



# Project Summary

## RAETRAD-F: Version 1.1 for Analyzing Site-Specific Measurements of Soil Radon Potential Category for Florida Houses

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**The RAETRAD-F (RAdon Emanation and TRAnsport into Dwellings—Florida) computer code provides a simple means of analyzing site-specific soil measurements to estimate upper-limit indoor radon concentrations in a reference house at a site. The code uses data from measured soil radium profiles, soil density and texture properties, water table depths, and soil radon concentrations to estimate the potential indoor radon concentrations. It also identifies the site's radon potential category for use in lieu of its radon protection map designation.**

***This project summary was developed by EPA's National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).***

### Introduction

The Florida Department of Community Affairs, under the Florida Radon Research Program (FRRP), has developed radon-protective building standards to reduce radon-related health risks. For residences, these standards are given in the Florida Standard for Passive Radon-Resistant New Residential Building Construction. This standard requires passive radon barriers in counties that adopt it. An earlier version of the standard contained more detailed requirements for both passive and active radon controls in areas identified by a radon protection map to have elevated radon potential. Although no longer

part of the adopted standard, the radon protection map and the related system for selecting different levels of radon control still provide useful guidance for residential radon control. A protocol was also developed under the FRRP for measuring the soil radon potential category of specific sites in a way that corresponds to the radon protection map designations.

The former standard required passive radon barriers and active sub-slab ventilation to reduce radon entry in regions that are prone to elevated radon levels. Regions requiring radon controls in new house construction are identified by red or yellow areas on the Florida Radon Protection Map. Regions where radon levels in a reference house could exceed 8.3 pCi/L at a 95% confidence limit are identified as Red regions, requiring both active and passive radon-protective features. Regions where radon levels could exceed 4.0 pCi/L at a 95% confidence limit, but not exceed 8.3 pCi/L, are identified as Yellow regions, requiring only passive radon-protective features. Regions with projected radon levels below 4.0 pCi/L at a 95% confidence limit require no special building features beyond those required by existing building codes. These regions are identified as Green regions.

While the radon protection maps give convenient regional guidance on the need for special radon controls in new houses, the building standard also recognizes measurements of the radon potential category of particular sites. Although site-specific analyses are not generally required, they can give valuable guidance in some cases. For example, a prospective builder may know of or suspect anomalous conditions

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at a site (from previous land use, soil or mineral observations, etc.) that could increase the radon potential above its mapped category. Alternatively, the builder may have reason to suspect that the land has lower radon potential than its mapped category, leading to the desire to reduce or eliminate radon controls unless they are specifically shown to be needed. In either case, site-specific tests could help lead to a more informed decision. The decision should also consider the relative costs of using conservative radon controls versus testing, as well as the U.S. EPA guidance on further reducing radon levels even in the 0- to 4-pCi/L range.

The RAETRAD-F computer code was developed for the Florida Department of Community Affairs to analyze the site-specific measurements produced by the FRRP protocol. The code's objective is to interpret the measurements in terms of the radon potential category of the site (Red, Yellow, or Green) in a way that is consistent with the radon protection maps. RAETRAD-F is a special version of the more general RAETRAD code. It contains the reference house and corresponding radium, water table, and statistical analyses that correspond to the radon protection map calculations. RAETRAD-F uses measured radium concentrations, soil density and texture, water table depths, and soil gas radon concentrations to estimate potential indoor radon levels and the radon potential category of a site.

### **The RAETRAD Algorithm**

RAETRAD-F computes potential indoor radon concentrations as used in the ra-

don protection map. It first calculates the geometric means and geometric standard deviations of the measured soil radium concentrations. It also determines the seasonal water table distribution as defined for the Florida Radon Protection Maps. It then uses this information to compute best estimates of indoor radon concentrations for the different seasonal water table conditions. After determining the geometric mean annual radon concentration in the reference house from seasonal values, the variations among seasonal conditions and among the radium concentrations are used to estimate the potential radon concentration in the reference house at a 95% confidence limit.

RAETRAD-F employs an efficient, numerical-analytical algorithm to solve the steady-state air flow and radon generation and transport equations in two-dimensional, elliptical-cylindrical geometry. It uses complete, multiphase equations to account for radon generation; radon exchange among solid, liquid, and gas phases; and radon transport by diffusion (concentration-driven) and advection (with pressure-driven air flow).

### **Operating Environment**

RAETRAD-F is designed to operate in the Microsoft® Disk Operating System (MS-DOS) environment only. As such, it will not operate under the Microsoft® Windows Operating environment. It is recommended that the code be installed on a Microsoft/Intel personal computer system equipped with a mathematics co-processor, at least 4 Mbytes of RAM, and a printer.

### **RAETRAD-F Results**

The RAETRAD-F output is divided into four sections: site location, measurements, results, and certification. The location section shows the user-specified input information with regard to the name of the company performing the measurements, the location of the test property, and the name of the code user. This section also gives the date and time of RAETRAD-F analysis.

The measurements section shows the user-specified input data for the soil characteristics. These data include the individual radium measurements, soil density and texture data, soil radon measurements, and water table information.

The results section is displayed in a box following the location and measurements sections. This section reports the indoor radon potential in picocuries per liter as well as the radon protection map color category that corresponds to this concentration. The user should note that the indoor radon potential printed by RAETRAD-F is an upper limit (95% confidence limit) of the range of radon concentrations that could occur at the site, and is therefore higher than the expected annual average radon concentration. The code determines the radon protection category by comparing the indoor radon potential concentration to the 4.0- and 8.3-pCi/L cut points used in the radon protection map.

The certification section at the bottom of the printout allows both the RAETRAD-F user and the agent for the company that performed the measurements to certify that the information used in the analysis is correct.

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*The complete report, entitled "RAETRAD-F: Version 1.1 User's Guide for Analyzing Site-Specific Measurements of Soil Radon Potential Category for Florida Houses," (Order No. PB97-115364; Cost: \$19.50, subject to change) will be available only from:*

*National Technical Information Service  
5285 Port Royal Road  
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