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# RADON DETECTION AND REMEDIATION IN NAVY FAMILY HOUSING



BY

ROBERT N. MORRISON

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# INTRODUCTION

Radon is a radioactive gas, first discovered in the early 1900's, It is now widely recognized that indoor radon is the largest single source of exposure to ionizing radiation in the environment. The potential health risks associated with indoor radon concentrations in Navy Family Housing has become a growing concern for those individuals tasked with providing Navy Families a healthy, safe, and comfortable place to live.

All housing units will contain a certain amount of radon, the concentration of that radon depends upon many factors. A housing unit may act as accumulator by trapping and in some cases actually drawing radon gas from surrounding soils, while another housing unit may act as a barrier to all but the lowest background level of radon.

The vast inventory of Navy Family Housing, includes units of every shape and style located in every continent of the globe. This requires that the local Housing Facility Engineer become familiar with the radon concentration levels within the local inventory, and if necessary act upon reducing those levels.

Naval Facilities Engineering Command conducted an initial radon detection program which identified over 10,966 units that were over the Environmental Protection Agencies

"Action Level" of 4 pCi/L. This initial program provided only a sampling of the units in each area. The need for additional testing in these problem areas is recommended.

This report is provided as a guide to assist the Housing Facilities Engineer in understanding the radon problem, detection methods, and current mitigation methods.

## DEFINITION OF RADON

### Properties of Radon

Radon is a radioactive gas, first discovered in the early 1900s. The most abundant of the several isotopes of radon is radon-222. Radon-222 is the direct product of the decay of the most prominent radium isotope, radium-226, which in turn is a product, several steps removed, of the decay of the most abundant uranium isotope, uranium-238 [Bodansky Et al. 1987, p.6] Other isotopes of radon exist, however because the half-lives of these isotopes are much shorter than that of radon-222 they are usually neglected.

Chemically, radon is a noble gas much like helium, argon, neon, krypton and xenon. These gases do not readily interact chemically with other elements under normal conditions. Like any other noble gas, radon is colorless, odorless and tasteless [Bodansky Et al. 1987, p.6] However, unlike the other noble gases, radon is radioactive with a half-life of 3.8 days and will further decay into radon progeny, which are themselves radioactive element with half-lives ranging from a fraction of a second to 22 years [Cole 1993, p.8] (see Figure 1).

The real problem is not the radon itself, radon gas flows quickly in and out of the lungs almost never lingering long enough to cause damage, but with the radon

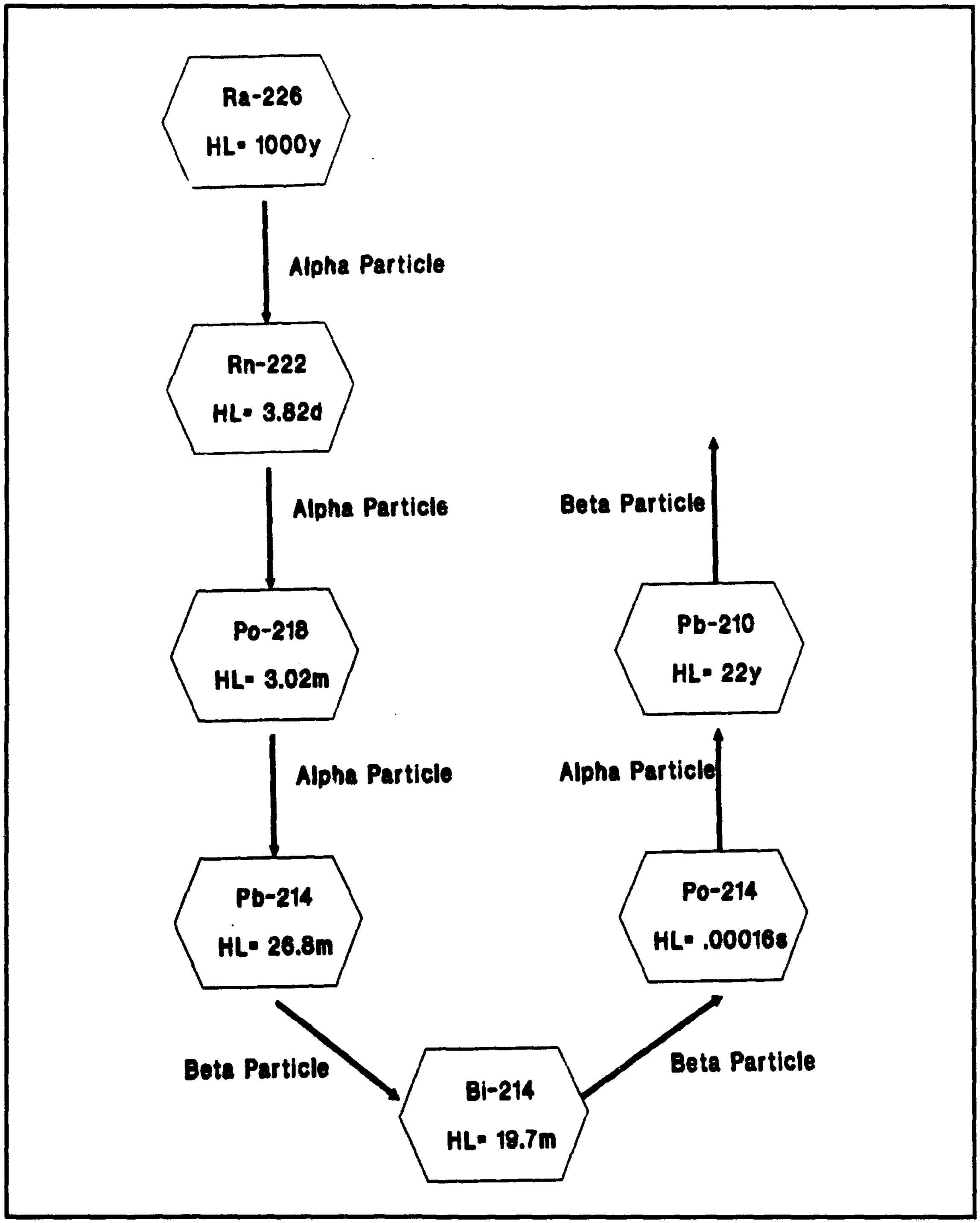


**Figure 1** Radium-226 Decay Scheme (Source: NCRP No.78, p.8)

progeny. These progeny, being solids, tend to lodge in the bronchial tree. Here they emit alpha particles, beta particles, and short wavelength gamma rays. Of the three kinds of emission, alpha particles are the most harmful; because of their greater electrical charge and relatively large mass, they can cause considerable damage to tissue [Cole 1993, p.9]. These progeny also are the key to the detection of radon.

Radon as a byproduct of the decomposition of uranium can be found everywhere. This is because uranium is found, in large concentrations, in granite, shale, and phosphate bearing formations and in smaller concentrations dispersed throughout the earth's crust [Cole 1993, p.8]. Since it is a gas, radon filters through cracks in the bedrock and soil before it eventually escapes into the atmosphere.

At the earth's surface atmosphere, the risk from radon or radon progeny is very slight. If, however, one builds a home or other dwelling, then the release of the radon to the atmosphere is blocked, and the radon accumulates in the dwelling [Brookins 1990, p.3]. Even in well ventilated dwellings, radon levels will be higher than in the open atmosphere. As we design dwellings for energy conservation, radon may accumulate to levels that constitute a health risk.

## Units of Measure

The Curie (Ci) is the traditional measure of radioactivity, equals 37 billion disintegrations per second of radioactive material. The Picocurie (pCi), one trillionths of one Curie, is more convenient for dealing with the amount of r ioactivity given off by radon. Another unit being used in more recent references is the Becquerel (Bq), the standard international (SI) unit of activity. A Becquerel is defined as one disintegration per second of radioactive material.

Concentrations of radon are generally expressed in either Picocuries per gram (pCi/g), or Picocuries per liter (pCi/L).

A much older unit, the Working Level (WL) is a measure of the concentration of radon progeny. The unit was once used to represent the maximum concentration of radon progeny that uranium miners could safely be exposed. Today, the Working Level is sometimes used to express radon progeny levels in dwellings.

## Indoor Radon

As stated previously, the risk from radon and radon progeny at the earth's atmosphere is very slight. Radon concentrations decrease with an increase in altitude. As noted in several studies, radon concentration dropped by about a factor of two in the first meter, by another factor of two in 100 meters, and again by a factor of two in the next kilometer [Bodansky Et al. 1987, p.45].

However, in a closed atmosphere, such as a dwelling, radon and radon progeny levels may accumulate to levels that constitute a health risk. The Environmental Protection Agency has estimated lung cancer deaths per 100 people associated with the following indoor radon levels: 4 pCi/L, between 1 and 5 deaths; 20 pCi/L, between 6 and 21 deaths; and 200 pCi/L, between 44 and 77 deaths assuming 70 years in the dwelling with 70 to 80 percent of time indoors [Brookins 1990, p.17]. Based upon these levels the Environmental Protection Agency has provided recommendations for remedial action (see Table 1).

**Table 1** EPA Recomendations for Remedial Action

Results higher than 200 pCi/L: "Exposures in this range are amount the highest observed in homes. Residents should undertake action to reduce levels as far below 200 pCi/L as possible. We recommend that you take action within several weeks. If this is not possible, you should determine, in consultation with appropriate state or local health or radiation officials, if temporary relocation is appropriate until the levels can be reduced."

Results from 20 to 200 pCi/L: "Exposures in this range are considered above average for residential structures. You should undertake action to reduce levels as far below 20 pCi/L as possible. We recommend that you take action within several months"

Results from 4 to 20 pCi/L: "Exposures in this range are considered above average for residential structures. You should undertake action to lower levels to about 4 pCi/L or below. We recommend that you take action within a few years, sooner if levels are at the upper end of this range."

Results about 4 pCi/L: "Exposures in this range are considered average or slightly above average for residential structures. Although exposures in this range do present some risk of lung cancer, reduction of levels this low may be difficult, and sometimes impossible, to achieve."

(Source: Brookins 1990, p.18)

## How Radon Enters

Radon gas can enter a dwelling by three principal routes: 1. soil gas, 2. potable water, and 3. building materials (see Figure 2) [EPA 1986, p.4].

### Soil Gas

The rocks and soil over which dwellings are built are the primary source of most radon detected in homes [Brookins 1990, p.85]. Radon can enter the inner atmosphere through cracks, joints, and around sump pumps and plumbing penetrations. Since uranium and radium are found in wide distribution, the composition of the soil and rock will have to a large extent an impact on how much radon is present in the dwelling. The estimated radium content of the soil in the United States is approximately 1 pCi/g. Even though this may seem low, this amount of radium can produce from 200 to 1000 pCi/L of radon in a broad range of soil conditions [EPA 1987, p.10].

One of the most important physical characteristics of soil as it relates to indoor radon is its permeability. The permeability of soils can vary a great deal, permeability values course gravels down to homogeneous clays can span more than 10 orders of magnitude [Nazaroff Et al. 1988, p.61].

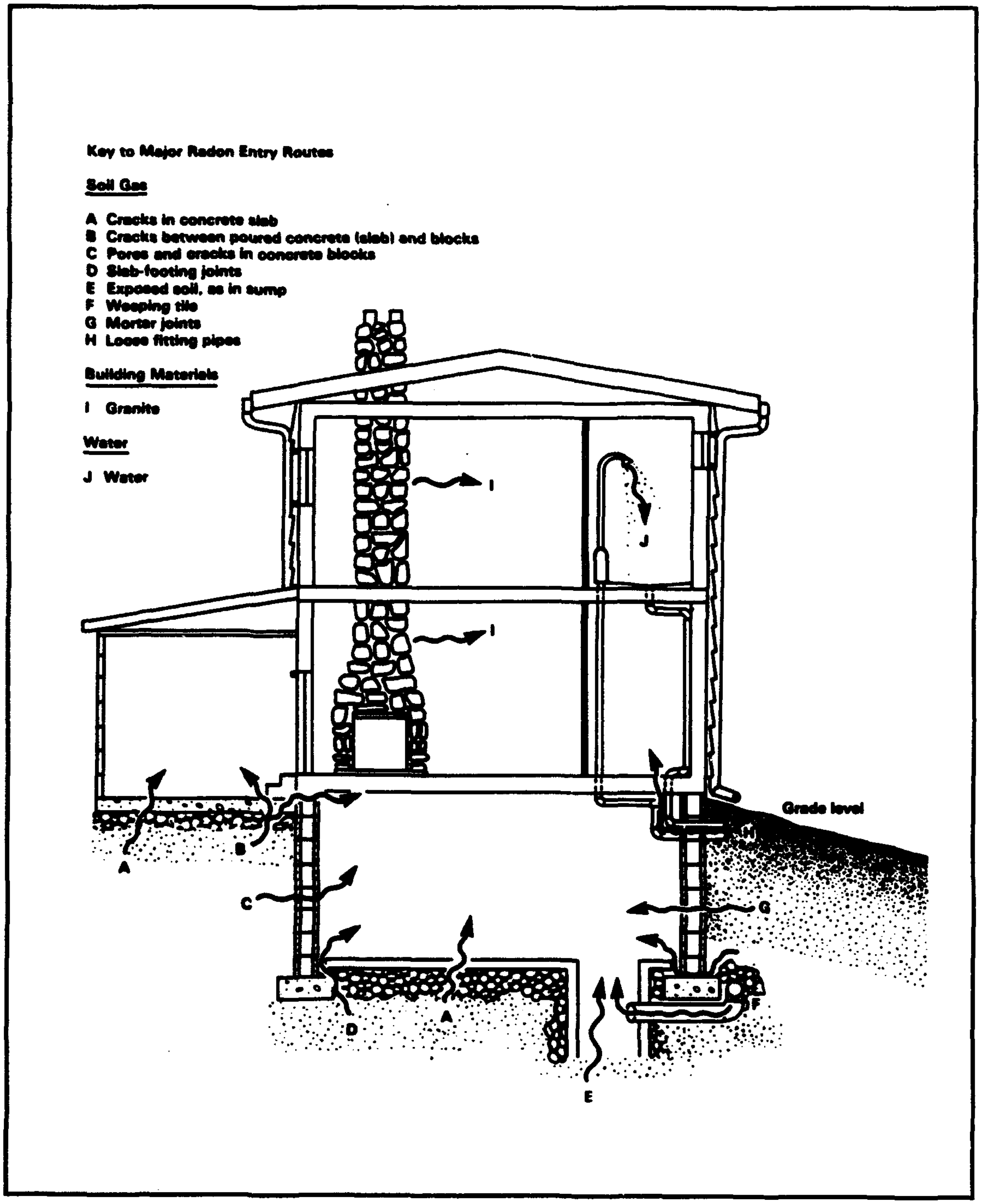


**Figure 2** Major Radon Entry Routes (Source: EPA 1986, p.4)

p.8)Two important processes for permeability are diffusion and convective flow. Studies have shown that of the two processes, convective flow is the processes that accounts for most of the elevated levels of indoor radon in american housing.

Diffusion is the process by which a particular species moves along a constant pressure gradient. The movement is caused by the thermal action of individual molecules.

Convective flow means that a circulating system, such as a pressure differential, of fluid causes matter to migrate [Brookins 1990, p.88]. Because it uses a pressure differential for movement, convective flow is also known as pressure-driven flow. Where the pressure inside the dwelling is lower than that outside, radon gas can be drawn into the dwelling by pressure-driven flow.

These pressure differences need not be large. Pressure differences of only a few Pascal arise from winds and indoor-outdoor temperature differences are enough to drive small flows of gas that can significantly elevate radon levels in dwellings [Nazaroff Et al. 1988, p.20]. Other changes in indoor pressure can result from the use of items such as bathroom and kitchen exhaust fans, clothes dryer exhausts and even heating and air-conditioning systems. Even decreases in barometric pressure can result in elevated radon levels.

During the winter heating season pressure-driven flow can be increased by the "stack effect". The stack effect works much the same as a chimney, but instead of smoke, warm air rises in the house and will eventually flow out the attic through loose fitting windows, and any other openings it may find. This rising air tends to draw radon into the inner atmosphere through cracks, joints, and around the sump pumps and plumbing penetrations. Eliminating the effects of pressure-driven flow will become the main strategy of the radon mitigation process.

## Potable water

The second most important route of entry for radon is the potable water service. Potable water service in the United States comes from surface sources (49.5 percent), public groundwater supplies (33.2 percent), and private wells (18.3 percent). Surface water have average radon concentrations of only 0.0005 pCi/L, groundwaters 0.009 pCi/L, and well waters 0.06 pCi/L [Brookins 1990, p.96]. While these average concentrations do not appear to be much of a problem, individual concentrations of up to 300,000 pCi/L have been found in some private wells. Radon is released by water on an average of about 0.1 pCi/L of radon in the air for every 1000 pCi/L of radon in water [Bodansky Et al. 1987, p.54].

Radon is soluble in water and can be easily released when the water is heated. Typical avenues of entry for radon by potable water are dishwasher (95 percent), shower (66 percent), bath (42 percent), toilet (30 percent), laundry (92 percent), drinking and cleaning (34 percent) [Brookins 1990, p.96]. This shows clearly that any remediation program for potable water should concentrate around the water heating system.

## Building Materials

The third most important route of entry for radon are building materials used in the construction of the dwelling. Although not nearly as important a source as soil gas and potable water, certain building materials that are derived from minerals in the earths crust may contribute to elevated radon levels (see Table 2). The amount of radon released by these building materials into the dwelling is relatively small. Approximate values include: concrete at 0.5 pCi/L, brick at 0.14 pCi/L, and by-product gypsum at 0.28 pCi/L [Brookins 1990, p.104].

**Table 2** Radium Content of Some Common Rocks & Building Materials

| Material | Radium Concentration (pCI/Kg) |
|---|---|
| Concrete | 270 - 2,160 |
| Brick | 540 - 5,405 |
| Granite | 2,700 - 5,405 |
| Gypsum Wall Board | 13,510 - 54,050 |

(Source: Brookins 1990, p.103)

## RADON DETECTION METHODS

### General Issues in Radon Detection

The concentration of radon and radon progeny within a dwellings atmosphere vary with time, on both a daily cycle and an annual cycle. These fluxations are dependent upon atmospheric changes, seasonal changes and the usage of the dwelling by the occupants [Bodansky Et al. 1987, p.31]. A decision must be made whether to use a short-term or long-term testing period, based on the type of information desired and the time available.

Short-term testing provides the quickest way to determine radon levels. However, because radon levels vary on a daily and seasonal basis, the short-term testing period will not give an accurate assessment of the dwellings year-round average radon level. Short-term testing is useful however, in determining whether a significant radon problem exists and if long-term testing is indicated [EPA 1993, p.13]. Both passive and active detecting devices may be used to carry out a short-term test.

Long-term testing is useful in determining the dwellings year-round average radon level. The long-term test is most useful in confirming initial short-term test results. Long-term tests are conducted for periods longer than 90 days [EPA 1993, p.13]. Because of the length of time involved with long-term testing, generally only passive detecting devices are used.

Radon testing should be conducted under closed-house conditions. This is especially true for short-term testing. When conducting a short-term test, windows and outside doors should be closed at least 12 hours prior to the start of the test. Normal use of door is permitted for entering and exiting, however. Long-term testing should conducted during seasons when the dwelling is normally more sealed, such as winter months in the north and late summer months in the south [Brookins 1990, p. 111].

Radon detecting devices should located in the lowest level of the dwelling suitable for occupancy. Devices should be place 20 inches above the floor and in a location away from drafts, high heat, high humidity and exterior walls [EPA 1993, p.12, 15].

## Passive Devices

Passive radon detecting devices do not require power to function. This makes passive detection devices inexpensive and ideal for both short-term and long-term testing applications. These devices normally include: charcoal canister detectors, alpha track detectors, charcoal liquid scintillation detectors and electret ion chamber detectors.

## Charcoal Canister Detectors

Charcoal canister detectors consist of tightly sealed canisters of activated charcoal that will allow air to filter into them when unsealed. Radon is absorbed by the activated charcoal, this absorbed radon decays and deposits its progeny in the charcoal. Once the detector is resealed, it is sent to a laboratory where radon concentration is measured by counting the gamma emissions of the short lived radon progeny [Lao 1990, p.79].

The detector is useful in measuring indoor radon concentrations over a period of 2 to 7 days. Because the half-life of radon-222 is 3.8 days, it is essential to return the detector to the laboratory as soon as the testing is completed.

## Alpha Track Detectors

Alpha track detectors utilize the fact that heavy atomic particles, such as alpha particles, leave a microscopic track of damage when passing through certain types of plastic emulsions. The tracks are enlarged by developing them with a chemical etching solution and counted with a microscope. Radon concentration is proportional to the number of tracks per unit area.

An alpha track detector consists of a small piece of plastic emulsion enclosed in a containers with a filter-covered opening. The filter allows radon to enter the container, but excludes radon progeny in the air. This allows only the radon within the container to decay into progeny [Lao 1990, p.78].

Alpha track detectors are long-term testing devices. They are most effective for testing periods of more than 3 months, and may be used for periods of up to a year.

## Charcoal Liquid Scintillation Detectors

Charcoal liquid scintillation detectors are identical to charcoal canister detectors at the test site. The difference however is in the way radon concentrations are measured. Measuring the concentration of radon and radon progeny is accomplished by dissolving the charcoal in liquid scintillation fluid. This is followed by counting of the fluid in a liquid scintillation detector or by de-emanation of radon from the charcoal in to a scintillation cell for alpha particle counting [Cothern Et al. 1987, p.69].

## Electret Ion Chamber Detectors

The electret ion chamber detector is a fairly recent testing device. This device utilizes a electrostatically charged plastic disc, known as an electret, mounted in a canister isolated form particulates by a filter. Radon passes through the filter and induces a negative charge in the air near the positively charged electret. The negative ions in the air are attracted to the electret surface and a voltage is imparted. The voltage change is measured and is proportional to radon concentrations [Brookins 1990, p.116].

## Active Devices

Active radon detecting devices require power to function. They can be expensive and require operation by trained testers. They do provide continuous measuring and recording of radon or radon progeny in the air of the dwelling. Active devices normally include continuous radon monitors and continuous working level monitors.

## Continuous Radon Monitors

Continuous radon monitors test for radon by continuously pumping air into a scintillation cell. As with most methods of testing, a filter is used to remove radioactive particulates and dust from the air. As the radon in the sample decays, alpha particle radon progeny strike the surface of the scintillation cell giving off a small burst of light. These bursts of light are recorded by a photomultiplier tube, and ultimately counted.

Continuous radon monitors are available as flow-through test units or periodic-fill test units. In flow-through units, air flows continuously through the scintillation cell and the counting is performed concurrently. Periodic-fill test units sample the air at preselected time intervals to perform counting [Lao 1990, p.82].

Continuous radon monitors are ideally suited for relatively short measurement periods, 6 hours for screening and 24 hours for follow-up measurements, but are highly expensive.

### Continuous Working Level Monitors

Continuous working level monitors measure the radon progeny concentrations of the air. Continuous working level monitors dwelling air by drawing air through a filter cartridge at a low flow rate. The filter collects airborne particles and allows an alpha detector to count the alpha particles emitted by radon progeny. The detector is normally set to detect alpha energies between 2 to 8 MeV, corresponding to alpha particles emitted by polonium-218 and polonium-214 [Lao 1990, p.83].

Continuous working level monitors are ideally suited for relatively short measurement periods, 6 hours for screening and 24 hours for follow-up measurements, but are highly expensive.

## EPA's Testing Checklist

Radon testing is not a difficult process, however attention to detail is require to ensure that it is performed properly. To ensure the accuracy of test results the Environmental Protection Agency provides a checklist for testing agencies to follow. This checklist explains the conduct of all parties required before, during, and after the testing period. Copies of the checklist are available through the EPA. Testing consultants should be able to confirm that all the items in the checklist have been followed [EPA 1993, p.16].

## RADON MITIGATION METHODS

### General Issues in Radon Reduction

With reference to Figure 2, the principal methods of preventing radon entry into a dwelling are:

1. Sealing and closing of all pores, voids, utility penetrations, construction joints, and exposed earth that permit soil-gas to enter a dwelling.
2. Reversing the direction of soil-gas flow so that air movement is from the dwelling to the soil and outside air.
3. Avoiding the use of potable water supplies, principally individual wells, that are contaminated with radon or removing radon prior to use.
4. Avoiding the use of building materials that may contain radium and release radon.

Currently, the only effective method for removing radon after it has entered a dwelling is by ventilating the affected living space. Ventilation entails bringing outside air into the dwellings living areas, basement, or crawl space to displace and replace an equal volume of indoor air and to mix with undisplaced indoor air. The effect of increasing ventilation rates for dwellings over a typical range of 0.2 to 2.0 air changes per hour (ach) is shown in Figure 3. This figure which shows four important characteristics associated with the use of ventilation for radon removal are discussed below [EPA 1986, pp.5-6]:

1. The use of ventilation for reducing indoor radon levels decreases with increased ventilation rates. Or said another way, ventilation is better suited and more cost effective for tight dwellings.

2. Increasing ventilation rates from 0.25 to 2.0 air changes per hour can reduce indoor radon levels by approximately 90 percent.

3. Ventilation, although helpful, can not reduce indoor radon levels below a finite level determined by radon source strength and entry rates.

4. While in theory ventilation can be utilized to effectively and efficiently reduce indoor radon concentrations, practical field experience has shown that it is difficult to operate ventilation systems so as not to induce pressure-driven flow.

There are a number of methods that can effectively reduce radon concentrations in dwellings. These methods either utilize dwelling ventilation/air exchange or control of radon at its source. It should be noted that while any one of these methods may be sufficient to lower radon concentrations in a given dwelling, higher concentration levels may be

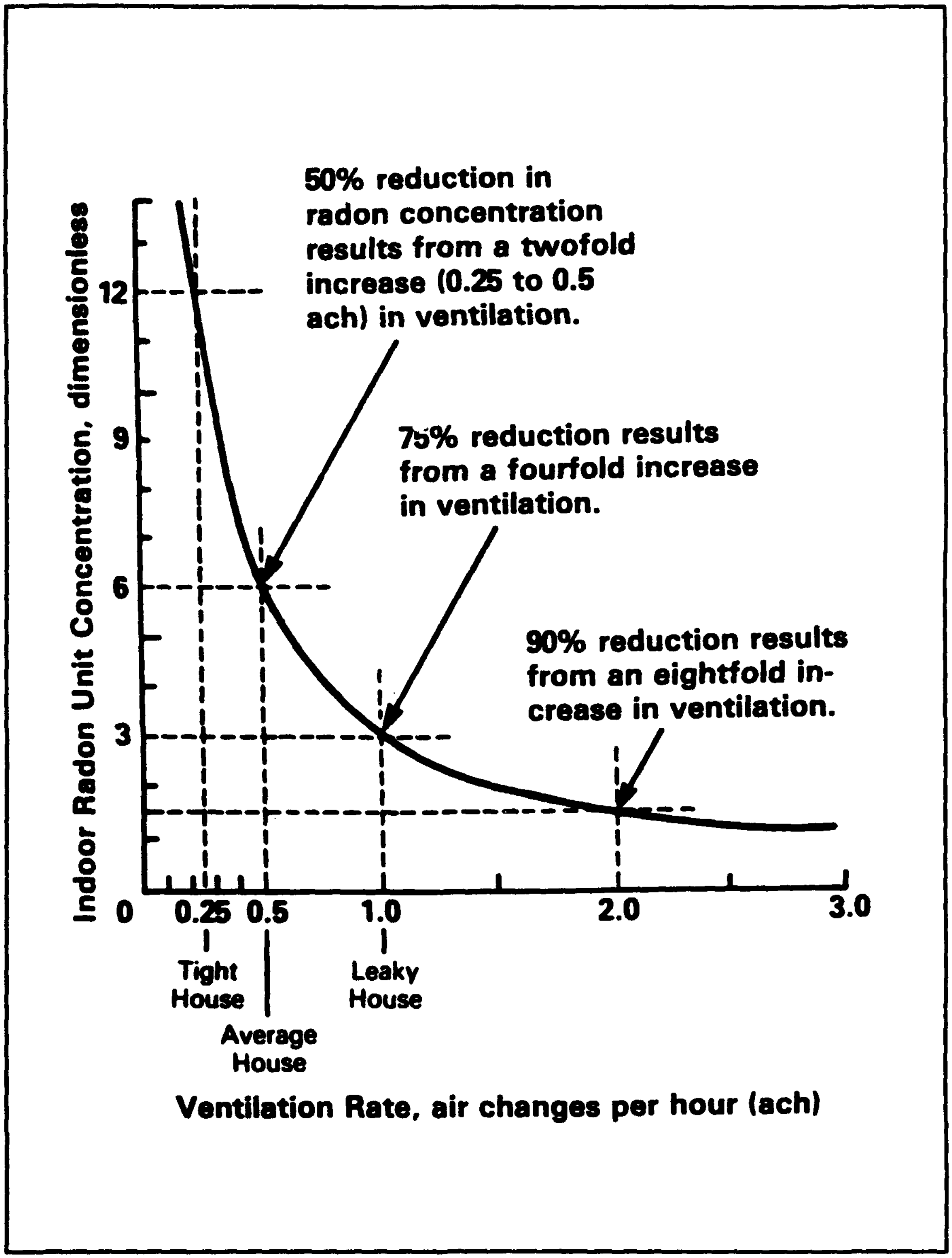


**Figure 3** Effect of Ventilation on Indoor Radon Concentrations (Source: EPA 1986, p.5)

more economically dealt with by using a combination of several methods [EPA 1986, p.6].

## Natural and Forced Air Ventilation

Natural Ventilation is the exchange of indoor air for outdoor air that occurs due to natural forces. The major forces driving natural ventilation are wind, pressure, and temperature differences between the indoor and outdoor atmospheres. Natural ventilation in a dwelling takes place through all passageways that allow free communication of with the outside air. Typical examples, normally associated with weatherstripping, include: openings around windows and doors, switch and receptacle plates, and open joints in building materials.

Forced air or mechanical ventilation relies on the use of fans to induce an increase in dwelling air exchange rates by: 1. blowing in fresh outside air or 2. exhausting indoor air with the assurance that it will be replaced with cleaner outside air.

In most American dwellings under normal use, the average air exchange rate is approximately 1.0 air change per hour (ach). Newer dwellings, built to be more energy efficient, have air exchange rates as low as 0.1 ach, and older dwellings may have air exchange rates as high as 2.0 ach [EPA 1986, p.10]. Again, dwellings with high air exchange rates are not suitable for the ventilation method of radon mitigation.

Both the natural and forced ventilation method reduce indoor radon concentrations by both the removal of radon-laden air and the dilution of the total indoor air volume with clean outdoor air.

The main drawback of natural and forced ventilation methods is the energy penalty imposed by the need to maintain human comfort conditions at potentially high ventilation rates. This drawback may be offset by closing off and limiting of these ventilation methods to areas such as basements. Natural ventilation of a basement can be accomplished if window around the perimeter are opened to allow cross ventilation. Forced ventilation can accomplish the same result by strategically locating two or three fans to provide for the cross ventilation.

Negligible installation costs are incurred with the natural ventilation method, while the forced ventilation method requires purchase of fans at a minimum. More sophisticated forced ventilation systems require new wiring, duct work, dampers, filters and smoke detectors. Operating costs, due to extra heat/cooling, can be expected if these methods are used during heating and cooling seasons.

## Forced Air Ventilation with Heat Recovery

Forced air ventilation with heat recovery is a technique that brings outside air into a dwelling, exhausting radon-laden air, and transferring and recovering heat energy from the exhaust air to the cleaner incoming air by means of a heat exchanger. This technique is similar to, but much superior than, the standard forced ventilation method. By transferring heat in the exhaust air to the incoming air ventilation as a radon mitigation method can be extended to a wider range of climatic conditions.

This application has the greatest potential in low-ventilation rate dwelling in cold climates. These conditions maximize the effectiveness of the ventilation and heat exchanger system [EPA 1986, p.11].

Installation costs will vary with the size and complexity of the system to be installed. A slight increase in operating cost will be seen, however, heat recovery rates of up to 70 percent are possible and should make this alternative more cost effective over extended periods.

## Active Avoidance of Dwelling Depressurization

The dwelling living space may be depressurized when certain household appliances that use and exhaust inside air to the outside are used and when unbalanced natural or forced air ventilation is applied. Depressurization of a dwelling occurs naturally in the winter as a result of the "stack effect". The winter depressurization in the dwelling is believed to be the main cause of increased soil-gas radon entry [EPA 1986, p.12].

Reducing depressurization associated with household appliances is fairly straightforward. The american Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has recommended the provision of outside makeup air for combustion appliances, such as furnaces, waterheaters, and clothes dryers since 1981 [EPA 1986, p.12]. Outside air duct work consisting of small dampered vents and flexible hose is relatively inexpensive and easy to install. Most modern combustion appliances come equipped from the factory with makeup air connections.

Installation costs for these modifications are very minor. Operation of these appliances with outside makeup air may increase efficiency and therefore provide a cost savings.

## Sealing Radon Sources

Soil gas has been determined to have the largest impact on dwelling radon concentrations, since uranium and radium are found in wide distribution, the composition of the soil and rock will have to a large extent an impact on how much radon is present in the dwelling. It is reasonable to assume that a great benefit would be derived from sealing off this source of radon from the interior of dwellings. This mitigation method is best categorized by the size of the source, therefore major and minor sources will be dealt with separately.

## Major Sources

The existence of exposed soil and rock under, around, or within a dwelling can be a major source of radon entry. These areas should be closed or sealed to prevent radon laden soil gas from entering the dwelling. Areas with exposed earth, such as soil floored basements and water drainage sump areas should be excavated and covered with a concrete cap, or at least covered with an impermeable membrane, and forced air exhausting of any below grade air space such as sump cavities [EPA 1986, p.13].

Generally speaking, capping and sealing major potential sources of radon laden soil gas entry has a significant reduction benefit. It is cautioned however that the durability of this method is limited to the quality of the installation and materials used. Even imperceptible movements of a dwelling's understructure may create small imperfections that result in passageways for the entry of radon laden soil gas.

Sealing and exhausting the sump area can have a dual benefit. Although the immediate purpose is to exhaust the radon laden soil gas that enters the sump, Figure 4 show that suction produced by the exhaust fan may draw soil gas from the attached drain tile and diminish soil gas entry for some distance [EPA 1986, p.13].

Installation costs of sealing and capping will vary depending upon size and material used. Sump exhaust system installation costs also vary with the size and complexity of the system to be installed. However, annual operating costs of exhaust systems are quite reasonable.

## Minor Sources

Entry of radon laden soil gas can be prevented by sealing cracks, openings, or other voids in the dwelling's envelope that may provide a passageway to the interior. These small passageways include: cracks, openings around utility services, and voids created by concrete form ties. This is often considered to be an initial radon reduction method, and is often utilized with other radon mitigation methods [EPA 1986, p.13].

Applicability of this method is generally limited by the knowledge of and access to all small soil gas entry routes. This is again complicated where the remodeling of dwelling basements has occurred. The limited access is a major impediment to the sealing process. An occupant should not expect sealing of all noticeable cracks or openings to eliminate an indoor radon problem.

Installation costs can vary according to the size and condition of the area to be sealed. Additionally, if remodeling has occurred further expenses may be incurred for its removal and replacement.

## Drain Tile Soil Ventilation

Dwellings utilizing surrounding perforated drain tiles next to the footings to drain moisture away from the foundation may also be used to draw radon laden soil gas away from the potential entry passageways through drain tile ventilation. Depending upon the permeability of the soil and of the aggregate beneath the slab, drain tile ventilation can also ventilate portions of the area underneath the slab and the soil well above the footing level [EPA 1986, p.15].

The advantage of drain tile ventilation is that it is the least expensive, for dwellings already having drain tiles, and least unobtrusive method of active soil ventilation. For dwellings without drain tiles other interior ventilation methods may prove to be more viable, unless concern for the appearance of a remodeled basement is a concern.

Another concern is the condition and extent of the drain tile run. Drain tiles should encompass the entire perimeter of the dwellings footing and be free of blockages such as silt.

Two methods of drain tile ventilation exist. The sump ventilation method was illustrated in Figure 4. As discussed in the previous section, the sump ventilation methods immediate purpose is to exhaust the radon laden soil gas that enters the sump, however suction that is produced by the exhaust fan may draw soil gas from the attached drain tile and diminish soil gas entry for some distance. The other drain tile ventilation method, illustrated in Figure 5, is used where the tiles drain to an above ground soakaway. The ventilation system is connected to the existing line running to the soakaway and consists of: a trap, a set of risers, and a fan. The ventilation system can be install anywhere along the drain line as long as trap is sufficiently deep underground to keep the water from freezing [EPA 1986, p.17].

Due to the outside location of the ventilation system in the soakaway method, operating and maintenance requirements are greater than with the sump method. Regular inspections to ensure that the fan is operating properly, the trap is full of water, and that the exposed seals are in good condition should be conducted by the occupant of maintenance staff [EPA 1986, p.19].

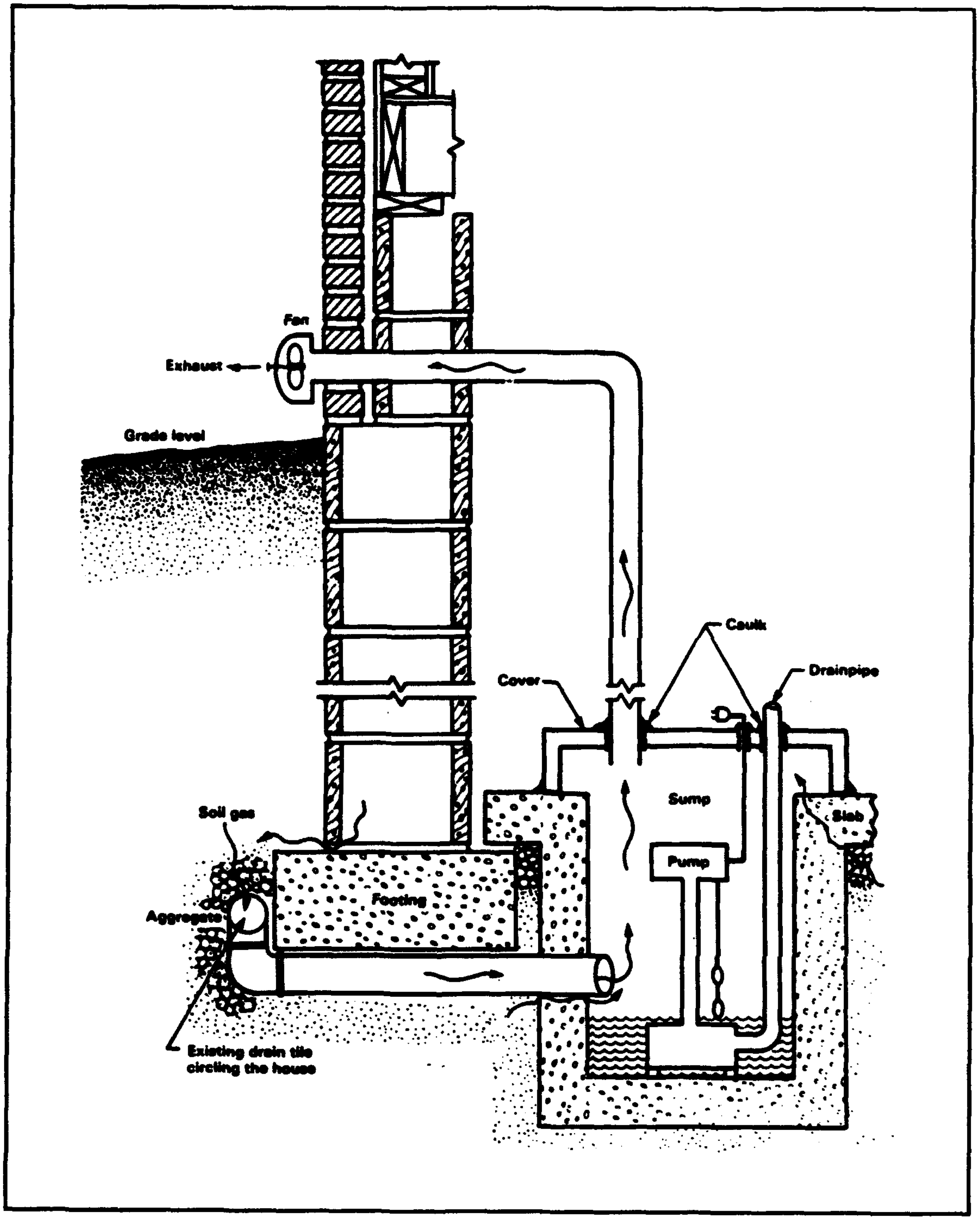


**Figure 4** Drain Tile Ventilation Where Tile Drains to Sump (Source: EPA 1986, p.14)

Installation cost will depend upon the choice of method for drain tile ventilation, and whether the installation is performed by contractors or occupants. Operating cost will include the electricity to run the fan, and perhaps a heating penalty due to the increased ventilation of the dwelling [EPA 1986, p.19].

## Active Ventilation of Hollow-Block Basement Walls

Concrete Masonry Units (CMU) that are used to erect basement walls contain void spaces. These void spaces are generally interconnected both vertically and horizontally within a wall, thereby allowing soil gas that enters the wall through mortar joint cracks or pores to migrate throughout the wall, and ultimately enter the dwelling.

Active ventilation of hollow-block basement walls is used to sweep the soil gas from the voids by drawing a vacuum on the voids within a wall. By placing the voids at a lower pressure than the basement, soil gas is drawn through to outside face of the basement and vented to the outside atmosphere instead of into the basement [EPA 1986, p.19].

Two methods of active ventilation of hollow-block basement walls have been evaluated. The first method consists of inserting one or two pipes, connected to exhaust fans that draw the vacuum, into the void network of each basement wall

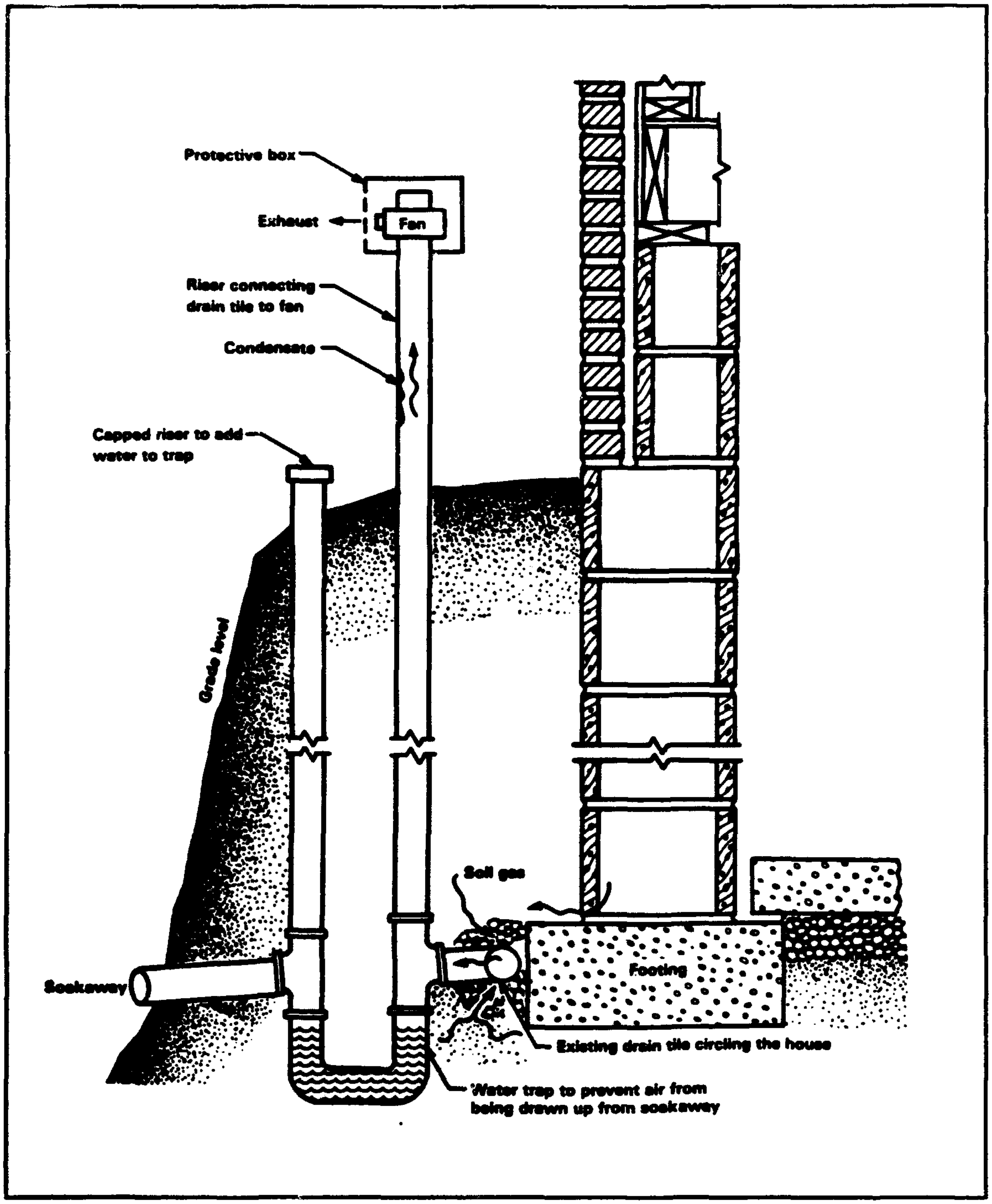


**Figure 5** Drain Tile Ventilation where Tile Drains to a Soakaway (Source: EPA 1986, p.18)

(see Figure 6). The second method involves encircling the perimeter of the basement with a sheet metal baseboard duct, covering the joint between the wall and the slab. Holes are drilled into the block wall at intervals inside the baseboard duct, and the wall is ventilated by drawing a vacuum on the baseboard with exhaust fans (see Figure 7). The baseboard duct method is more effective at ventilating basement walls, but is more expensive than the individual pipe system. Additionally, the baseboard duct method to wall ventilation is especially useful in block basements having French drains around the inside perimeter of the basement wall for drainage. The baseboard duct covers the drain gap and not only draws soil gas from the block wall, but also the aggregate underneath the slab.

Inorder for either hollow-block ventilation method to be effective, the vacuum drawn on the wall void network requires that all major openings in the wall be closed. These major openings include: openings in the top layer of block, gaps between the concrete masonry units and the brick veneer, and utilities penetrations [EPA 1986, p.20].

Operation and maintenance of either wall system should include regular inspections by the occupant or maintenance staff to ensure that the fans are operating properly, and that all seals are in good condition.

Installation cost will depend upon the choice of method for ventilation of hollow-block basement walls, and whether the installation is performed by contractors or occupants. As with any interior mitigation method, dealing with a remodeled basement will increase installation costs. Operating cost will include the electricity to run the fans, and perhaps a heating penalty due to the increased ventilation of the dwelling [EPA 1986, p.31].

## Sub-Slab Depressurization System

Soil gas accumulates in the soil and aggregate that underlie concrete slabs in basements or on grade. This gas once accumulated can migrate into a dwelling through any openings such as: wall/floor joints, settling cracks, cold joints, or openings around utility penetrations.

Sub-slab depressurization uses a fan to create a vacuum within the soil and aggregate underlying the slab. By causing a vacuum within the soil and aggregate, any gas flow consists of cleaner indoor air flowing outward into the aggregate through the openings in the slab rather than soil gas flowing into the dwelling [EPA 1986, p.32].

Two methods of sub-slab depressurization have been evaluated. The first method consists of inserting two or

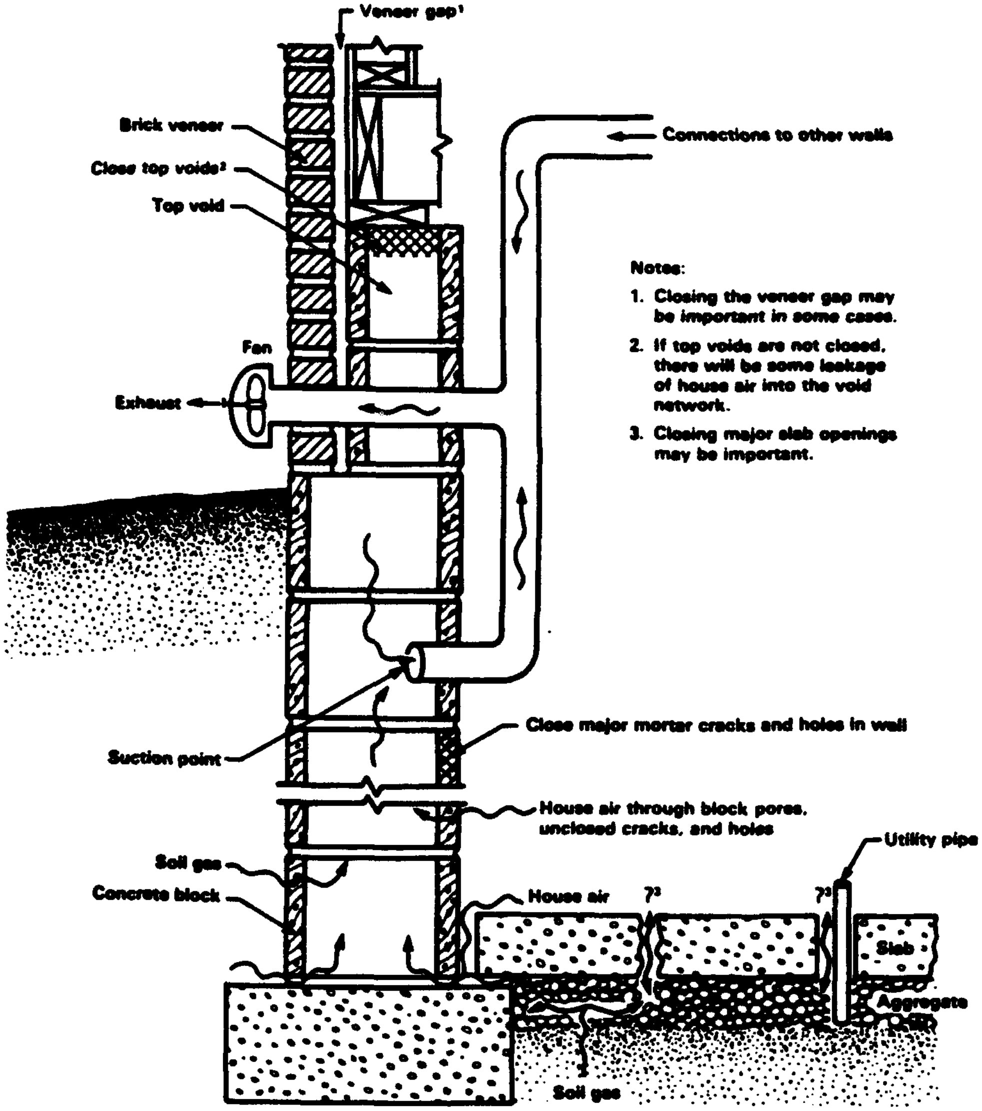


**Figure 6** Wall Ventilation with Individual Suction Points in each Wall (Source: EPA 1986, p.23)

more nonperforated pipes vertically down through the slab and into the aggregate and all ventilation is achieved by drawing a vacuum on these pipes with fans (see Figure 8). The second method, used more in Canada than the United States, consists of a network of horizontally laid perforated pipes underneath the slab. The network is connected to vertical risers which by means of fans produce a vacuum within the network. This second system is less dependant upon soil and aggregate permeability than the first.

Installation of a sub-soil depressurization system depends upon the dwelling situation. In new construction, use of the horizontally laid perforated pipe system should be considered for installation prior to slab placement. In some cases, newer dwellings have perforated pipe already installed beneath the slab for water drainage, this drainage network could be easily used as part of a sub-soil depressurization system. In retrofit applications, the vertical piping method seems to be the best alternative. Even in less permeable soil a small sump can be added to the system to create a void space for soil gas to accumulate. By careful placement of suction points, this type of system will ensure effective depressurization of the slab.

Operation and maintenance of either sub-soil depressurization system include regular inspections by the occupant or maintenance staff to ensure that the fans are operating prop

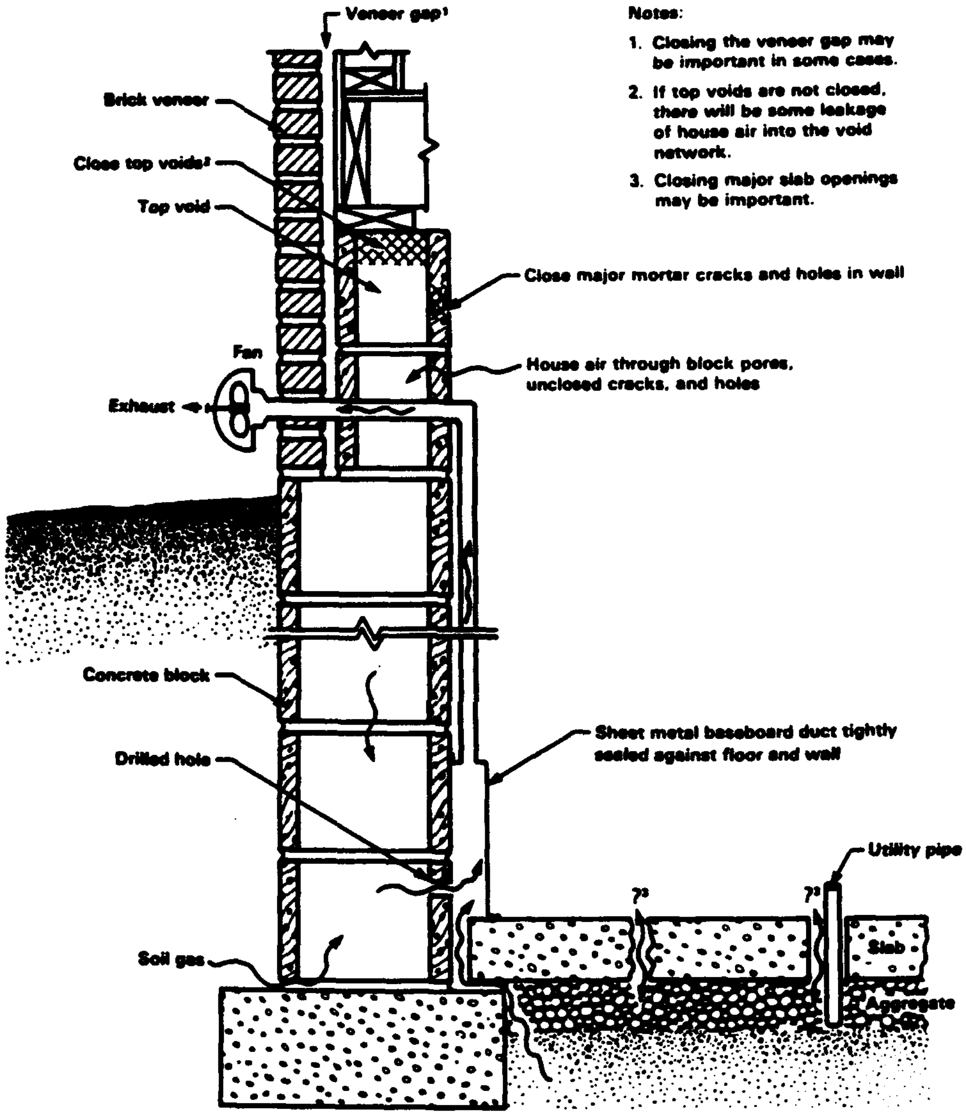


**Figure 7** Wall Ventilation with Baseboard Duct (Source: EPA 1986, p.29)

erly, that all seals are in good condition, and the new concrete remains intact.

Installation cost will depend upon the choice of method for sub-slab depressurization, and whether the installation is performed by contractors or occupants. Installation of a sub-slab depressurization system is not an easy do-it-yourself job, but some more knowledgeable occupant could save a considerable amount by performing the work themselves. As with any interior mitigation method, dealing with a remodeled basement will increase installation costs. Operating cost will include the electricity to run the fans, and perhaps a heating penalty due to the increased ventilation of the dwelling [EPA 1986, p.40].

## RADON LEVELS IN NAVY FAMILY HOUSING UNITS

In 1989, the Naval Facilities Engineering Command undertook a study to determine radon concentrations in the worldwide inventory of Navy and Marine Corps Family Housing units. The study only included Family Housing because in 1989, Naval Facilities Engineering Command was responsible only for the Navy Family Housing Program, however, later the Secretary of the Navy and the Chief of Naval Operations transferred the responsibility for Bachelor Officer and Enlisted Quarters to Naval Facilities Engineering Command in

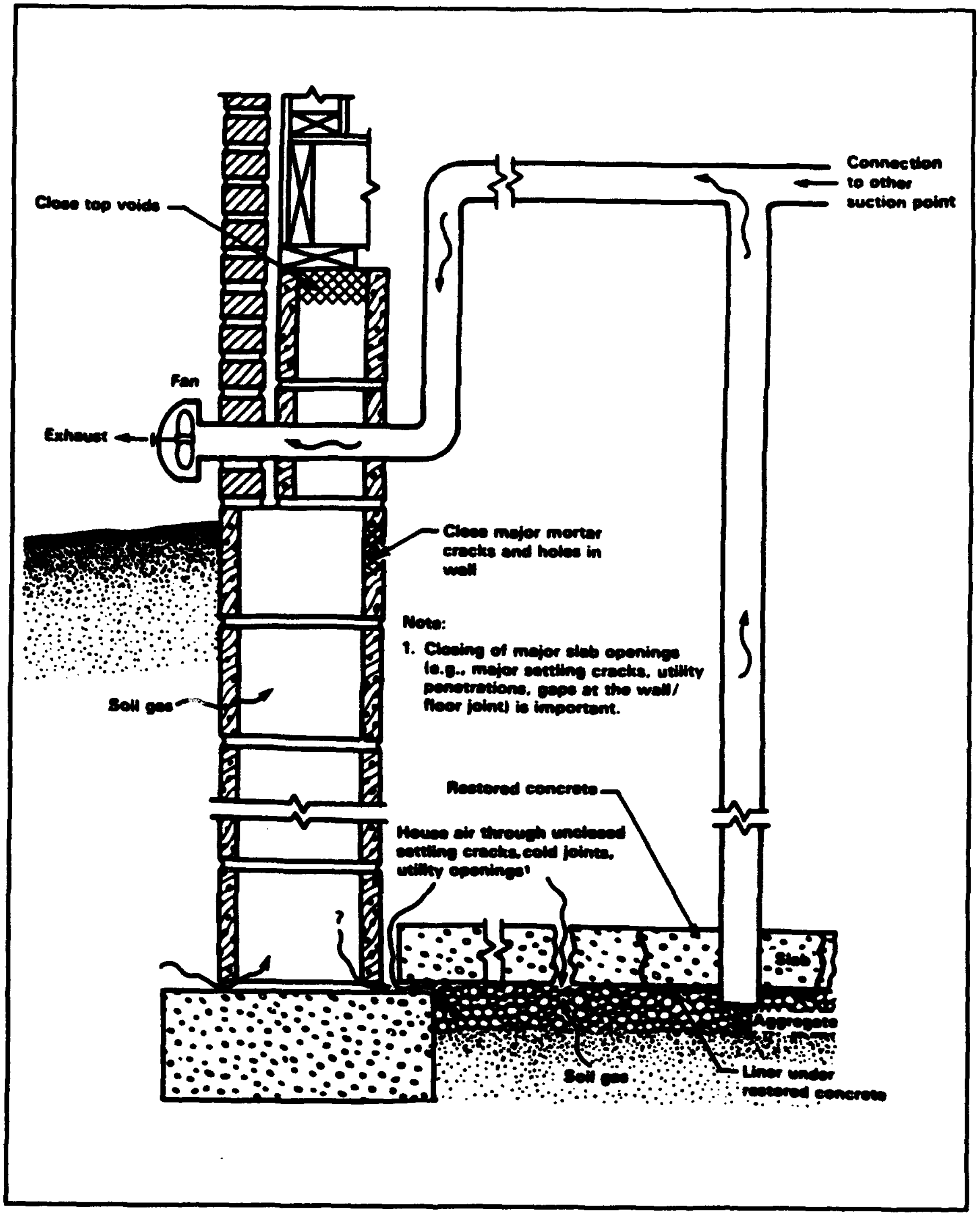


**Figure 8** Sub-Slab Ventilation using Individual Suction Point Approach (Source: EPA 1986, p.34)

1993 from Naval Supply Systems Command. Naval Facilities Engineering Command undertook a similar study for these bachelor quarters, and will be integrating the data in the near future.

The study was contracted out and was to be conducted during the winter heating season of 1989, however, due to scheduling problems, the contractor was unable to deliver detection devices to all Family Housing Areas in time for installation. Overseas areas received their detectors several months after the heating season began. On a complaint from this author, and several other Facilities Engineers, the program was extended to ensure accurate measurements where obtained for all units.

The study used passive charcoal canister and alpha track detectors to determine the minimum, maximum, and average radon concentrations in each type and location of Navy Family Housing. After training from Facilities Engineers, Housing Inspectors installed and recorded all pertinent information on the detector data sheets. As the study continued the contractor would recall certain detectors for testing. The inspectors would retrieve those detectors and complete the detector data sheets. These detectors would then be shipped back to the contractor for testing. This process continued until all detectors had been recalled.

Appendix A is a listing of all Navy Family Housing Units worldwide, by type and location, in which excessive concentrations of radon have been detected. Over 10,966 units have been identified with maximum radon levels in excess of the 4 pCi/L "Action Level".

## SAMPLE RADON MITIGATION PROJECT DOCUMENTATION

The Commander, Naval Facilities Engineering Command has established policies dictating that Field Activities are responsible for maintaining family housing facilities at a standard which provides adequate and habitable accommodations. The Field Activity Housing Manager, or Housing Facilities Engineer, is responsible for initiating necessary documentation and justification for all repair projects funded from the Family Housing Management Account, Defense [NAVFAC P-930 1983, p.20-2]. Repair projects are defined in the NAVFAC P-930 as:

> "To restore a real property facility or system to such condition that it may be effectively used for its designated purpose and which does not increase the property account value. This includes the replacement of constituent parts or materials which have deteriorated by action of the elements or use and have not been corrected through maintenance."

Clearly radon mitigation programs fall within the scope of this definition. Projects that safeguard the health of housing occupants are always considered repair projects. Recent examples include asbestos abatement projects and numerous structural projects.

The Environmental Protection Agency has established an "Action Level" for the mitigation process at 4 pCi/L [EPA 1993, p.11]. Thus any Navy Family Housing unit determined to have maximum or average radon concentrations of 4 pCi/L or higher should be programmed for radon mitigation repairs.

Funding for mitigation repairs must be requested utilizing: DD Form 1391 and DD Form 1391c, Military Construction Project Data Sheets (see Figures 9 and 10); and a NAVFAC 11013/7 Cost Estimating Form (see Figure 11). Sample project documentation was completed in accordance with NAVFAC P-930.

| 1. COMPONENT | FY 19 94 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE |
|---|---|---|
| NAVY | | 15 JUL 1994 |

| 3. INSTALLATION AND LOCATION | 4. PROJECT TITLE |
|---|---|
| Marine Corps Finance Center<br>Kansas City, MO | Repairs to 256 Capehart<br>Family Housing Units |

| 5. PROGRAM ELEMENT | 6. CATEGORY CODE | 7. PROJECT NUMBER | 8. PROJECT COST ($000) |
|---|---|---|---|
| AC | | HR-1-94 | $1,031.3 |

9. COST ESTIMATES

| ITEM | U/M | QUANTITY | UNIT COST | COST ($000) |
|---|---|---|---|---|
| Block ventilation system | UN | 256 | 2,803 | 717.6 |
| Engineering Estimate | | | | 717.6 |
| Contractor's OH&P | | | | 179.3 |
| Subtotal | | | | 896.9 |
| Contingency (5%) | | | | 44.8 |
| Total Contract Cost | | | | 941.8 |
| SIOH (3.5%) | | | | 32.9 |
| Design (6%) | | | | 56.7 |
| Total Requested (FY 94 Dollars) | | | | 1,031.3 |

10. DESCRIPTION OF PROPOSED CONSTRUCTION

This project encompasses all radon mitigation repairs required to officers and enlisted Capehart housing units at Marine Corps Finance Center, Kansas City, MO. Seal all suspected cracks, replace vapor barrier, and install active ventilation of hollow-block wall devices.

11. REQUIREMENTS

PROJECT: Correct hazardous radon exposure situation.

REQUIREMENT: High radon gas concentration levels were indicated during the recent NAVFAC radon survey. Concentrations are significantly above the EPA action level.

CURRENT SITUATION: Further analysis has determined that radon gas is entering housing units via hollow-block foundation walls.

IMPACT IF NOT PROVIDED: Health risks to family housing occupants is unacceptable. Radon is linked to high rates of lung cancer. This is a severe morale problem. If repairs are not completed, these housing units will be removed from our inventory.

DD FORM 1 DEC 76 1391 PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED PAGE NO.

S/N 0102-LF-001-3910

Figure 9 Sample Radon Mitigation Project Documentation, DD Form 1391

| 1. COMPONENT | FY 19 94 MILITARY CONSTRUCTION PROJECT DATA | 2. DATE |
|---|---|---|
| NAVY | | 15 JUL 94 |

3. INSTALLATION AND LOCATION

Marine Corps Finance Center, Kansas City, MO

| 4. PROJECT TITLE | 5. PROJECT NUMBER |
|---|---|
| Repairs to 256 units of Capehart Family Housing Units | HR-1-94 |

1. UNIT COMPOSITION AND BILLET DESIGNATION

a.

| Units | (Bldgs) | Bldg Type | (Stories) | BR | Bath | Rank | Cat-Code |
|---|---|---|---|---|---|---|---|
| 215 | (215) | Single | (1) | 3 | 1.5 | ENL | 711-25 |
| 34 | (34) | Single | (1) | 3 | 1.5 | OFF | 711-26 |
| 7 | (7) | Single | (2) | 4 | 2 | OFF | 711-26 |

b.

| Units | YR Built | Acquired | Life | Type Const |
|---|---|---|---|---|
| 256 | 1961 | FY 60 Capehart | 25 | Frame |

c. N/A

2. REPAIR AND IMPROVEMENT PROJECTS (Last 5 Years)

| Project No. | Description | Completed | Cost |
|---|---|---|---|
| HR-8-89 | Replace Kitchen Fl. | 09.91 | $ 57,000 |

3. PROPOSED METHOD OF ACCOMPLISHMENT

a. Contractor.
b. No increments.

4. PHOTOGRAPHS N/A

5. DRAWINGS N/A

6. OTHER N/A

7. REMAINING REPAIR & IMPROVEMENT WORK REQUIRED

| Proj. Class | Work Required | Est. Cost |
|---|---|---|
| AC | Replace roofing & furnaces | $3,030.3K |

DD FORM 1 DEC 76 1391c    PREVIOUS EDITIONS MAY BE USED INTERNALLY UNTIL EXHAUSTED    PAGE NO.

S/N 0102-LF-001-3910

Figure 10 Sample Radon Mitigation Project Documentation, DD Form 1391c

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

**COST ESTIMATE**

DATE PREPARED: 15 JUL 94 | SHEET 1 OF 1

ACTIVITY AND LOCATION: Marine Corps Finance Center, Kansas, City, MO

CONSTRUCTION CONTRACT NO:

IDENTIFICATION NUMBER: HR-1-94

PROJECT TITLE: Radon Mitigation, Hollow-Block Wall Foundations - 256 Capehart Units

ESTIMATED BY: R. N. Morrison

CATEGORY CODE NUMBER: 711-25,711-26

STATUS OF DESIGN: [X] PFD [ ] 35% [ ] 100% [ ] FINAL [ ] Other (Specify) ________

JOB ORDER NUMBER:

| ITEM DESCRIPTION | QUANTITY | | MATERIAL COST | | LABOR COST | | ENGINEERING ESTIMATE | |
|---|---|---|---|---|---|---|---|---|
| | NUMBER | UNIT | UNIT COST | TOTAL | UNIT COST | TOTAL | UNIT COST | TOTAL |
| Fan, Centrifugal 250 Cfm, 4" Opening | 1 | EA | 200 | 200 | 59 | 59 | 259 | 259 |
| PVC, Schedule 40, 4" OD | 120 | LF | 1.16 | 139.20 | 10.50 | 1260.00 | 11.66 | 1,399 |
| 90° Elbow, PVC, Sch 40, 4" OD | 12 | EA | 3.00 | 36.00 | 7.50 | 90.00 | 10.50 | 126 |
| Tee, PVC, Sch 40, 4" OD | 3 | EA | 3.70 | 11.10 | 7.50 | 22.50 | 11.20 | 34 |
| Caulking, Butal Latex | 200 | LF | .17 | 34.00 | 1.59 | 318.00 | 1.76 | 352 |
| Electrical Cable, 3 Conductor | 50 | LF | .31 | 15.50 | .45 | 22.50 | .76 | 38 |
| Junction Box | 1 | EA | 2.09 | 2.09 | 5.29 | 5.29 | 7.39 | 8 |
| Fill CMU Voids | 140 | LF | 1.04 | 145.60 | 1.01 | 141.40 | 2.05 | 287 |
| Vapor Barrier | 1200 | SF | .03 | 36.00 | .22 | 264.00 | .25 | 300 |
| Engineering Estimate | | | | | | | | 2,803 |
| 256 Units | | | | | | | | 717,568 |
| Contractors OH$P | | | | | | | | 179,392 |
| Subtotal | | | | | | | | 896,960 |
| Contingency (5%) | | | | | | | | 44,848 |
| Total Contract Cost | | | | | | | | 941,808 |
| *SIOH* (3.5%) | | | | | | | | 32,963 |
| ~~Design (6%)~~ | | | | | | | | 56,508 |
| Total Requst | | | | | | | | 1,031,279 |

S/N 0105-LF-010-1305

**Figure 11 Sample Radon Mitigation Project Documentation,... NAVFAC Form 11013/7**

## CONCLUSION

The purpose of this report was to understand the radon problem as it relates to Navy Family Housing Units. It is intended to be used as a guide for Housing Facilities Engineers who have never dealt with, and are facing radon problems within their own housing unit inventory. The Engineer is provided with a concise background on the: Definition of the Radon Problem, Radon Detection Methods, Radon Mitigation Methods, a Listing of Excessive Radon Levels in Navy Family Housing Units Worldwide, and a Sample of Radon Mitigation Project Documentation.

Because the Housing Facilities Engineer is tasked with the maintenance and repair of existing housing facilities, special emphasis was placed on providing information on current radon mitigation methods. This combined with the listing of excessive radon levels and the sample project documentation should provide the Housing Facilities Engineer with tools necessary to arrive at a sound engineering solution.

# APPENDIX A

## LISTING OF EXCESSIVE RADON LEVELS

## IN

## NAVY FAMILY HOUSING UNITS

## WORLDWIDE

Page No. 1
06/25/94

| | |
|---|---|
| CITY | ADAK NS |
| STATE | AK |
| DESC | 2 BEDROOM NEW ROBERTS |
| BLDG | 50 to 69 |
| UNITS | 6 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | 09/03/89 |
| STOP | 05/21/90 |

| | |
|---|---|
| CITY | ADAK NS |
| STATE | AK |
| DESC | 4 BEDROOM KULUK |
| BLDG | 50 to 69 |
| UNITS | 17 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | 08/02/89 |
| STOP | 05/02/90 |

| | |
|---|---|
| CITY | ALBANY MCLB |
| STATE | GA |
| DESC | CAPEHART HILL VILLAGE SG OFF |
| BLDG | CAPE |
| UNITS | 3 |
| MIN_PCI_L | 3.07 |
| MAX_PCI_L | 8.00 |
| AVG_PCI_L | 6.00 |
| START | 04/12/89 |
| STOP | 11/13/89 |

| | |
|---|---|
| CITY | ALBANY MCLB |
| STATE | GA |
| DESC | DOD 10300 AREA HILL VILLAGE BRICK |
| BLDG | 50 to 69 |
| UNITS | 11 |
| MIN_PCI_L | 1.70 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 3.00 |
| START | 04/13/89 |
| STOP | 11/10/89 |

| | |
|---|---|
| CITY | ALBANY MCLB |
| STATE | GA |
| DESC | DOD HILL VILLAGE ENL BRICK |
| BLDG | 50 to 69 |
| UNITS | 83 |
| MIN_PCI_L | 1.43 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 4.00 |
| START | 04/06/89 |
| STOP | 11/09/89 |

| | |
|---|---|
| CITY | ANNAPOLIS NSRDC |
| STATE | MD |
| DESC | QTRS A-COMMAND |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 3.96 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 04/13/89 |
| STOP | 03/22/90 |

| | |
|---|---|
| CITY | ANNAPOLIS NSRDC |
| STATE | MD |
| DESC | QUARTERS B |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 4.04 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 04/13/89 |
| STOP | 03/21/90 |

| | |
|---|---|
| CITY | ANNAPOLIS NSRDC |
| STATE | MD |
| DESC | QUARTERS E |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 4.26 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 04/13/89 |
| STOP | 03/21/90 |

| | |
|---|---|
| CITY | ANNAPOLIS USNA |
| STATE | MD |
| DESC | UPSHUR/RODGERS |
| BLDG | < 1950 |
| UNITS | 22 |
| MIN_PCI_L | 0.54 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 04/06/89 |
| STOP | 03/23/90 |

| | |
|---|---|
| CITY | ANNAPOLIS USNA |
| STATE | MD |
| DESC | 51 COUNTY RD |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 5.87 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 6.00 |
| START | 04/06/89 |
| STOP | 03/22/90 |

| | |
|---|---|
| CITY | ANNAPOLIS USNA |
| STATE | MD |
| DESC | BUILDING DESCRIPTION -1950 |
| BLDG | < 1950 |
| UNITS | 10 |
| MIN_PCI_L | 0.84 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 4.00 |
| START | 04/11/89 |
| STOP | 03/18/90 |

| | |
|---|---|
| CITY | ANNAPOLIS USNA |
| STATE | MD |
| DESC | DAIRY FARM QTRS |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 5.69 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 6.00 |
| START | 04/06/89 |
| STOP | 03/28/90 |

| | |
|---|---|
| CITY | ANNAPOLIS USNA |
| STATE | MD |
| DESC | HALLIGAN ROAD QTRS |
| BLDG | < 1950 |
| UNITS | 6 |
| MIN_PCI_L | 2.15 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 5.00 |
| START | 04/11/89 |
| STOP | 03/16/90 |

| | |
|---|---|
| CITY | ANNAPOLIS USNA |
| STATE | MD |
| DESC | WOOD RD |
| BLDG | < 1950 |
| UNITS | 3 |
| MIN_PCI_L | 3.57 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 04/04/89 |
| STOP | 03/22/90 |

| | |
|---|---|
| CITY | BRUNSWICK NAS |
| STATE | ME |
| DESC | FLAG QTRS 904 + 905 |
| BLDG | < 1950 |
| UNITS | 2 |
| MIN_PCI_L | 0.77 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 3.00 |
| START | 04/16/89 |
| STOP | 04/06/90 |

CITY BRUNSWICK NAS
STATE ME
DESC PUBLIC QUARTERS E-I,EA-EE
BLDG 50 to 69
UNITS 10
MIN_PCI_L 0.99
MAX_PCI_L 5.00
AVG_PCI_L 2.00
START 04/09/89
STOP 03/20/90

CITY CAMP LEJEUNE MCB
STATE NC
DESC CAPEHART 43 UNITS VINYL SIDED MCAS
BLDG CAPE
UNITS 43
MIN_PCI_L <0.5
MAX_PCI_L 4.00
AVG_PCI_L 1.00
START 04/12/89
STOP 03/12/90

CITY CHESAPEAKE BEACH NRL
STATE MD
DESC QTRS D
BLDG < 1950
UNITS 1
MIN_PCI_L 5.06
MAX_PCI_L 5.00
AVG_PCI_L 5.00
START 03/23/89
STOP 01/24/90

CITY CHESAPEAKE BEACH NRL
STATE MD
DESC QUARTERS A,B,C
BLDG < 1950
UNITS 3
MIN_PCI_L 3.98
MAX_PCI_L 5.00
AVG_PCI_L 4.00
START 03/23/89
STOP 01/24/90

CITY CRANE NWSC
STATE IN
DESC FARMHOUSE-1
BLDG < 1950
UNITS 1
MIN_PCI_L 4.38
MAX_PCI_L 4.00
AVG_PCI_L 4.00
START 05/11/89
STOP 08/14/89

| | |
|---|---|
| CITY | CRANE NWSC |
| STATE | IN |
| DESC | FARMHOUSES 2 3+5 |
| BLDG | < 1950 |
| UNITS | 3 |
| MIN_PCI_L | 2.21 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 4.00 |
| START | 05/10/89 |
| STOP | 08/14/89 |

| | |
|---|---|
| CITY | CRANE NWSC |
| STATE | IN |
| DESC | QTRS B,BB,C,D,E,F,G,H,I |
| BLDG | < 1950 |
| UNITS | 9 |
| MIN_PCI_L | 2.85 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 5.00 |
| START | 01/10/89 |
| STOP | 01/14/89 |

| | |
|---|---|
| CITY | CRANE NWSC |
| STATE | IN |
| DESC | QTRS J K L M N O P Q R S T U |
| BLDG | < 1950 |
| UNITS | 12 |
| MIN_PCI_L | 3.18 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 4.00 |
| START | 05/09/89 |
| STOP | 08/14/89 |

| | |
|---|---|
| CITY | CRANE NWSC |
| STATE | IN |
| DESC | QTRS W1+W2 |
| BLDG | < 1950 |
| UNITS | 2 |
| MIN_PCI_L | 3.52 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 4.00 |
| START | 05/10/89 |
| STOP | 08/14/89 |

| | |
|---|---|
| CITY | CRANE NWSC |
| STATE | IN |
| DESC | QTRS X+Y |
| BLDG | < 1950 |
| UNITS | 2 |
| MIN_PCI_L | 3.15 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 3.00 |
| START | 05/11/89 |
| STOP | 08/14/89 |

| | |
|---|---|
| CITY | DALLAS NAS |
| STATE | TX |
| DESC | DUNCANVILLE ANNEX |
| BLDG | 50 to 69 |
| UNITS | 9 |
| MIN_PCI_L | 1.29 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 3.00 |
| START | 03/13/89 |
| STOP | 06/12/89 |

| | |
|---|---|
| CITY | DAVISVILLE CBC |
| STATE | RI |
| DESC | NAVAL CONSTRUCTION BATTALION CENTER |
| BLDG | < 1950 |
| UNITS | 9 |
| MIN_PCI_L | 0.91 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 5.00 |
| START | 04/16/89 |
| STOP | 03/19/90 |

| | |
|---|---|
| CITY | EDZELL NSGA |
| STATE | UK |
| DESC | BRECHIN LEASED HOUSING |
| BLDG | LEASE |
| UNITS | 102 |
| MIN_PCI_L | 0.65 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 11/06/89 |
| STOP | 03/21/90 |

| | |
|---|---|
| CITY | EDZELL NSGA |
| STATE | UK |
| DESC | RAF STYLE HOUSING |
| BLDG | < 1950 |
| UNITS | 71 |
| MIN_PCI_L | 1.64 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 11/07/89 |
| STOP | 03/25/90 |

| | |
|---|---|
| CITY | FALLON NAS |
| STATE | NV |
| DESC | CAPEHART |
| BLDG | CAPE |
| UNITS | 106 |
| MIN_PCI_L | 0.58 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 03/15/89 |
| STOP | 12/13/89 |

| | |
|---|---|
| CITY | FOREST PARK NMCRC |
| STATE | IL |
| DESC | N&MCRC FOREST PARK |
| BLDG | < 1950 |
| UNITS | 0 |
| MIN_PCI_L | 2.33 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 5.00 |
| START | 09/22/89 |
| STOP | 02/14/90 |

| | |
|---|---|
| CITY | FORT CUSTER NRC |
| STATE | MI |
| DESC | BATTLE CREEK N&MCRC |
| BLDG | N/A |
| UNITS | 24 |
| MIN_PCI_L | 2.39 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 3.00 |
| START | 06/13/89 |
| STOP | 05/06/90 |

| | |
|---|---|
| CITY | GLENVIEW NAS |
| STATE | IL |
| DESC | FARMHOUSES |
| BLDG | < 1950 |
| UNITS | 7 |
| MIN_PCI_L | 1.63 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 3.00 |
| START | 03/21/89 |
| STOP | 04/11/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | 100 UNITS OF WHERRY HOUSING |
| BLDG | WHERR |
| UNITS | 100 |
| MIN_PCI_L | 0.89 |
| MAX_PCI_L | 15.00 |
| AVG_PCI_L | 3.00 |
| START | 10/16/89 |
| STOP | 03/06/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | 150 UNITS OF FUND HOUSING 1970 AND AFTER |
| BLDG | 1970 > |
| UNITS | 150 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 09/14/89 |
| STOP | 03/17/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | 16 PRE-1950 FAMILY HOUSING UNITS |
| BLDG | < 1950 |
| UNITS | 16 |
| MIN_PCI_L | 0.61 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 07/21/89 |
| STOP | 03/16/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | 30 PRE-1950 FAMILY HOUSING UNITS |
| BLDG | < 1950 |
| UNITS | 30 |
| MIN_PCI_L | 0.83 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | 10/01/89 |
| STOP | 03/24/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | 6 UNITS OF FUND HOUSING 50-69 2ND INC |
| BLDG | 50 to 69 |
| UNITS | 6 |
| MIN_PCI_L | 1.57 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 3.00 |
| START | 10/10/89 |
| STOP | 02/15/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | 750 UNITS OF WHERRY HOUSING |
| BLDG | WHERR |
| UNITS | 750 |
| MIN_PCI_L | 0.92 |
| MAX_PCI_L | 15.00 |
| AVG_PCI_L | 5.00 |
| START | 08/29/89 |
| STOP | 03/06/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | FLAG QUARTERS AA |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 3.80 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 05/26/89 |
| STOP | 04/26/90 |

| | |
|---|---|
| CITY | GREAT LAKES PWC |
| STATE | IL |
| DESC | HANNA CITY PEORIA N&NCRC |
| BLDG | < 1950 |
| UNITS | 18 |
| MIN_PCI_L | 2.09 |
| MAX_PCI_L | 11.00 |
| AVG_PCI_L | 5.00 |
| START | 10/02/89 |
| STOP | 05/03/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | APRA HEIGHTS |
| BLDG | 1970 > |
| UNITS | 60 |
| MIN_PCI_L | 2.59 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 5.00 |
| START | 09/11/89 |
| STOP | 03/09/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | FAA HOUSING |
| BLDG | 50 to 69 |
| UNITS | 89 |
| MIN_PCI_L | 1.52 |
| MAX_PCI_L | 17.00 |
| AVG_PCI_L | 5.00 |
| START | 09/19/89 |
| STOP | 02/22/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | LOCKWOOD TERRACE |
| BLDG | 50 to 69 |
| UNITS | 82 |
| MIN_PCI_L | 1.26 |
| MAX_PCI_L | 12.00 |
| AVG_PCI_L | 3.00 |
| START | 09/06/89 |
| STOP | 03/02/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NAS |
| BLDG | 50 to 69 |
| UNITS | 52 |
| MIN_PCI_L | 0.93 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 3.00 |
| START | 10/06/89 |
| STOP | 04/05/90 |

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| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NAS |
| BLDG | 50 to 69 |
| UNITS | 85 |
| MIN_PCI_L | 1.36 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 09/18/89 |
| STOP | 02/19/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NAS |
| BLDG | 50 to 69 |
| UNITS | 220 |
| MIN_PCI_L | 0.71 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 09/17/89 |
| STOP | 04/03/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NAV HOSP |
| BLDG | 1970 > |
| UNITS | 4 |
| MIN_PCI_L | 1.64 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 4.00 |
| START | 09/13/89 |
| STOP | 03/22/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NEW APRA HEIGHTS |
| BLDG | 1970 > |
| UNITS | 56 |
| MIN_PCI_L | 1.93 |
| MAX_PCI_L | 11.00 |
| AVG_PCI_L | 4.00 |
| START | 09/13/89 |
| STOP | 03/06/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NEW APRA HEIGHTS |
| BLDG | 1970 > |
| UNITS | 114 |
| MIN_PCI_L | 1.67 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 3.00 |
| START | 09/08/89 |
| STOP | 02/27/90 |

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| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NIMITZ HILL-FLAG CIRCLE |
| BLDG | 50 to 69 |
| UNITS | 64 |
| MIN_PCI_L | 0.52 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 09/11/89 |
| STOP | 02/26/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | NIMITZ HILL-FLAG CIRCLE |
| BLDG | < 1950 |
| UNITS | 7 |
| MIN_PCI_L | 1.26 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 3.00 |
| START | 09/17/89 |
| STOP | 03/06/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | SOUTH FINEGAYAN SECOND INCREMENT |
| BLDG | 1970 > |
| UNITS | 116 |
| MIN_PCI_L | 1.46 |
| MAX_PCI_L | 38.00 |
| AVG_PCI_L | 13.00 |
| START | 09/27/89 |
| STOP | 03/30/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | SOUTH FINEGAYAN SECOND INCREMENT |
| BLDG | 1970 > |
| UNITS | 184 |
| MIN_PCI_L | 1.55 |
| MAX_PCI_L | 13.00 |
| AVG_PCI_L | 8.00 |
| START | 09/23/89 |
| STOP | 02/11/90 |

| | |
|---|---|
| CITY | GUAM PWC |
| STATE | GU |
| DESC | SUMAY |
| BLDG | 50 to 69 |
| UNITS | 132 |
| MIN_PCI_L | 0.76 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 09/06/89 |
| STOP | 02/20/90 |

| | |
|---|---|
| CITY | INDIAN HEAD NOS |
| STATE | MD |
| DESC | FUND QUARTERS - WOOD FRAMED |
| BLDG | < 1950 |
| UNITS | 22 |
| MIN_PCI_L | 0.63 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 09/19/89 |
| STOP | 02/26/90 |

| | |
|---|---|
| CITY | IWAKUNI MCAS |
| STATE | JA |
| DESC | MIDRISE (6 STORY) |
| BLDG | FORN |
| UNITS | 164 |
| MIN_PCI_L | 0.90 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 05/15/89 |
| STOP | 11/13/89 |

| | |
|---|---|
| CITY | IWAKUNI MCAS |
| STATE | JA |
| DESC | TOWNHOUSE |
| BLDG | FORN |
| UNITS | 168 |
| MIN_PCI_L | 0.89 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 05/15/89 |
| STOP | 11/21/89 |

| | |
|---|---|
| CITY | KANSAS CITY MCFC |
| STATE | MO |
| DESC | CAPEH ENL |
| BLDG | CAPE |
| UNITS | 215 |
| MIN_PCI_L | 2.53 |
| MAX_PCI_L | 10.00 |
| AVG_PCI_L | 6.00 |
| START | 03/23/89 |
| STOP | 03/01/90 |

| | |
|---|---|
| CITY | KANSAS CITY MCFC |
| STATE | MO |
| DESC | CAPEH OFF CG |
| BLDG | CAPE |
| UNITS | 14 |
| MIN_PCI_L | 3.50 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 5.00 |
| START | 03/22/89 |
| STOP | 03/02/90 |

| | |
|---|---|
| CITY | KANSAS CITY MCFC |
| STATE | MO |
| DESC | CAPEH OFF FG |
| BLDG | CAPE |
| UNITS | 7 |
| MIN_PCI_L | 2.93 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 6.00 |
| START | 03/22/89 |
| STOP | 03/02/90 |

| | |
|---|---|
| CITY | KANSAS CITY MCFC |
| STATE | MO |
| DESC | ENL 50-69 |
| BLDG | 50 to 69 |
| UNITS | 5 |
| MIN_PCI_L | 3.10 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 4.00 |
| START | 03/22/89 |
| STOP | 03/02/90 |

| | |
|---|---|
| CITY | KEY WEST NAS |
| STATE | FL |
| DESC | WHERRY |
| BLDG | WHERR |
| UNITS | 188 |
| MIN_PCI_L | 0.70 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 06/04/89 |
| STOP | 01/12/90 |

| | |
|---|---|
| CITY | LAKEHURST NAEC |
| STATE | NJ |
| DESC | OFFICERS HOUSING |
| BLDG | < 1950 |
| UNITS | 33 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 2.00 |
| START | 10/14/89 |
| STOP | 03/05/90 |

| | |
|---|---|
| CITY | LONDON NAVACTS |
| STATE | UK |
| DESC | 42/43 WIMPOLE ST FLAT 16 |
| BLDG | N/A |
| UNITS | 1 |
| MIN_PCI_L | 2.49 |
| MAX_PCI_L | 20.00 |
| AVG_PCI_L | 9.00 |
| START | 06/09/89 |
| STOP | 07/30/90 |

| | |
|---|---|
| CITY | LONDON NAVACTS |
| STATE | UK |
| DESC | BLDG 312 |
| BLDG | LEASE |
| UNITS | 1 |
| MIN_PCI_L | 2.49 |
| MAX_PCI_L | 20.00 |
| AVG_PCI_L | 9.00 |
| START | 06/16/89 |
| STOP | 07/13/90 |

| | |
|---|---|
| CITY | LONDON NAVACTS |
| STATE | UK |
| DESC | FAIR LIGHT - BUILDING 40 |
| BLDG | LEASE |
| UNITS | 1 |
| MIN_PCI_L | 2.49 |
| MAX_PCI_L | 20.00 |
| AVG_PCI_L | 9.00 |
| START | 06/14/89 |
| STOP | 07/16/90 |

| | |
|---|---|
| CITY | MECHANICSBURG NSPCC |
| STATE | PA |
| DESC | EDSON DRIVE OTHER QTRS X1 X2 Y1 Y2 |
| BLDG | < 1950 |
| UNITS | 4 |
| MIN_PCI_L | 3.28 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 6.00 |
| START | 03/15/89 |
| STOP | 04/20/90 |

| | |
|---|---|
| CITY | MECHANICSBURG NSPCC |
| STATE | PA |
| DESC | EDSON DRIVE QTRS V |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 7.10 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 7.00 |
| START | 03/13/89 |
| STOP | 04/19/90 |

| | |
|---|---|
| CITY | MECHANICSBURG NSPCC |
| STATE | PA |
| DESC | EDSON DRIVE-QTRS |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 7.10 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 7.00 |
| START | 10/03/89 |
| STOP | 05/02/90 |

| | |
|---|---|
| CITY | MECHANICSBURG NSPCC |
| STATE | PA |
| DESC | SITES A&B-CATEGORY C |
| BLDG | 50 to 69 |
| UNITS | 55 |
| MIN_PCI_L | 2.40 |
| MAX_PCI_L | 13.00 |
| AVG_PCI_L | 7.00 |
| START | 03/16/89 |
| STOP | 03/09/90 |

| | |
|---|---|
| CITY | MECHANICSBURG NSPCC |
| STATE | PA |
| DESC | SITES A&B-CATEGORY C ANNEX |
| BLDG | 50 to 69 |
| UNITS | 20 |
| MIN_PCI_L | 1.83 |
| MAX_PCI_L | 16.00 |
| AVG_PCI_L | 7.00 |
| START | 03/18/89 |
| STOP | 02/16/90 |

| | |
|---|---|
| CITY | MECHANISBURGH NSPCC |
| STATE | PA |
| DESC | SITES A&B-CATEGORY C ANNEX-B |
| BLDG | 50 to 69 |
| UNITS | 0 |
| MIN_PCI_L | 2.49 |
| MAX_PCI_L | 20.00 |
| AVG_PCI_L | 9.00 |
| START | 03/22/89 |
| STOP | 04/15/90 |

| | |
|---|---|
| CITY | MIRAMAR NAS |
| STATE | CA |
| DESC | PUBLIC QUARTERS INCREMENT 2-6 UNITS |
| BLDG | 50 to 69 |
| UNITS | 275 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | 07/01/89 |
| STOP | 06/01/90 |

| | |
|---|---|
| CITY | MONTEREY NPGS |
| STATE | CA |
| DESC | CAPEHART HOUSING |
| BLDG | CAPE |
| UNITS | 150 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 1.00 |
| START | 05/08/89 |
| STOP | 03/25/90 |

| | |
|---|---|
| CITY | MONTEREY NPGS |
| STATE | CA |
| DESC | POINT SUR FAMILY HOUSING |
| BLDG | CAPE |
| UNITS | 24 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 04/11/89 |
| STOP | 03/05/90 |

| | |
|---|---|
| CITY | NAVS [illegible] ISLAND |
| STATE | CA |
| DESC | 100 TOWNHOUSES |
| BLDG | 50 to 69 |
| UNITS | 100 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 0.00 |
| START | 04/22/89 |
| STOP | 03/11/90 |

| | |
|---|---|
| CITY | NAVSTA MARE ISLAND |
| STATE | CA |
| DESC | 17 BUNGALOW QUARTERS |
| BLDG | < 1950 |
| UNITS | 17 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 2.00 |
| START | 05/17/89 |
| STOP | 03/20/90 |

| | |
|---|---|
| CITY | NAVSUPPACT HOLY LOCH |
| STATE | UK |
| DESC | GLADSWOOD VILLA |
| BLDG | N/A |
| UNITS | 1 |
| MIN_PCI_L | 2.49 |
| MAX_PCI_L | 20.00 |
| AVG_PCI_L | 9.00 |
| START | 01/18/89 |
| STOP | 08/10/90 |

| | |
|---|---|
| CITY | NAVSUPPACT HOLY LOCH |
| STATE | UK |
| DESC | OFF HSG-EAGLE |
| BLDG | N/A |
| UNITS | 45 |
| MIN_PCI_L | 2.49 |
| MAX_PCI_L | 20.00 |
| AVG_PCI_L | 9.00 |
| START | 01/30/89 |
| STOP | 07/28/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CN |
| DESC | DODFH WESTOVER - CHICOPEE |
| BLDG | < 1950 |
| UNITS | 5 |
| MIN_PCI_L | 1.86 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 01/13/90 |
| STOP | 04/20/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CN |
| DESC | DODFH WESTOVER - CHICOPEE/DUPLEX |
| BLDG | CAPE |
| UNITS | 184 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 01/07/90 |
| STOP | 04/14/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CN |
| DESC | DODFH WESTOVER - CHICOPEE/MULTIPLES |
| BLDG | CAPE |
| UNITS | 124 |
| MIN_PCI_L | 1.00 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 01/12/90 |
| STOP | 04/01/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | CONNING TOWERS GROTON |
| BLDG | 50 to 69 |
| UNITS | 156 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 10/30/89 |
| STOP | 03/23/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | MCON ON BASE GROTON |
| BLDG | 50 to 69 |
| UNITS | 40 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 2.00 |
| START | 10/17/89 |
| STOP | 03/13/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | MOQ ON BASE GROTON |
| BLDG | < 1950 |
| UNITS | 70 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 27.00 |
| AVG_PCI_L | 3.00 |
| START | 10/23/89 |
| STOP | 03/21/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | NAUTILUS PARK 1ST INCREMENT GROTON |
| BLDG | CAPE |
| UNITS | 500 |
| MIN_PCI_L | 1.11 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 3.00 |
| START | 10/25/89 |
| STOP | 03/26/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | NAUTILUS PARK 2ND INCREMENT GROTON |
| BLDG | CAPE |
| UNITS | 496 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 10/26/89 |
| STOP | 03/14/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | NAUTILUS PARK 3RD INCREMENT GROTON |
| BLDG | CAPE |
| UNITS | 250 |
| MIN_PCI_L | 0.55 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 10/28/89 |
| STOP | 03/19/90 |

| | |
|---|---|
| CITY | NEW LONDON NSB |
| STATE | CT |
| DESC | POLARIS PARK GROTON |
| BLDG | 1970 > |
| UNITS | 300 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 10/20/89 |
| STOP | 03/15/90 |

| | |
|---|---|
| CITY | NEW ORLEANS NSA |
| STATE | LA |
| DESC | UNITS CONST FY75 |
| BLDG | 1970 > |
| UNITS | 116 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 1.00 |
| START | 06/20/89 |
| STOP | 10/30/89 |

| | |
|---|---|
| CITY | NEWPORT NETC |
| STATE | RI |
| DESC | ANCHORAGE |
| BLDG | < 1950 |
| UNITS | 180 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 1.00 |
| START | 04/01/89 |
| STOP | 03/04/90 |

| | |
|---|---|
| CITY | NEWPORT NETC |
| STATE | RI |
| DESC | FY71-72 400 UNITS FORTADAMS GREENELANE |
| BLDG | 1970 > |
| UNITS | 400 |
| MIN_PCI_I | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 04/01/89 |
| STOP | 02/27/90 |

| | |
|---|---|
| CITY | NORFOLK PWC |
| STATE | VA |
| DESC | WOODBRIDGE CROSSING (801) |
| BLDG | LEASE |
| UNITS | 300 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 07/27/89 |
| STOP | 04/20/90 |

| | |
|---|---|
| CITY | ORLANDO NTC |
| STATE | FL |
| DESC | THIS PROJECT HAS 300 TOWNHOUSE UNITS |
| BLDG | 1970 > |
| UNITS | 300 |
| MIN_PCI_L | 0.56 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 1.00 |
| START | 03/27/89 |
| STOP | 12/23/89 |

| | |
|---|---|
| CITY | PHILADELPHIA NRMC |
| STATE | PA |
| DESC | MAIN-LINE UNITS (BEFORE 1950) |
| BLDG | < 1950 |
| UNITS | 0 |
| MIN_PCI_L | 3.14 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 03/23/89 |
| STOP | 03/21/90 |

| | |
|---|---|
| CITY | POINT MUGU PMTC |
| STATE | CA |
| DESC | CAPEHART I GRAVEL ROOF |
| BLDG | CAPE |
| UNITS | 153 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 10/27/89 |
| STOP | 03/23/90 |

| | |
|---|---|
| CITY | POINT MUGU PMTC |
| STATE | CA |
| DESC | CAPEHART III SINGLE STORY DUPLEX CAMARIL |
| BLDG | CAPE |
| UNITS | 14 |
| MIN_PCI_L | 0.63 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 10/19/89 |
| STOP | 03/12/90 |

| | |
|---|---|
| CITY | POINT MUGU PMTC |
| STATE | CA |
| DESC | CAPEHART III TWO STORY DUPLEX CAMARILLO |
| BLDG | CAPE |
| UNITS | 26 |
| MIN_PCI_L | 0.80 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 10/23/89 |
| STOP | 03/15/90 |

| | |
|---|---|
| CITY | PORTSMOUTH NSY |
| STATE | NH |
| DESC | 200UNITSOFFAMILYHOUSINGADMIRALTYVILLAGE |
| BLDG | 1970 > |
| UNITS | 200 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 3.00 |
| START | 03/13/89 |
| STOP | 03/28/90 |

| | |
|---|---|
| CITY | PORTSMOUTH NSY |
| STATE | NH |
| DESC | ON BASE OFFICER UNITS |
| BLDG | < 1950 |
| UNITS | 34 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 13.00 |
| AVG_PCI_L | 5.00 |
| START | 03/15/89 |
| STOP | 04/05/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | 1100 |
| BLDG | < 1950 |
| UNITS | 9 |
| MIN_PCI_L | 0.71 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 11/02/89 |
| STOP | 01/24/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | CHAMBERLAIN |
| BLDG | < 1950 |
| UNITS | 49 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 01/13/89 |
| STOP | 01/10/90 |

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|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | GEIGER RIDGE |
| BLDG | < 1950 |
| UNITS | 25 |
| MIN_PCI_L | 0.58 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 01/07/89 |
| STOP | / / |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LUST 2700 |
| BLDG | < 1950 |
| UNITS | 54 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 2.00 |
| START | 01/12/89 |
| STOP | 01/24/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | < 1950 |
| UNITS | 6 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 3.00 |
| START | 01/17/89 |
| STOP | 01/23/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 22 |
| MIN_PCI_L | 0.81 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | / / |
| STOP | 01/18/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 22 |
| MIN_PCI_L | 1.82 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 3.00 |
| START | / / |
| STOP | 01/18/90 |

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|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 28 |
| MIN_PCI_L | 0.66 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | / / |
| STOP | 01/18/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 34 |
| MIN_PCI_L | 0.95 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 3.00 |
| START | / / |
| STOP | 01/18/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 68 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 3.00 |
| START | / / |
| STOP | 01/04/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 80 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 2.00 |
| START | / / |
| STOP | 01/17/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | LYMAN PARK |
| BLDG | CAPE |
| UNITS | 109 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 3.00 |
| START | / / |
| STOP | 01/01/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | Q-#6 |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 3.52 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 4.00 |
| START | 10/12/89 |
| STOP | 01/23/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | Q-331,334,337,350,354,411,411 ˜431 |
| BLDG | < 1950 |
| UNITS | 6 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 01/07/89 |
| STOP | 01/12/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | SPLIT LEVEL 2700+2000 |
| BLDG | 50 to 69 |
| UNITS | 96 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 01/12/89 |
| STOP | 01/23/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | SPLIT LEVEL 300 |
| BLDG | 50 to 69 |
| UNITS | 36 |
| MIN_PCI_L | 1.04 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | 01/10/89 |
| STOP | 01/17/90 |

| | |
|---|---|
| CITY | QUANTICO MCDEC |
| STATE | VA |
| DESC | SPLIT LEVEL 300 |
| BLDG | 50 to 69 |
| UNITS | 39 |
| MIN_PCI_L | 0.8 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 2.00 |
| START | 01/13/89 |
| STOP | 01/20/90 |

| | |
|---|---|
| CITY | SAN FRANCISCO PWC |
| STATE | CA |
| DESC | RAFAEL VILLAGE DODHF NOVATO |
| BLDG | WHERR |
| UNITS | 505 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 04/07/89 |
| STOP | 04/29/90 |

| | |
|---|---|
| CITY | SASEBO COMFLEACTS |
| STATE | JA |
| DESC | DRAGON HEIGHTS APARTMENT |
| BLDG | FORN |
| UNITS | 18 |
| MIN_PCI_L | 0.76 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 2.00 |
| START | 06/02/89 |
| STOP | 05/16/90 |

CITY SASEBO COMFLEACTS
STATE JA
DESC DRAGON HEIGHTS/VALE HOUSING
BLDG FORN
UNITS 63
MIN_PCI_L 0.76
MAX_PCI_L 4.00
AVG_PCI_L 2.00
START 05/25/89
STOP 04/27/90

CITY SASEBO COMFLEACTS
STATE JA
DESC HARIO HOUSING AREA
BLDG FORN
UNITS 105
MIN_PCI_L 0.76
MAX_PCI_L 4.00
AVG_PCI_L 2.00
START 05/12/89
STOP 05/17/90

CITY SASEBO COMFLEACTS
STATE JA
DESC SAFURA TOWER
BLDG FORN
UNITS 28
MIN_PCI_L 0.76
MAX_PCI_L 4.00
AVG_PCI_L 2.00
START 05/17/89
STOP 04/10/90

CITY SIOUX CITY
STATE IO
DESC NAVY AND MARINE CORPS RESERVE CENTER
BLDG < 1950
UNITS 0
MIN_PCI_L 2.75
MAX_PCI_L 16.00
AVG_PCI_L 6.00
START 10/11/89
STOP 04/18/90

CITY STOCKTON NCS
STATE CA
DESC WHERRY HOUSING FORRESTAL VILLAGE
BLDG WHERR
UNITS 40
MIN_PCI_L 0.73
MAX_PCI_L 4.00
AVG_PCI_L 2.00
START 03/21/89
STOP 06/19/89

| | |
|---|---|
| CITY | SUGAR GROVE NRS-R |
| STATE | WV |
| DESC | NEW HOUSING CAT B |
| BLDG | 1970 > |
| UNITS | 10 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 7.00 |
| AVG_PCI_L | 2.00 |
| START | 05/19/89 |
| STOP | 04/25/90 |

| | |
|---|---|
| CITY | WARMINSTER NADC |
| STATE | PA |
| DESC | QUARTER'S B |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 25.0 |
| MAX_PCI_L | 25.00 |
| AVG_PCI_L | 25.00 |
| START | 03/29/89 |
| STOP | 03/01/90 |

| | |
|---|---|
| CITY | WARMINSTER NADC |
| STATE | PA |
| DESC | QUARTERS A |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 6.22 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 6.00 |
| START | 03/27/89 |
| STOP | 03/06/90 |

| | |
|---|---|
| CITY | WATERLOO NMCRC |
| STATE | IA |
| DESC | NAVY AND MARINE CORPS RESERVE CENTER |
| BLDG | < 1950 |
| UNITS | 23 |
| MIN_PCI_L | 1.06 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 3.00 |
| START | 04/13/89 |
| STOP | 09/04/89 |

| | |
|---|---|
| CITY | WILLOW GROVE NAS |
| STATE | PA |
| DESC | SINGLE FAMILY HOMES OVER 40YRS OLD |
| BLDG | < 1950 |
| UNITS | 1 |
| MIN_PCI_L | 4.91 |
| MAX_PCI_L | 5.00 |
| AVG_PCI_L | 5.00 |
| START | 05/04/89 |
| STOP | 04/12/90 |

| | |
|---|---|
| CITY | WILLOW GROVE NAS |
| STATE | PA |
| DESC | SINGLE FAMILY HOMES OVER 40YRS OLD |
| BLDG | < 1950 |
| UNITS | 5 |
| MIN_PCI_L | 0.55 |
| MAX_PCI_L | 9.00 |
| AVG_PCI_L | 4.00 |
| START | 05/04/89 |
| STOP | 04/12/90 |

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|---|---|
| CITY | YORKTOWN NWS |
| STATE | VA |
| DESC | MASON'S ROW A-G AND M&N |
| BLDG | < 1950 |
| UNITS | 9 |
| MIN_PCI_L | 1.38 |
| MAX_PCI_L | 6.00 |
| AVG_PCI_L | 3.00 |
| START | 04/13/89 |
| STOP | 03/19/90 |

| | |
|---|---|
| CITY | YORKTOWN NWS |
| STATE | VA |
| DESC | MOQ-MEMQ KISKIAK/SKIFFES CREEK |
| BLDG | 50 to 69 |
| UNITS | 100 |
| MIN_PCI_L | <0.5 |
| MAX_PCI_L | 4.00 |
| AVG_PCI_L | 1.00 |
| START | 04/12/89 |
| STOP | 03/19/90 |

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