



## Project Summary

# Recommended Performance Standard of the Florida Radon Research Program

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This report is a revised version of a support document for the performance testing portion of the proposed Florida statewide building standard for radon-resistant construction. The support document was developed by the Alternate Performance Standard Development Committee of the Florida Radon Research Program (FRRP), commissioned by the Florida Department of Community Affairs. This report contains the rationale and technical justification for the version of the Performance Testing Section (Section 5) of the standard which was recommended by the Standard Development Committee, as well as recommended text for the section. The recommendations and draft standard language were based largely on an FRRP research project which involved study of short-term and long-term average indoor radon concentrations in 80 Florida houses for over a year. At the time of the committee report, this project had collected 6 months of data from roughly half the houses and 3 months of data from the remaining half. After a brief review of the variability of indoor radon, the report describes background, methodology, data analysis strategy, and early results from the short-/long-term radon correlation project. These are followed by a rationale for the recommended standard section. Significant peer review comments follow.

*This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, 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

This is a revised version of a Recommended Code and Linking Document developed as a support document for the performance testing portion of the proposed Florida statewide building standard for radon-resistant construction. The support document was developed by the Alternate Performance Standard Development Committee of the Florida Radon Research Program (FRRP), commissioned by the Florida Department of Community Affairs (DCA). The mission of this committee and of four other FRRP Standards Development Committees is to provide technical assistance for the major phases of development of the building standard. This assistance consists of development of the technical background and basis for elements of the standard by review of alternative strategies for indoor radon control, interpretation of results from FRRP-sponsored and other research projects, recommendation of research to meet outstanding information needs relevant to the standards, and recommending specific elements of the standard.

The original version of this report, containing the rationale and technical justification for the recommended Performance Testing Section (Section 5) of the standard, was issued in August 1990. The recommended standard section itself is included as Appendix A to the report. These recommendations and draft standard language were based in large part on an FRRP research project which in-



volved study of short- and long-term average indoor radon concentrations in 80 Florida houses for over a year. At the time of the development of these recommendations, this project had collected 6 months of data from roughly half the houses and 3 months of data from the remaining half.

Subsequent to the release of August 1990 report, several relevant events occurred. The research project continued, and data collection was completed in March 1991, with at least a full year in 65 houses (five quarters in over half of these) and somewhat less (two or three quarters) in the remaining 15 houses. During the course of the project, improved predictive threshold radon concentrations were calculated each quarter based on the growing pool of data generated by the project. The draft final report was submitted in June 1991 and was released as an EPA final report in October 1991 after technical and administrative review. That report (Development of Alternate Performance Standard for Radon Resistant Construction Based on Short-Term/Long-Term Indoor Radon Concentrations, EPA-600/8-91-210a,b) contains a much more detailed description of the project than the present document, and should be used for further reference.

The DCA issued the draft Standard for Radon-Resistant Construction for public comment in October 1990. The performance testing section of that standard incorporated the language of Appendix A as modified by internal department review and later in response to public comments. The proposed standard was subsequently withdrawn, revised, and renounced as a result of legal challenge, and was still in the rule-making process in October 1991. Later versions of the standard contained different acceptance thresholds due to the incorporation of revised predictions based on more complete data from the research project.

Concurrently with the initial rule-making activities, the committee report was also subjected to peer review in September 1990 by other scientists within the FRRP. The peer review comments included both technical and editorial comments concerning the committee report, questions and suggestions regarding the standard itself, and recommendations for further research.

In order to maintain the historical integrity of the original August 1990 committee report, the peer review comments were addressed. Obvious editorial deficiencies were corrected in this revised version. Likewise, mathematical errors in the original version were corrected, using only the data that were available at the time of the original report. The other comments and ap-

propriate responses have been summarized in Appendix B of the report.

## Background of Performance Standard

Section 5 (Performance Testing) of the proposed code for radon resistant construction provides a performance testing option as an alternative to fully engineered radon controls which may not be cost-effective or necessary in all parts of the state. The philosophy of the performance standard recommended in this text can be briefly stated as a compromise between conflicting needs in the light of measurement uncertainty. First, as described below estimates of long-term radon exposure from single short-term radon measurements are subject to considerable uncertainty, which can be reduced only by long-term or multiple measurements. The state needs to have confidence that a building actually will conform to the long-term radon concentration standard set by the Department of Health and Rehabilitative Services (DHRS); therefore, the needs of the state are best served either by a longer testing period (which decreases measurement uncertainty) or by a conservative performance threshold (i.e., lower than the DHRS standard). Builders and developers need to minimize delays between construction and occupancy; therefore, the construction industry is best served by as short a test period as is feasible. The proposed standard was developed to offer optional measurement devices and sampling periods to address both needs.

## The FRRP Alternate Performance Standard Development Project

### Methodology

The short- /long-term portion of the Alternate Performance Standard Project includes the monitoring of approximately 80 houses in four regions of the state including, Alachua, Dade, Leon, and Polk Counties. The houses were selected based on the characteristics identified as common to Florida housing stock such as:

- Single family, single level, slab-on-grade housing with forced air heating and cooling
- Low to moderate radon level - 2 to 20 pCi/L
- Unmitigated (although two previously mitigated houses were selected for comparison in Polk County)
- Air handler characteristics: split between houses with air handler inside

building shell (closet) and outside shell (garage, attic)

- Natural ventilation: about half of the houses selected never use natural ventilation for cooling.

Four types of radon measurement devices have been selected for this study. The devices include:

- Radtrak alpha track detectors
- High and low sensitivity electret passive environmental radon monitors
- A 7-day passive diffusion barrier and 2-day open-face charcoal canisters
- A Pylon AB-5 continuous radon monitor with a passive radon detectors.

In order to develop a predictive relationship between short-term measurements and long-term (annual) average concentrations, a variety of short- and long-term sampling approaches are currently employed in each study house. The devices selected and their deployment periods are:

- Alpha-track detector (deployed for 1 year or project duration)
- Alpha-track detector (deployed for one quarter each—four per house)
- Low sensitivity electret passive environmental radon monitor (read on approximately 28-day intervals)
- High sensitivity electret passive environmental radon monitor (read on approximately 7- and 14-day intervals)
- Seven-day charcoal canisters (1 week per month per house)
- Two-day charcoal canisters (1- or 2-day deployment per month per house)
- Pylon AB-5 with passive radon detector (rotated between houses approximately 4 weeks per house).

### Data Analysis Strategy

An overall strategy for data analysis was developed with certain presumptions as to the form of the data. First, the distribution of radon concentrations within a typical house is assumed to be log-normal; within this framework predictive models for long-term radon levels are developed. The data analysis scheme outlined in the full report was applied to two quarters' data from the first set of 40 houses and to one quarter's data from the second set of 40 houses. First, some strong suggestions of seasonal differences are present, with the winter quarter averages significantly higher than the spring averages. While a 6-month study period cannot substitute for a full year, an argument

can be made that the current data set is a reasonable approximation for the variability of a full year's data set.

### Technical Rationale of the Recommended Standard

The data collected and analyzed to date in the FRRP Alternate Performance Standard project have been incorporated into thresholds in the recommended code in report Appendix A. The assumptions and philosophy that have been used to develop the standard are:

1. The goal of a building standard is to reduce the long-term average (annual or longer) radon concentration in the building to be occupied.
2. Short-term measurements in the building will have uncertainty due to (a) measurement accuracy of the device used and (b) variability of the indoor radon concentration with time. Uncertainty due to effect (b) can be reduced by increasing the measurement time.
3. A performance test must be completed and the results known prior to occupancy for practical enforce-

ment of a construction performance standard. In view of the time pressures on the construction industry, the measurement period in a workable performance standard will probably be a compromise between the schedule needs of the builder and the uncertainty of the radon measurement.

4. The radon standard set by DHRS is assumed to remain at 4 pCi/L.
5. The threshold for passing a short-term performance test should be conservative; i.e. low enough to ensure that (within a confidence level to be determined by the State) the building will not have a long-term average radon concentration in excess of the DHRS standard if a short-term performance test gives results less than the threshold.
6. Thresholds of this type are being developed for several device/measurement period combinations, so that the builder may elect to use a shorter-duration test with a lower pass/fail threshold in order to achieve the same confidence that the building will comply with the standard.

7. Similarly, the project data have been analyzed to allow the state to choose thresholds based on different levels of confidence according to both its regulatory priorities and the standard ultimately to be set by DHRS.

8. If the effects of the time of year on indoor radon concentration can be quantified, an algorithm to account for seasonal effects will be built into the threshold criteria. If such an algorithm cannot be developed, the variability due to season must be included in the total variability of radon measurements in determining the thresholds for all times of the year. (This approach has been taken in the current recommendations.)

Model language for a performance standard developed by these steps, as well as explanatory annotations, are contained in the full report. The code language incorporates the possibility of several combinations of device and measurement period. No provision for incorporating "average" seasonal variations in radon data is included, due to lack of sufficient data on the form of systematic seasonal differences.

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**David C. Sanchez** is the EPA Project Officer (see below).

*The complete report, entitled "Recommended Performance Standard of the Florida Radon Research Program," (Order No. PB93-122281/AS; Cost: \$17.00; subject to change) will be available only from:*

*National Technical Information Service*

*5285 Port Royal Road*

*Springfield, VA 22161*

*Telephone: 703-487-4650*

*The EPA Project Officer can be contacted at:*

*Air and Energy Engineering Research Laboratory*

*U.S. Environmental Protection Agency*

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