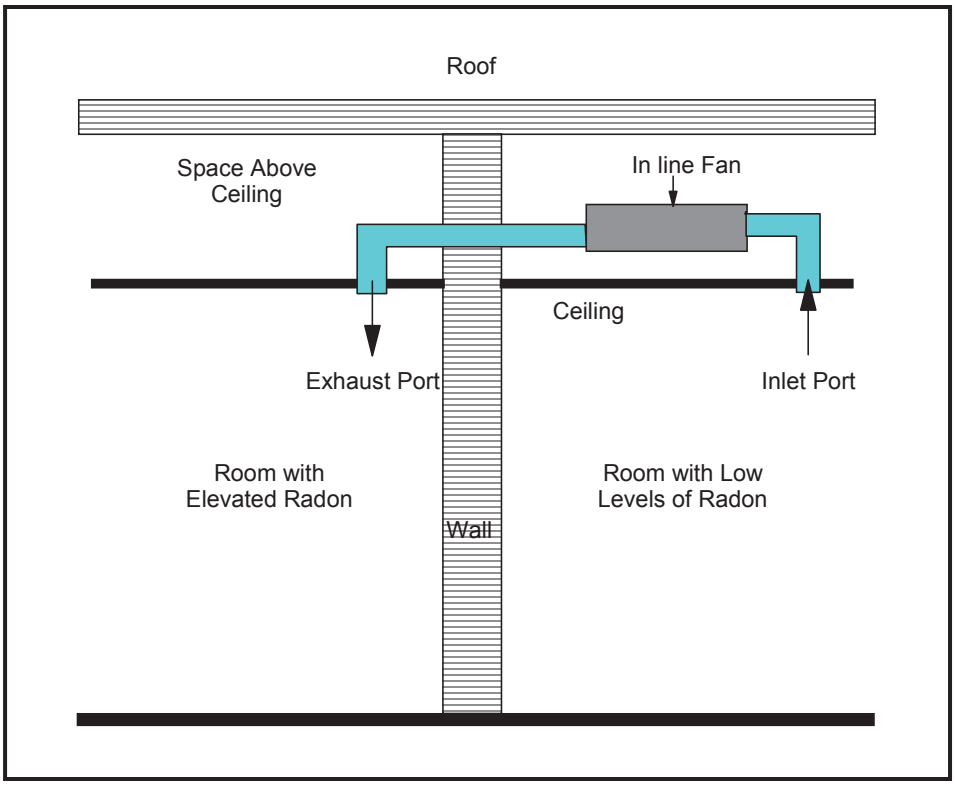


Fig. 19. Supplemental air mitigation system.

A drawback for this mitigation technique is its range of application. Typically, for SAM to be a viable option, the room in question must have radon levels <20 pCi/L, be <3,500 ft^3 in volume, and have a low pre-exiting air-exchange rate (e.g., <0.2 ACH). In addition, the room must be located near a large room or common area from which the required volume of conditioned air containing low radon levels can be withdrawn without a significant risk of depressurization.

In addition to the design parameters, particular attention must be paid to noise and occupant comfort. Because these systems are usually used in single or double offices, the noise generated by the discharge of the supply air may pose an inadvertent distraction to the occupant(s). Therefore, the supply diffuser, in addition to being aesthetically pleasing, must afford the least amount of noise. Another important consideration is the location of the discharge point. The discharge air velocity from a typical SAM system is comparable to that of a forced-air system. So to the best extent possible, the discharge needs to be in a location that would not appreciably increase the air velocity in the primary work areas.

3.1.5 High-Efficiency Particulate Air Mitigation

Another post-entry mitigation method involves the use of high-efficiency air filtration systems that remove particulates from air (similar in design to the portable HEPA filtration units used by asbestos abatement companies). These units are commercially available (air filtration units commonly found in consumer retail stores do not meet

ASHRAE Standard 52.2-2007 [ASHRAE 2007] for this application) and are typically integrated into the existing return air ducting. Like ERVs, these units need to be properly sized (unit and installation costs are comparable to ERV) for the required air volume. The long-term operational cost of HEPA typically exceeds that of ERV because of the need to frequently replace (e.g., weekly or monthly as required) the highly specialized filters (HEPA filters commonly found in consumer retail stores do not meet ASHRAE Standard 52.2-2007 [ASHRAE 2007] for this application).

Although studies have shown that air filtration methods do reduce the concentration of radon daughters in air, there are questions in the scientific community as to whether there is an analogous reduction in risk. The basis for this concern is that filtration of the air changes the distribution of the sizes of the particles in the air to lower sizes. Radon progeny attached to particles of decreased size present in the air may become more effective in delivering dose to the lung; thus the reduction in progeny filtration may not provide equal health risk reduction (Jalbert and Fisher 2008, US EPA correspondence to Douglas County School Board, Minden, Nevada [included in Exhibit 1]). In summary, although HEPA or other high-efficiency filtration can be used to remove particulates and reduce radon progeny in the air, it does not affect the radon gas concentration; therefore, radon progeny will continue to be produced in the ambient air. The resulting shift in particle size distribution in the air will deliver an unknown dose from radon progeny to the lung. Further, radon gas measurements will be unaffected by filtering, and the assessment of the effect of filtration involves multiple measurements of radon progeny concentrations and particle size distributions throughout the building. Therefore, at this time, EPA does not support the use of air filtration as a means of mitigating the health effects of radon (Jalbert and Fisher 2008).

3.1.6 Mechanical Adjustments as a Mitigation Method

Depending on their design and operation, a nonresidential building's mechanical systems can influence radon levels by

- increasing ventilation (diluting indoor radon concentrations with outdoor air)
- decreasing ventilation (allowing radon gas to build up)
- pressurizing a building (keeping radon out)
- depressurizing a building (drawing radon inside)

Consequently, restoring the building's forced air and exhaust systems to their original design specifications may provide the desired reduction in radon levels (EPA April 1994, 402-R-94-008). However, caution should be exercised in making adjustments to the unit's makeup air damper to compensate for a negative shell pressure. Before any adjustments are performed, a review of the building mechanical plans (supply and exhaust) should be performed and an audit of the current mechanicals performed. If the installed mechanical components match the original design specifications, then the fresh-air damper can be adjusted to match the specified flow. However, before the adjustments, it is recommended that temperature and relative humidity measurements (continuous measurement is preferred) be taken in all areas of the building to provide a

baseline. These measurements should continue for an extended period of time (days or weeks as needed) to ensure that the forced air system can handle the added heating, cooling, and dehumidification load. If significant changes in the humidity or temperature are observed, then the original fresh-air damper setting should be restored immediately to prevent mold and mildew formation. In cases in which the mechanical audit finds mechanical components other than those specified in the mechanical drawings (e.g., the exhaust blowers have a higher capacity than those specified) or exhaust systems added after the original construction (e.g., fume or exhaust hoods), an HVAC engineer should be consulted before any fresh-air damper adjustments.

The frequency and thoroughness of HVAC maintenance can also play an important role. For example, if air intake filters are not periodically cleaned and changed, the amount of outdoor air ventilating the indoor environment can be significantly reduced. Less ventilation allows radon to build up indoors. An understanding of the design, operation, and maintenance of a building's HVAC system and how it influences indoor air conditions is essential for understanding and managing a radon problem, as well as managing other indoor air quality concerns in buildings. Although HVAC balancing, repair, and restoration to original design parameters are recognized as passive radon mitigation techniques, it may be advantageous to consult an HVAC engineer before making any modification or changes.

Although HVAC mitigation is effective in the short term, long-term studies conducted by DOE have found problems with sustaining mitigation. For example, in buildings that were mitigated by restoring the fresh air to the original design parameters, 50% of the buildings were found not to be mitigated after 5 years. The primary reasons are reduction in the fresh air makeup as a means of energy conservation, and lack of system maintenance (clogged intake filters). System labeling and education of maintenance staff resulted in only marginal improvements.

3.1.7 Considerations in Mitigation Selection

If passive mitigation techniques are not viable, then the installation of an active mitigation system will be needed. Although initial installation costs and long-term operation and maintenance costs are important considerations, the following issues may have an impact on the selection and system design.

- added energy for conditioning outdoor air
- aesthetics
- noise reduction
- minimal loss of living or working space
- local and state requirements
- proposed and pending renovations
- an understanding of the occupants' concerns about radon exposure

If all active mitigation systems were equivalent in installation and O&M costs, the decisions would be greatly simplified. However, the three most common types of

mitigation (SP, ERV, and SSD) differ significantly in installation and O&M costs. For example, using a simple intake grill and duct system, a Type 1 SP mitigation system costs approximately $500 to install. However, the annual operation cost (e.g., energy costs associated with conditioning the air) and the maintenance costs (e.g., cleaning filters and rebalancing the system) are significantly higher than for ERV and SSD. Because O&M of a building's radon mitigation system is permanent for the remaining life cycle of the building, the true cost of mitigation must be looked at over a much longer period. Figure 20 compares the 10 year life-cycle energy consumption cost and the initial installation cost for each of the mitigation systems. For SP and ERV, the higher operation costs reflect the added heating and cooling load for the intake of outside air and maintenance. Because of cost considerations like these, whenever feasible, SSD should be preferred over ERV and SP.

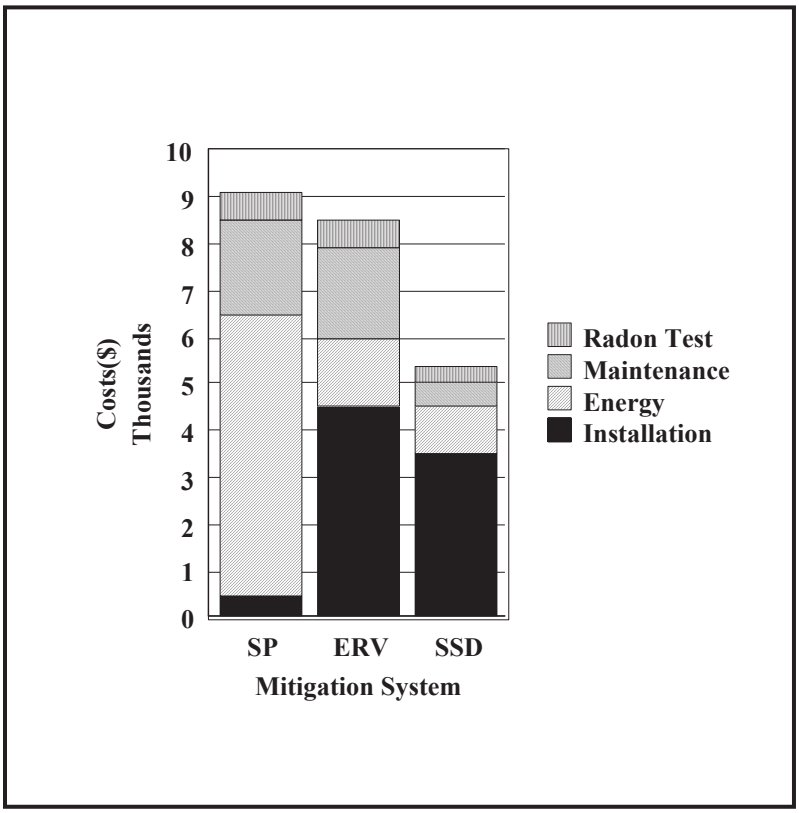


Fig. 20. Comparative 10-year cost for radon mitigation.

3.1.8 Radon Mitigation Diagnostic Measurements

There are many alternatives for passive and active radon mitigation. Selection of the optimal mitigation system for a building is essential for a long-term, cost-effective solution. If a poor selection is made, the radon problem may not be abated, the operational expense (energy penalty) may be higher, the system may fail shortly after installation, and/or the radon level may increase. If any of these problems should occur, then the effort and funds expended for the task would be wasted. It is also important to note that, in some large buildings, a combination of approaches (active and passive) may

be needed to successfully mitigate the building (e.g., HVAC adjustment with SSD or ERV with passive sealing). To assist in the selection process, EPA recommends that a series of scientific tests, called mitigation diagnostics, be performed (EPA March 1994, 402-R-94-009). These diagnostics gather technical information on the characteristics of the building, which can then be used to determine the most appropriate mitigation means for the building.

The first diagnostic usually performed (EPA April 1994, 402-R-94-008) is a close examination of the building's radon data vs. the building plans (i.e., floor, foundation, HVAC, and structural plans). Generally speaking, buildings with multiple rooms with elevated radon fall into one of the following categories (Fig. 21):

- random, no discernable pattern
- uniform, all rooms are about the same
- linear, all the elevated rooms are aligned
- clustered, all the elevated rooms are in the same area of the building
- combinations of the four patterns in exceptionally large buildings.

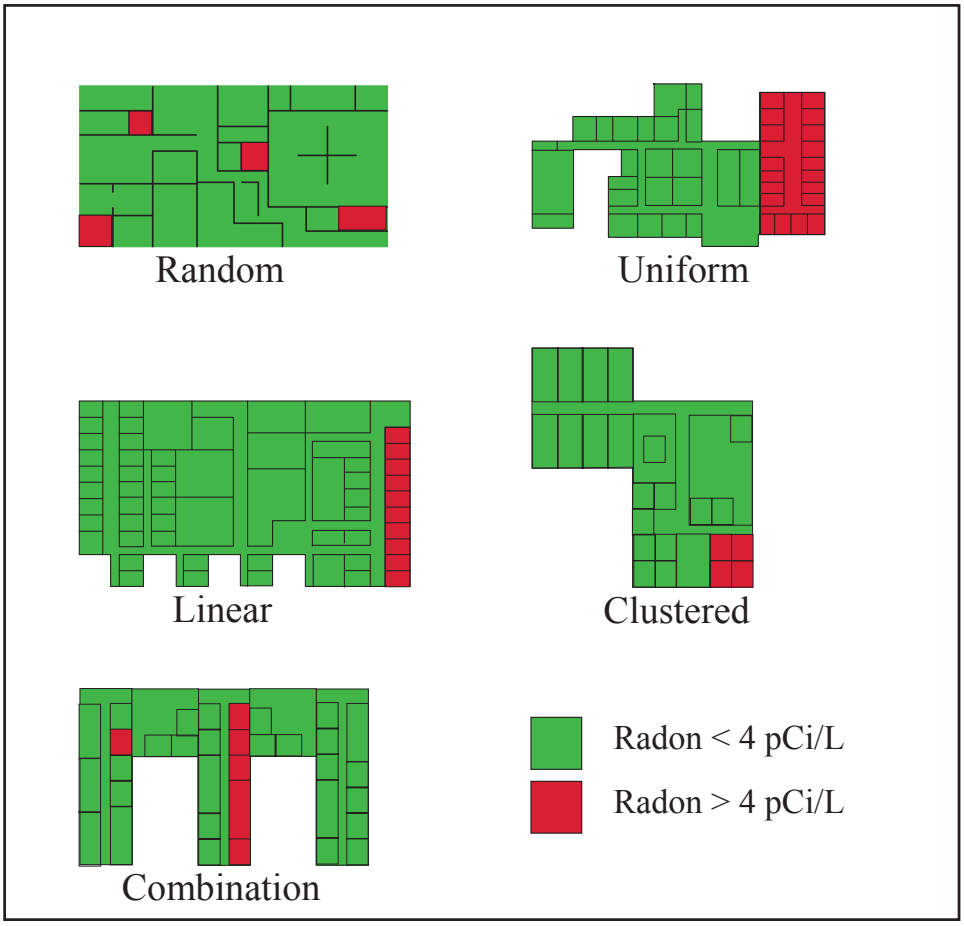


Fig. 21. Distribution patterns of elevated radon in nonresidential buildings.

Analysis of historical data has shown that certain types of patterns may indicate a potential problem in the building. For example, a uniform pattern in which all the rooms in the building are at or near the same concentration indicates that the radon is being mined and distributed by the building's mechanical system. Linear or clustered patterns tend to indicate rooms with localized, substandard ventilation or a possible expansion joint or opening in the slab. Therefore, during the diagnostics phase, all the building's mechanical components (HVAC and exhausts) should be closely examined. The examination should include a detailed review of the building's mechanical drawings followed by a detailed inspection to confirm that the plans are current and accurate (review and inspection should be performed by a qualified HVAC engineer). Concurrent with the plans and mechanical inspection, mechanical diagnostics are usually performed to determine the current system performance. These diagnostics are

- Mechanical balance: A specialized instrument (i.e., flow hood, hot wire anemometer, or pitot tube) is used to measure the supply, return air and exhaust volumes throughout the building.
- Differential pressure: A micomanometer is used to map room-to-room and differential pressure relative to the outdoors or subslab.

If mechanical issues are not suspected or correction has failed to mitigate the building, then additional diagnostics should be performed by a qualified radon mitigator. These diagnostics include but are not limited to the following:

- Radon entry pathway: A specially configured CRM is used to locate entry points in the floor or walls of the building.
- Air change measurement: An instrument is used to monitor the loss rate of an inert tracer gas within a room or building.
- Shell leakage: A blower door is used to generate a plot of shell pressure vs. intake air volume.
- Subslab diagnostic measurements: An artificial vacuum field is induced under the floor to measure the lateral field extension (LFE) through a series of small holes drilled into the floor (see Fig. 22). Concurrent with this measurement, a subslab permeability measurement can also be made which can be used for proper fan selection (Fig. 23).

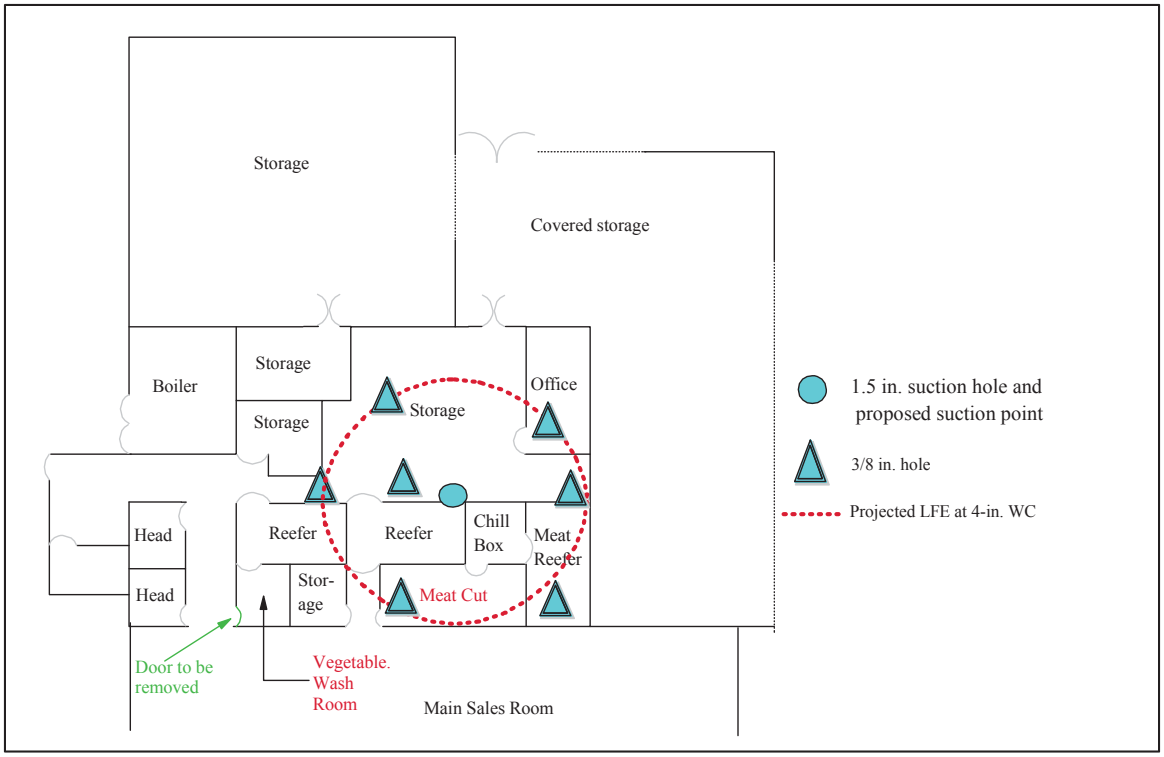


Fig. 22. Example of an SSD LFE diagnostic measurement.

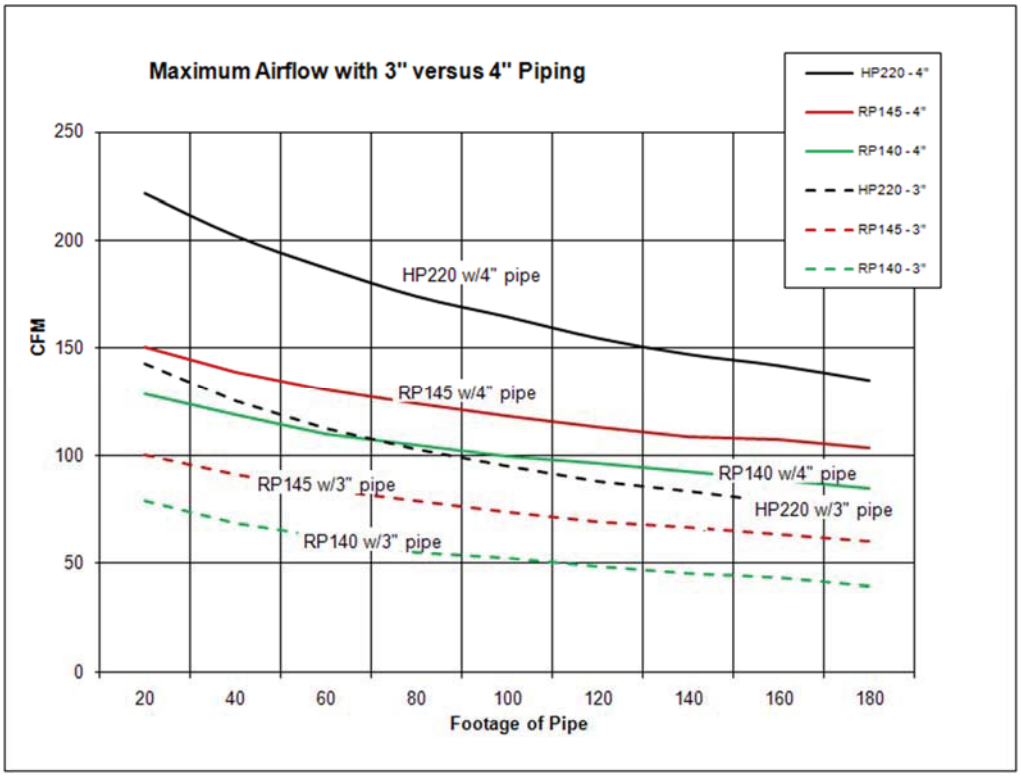


Fig. 23. Typical subslab fan performance curves.

Table 6 summarizes typical mitigation diagnostics performed to determine the best mitigation method in nonresidential buildings. For more detailed information on mitigation diagnostics, see *Reducing Radon in Schools: A Team Approach* (EPA April 1994, 402-R-94-008; available for download at http://www.epa.gov/radon/pubs/index.html).

Table 6. Mitigation diagnostic summary

Diagnostic test	Description	Mitigation method
Radon entry pathway	Performs continuous radon measurements in suspected entry pathways	Passive sealing
Air change	Measures the air turnover rate of the unit	Energy recovery ventilation, supplemental air mitigation
Shell leakage	Determines the quantity of outdoor air required to pressurize the building to 4 Pa	Shell pressurization
Subslab diagnostic and permeability measurements	Quantifies the amount of vacuum required to adequately evacuate the subslab. Assists in the selection of suction point locations and fan size	Subslab depressurization
Differential pressure	Measures the differential pressure across the building shell relative to the outside	Passive mitigation via balancing of existing mechanical systems
Mechanical balance	Quantifies the volume of air being supplied or discharged at a mechanical register	Passive mitigation via balancing of existing mechanical systems

3.2 OPERATION AND MAINTENANCE OF RADON MITIGATION SYSTEMS

Because radon is emanating from the rock and soil beneath a building, it can only be controlled and never removed. For this reason, EPA (EPA 1994, 402-R-93-078) recommends that all mitigation systems be inspected periodically (e.g., performance indicator check) and the impacted building be retested every 2 years to ensure that the radon mitigation system is still working properly. This retesting recommendation also applies to buildings that were mitigated using mechanical balance and HVAC adjustments (EPA April 1994, 402-R-94-008). In these types of buildings, retesting after every mechanical adjustment may be in order. In addition to EPA recommendations, manufacturers and installers may have prescribed additional O&M requirements. For example, ERVs typically require filter replacement every 30 days. SAM and SP mitigation usually require cleaning of the intake duct periodically as well.

3.3 MITIGATION OF RADON IN WATER

Radon can be removed from water using one of two methods:

- aeration treatment—spraying water or mixing it with air and then venting the air from the water before use
- granular activated carbon (GAC) treatment—passing water through a GAC bed

However, if GAC is used, disposal of the carbon may require special handling if it is used at a high radon level or if it has been used for a long time. For either treatment method, it is important to treat the water where it enters the building (point-of-entry device) so that all the water will be treated. Point-of-use devices such as those installed on taps or under sinks will treat only a small portion of the water and are not effective in reducing radon in water. It is also important to maintain the water treatment units properly, because failure to do so can lead to other water contamination problems. In addition, EPA and the CDC recommend that the water be tested at least once a year after installing the treatment system.

4. RADON-RESISTANT NEW CONSTRUCTION

4.1 OVERVIEW OF RADON-RESISTANT NEW CONSTRUCTION

Within the last 15 years, the ASTM, American Association of Radon Scientists and Technologists, the Department of Defense, and EPA have published standards and guidance documents to assist with incorporation of radon-resistant features into new construction. The following are examples of available radon-resistant new construction (RRNC) documents.

Residential

- *Building Radon Out: A Step-by-Step Guide on How to Build Radon-Resistant Homes* (EPA April 2001, 402-K-01-002)
- *Model Standards and Techniques for Control of Radon in New Residential Buildings* (EPA March 1994, 402-R-94-009)
- *Standard Practice for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings* (ASTM E1465-08a)
- *Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings* (ASTM E2121-09, X3.3 and X4)
- *RRNC 2.0 Reducing Radon in New Construction of 1&2 Family Dwellings and Townhouses* (ANSI 2013)

Nonresidential

- *Indoor Radon Prevention and Mitigation* (UFC May 2003, 3-490-04A)
    - Note: This standard has been declared inactive without an active replacement
- *Radon Prevention in the Design and Construction of Schools and Other Large Buildings* (EPA June 1994, 625-R-92-016)
- ASHRAE, *Indoor Air Quality Guide,* Section 3.3 (ASHRAE 2010)

Each document has its own strengths and weakness in selecting the most appropriate standard or guideline to follow. However, in most cases a blended approach (e.g., taking the most applicable parts of each) is best in drafting a nonresidential RRNC design. For example, in deciding the extent of RRNC techniques needed, UFC 3-490-04A (UFC May 2003) recommends taking into account the type of facility, along with the potential for elevated radon based upon the highest radon result collected in close proximity to the new facility. ASTM, on the other hand simply details options that could be incorporated into the design. Another consideration is that certain nonresidential construction techniques go counter to what is needed to incorporate radon-resistant features. For example, when high ground-floor loads are expected or the ground floor is part of a structural support member, compaction of the subslab aggregate is required. Therefore, in this case a “to the best extent possible” approach for RRNC incorporation will have to be employed. The following sections provide an overview of some of the most common options available for RRNC integration.

4.2 PASSIVE SEALING

A common theme in all RRNC approaches is the need to perform sealing in the floor/foundation system to prevent radon entry through openings in the slab (e.g., expansion and foundation joints, pipe penetrations). Presumably, if these are sealed, the radon flux into the building can be greatly reduced. However, more recent additional benefits such as reduction of moisture and insect intrusion into the building have also been identified. Sealing also offers energy savings if SSD mitigation is needed in the future. Studies by DOE and EPA have shown that up to 75% of the exhaust air from an SSD system comes from the living area. Although the energy penalty associated with the loss of this small volume of air is small (typically 50–75 cfm costs about $50/year), the cumulative cost over the lifetime of the building can be significant. Typical estimates for the cost of the sealing range from $0.10 to $0.25 per gross square foot (cost will vary from region to region). Therefore, for a 10,000 ft^2 building, sealing would add an additional $1,000 to $2,500 to the construction cost. It is because of this low cost and the variety of resulting benefits that the authors of the various standards encourage this approach as a minimum for new construction.

4.3 PASSIVE STACK

In addition to sealing, ASTM and EPA recommend what is called a passive stack approach. In addition to passive sealing, they recommend the installation of a 3 or 4 in. PVC vent pipe that runs from the aggregate bed (minimum 4 in. layer of clean coarse gravel [½–¾ in. mesh]) through the building and roof (Fig. 24). The idea is that the pipe would allow some radon to passively vent to the outside above the roof and not diffuse into the building. If this approach is used, they also recommend that an electrical junction box be placed in the attic or outside near the pipe in case a fan is needed later to activate the system. EPA recommends at least one vent pipe for every 2,000 ft^2 of slab area. Cost estimates for this method range from $200 to $400 per vent pipe, which also includes the electrical junction box. For a 10,000 ft^2 building, installing five passive vent pipes would add an additional $1,000 to $2,000 to the construction cost. Unlike sealing, other than the possibility of passive radon control, installing a passive vent pipe offers no other apparent benefits. However, if active mitigation is required, the cost of converting a passive vent pipe to an active SSD system is typically around 10% of the cost of installing a new system. Thus five passive vent stacks could be installed in new construction for approximately the cost of installing one from scratch for an active SSD system.

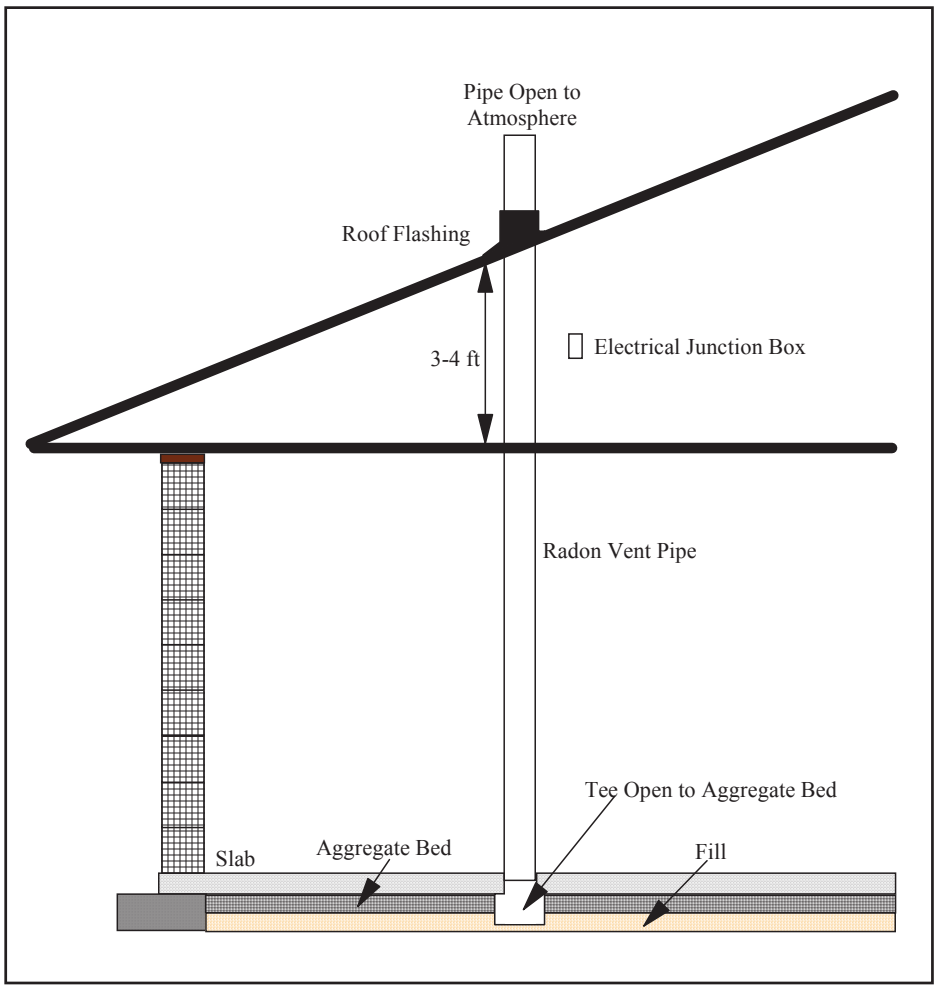


Fig. 24. Basic passive stack design for nonresidential buildings with attics.

From an RRNC contractual point of view, it would be expedient to install the mitigation fan and go ahead and take the system active as part of the construction project; however, the long-term costs of maintaining a system that is not needed can be significant over the lifetime of the building. For example, over 30 years, a 150 W radon fan would accrue $4,500 in electrical cost (assume $0.08/kwh; cost will vary from region to region). Using industry averages, fan replacements would cost an additional $900 ($300/fan replaced on average every 10 years). Finally, active systems need periodic testing with an inspection (every 2 years) to ensure that the system is operating properly, which would require an additional $7,500 (five rooms/system at $100/room every 2 years). Therefore, over 30 years, the projected cost of operating an active system would be approximately $13,000. Not included in this estimate would be any institutional cost (e.g., periodic inspections and recordkeeping) associated with the active system. However, although the 30 year cost of active mitigation is significant, mitigating circumstances (e.g., location, historical test data, type of building) may be an overriding factor in the decision to go active.

4.4 SOIL GAS COLLECTION SYSTEM

Over the past 10 years, there has been a considerable increase in the number and types of soil gas collections systems available for incorporation in new construction. The oldest and perhaps simplest designs focused primarily on making the aggregate bed as permeable as possible. In this design, 6–8 in. of noncompacted, clean, ½–¾ in. mesh stone was used under the slab, grade beams, and interior footings. If radon mitigation were required later, an SSD system was installed. The key advantage of this approach was the low cost for initial installation and the additional and predictable subslab coverage (typically 2,000 ft^2 for an active system) offered by the added aggregate. In cases where the additional aggregate was not available or not practical, later designs made use of trenches filled with aggregate or proprietary strip mats.

To enhance subslab coverage for both passive and active mitigation systems, later approaches used, in addition to the enhanced aggregate bed, a network of perforated pipe under the slab. This network consists of a perforated 4 in. PVC pipe (commonly called septic field line or slotted PVC well casing) in the aggregate bed which bisects the length of the slab and, as needed, branches to penetrate interior footings or foundations (Fig. 25). In lieu of using PVC pipe, 4 in. polyethylene slotted, flexible, corrugated drain pipe can be used, but care must be taken to ensure that the pipe is not crushed before the slab is poured. In this technique, the flexible pipe is looped around the perimeter of the subslab on top of a layer of aggregate (Fig. 26). At a convenient location, one side of the loop is connected (by solid or flexible pipe) to the other side and a tee is inserted. Inside the tee, a section of solid PVC is installed that will extend at least 6 in. above the top of the slab. To successfully cover the perforated pipe, an additional 3–4 in. (½–¾ in. mesh) of aggregate (8 in. total) is applied, in addition to a vapor barrier on top of the aggregate. In designing the soil gas collection system, it is imperative that the pipe extend into each and every compartment of the subslab. In addition, aggregate depth, size, and degree of compaction have a strong influence on the coverage. For example, if 8 in. of noncompacted, ½–¾ in. mesh stone is used, the vacuum field will extend up to 50 ft from each side of the branch in a non-subdivided subslab compartment. However, if the same aggregate is highly compacted, the coverage can drop to <10 ft. If the system is properly installed and if the correct aggregate is used, field extensions of 5,000 ft^2 or more can be expected for active mitigation systems.

More recently, in 2008, ASTM conducted a review of all available soil gas system methods and consolidated its findings in *Standard Practice for Radon Control Options for the Design and Construction of New Low-Rise Residential Buildings (*ASTM E1465-08a). The ASTM standard has categorized the most common soil gas collection systems into five general designs (Table 2, page 9) each with its own options (Table 4, page 10). Although this document was drafted for residential applications, the decision tree and specifications extrapolate readily to nonresidential applications.

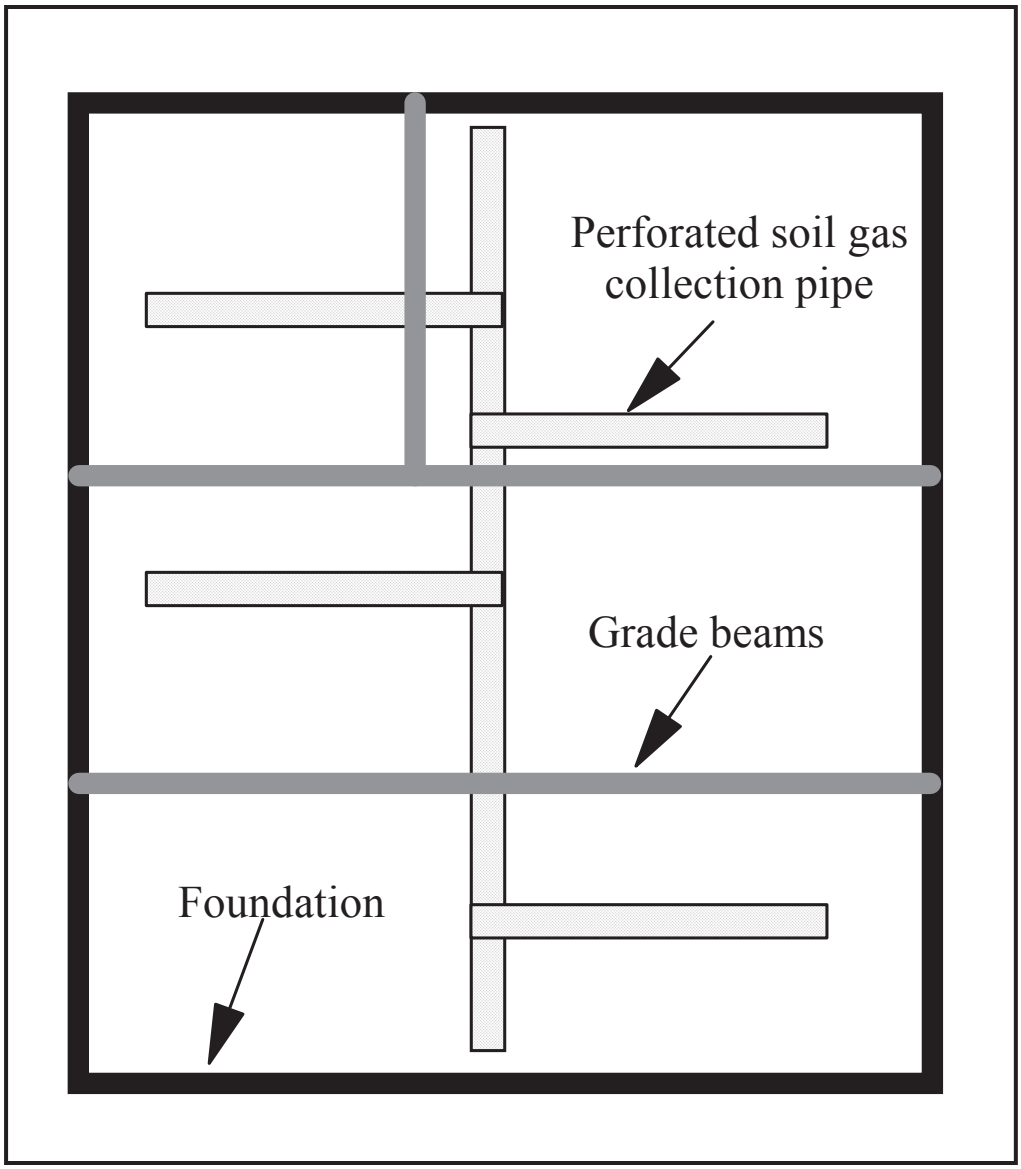


Fig. 25. Example of a simple, rigid, soil gas collection system.

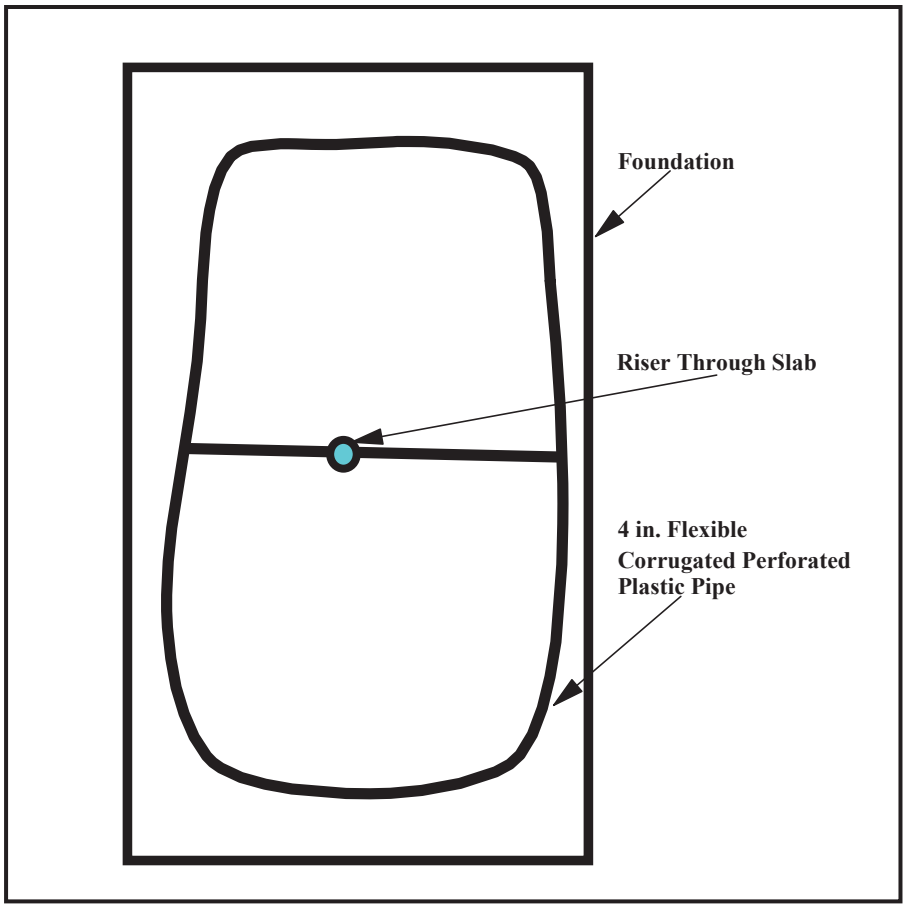


Fig. 26. Example of a simple, flexible, soil gas collection system.

4.4.1 Vent Pipe Options for Soil Gas Collection System

If a soil gas collection system is installed, the pipe network must be connected either to a passive stack vent or to a pipe that is stubbed out and capped either in the living area or attic or on the exterior of the building. The number of vent pipes, commonly referred to as risers, depends upon the aggregate depth, size, and degree of compaction. For example, if 8 in. of noncompacted, ½–¾ in. mesh stone is used, one riser would usually cover 3,000–5,000 ft^2 in a non-subdivided compartment. However, if the same aggregate is highly compacted, the coverage can drop to <1,000 ft^2; in that case, additional stacks would be needed to provide the same coverage. Because of the possibility of passive mitigation in noncompacted aggregate beds, EPA recommends that a passive stack be connected to the soil gas collection system with allowances for the installation of a fan if needed later.

Because not all building designs can accommodate a passive stack, another option is to extend a branch through the outside foundation to the outside of the building and install a capped riser (Fig. 27) with an electrical junction box nearby. If later testing determines that an active system is needed, the vent pipe and fan can be installed at a significant cost savings compared with installing a new mitigation system for an existing building.

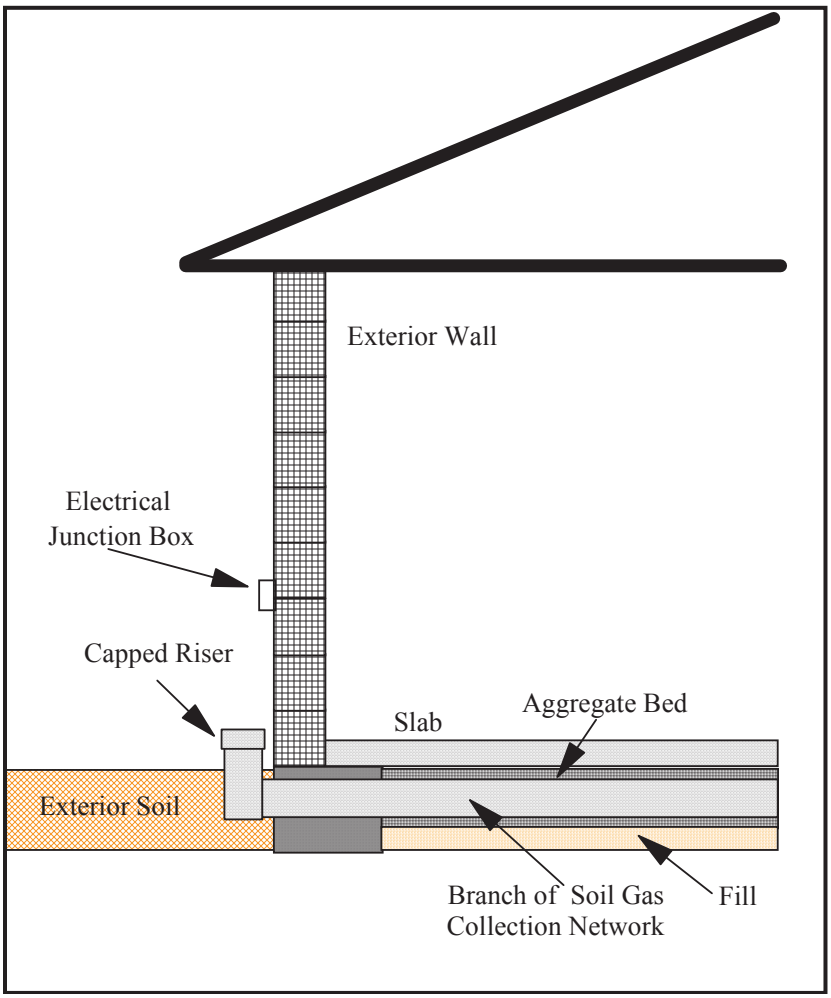


Fig. 27. Exterior riser on a soil gas collection network.

4.5 ROLE OF BUILDING MECHANICAL SYSTEMS IN RRNC

Another RRNC technique in nonresidential construction that supplements the techniques mentioned previously is to design the building mechanical systems so that all the rooms in ground contact are pressurized relative to the subslab (ASHRAE 2010, *Indoor Air Quality Guide*, Section 3.3). Although no standard has been proposed for how much pressure is needed, studies by DOE have found 4 Pa (0.016 WC) sufficient for consistent radon control. Another option is to allow for additional ventilation in the ground-contact rooms in the design. However, the inability to predict in advance what the radon levels might be within those rooms limits the application of this technique.

4.6 CONSIDERATIONS FOR RRNC IN NONRESIDENTIAL BUILDINGS

Although EPA recommends that RRNC techniques be considered for all new construction, this statement is based primarily on successes in residential applications.

For most residential applications, the average cost of an RRNC passive stack connected to a soil gas collection system is around $500. If post-construction testing finds elevated radon, then only a fan is needed to complete installation. If installed properly and with the right aggregate, one riser can typically handle up to 5,000 ft^2 of subslab. In nonresidential buildings, however, subslab construction usually contains grade beams, interior footings and foundations, pier supports, and enclosed utility chases. In addition, aggregate compaction is commonly used to prevent excessive slab settling or to support the slab in areas of high load potential. All of these features will have a significant impact on the efficiency of the soil gas collection network. To compensate, additional branches, multiple soil gas collection networks, and risers may be needed (Fig. 28). This added complexity increases the cost of nonresidential RRNC (additional materials and installation labor plus qualified designers and reviewers) and may bring into question its overall cost benefit. In fact, in some continental United States Department of Defense nonresidential applications following ASTM E 1465-08a, total costs (design through installation) were about $1–2/$ft^2$ of ground-contact area. In areas of high radon potential (e.g., EPA Zone 1, Fig. 4) population studies have shown that RRNC is cost-effective. However in marginal and low-potential areas (e.g., EPA Zones 2 and 3, respectively), the potential savings is not as clear.

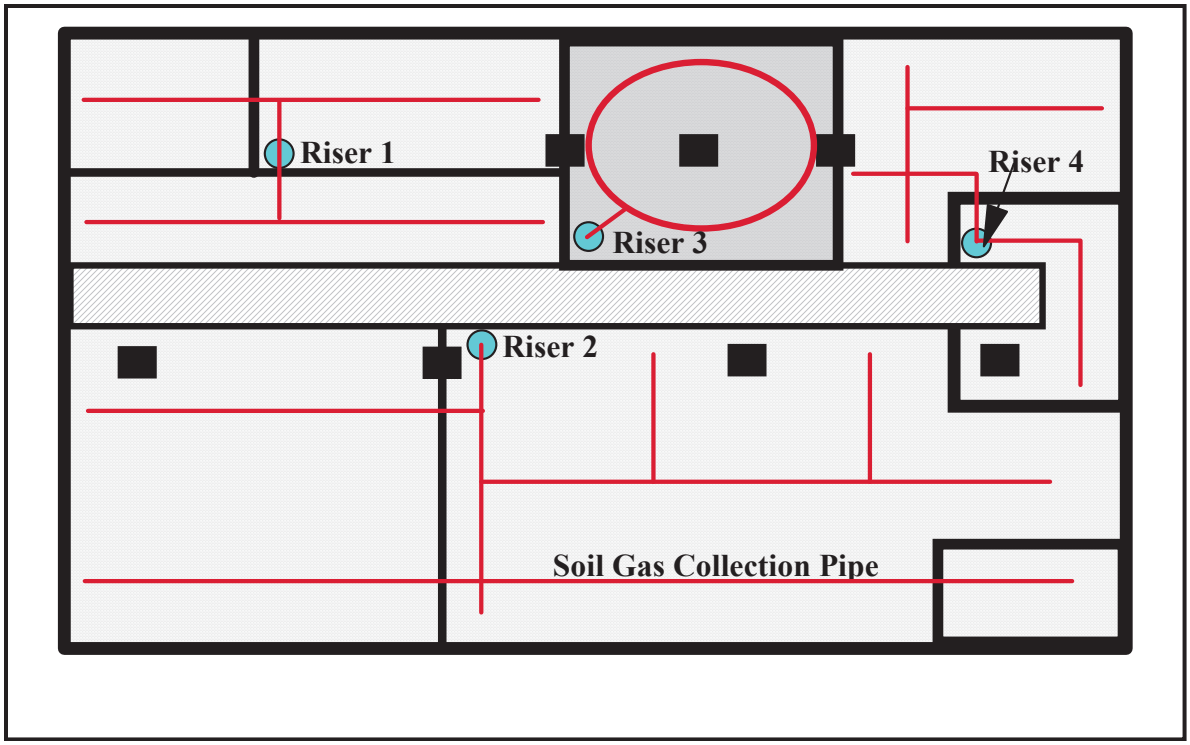


Fig. 28. Example of a nonresidential soil gas collection network.

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DEFINITIONS AND TERMS

Blank: A radon detector that is returned to the laboratory unexposed in order to measure the background of the device.

Closed-building conditions: During the radon test, the building's windows and exterior doors are closed except for routine entrances and exits.

Collocated: Radon test devices that are placed within 12 in. of each other during a simultaneous measurement.

Duplicate: Radon measurements that are performed using two radon testing devices at the same time that are collocated with each other.

Equivalent Picocurie per liter (EpCi/L): The equivalent radon gas concentration assuming 100% plate out of all unattached RDP in air.

Karst: Landscape underlain by limestone that has been eroded by dissolution, producing ridges, towers, fissures, sinkholes, and other characteristic landforms.

Mitigation: The corrective action taken in buildings or rooms that have been found to have radon levels ≥4 pCi/L.

Nonresidential building: Simply put, a building that is not considered family housing.

Picocurie per liter (pCi/L): A common unit of measurement of the concentration of radioactivity in a fluid (liquid or gas). A picocurie per liter corresponds to 0.037 radioactive disintegrations per second in every liter of fluid. For radon testing purposes, pCi/L is the unit of measure of radon gas. EPA has set an action level of 4 pCi/L.

Picocurie per liter per day (pCi/L-day): A measure of the detector dose; 1 pCi/L-day is the dose a detector receives if it is exposed to 1 pCi/L for 1 day.

Spike: A radon detector exposed at a laboratory to a known radon concentration. When used in conjunction with field testing, spikes measure the accuracy of the survey radon results.

Radon: A naturally occurring, odorless, colorless, radioactive gas caused by the breakdown of uranium. Studies have shown that many years of exposure to elevated indoor levels of radon increase the risk of contracting lung cancer.

Radon progeny: Radon particles that can be breathed into the lungs, where they continue to release radiation as they further decay. Also known as radon decay products or radon daughters.

EXHIBIT 1: EPA CORRESPONDENCE

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
Office of Radiation and Indoor Air
Indoor Environments Division

March 6, 2008

Ms. Teri Jamin, President
Douglas County School Board
1638 Mono Avenue
P.O. Box 1888
Minden, Nevada 89423

Dear Ms. Jamin:

Thank you for your letter of February 19, 2008 requesting assistance in answering questions posed by you and Ms. Luna with regard to the Zephyr Cove Elementary School (ZCES). We also received additional information from Mr. Greg Felton. He provided the minutes of the School Board Meeting (February 12, 2008) and a detailed email (March 4, 2008) on his observations and five questions related to radon risk. We normally refer such requests to our Regional offices. However, in this case, the EPA Region 9 office (San Francisco) has asked us to respond directly to your request.

Please be aware that this response is based only on the information we have received. Therefore, in the absence of complete information or a site inspection, we've limited our response to several general observations and recommendations. Our response addresses measurement, risk, mitigation and technical assistance. EPA's policies on radon measurement and mitigation are necessarily conservative and protective, and based on many years of research and experience in a wide variety of buildings, including schools. EPA's guidance on radon is a prudent and cost-effective long-term approach to risk reduction that is protective of students and staff alike.

Radon measurement. EPA's recommended action level has always been primarily defined as a radon gas measurement, i.e., 4 picocuries per liter of air (pCi/L). The Fallon report incorrectly claims that EPA views working level (WL or progeny) measurements as equally acceptable to radon gas (pCi/L) measurements. Radon gas measurements should always be preferred, especially when the measurement result will be used in mitigation decisions.

Since the actual radon gas measurements from the ZCES are available, they should be used in mitigation decisions, provided the measurements were obtained in accordance with the EPA Radon Measurement in Schools Protocol (EPA 420-R-92-014, July 1993). The Schools protocol allows for initial short-term measurements to be conducted in every ground contact room. Measurement results at or above 4 pCi/L (e.g., 4-10 pCi/L) should be verified with follow-up measurements which can be long-term or short-term. Long-term measurements (90-days+) give a more accurate estimate of the average annual radon level.

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Making a good working level or progeny measurement is more difficult than making a radon gas measurement. Because of the uncertainties associated with progeny measurements, the state of New Jersey and the American Association of Radon Scientists and Technologists (AARST) do not recommend making mitigation decisions based on working level measurements. Working level (WL) measurements are mentioned very briefly in EPA documents. The main reason for their inclusion is that in the early years of EPA's radon program there were some devices being used in the market to measure working level (progeny). The use of WL devices has declined over time due to the difficulty and expense of making such measurements.

For the reasons above, EPA's recommendation is to base a mitigation decision on a gas measurement, which we consider a conservative and protective, as well as practical way to evaluate potential risk. More simply put, "no radon gas, no risk." Of course, there is rarely, if ever, "no" radon gas. Background concentrations of radon in outdoor air can vary from place to place and time of day. The available data suggest that the outdoor average is about 0.4 pCi/L, or 1/10th EPA's action level.

Radon health risk. To our knowledge, lung cancer is the only health effect from exposure to radon in air. There are no data to suggest that children are at greater risk from exposure to radon in air than are adults. Recent radon risk assessments confirm that the risk at relatively low levels of radon is significant. For this reason, EPA recommends that mitigation be considered at levels even below our action level of 4 pCi/L (and specifically between 2 and 4 pCi/L) for residential structures. As you know, the 2003 EPA risk assessment estimated 20,000 annual radon-related lung cancer deaths. It's important to remember that this estimate is based on exposure to 1.25 pCi/L, which is the average U.S. indoor radon level. It is for these reasons that the International Commission on Radiation Protection (ICRP) recommends that radon be reduced to a level as low as reasonably achievable (ALARA).

Mitigation. EPA's principal recommendation for mitigating radon levels in school buildings is to control the source, i.e., to minimize or prevent radon entry. The technique used most often and successfully is sub-slab or sub-membrane Active Soil Depressurization (ASD). From the Fallon report we reviewed, it appears that the existing ZCES ASD systems have not been adequately evaluated for their effectiveness.

A complete and thorough evaluation of the existing ASD systems should be conducted. The evaluation should identify needed upgrades to, or extensions of, the existing radon mitigation systems. Any upgrades or new systems should conform to EPA's guidance. We recommend that school ASD systems be operated continuously. For the school's slab-on-grade footprint not served by an existing ASD system, if measurement results warrant mitigation, additional diagnostics should be done to determine whether ASD can be employed. These evaluation/diagnostic activities should

be conducted by a qualified professional with experience in large, low-rise, slab-on-grade/crawlspace school/commercial buildings. Evaluations and diagnostics can be conducted independent of weather conditions and when convenient.

EPA does not recommend filtration as a radon control measure; the use of High Efficiency Particle Air (HEPA) filtration devices is not recommended as a mitigation technique. While there is evidence that filtration can reduce progeny concentrations, many factors can impinge on the effectiveness of filtration in maintaining reduced progeny concentrations with an attendant reduction in radon dose.

Some of these complicating factors include: a potential increase in ultra fine particles available for progeny attachment and deposition in the lung; a potentially larger percentage of progeny as an unattached fraction available to be deposited in the lung; maintaining a consistent air volume setting; human interference with filtration device operation; uncertainties with filter loading and progeny reductions; and the frequency of radon progeny measurements needed to maintain the target progeny concentration.

Technical assistance. Further technical assistance may be available to assist you in your ZCES deliberations. Radon professionals at EPA and the State of Nevada are available to support you through letters like this, via conference calls, etc. Also, onsite technical assistance may be available through the Conference of Radiation Control Program Directors (CRCPD). For such a request you should contact Adrian Howe with the Nevada State Radon Program (775-687-7531, ahowe@health.nv.gov).

We acknowledge the good offices of the State of Nevada Radon Program in addressing this issue to date. Thank you for the opportunity of joining in the effort to assist the Douglas County School District in resolving this important public health issue.

Sincerely,

Phil Jalbert [signed]
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cc:
Ms. Holly Luna, Director, Business Services, Douglas County School District
Ms. Carol Lark, Superintendent, Douglas County School District
Dr. Susan Conrath, MPH, PhD, U.S. Public Health Service, EPA
Mr. Bill Long, Director, EPA Center for Radon and Air Toxics, EPA
Mr. Adrian Howe, State of Nevada Radon Program
Ms. Louise Hill, EPA Region 9 Radon Coordinator
Ms. Kelly Krolicki
Mr. Greg Felton

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