# Mandatory Follow-Up Radon Testing Noncompliance Among Schools, Child Care Centers, and Adult 24-Hour Care Facilities in Florida

Sarah R. Labat, MPH
*Florida Department of Health*
*Radon Program*
*University of South Florida*

Abstract **Radon causes approximately 21,000 lung cancer deaths every year in the U.S. Facilities that are required to test for radon in Florida include public and private schools, state-regulated child care centers, and adult 24-hour care facilities. All these facilities are required to perform an initial test with a 5-year follow-up test. This study examined noncompliance among facilities with mandatory testing, the effectiveness of outreach to noncompliant facilities, and whether certain groups are more likely to be noncompliant. To determine noncompliance, a sample of 656 facilities was selected from the state-operated database on mandatory radon testing. Outreach to noncompliant facilities was attempted to alert them of their noncompliant status and what they needed to do to become compliant. The database was consulted to determine which facilities became compliant after outreach. The results showed a 50% success rate in outreach. There were no statistically significant relationships between noncompliance and any of the groupings examined. It is recommended that the methods of outreach employed only be used as a supplement to other forms of outreach when seeking to reduce noncompliance among mandatory testing facilities in Florida.**

## Introduction

Radon is a colorless, odorless, tasteless gas that is formed when radium undergoes radioactive breakdown. Radium is naturally present in most of the soil in Florida. Radon gas can enter buildings through small openings in the foundation and accumulate, leading to an increased indoor concentration. The primary risk from radon comes from exposure to its decay products. The decay process leads to the formation of alpha particles that can damage the DNA of human lung cells. Long-term exposure can lead to lung cancer and higher radon concentrations are associated with high rates of lung cancer. In the U.S., radon is the leading cause of lung cancer among nonsmokers and 21,000 deaths are attributed to radon every year. In Florida, elevated levels of radon above the U.S. Environmental Protection Agency (U.S. EPA) established action level of 4 pCi/L are found in 20% of homes tested (Florida Health, 2019; U.S. Department of Commerce, 1980; U.S. EPA, 2016).

The Radon Program was created by the Florida legislature in 1988 with three primary missions: 1) to educate the public about radon and its health effects, 2) to protect the public from deceptive radon measurement and mitigation practices by certifying radon professionals, and 3) to oversee the state mandatory radon testing program (Florida Health, 2015a). This study examines the third mission.

Specific facilities in Florida are required to test for radon. These facilities include all public and private school buildings or school sites housing K-12 students; all state-owned, operated, regulated, or licensed adult 24-hour care facilities; and all state licensed child care centers for children or minors that are located in counties designated within the Department of Business and Professional Regulation's Florida Radon Protection Map categories as "intermediate" or "elevated radon potential."

An initial test and a 5-year follow-up test are required. Additional testing is not required unless the building has a structural change, an addition, or receives approval for a new or amended license (Environmental Radiation Standards and Projects, 2019; Florida Health, 2015b, 2017). Structural changes are defined as any modification, replacement, or repair of foundation, walls, floors, ceilings, or roof assembly, or any addition to the existing building. Some counties in Florida have operating procedures where a specific individual is responsible for radon testing of public schools, which is the case in Pasco, Miami-Dade, Broward, Pinellas, and Palm Beach counties.

The Florida Radon Program keeps a database of all mandatory radon tests performed and reported to the Florida Department of Health. The radon test results examined in this study were recorded on the Department of Health's mandatory testing forms DH1777 (Nonresidential Radon Measurement Report for buildings other than single- or multi-family dwelling) and DH1778 (Residential Radon Measurement Report

TABLE **1**

**Overall Compliance Status of Facilities (*N* = 656)**

| Facility Status | # | % |
|---|---|---|
| Compliant | 401 | 61.1 |
| Noncompliant | 192 | 29.3 |
| Closed | 63 | 9.6 |

TABLE **2**

**Submission of Follow-Up Mandatory Test Reports Among Noncompliant Facilities (*n* = 192)**

| Submitted Report | # | % |
|---|---|---|
| Yes | 96 | 50.0 |
| No | 96 | 50.0 |

for buildings built as and used as a home or apartment). Results were then sent to the Florida Radon Program where they were entered into the database.

This study sought to examine noncompliance with mandatory radon testing rules by county and facility type in Florida, as well as the efficacy of outreach to facilities that were determined to be noncompliant. It was hypothesized that there would be a significant difference in noncompliance among facility types. Additionally, it was hypothesized that there would be a significant difference in noncompliance among those counties with a specific individual designated responsible for radon testing of public schools and those counties who do not have such a designated individual.

## Methods

The radon database was examined to determine 5-year follow-up test compliance among those who had previously submitted a radon test in the years 2010 or 2011. Noncompliance was determined for facilities that a) did not have a 5-year follow-up test on record, b) performed their 5-year follow-up test too early, c) made significant structural changes or additions to the building and did not retest, or d) received approval for a new or amended license.

If there was a large gap of time between the initial test and the follow-up test, for example 1995–2010, then the property appraiser's website specific for that county was consulted to determine if structural changes had been permitted that would necessitate a new test to be performed. If it was established that such structural changes had been made, noncompliance was determined.

Facilities determined to be noncompliant and still in operation were contacted by phone and by mail to notify them of their possible noncompliance with Florida Statute 404.056. Contact information was obtained from the corresponding mandatory testing record. When there was a county-specific individual responsible for radon testing in public schools, that person was contacted rather than or in addition to the facility.

Initial attempts to contact noncompliant facilities were made by phone using the contact number(s) provided on the mandatory testing report from their initial radon test and/or the facility's website. If no response was received within 2 weeks, a letter stating that the Florida Department of Health was unable to determine the facility's compliance with the statute was sent to the address given on the application and/or business website. Noncompliant facilities were given a minimum of 30 days from the date the letter was sent to have a new radon test performed and send their mandatory testing report to the Radon Program. Reports were received by mail, fax, and e-mail. Both paper records and database entries were assessed to determine if reports had been received for noncompliant facilities.

The following data points were gathered:

- Total number of facilities assessed.
- Number of facilities that were no longer operating or licensed.
- Number of noncompliant facilities.
- Number of compliant facilities.
- Number of noncompliant facilities to which contact was attempted and they did not send in their follow-up mandatory test report.
- Number of noncompliant facilities to which contact was attempted and they did send in their follow-up mandatory test report.
- County for each facility assessed.
- Type of facility assessed.

In addition to the above data points, this study intended to examine noncompliance among rural counties that are considered economically distressed. A rural county is defined as a county with a population of ≤75,000 or a population of ≤125,000 that is contiguous to a county with a population of ≤75,000 (Rural Economic Development Initiative, 2019). An economically distressed rural county will, in addition to those factors described above, exhibit three or more economic distress factors. Economic distress factors include low per capita income, low per capita taxable values, high unemployment, high underemployment, low weekly earned wages, low housing values, high percentages of the population receiving public assistance, and high poverty levels.

Noncompliance was examined using SPSS statistical software. The categories for the compliance variable were transformed into noncompliance and compliance with closed facilities being coded as missing. Those facilities that were compliant and those that submitted reports were coded as compliant. Facilities that did not submit reports were coded as noncompliant.

The variable for facility type was transformed into a new variable with the following four categories: child care center, private school, public school, and adult 24-hour care. Child care center included the facility type: day care, foster care, or family day care. Adult 24-hour care included the facility type: assisted living facility, nursing facility, or adult family care home. Other facility types were not specifically examined because of small sample sizes. The new variable was further transformed with each category becoming a dichotomous variable with categories being "belonging to that facility type" and "not belonging to that facility type." Closed facilities were coded as missing.

The variable for counties was transformed into counties that have a specific individual responsible for radon testing in public schools or those that do not. Counties for which the sample size was zero were coded as missing. County-designated individuals are responsible for radon testing only within public schools; therefore, facility types that were not public schools were not included within the county variable. Closed facilities were coded as missing.

A binomial logistic regression was performed to determine significance among the facility type variables and noncompliance. A binomial logistic regression was chosen because it was desirable to understand if

TABLE **3**

**Compliance by Facility Type**

| Facility Type | # | Compliant | | Noncompliant: Submitted Report | | Noncompliant: Did Not Submit Report | | Closed | |
|---|---|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % | # | % |
| Child care center | 97 | 49 | 50.5 | 21 | 21.6 | 14 | 14.4 | 13 | 13.4 |
| Public school | 209 | 177 | 84.7 | 15 | 7.2 | 15 | 7.2 | 2 | 1.0 |
| Private school | 244 | 129 | 52.8 | 44 | 18.0 | 41 | 16.8 | 30 | 12.3 |
| Adult 24-hour care | 84 | 30 | 34.5 | 13 | 15.5 | 23 | 27.4 | 18 | 22.6 |
| Hospital | 8 | 4 | 50.0 | 1 | 12.5 | 3 | 37.5 | 0 | 0 |
| Alcohol, drug, and mental health | 11 | 10 | 90.9 | 1 | 9.1 | 0 | 0 | 0 | 0 |
| Detention center | 3 | 2 | 66.7 | 1 | 33.3 | 0 | 0 | 0 | 0 |
| Total | 656 | 401 | | 96 | | 96 | | 63 | |

noncompliance could be predicted based on facility type. In this way, certain facility types could be targeted for outreach. Such information could be useful when outreach resources are limited. A chi-square test was performed to determine significance among noncompliance and counties with a designated individual for public schools. This test was chosen because it sought to examine the relationship between two categorical variables. If a relationship was found, then additional statistical tests would have been performed to determine the nature of the relationship. A $p < .05$ was considered statistically significant.

## Results

Of the 656 facilities assessed, 401 were compliant, 192 were noncompliant, and 63 were found to be closed (Table 1). Noncompliant facility values and percentages are shown in Table 2. Values and percentages for the facility and county variables are shown in Tables 3 and 4, respectively. There were several counties with the mandatory testing requirement that had zero facilities sampled. Upon examination of the data, it was found that the sample size for noncompliant economically distressed rural counties was too small to make any meaningful conclusion about their noncompliance.

For the facility type variables, a Hosmer–Lemeshow goodness of fit test was performed and the *p*-value ($p = .814$) indicated a good fit model (the observed event matches the expected event rates). The results of the binomial logistic regression are shown in Table 5. The regression weights indicate that those facilities classified as child care center have a greater likelihood of being noncompliant ($B = 0.24$), but the relationship was not statistically significant ($p = .73$). Those facilities classified as public school were shown to have a lower likelihood of being noncompliant ($B = -0.70$), but the relationship was not statistically significant ($p = .30$). Those facilities classified as private school were shown to have a greater likelihood of being noncompliant ($B = 0.41$), but the relationship was not statistically significant ($p = .53$). Those facilities classified as adult 24-hour care were shown to have a greater likelihood of being noncompliant ($B = 1.22$), but this relationship was not statistically significant ($p = .07$). The predictor variables do not appear to have a significant impact on the odds of facilities being noncompliant. The null hypothesis regarding facility types was not rejected, indicating that there is no apparent difference in noncompliance among facility types.

For the designated individual variable, the *p*-value indicated that there was no statistically significant relationship between noncompliance and counties with a designated individual for public schools [$\chi^2$ (1, $N = 207$) $= 1.374$, $p = .241$]. The null hypothesis regarding county designated individuals for public schools was not rejected, indicating that there is no apparent difference in noncompliance among those counties with a specific individual designated responsible for radon testing of public schools and those counties who do not have a designated individual.

## Discussion

Examination of the overall compliance among facilities with the mandatory testing requirement revealed that less than one third of the facilities examined were noncompliant. This finding shows that most of the facilities are following the mandatory testing requirement.

All the facility types examined in this study did not show a statistically significant relationship to noncompliance. As such, it is not recommended to implement an outreach approach that targets specific types of facilities. Implementing a process to routinely reach out to facilities prior to and immediately following the 5-year follow-up test date might be more effective, but further research is needed.

Counties with a designated individual responsible for testing of certain facilities did not exhibit a statistically significant relationship to noncompliance. It should be noted that all the counties with a designated individual have population densities >250 persons per square mile (Rayer & Wang, 2018), which places these counties among the most densely populated areas within Florida. It might be necessary for these counties to have a designated individual due to the increased number of public schools rather than as a measure to ensure greater compliance. Based on the results found

TABLE **4**

**Facility Compliance Among Counties With Mandatory Testing Requirements**

| County | # | Compliant | | Noncompliant: Submitted Report | | Noncompliant: Did Not Submit Report | | Closed | |
|---|---|---|---|---|---|---|---|---|---|
| | | # | % | # | % | # | % | # | % |
| Alachua | 6 | 4 | 66.7 | 1 | 16.7 | 0 | 0 | 1 | 16.7 |
| Brevard | 40 | 24 | 60.0 | 1 | 2.5 | 8 | 20.0 | 7 | 17.5 |
| Broward | 54 | 32 | 59.3 | 5 | 9.3 | 13 | 24.1 | 4 | 7.4 |
| Charlotte | 5 | 3 | 60.0 | 2 | 40.0 | 0 | 0 | 0 | 0 |
| Citrus | 2 | 1 | 50.0 | 1 | 50.0 | 0 | 0 | 0 | 0 |
| Columbia | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| De Soto | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Duval | 44 | 24 | 54.5 | 4 | 9.1 | 9 | 20.5 | 7 | 15.9 |
| Gadsden | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 100 |
| Hernando | 7 | 4 | 57.1 | 2 | 28.6 | 1 | 14.3 | 0 | 0 |
| Highlands | 2 | 2 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hillsborough | 37 | 24 | 64.9 | 5 | 13.5 | 4 | 10.8 | 4 | 10.8 |
| Holmes | 1 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Indian River | 6 | 5 | 83.3 | 0 | 0 | 1 | 16.7 | 0 | 0 |
| Leon | 6 | 3 | 50.0 | 1 | 16.7 | 2 | 33.3 | 0 | 0 |
| Manatee | 7 | 1 | 14.3 | 2 | 28.6 | 2 | 28.6 | 2 | 28.6 |
| Marion | 8 | 2 | 25.0 | 2 | 25.0 | 1 | 12.5 | 3 | 37.5 |
| Martin | 1 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 |
| Miami-Dade | 95 | 50 | 52.6 | 24 | 25.3 | 12 | 12.6 | 9 | 9.5 |
| Okaloosa | 2 | 1 | 50.0 | 0 | 0 | 1 | 50.0 | 0 | 0 |
| Osceola | 7 | 4 | 57.1 | 0 | 0 | 2 | 28.6 | 1 | 14.3 |
| Palm Beach | 143 | 103 | 72.0 | 20 | 14.0 | 8 | 5.6 | 12 | 8.4 |
| Pasco | 16 | 6 | 37.5 | 6 | 37.5 | 3 | 18.8 | 1 | 6.3 |
| Pinellas | 59 | 40 | 67.8 | 6 | 10.2 | 11 | 18.6 | 2 | 3.4 |
| Polk | 9 | 4 | 44.4 | 2 | 22.2 | 3 | 33.3 | 0 | 0 |
| Putnam | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 100 |
| St. Johns | 3 | 1 | 33.3 | 0 | 0 | 1 | 33.3 | 1 | 33.3 |
| St. Lucie | 4 | 2 | 50.0 | 1 | 25.0 | 1 | 25.0 | 0 | 0 |
| Sarasota | 22 | 15 | 68.2 | 2 | 9.1 | 4 | 18.2 | 1 | 4.5 |
| Seminole | 35 | 27 | 77.1 | 2 | 5.7 | 5 | 14.3 | 1 | 2.9 |
| Sumter | 11 | 9 | 81.8 | 1 | 9.1 | 0 | 0 | 1 | 9.1 |
| Taylor | 1 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 |
| Volusia | 16 | 5 | 31.3 | 4 | 25.0 | 3 | 18.8 | 4 | 25.0 |
| Walton | 3 | 2 | 66.7 | 0 | 0 | 1 | 33.3 | 0 | 0 |
| Total | 656 | 401 | | 96 | | 96 | | 63 | |

*Note.* The following counties had no sampled facilities: Calhoun, Dixie, Gilchrist, Gulf, Hamilton, Hardee, Jackson, Jefferson, Levy, Liberty, Madison, Nassau, Suwannee, and Union.

in this study, it is not recommended for every county to have a designated individual, as not having one could not be shown to have a significant association with noncompliance.

The success rate of the forms of outreach used in this study, as measured in the number of noncompliant facilities that sent in their mandatory testing reports, was exactly 50%. Based on this finding, it is recommended that the forms of outreach used in this study be used only as a supplement to other forms of outreach.

The reason for the small sample size of noncompliant facilities in economically distressed rural counties can be attributed to the fact that there are many economically distressed rural counties which lack a mandatory radon testing requirement for the facility types examined in this study. These counties lack this requirement because they have not been designated by the Department of Business and Professional Regulation's Florida Radon Protection Map categories as having "intermediate" or "elevated radon potential." Additionally, population size within these counties tends to be relatively small and therefore they have fewer facilities that must abide by the mandatory radon testing requirement (Office of Economic and Demographic Research, 2019).

There are a few limitations in this study that should be considered. Some of the facility types and the facility statuses might not have been appropriately classified. Facility type data were based on how the facilities listed themselves on their testing reports. Facility status was based on the reports and information gathered about facilities from their licensing agency, website(s), and listed contact person(s). Information received from the Florida Department of Education after the study had been completed revealed that several facilities had misclassified their facility type and/or not maintained their registration with the Florida Department of Education. Those facilities that had not maintained their registration should have been classified as closed. Additionally, during the status assessment process, only the statuses of noncompliant facilities were assessed. This assessment could have skewed the results, as several of the compliant facilities might have been closed.

Future studies involving the mandatory reporting of radon testing within Florida should include an assessment of the effectiveness of outreach to facilities near their follow-up test date and an evaluation of compliance among schools that do and do not participate in state scholarship programs.

TABLE **5**

**Results of Regression Analysis**

| Facility Type | *B* | *SE* | *df* | *p*-Value | Exp(*B*) | 95% *CI* for Exp(*B*) |
|---|---|---|---|---|---|---|
| Child care center | 0.24 | 0.69 | 1 | .73 | 1.27 | 0.33, 4.87 |
| Public school | -0.70 | 0.68 | 1 | .30 | 0.50 | 0.13, 1.86 |
| Private school | 0.41 | 0.65 | 1 | .53 | 1.50 | 0.42, 5.32 |
| Adult 24-hour care | 1.22 | 0.67 | 1 | .07 | 3.39 | 0.91, 12.67 |

*CI* = confidence interval; *df* = degrees of freedom; *SE* = standard error.

## Conclusion

After examining compliance status among 656 facilities with the mandatory testing requirement, the statistical analysis concluded that there is no statistically significant difference among facility types or among those counties with a specific individual designated responsible for radon testing of public schools and those counties that do not have a designated individual. The null hypothesis was not rejected for either hypothesis. Therefore, it is not recommended to implement outreach approaches that target facilities based on their facility type or county.

It is recommended that the forms of outreach used in this study be implemented as a supplement to other forms of outreach. A 50% improvement in compliance is good, but 50% of facilities remain noncompliant, and that must be addressed.

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*Corresponding Author:* Sarah R. Labat, Radon Program, Florida Department of Health, 11739 Sweet Serenity Lane, Unit 205, New Port Richey, FL, 34654.
E-mail: srl10e@my.fsu.edu.

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# Did You Know?

NEHA has posted two COVID-19 food safety resources: COVID-19 FAQs for Food Establishments and COVID-19 FAQs for Food Safety Regulators. NEHA is committed to supporting the environmental health workforce to effectively and safely do their jobs, as well as have access to critical information and updates. As new information comes to light, updates to these FAQs will be posted on NEHA's COVID-19 resources page at www.neha.org/covid-19.