

**RADON MEASUREMENTS IN NEW JERSEY**

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**ABSTRACT**

The New Jersey Department of Environmental Protection maintains three data bases which contain radon measurement data for New Jersey homes. The first contains data for over 25,000 homes submitted by 60 firms participating in an Interim Certification Program for Testing and Mitigation. The second consists of data collected through a confirmatory monitoring program and includes both firm or commercial and DEP measurements for over 6,000 homes. Radon levels measured through a land-based survey of approximately 6,000 homes statewide make up the third data base. This paper compares the Statewide radon survey and firm measurements. The relationship of radon measurements made by DEP to those performed by firms in the same homes is also evaluated. Both airborne and waterborne radon data is reviewed. Preliminary analysis of the data shows that statewide averages do not differ considerably between firm and statewide survey data.

## INTRODUCTION:

In recent years different methods for measuring radon in air have been developed. In each case the method was basically designed for a specific use, such as a varying of concentration level, required accuracy or overall sampling environment. Most of these methods are expensive and some are too slow or complicated for large-scale surveys where high accuracy is not demanded. Among these methods, activated carbon canisters were found to be much more suitable for large-scale surveys as in the case of testing radon in New Jersey homes. In this paper, the data reported were collected using charcoal canisters under standard conditions. The radon data base has been started since the beginning of 1986. Currently, the Department of Environmental Protection maintains three data bases which will be discussed in detail later. Over 1,000 water samples were also collected and analyzed.

## BACKGROUND:

Radon is a naturally occurring, chemically inert, radioactive gas. It is odorless, colorless and tasteless, and therefore cannot be detected by the human senses. Radon can be found virtually everywhere, in at least small concentrations, since its predecessor, radium-226, is found in all rock and soil. In the outdoor air, radon is diluted to low concentrations. However, indoors, it can accumulate to harmful levels as a result of a combination of factors, including building construction techniques and geologic characteristics. Exposure to elevated levels of radon is associated with an increased risk of developing lung cancer. The United States Environmental Protection Agency (USEPA) has estimated that between 5000 and 20,000 of the approximately 125,000 lung cancer deaths per year in the United States may be due to radon. Exposure to radon has been well documented in uranium miner studies and verified by animal studies. In view of this, the USEPA has established 4.0 picocuries/l (0.02 WL) as a continuous exposure limit. Corrective action is therefore recommended for homes in which there is an annual average exposure to radon greater than or equal to 4.0 pCi/l.

In January of 1985, the Pennsylvania Department of Environmental Resources notified the State of New Jersey of the discovery of elevated radon concentrations in a residence located on a uranium rich geologic feature in Boyertown, Pennsylvania. Known as the Reading Prong, this feature extends from Pennsylvania through New Jersey and into New York State. The level of radon discovered at the residence was well over the average level of radon that uranium miners are allowed under existing federal regulations. Examination of New Jersey's geological and radiological data indicated that the radon problem experienced in Pennsylvania could also exist in New Jersey. Currently, it is estimated that as many as 1.9 million New Jersey homes have potentially elevated radon levels.

The State's initial response was to establish a toll-free information hot-line to address the public's questions on radon. Concurrently, reports of elevated radon levels in Pennsylvania were publicized in the New York Times, adding to the concerns of New Jersey residents, and prompting hundreds of calls to the information hot-line.

In response to the potentially significant health risk posed by radon and its decay products, legislation was sponsored in New Jersey to provide \$3.2 million for a 6000 home Statewide Scientific Study of radon; a joint NJDEP/NJDOH epidemiological study; a confirmatory monitoring program which assists homeowners in the identifying and remediating of their radon problems; and a public information/outreach program. A second bill, signed into law, provided an additional \$1 million to create programs for the certification of radon testing and mitigation firms throughout the State.

Regulations to implement the NJDEP's certification program for these testing and mitigation firms are expected to be in effect next year. Current program trends include providing information on radon to interested parties through the public outreach element; assuring high quality radon measurement/mitigation services to New Jersey residents through the certification programs; and enhancing the understanding of the extent of the radon problem and mitigation methods through the Statewide Study and research on mitigation techniques.

Since its inception in July of 1985, the Radon Program's Information Line has received over 75,000 calls and mailed out over 35,000 information packets on measurements and mitigation.

Initial funding which was provided for the 6000 home Statewide Scientific Study of radon has allowed the State to define the regions and housing types at risk of elevated radon throughout New Jersey.

In addition, DEP staff have participated in over 400 public, professional, and scientific meetings/training sessions.

The program has awarded special purpose contracts to behavioral scientists to conduct a public perception survey on risks, and to a firm specializing in public information, to provide assistance in the designing of radon information brochures and slides.

Since July of 1985, the Radon Program has been informed by homeowners of results of radon/radon decay product testing performed by commercial firms in over 10,000 homes. Program staff, with the assistance of local health officers, have conducted confirmatory monitoring visits, free of charge, at approximately 7100 homes with initial firm results greater than or equal to 4.0 pCi/l. This confirmatory monitoring program serves to ensure the quality of test results provided to New Jersey homeowners and provides the Department with its confirmatory testing database.

In addition, the Program has tested the private wells of over 1,000 residences and performed follow-up testing of approximately 1500 residences in which remediation has been done to reduce the levels of radon. Confirmatory monitoring and technical consultations on remediation techniques have been provided for over 90 public buildings.

Currently, there are 87 radon testing firms and 35 mitigation firms participating in the State's Voluntary Certification Program. Commercial firms have voluntarily submitted data summarized by municipality and zip code, for radon measurements made in over 25,000 homes. This data provides the Radon Program with its Voluntary Database.

Following the identification of a group of homes with very high radon levels in Clinton, New Jersey, the NJDEP initiated a Radon Cluster Identification Program. Over 20 such clusters have been identified.

In addition, several program extensions in regard to radon remediation techniques have developed since funding was made available.

The Radon Program is also cooperating with the NJDOH's Special Epidemiological Services in conducting an epidemiological study to determine the relationship between exposure to radon in a residential setting and an increased risk of developing lung cancer.

Based on the preliminary results from the Statewide Scientific Study and data collected through these other components of the State's Radon Program, the NJDEP has been able to identify areas of the State which are at greater risk for radon, and thereby to recommend radon testing with greater urgency.

#### DATA BASES:

##### CONFIRMATORY DATABASE

DEP offered confirmatory testing to homeowners/residents who have tested their homes with commercial firms and obtained radon concentrations equal to or greater than the 4 pCi/l guidance levels, at which point the EPA recommends further testing. Confirmatory monitoring is now provided either directly or through mail out canisters. The confirmatory database which is contained within a DBASE III + management system, which consists of four files. The CONDATA file includes the name of the homeowner, street address, mailing address and telephone number (kept strictly confidential as mandated by law). The FIRMDATA file contains firm identify code, test start date, radon concentration for level 0 (basement) and level 1 (first floor). The DEPDATA file contains start date, radon concentration for levels 0 and 1 as analysed by DEP Lab (BEL. Bureau of

Environmental Laboratories) etc. The BLDGDATA file contains 24 fields which covers selected information about the structure of the home.

### VOLUNTAR DATABASE:

The voluntar database contains over 25,000 data points submitted by 60 commercial firms. These firms are certified by DEP under the Interim Certification Program. They are mandated to report all radon measurement data on a monthly basis, containing firm name, address, contact person's name, telephone number, submission date, test method, municipality name, zip code, floor of home, radon concentration and radon daughter concentration.

### LAND-BASED SURVEY DATA BASE:

In October, 1986, the DEP contracted with an environmental engineering firm to perform a statewide scientific study of radon occurrence in homes and municipal buildings. The main objectives of this study are:

- a. To map areas that pose a potential radon problem using all available geographic, geologic, radiometric and demographic data.
- b. To develop a computerized database for the information collected in the statewide study.
- c. To provide a summary report containing the most technically/scientifically valuable findings of the statewide study for presentation to the New Jersey State Legislature and the public.

This study involved sampling over 6000 homes and public buildings for radon for a two year period. In this database, there are nine different files covering over 300 fields.

## RESULTS AND DISCUSSIONS

### CONFIRMATORY DATA BASE

A total of over 6,000 home owners reported the results of radon concentration tests which were above the EPA recommended 4 pCi/l guideline to DEP for confirmation. Out of these 6,000 homes, 5,420 and 5,961 are for basement (level 0) for DEP and firms respectively. A simple statistical analysis has been performed on these radon results as presented in table 1. The averages of the DEP and firm basement measurements are 22.39 and 21.93 pCi/l respectively. As mentioned before, this data base contains only radon concentrations higher than 4 pCi/l which makes the average radon concentration high. This data base will be used to evaluate the performance of the testing firms and not

not for any other purposes. The medians of the DEP and Firm are 9.2 and 9.8 pCi/l respectively, in good agreement. The waterborne radon data were analyzed. They did not show any significant relationship with airborne radon concentration. A typical example of radon concentration distribution at basement level is shown in figure 1.

### VOLUNTAR DATA BASE

A total of 25,000 radon measurements in the basement (level 0) are entered into the Voluntar Data Base. The average basement measurement is 5.26 pCi/l and the median is 2.0 pCi/l. The percentage of homes with radon concentration equal to or greater than 4 pCi/l is 27.5. This data base is not based on the same statistical design (that of uniform distribution) as the land-based survey data base. A typical example of radon concentrations distribution at basement level is shown in figure 2.

### LAND-BASED SURVEY DATA BASE

The final study of this survey provides a summary of the radon testing data obtained in homes at the basement level presented by county. The percentage derived from this study is 33.0 percent. The average basement measurement is 5.2 pCi/l, while the average of similar measurements derived from the Voluntar Database is 5.26 pCi/l. Radon statistics by county are presented in table 2. It can be seen from table 2. that Warren County has the highest average radon concentration (11.57 pCi/l.).

### CONCLUSION

All three data bases clearly indicate radon is a problem in many homes in New Jersey. In particular, central and northern New Jersey homes are affected. The waterborne radon did not show any relationship with airborne radon. However, further study may indicate a relationship.

TABLE-1

RADON STATISTICS FOR DEP/FIRM DATA

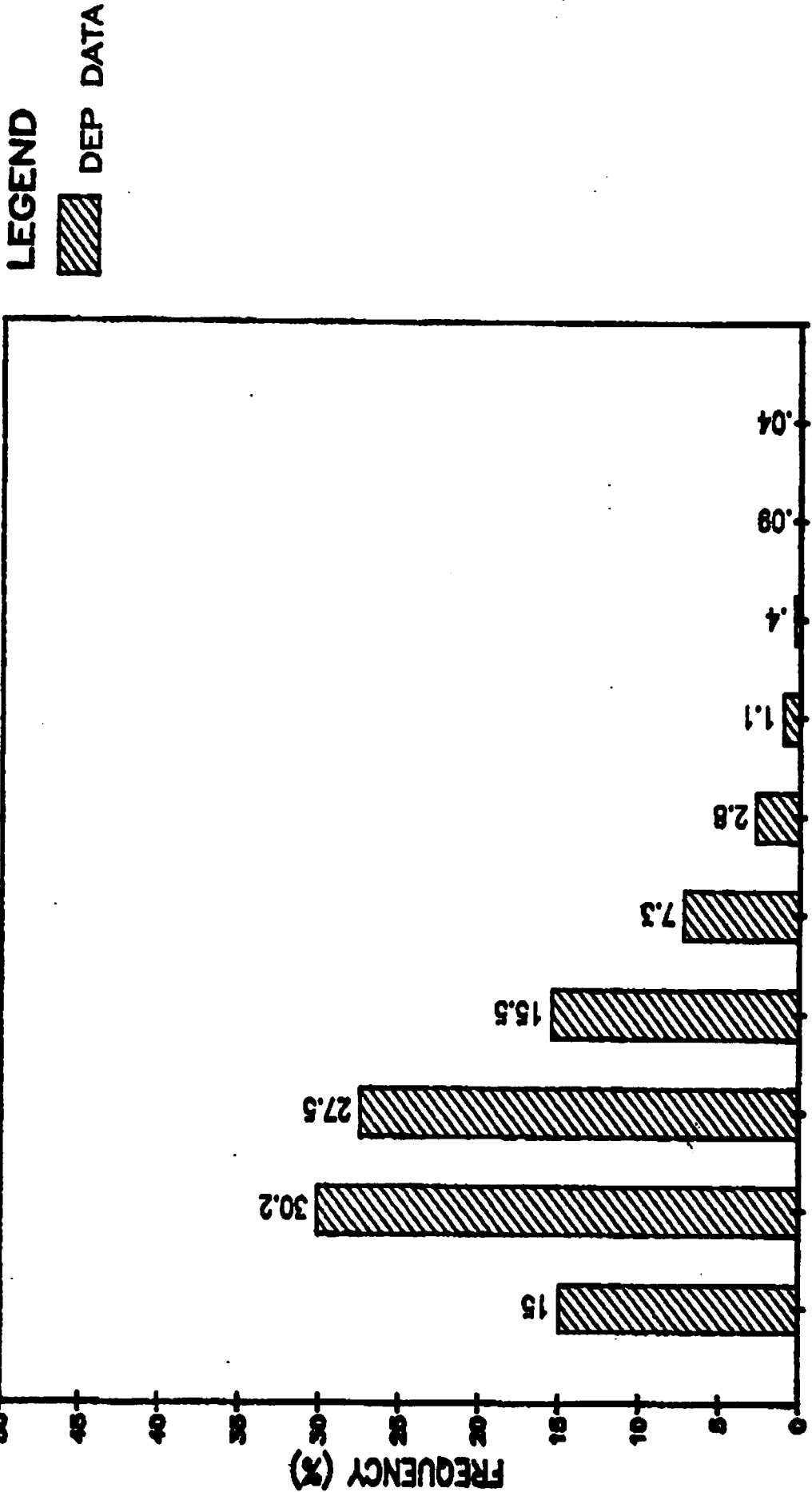
	# OF RECORDS	MEAN	MEDIAN	STANDARD DEVIATION
DEP DATA	5420	22.39	9.2	91.68
FIRM DATA	5961	21.93	9.8	60.76

**TABLE-2**  
**RADON STATISTICS**  
**BY COUNTY**

<b>COUNTY</b>	<b>ARITHMETIC MEAN</b>	<b>STANDARD DEVIATION</b>	<b>PERCENT Rn&gt;4 (pci/l)</b>
ATLANTIC	0.85	0.61	0
BERGEN	1.81	2.32	6.4
BURLINGTON	1.87	2.35	9.7
CAMDEN	2.19	1.99	17.8
CAPE MAY	1.09	1.80	5.9
CUMBERLAND	1.89	2.49	11.8
ESSEX	1.28	1.03	4.3
GLOUCESTER	2.99	6.33	10.0
HUDSON	2.54	6.31	3.6
HUNTERDON	6.98	11.78	45.7
MERCER	5.02	12.51	26.3
MIDDLESEX	2.01	2.62	11.8
MONMOUTH	2.96	4.66	16.9
MORRIS	5.71	9.84	36.4
OCEAN	1.05	1.19	4.4
PASSIAC	3.11	4.44	21.7
SALEM	2.43	4.27	15.1
SOMERSET	4.77	7.77	30.8
SUSSEX	6.36	9.28	49.2
UNION	1.57	1.63	5.8
WARREN	11.57	19.83	66.9



# RADON DISTRIBUTION TESTED BY DEP



RADON CONCENTRATION (pci/l)

FIG. 1.

# RADON DISTRIBUTION TESTED BY FIRMS

LEGEND  
FIRM DATA

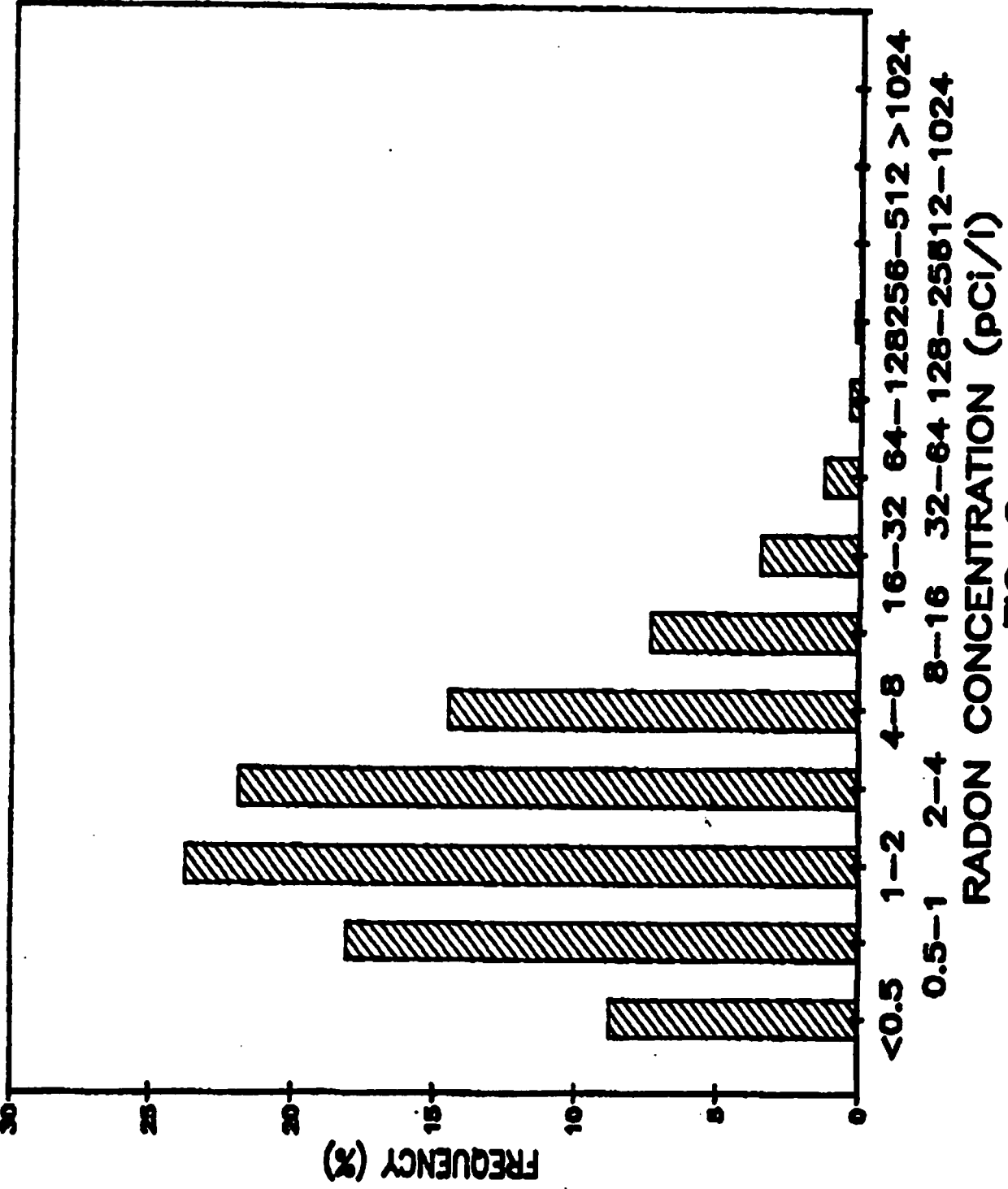


FIG. 2.

## Bibliography

1. U.S.E.P.A. Radon Reference Manual, 520/1-87-20, September, 1987.
2. U.S.E.P.A. A Citizen's Guide To Radon: What It Is And What To Do About It, OPA-86-004, August, 1986.
3. U.S.E.P.A. Radon Reduction Methods: A Homeowner's Guide, OPA-87-010, September, 1987.