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Preliminary Radon Testing Results
for the
Residential Standards Demonstration Program

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I. EXECUTIVE SUMMARY

Measurements are reported of heating season radon concentration in indoor air for 289 homes in the Pacific Northwest. The homes are part of the BPA Residential Standards Demonstration Program, and include 143 dwellings constructed to the Model Conservation Standards proposed by the Northwest Power Planning Council (MCS homes) and 146 control dwellings built over the last several years to current building code (control homes).

For the entire sample of homes, the mean radon concentration was 1.4 pCi/l, and 16 percent of the homes exceeded the BPA Residential Weatherization Program's action level of 5 pCi/l. The mean level in the MCS dwellings was 8 percent higher than in the control dwellings, but the result is not statistically significant ($P < 0.05$). No statistically significant differences were observed between MCS and control dwellings on the basis of climate zone or state except for the state of Washington, where MCS dwellings had a 35% higher radon concentration than control dwellings (geometric means of 0.81 and 0.61 pCi/l, respectively). Control dwellings in Idaho and Montana had higher radon concentrations than MCS dwellings, but the result was not statistically significantly. Statistically significant differences were observed between climate zone 1 and both zones 2 and 3, and between Washington and both Idaho and Montana, with the later having higher concentrations.

These results indicate that the location of the dwelling was a much more important determinant of indoor radon concentration than was use or non-use of the MCS. This is not surprising considering that the MCS and control dwellings are thought to have similar air exchange rates (due to use of air-to-air heat exchangers in the MCS dwellings). This conclusion is still preliminary and must await infiltration and twelve-month radon test results before finalizing.

Previous studies have shown that radon levels in dwellings are only weakly correlated with air exchange rate, and that control of radon sources is a much more practicable and effective method of reducing indoor concentrations. Radon is derived from the radioactive decay of radium, a trace element present in soils in widely varying concentrations. It enters homes generally via soil gases, and therefore can be controlled by venting such gases before they enter the home or in some cases by sealing the home from the soil.

II. INTRODUCTION

This report summarizes radon concentrations in indoor air observed for 289 occupied residential dwellings in the Pacific Northwest during the 1984–1985 heating season. The measurements are average values for three months, and were made using passive detectors supplied by Terradex Corporation of Walnut Creek, California. The dwellings are part of the Bonneville Power Administration's (BPA) Residential Standards Demonstration Program (RSDP) (1), and represent approximately one third of the total measurements which will be made and reported under the program. Both single and multi-family non-manufactured dwellings are included. Measurements for all homes will be completed during 1986 and will be reported in a final report, which will also include more analysis, discussion, and interpretation.

The RSDP is a field demonstration project of the Model Conservation Standards (MCS) proposed by the Northwest Power Planning Council (2). Under the RSDP, 500 all electric dwellings were constructed in compliance with the MCS (MCS dwellings), including both single and multi-family dwellings. These were matched on an aggregate basis to 500 control dwellings build over the last several years in compliance with current local building codes (control dwellings). A subset of the MCS dwellings (matched pair dwellings) were paired directly with control dwellings constructed concurrently with the MCS dwellings, and identical except for changes required by the new building code. The number of matched pair dwellings is currently insufficient for analysis. The dwellings in which the initial radon measurements were made are summarized in Table I.

Construction cost, thermal performance, and indoor air quality effects of the MCS are being studied under the RSDP, principally through aggregate comparison of these parameters between the MCS and control dwellings. Construction cost is being studied using detailed cost accounting obtained from the builder of the MCS dwelling and a hypothetical equivalent dwelling build to current practice. Thermal performance is being assessed using weekly summaries of submetered space and water heating energy, and concurrent actual heating degree days. This information is recorded by occupants. Indoor air quality is being studied using a fan pressurization infiltration test, three-month and one-year passive radon tests, a one week passive formaldehyde test, and a one-time measurement of air-to-air heat exchanger (AAHX) flow. The radon results are reported here, and the other results are in reports similar to this one.

In compliance with agency environmental policy, all MCS dwellings in the RSDP were equipped with an AAHX. These were designed and controlled to result in an overall infiltration rate (natural plus forced) of 0.6 air changes per hour (ach), the presumed rate for current practice dwellings. The control dwellings did not have an AAHX.

III. BACKGROUND

Radon is an odorless, colorless, radioactive gas which occurs naturally as a decay product of radium, a radioactive trace element present in most soils and rocks. Radium in turn is produced as a decay product of uranium. Because uranium tends to be very unevenly distributed in the earth's crust, radon source strength varies widely from location to location.

Radon (^{222}Ra) decays with a half life of 3.8 days into a number of short-lived progeny, including ^{218}Po, ^{214}Bi, ^{214}Po, and ^{214}Pb, which are generated as charged particles and adhere to surrounding surfaces and solids (Figure 1). If the progeny adhere to respirable particulates (dust particles of an appropriate size range to enter and remain in the lungs), or if they enter the respiratory system unattached, they may expose lung tissue to radiation (especially alpha) and therefore be mutagenic or carcinogenic. This is the principle exposure route for radon in man (3). It is estimated that approximately five percent of all lung cancers are due to radon, while smoking accounts for about eighty percent (4).

Radon concentration in indoor air is determined by the source strength of the surrounding soil (and in some cases masonry), pressure differences between soil gas and indoor air, and the air exchange rate for indoor air. Radon source strength is a function both of radium content of soils or masonry and soil gas transport. Once formed by radioactive decay, radon will diffuse through the soil or rock particles in which it is born into the surrounding gas. Due to the shorter diffusion distances involved, small particles will release a larger fraction of their radon before it decays and is trapped than will larger particles or rocks. Soil particles typically release about sixty percent of the radon born within them. Clay soils may have high source strengths if their radium content is high.

Although soil gas it typically the largest source of radon in dwellings, well water, natural gas, and masonry may also be contributing sources. This will be the case particularly for areas of high radium (uranium) content, where radon will tend to accumulate in aquifers, gas deposits, or aggregates used in concrete. A special case is slag from phosphate mining, which typically contains very high levels of uranium. Such slag was used in building materials in southeastern Idaho from 1962 through 1977 (5).

Soil gases exchange with the surrounding environment both by diffusion, driven by concentration gradients, and by convection, driven by pressure gradients. Convection is typically far more important than diffusion, and soils of higher porosity (such as glacial till) are belived to support larger radon fluxes. Soil moisture and the level of the water table may also effect radon transport as soil pores are filled or reduced.

Typically, the radon flux at ground level originates within the top few meters of soil (6). Soil gases enter dwellings through holes and cracks in surfaces which contact the soil, such as basement floors and walls. Such leakage can be reduced by a continuous barrier (such as polyethylene sheet) applied between the soil and the building shell, but it is difficult to insure continuity during installation or to maintain the integrity of such a barrier over the dwelling life. Even small holes with greatly reduce the effectiveness of the barrier.

Convection of soil gases into dwellings will be increased by reductions in indoor barometric pressure. Such reductions may be driven by buoyancy (stack effect), wind, mechanical ventilation, etc. Poorly balanced air-to-air heat exchangers (AAHX), exhaust fans, and combustion appliances without adequate outside combustion air can all contribute to this depressurization and thereby increase radon transport into the dwelling.

IV: MONITORING METHODOLOGY

Radon concentrations in indoor air were measured using passive samplers (Track-Etch detectors) developed by:

Terradex Corporation
460 North Wiget Lane
Walnut Creek, California, 94598.
415-938-2545

The samplers are designed to determine average radon concentration in indoor air when exposed for at least one month. A three-month sampling period was chosen in order to average concentration variations which occur in response to environmental factors (such as the level of the water table) and natural and forced ventilation. The period chosen was during the heating season (between November and March) in order to get an indication of worst case (minimum ventilation) exposure. A twelve-month test was begun simultaneously with the three month test and will be reported in 1986. This later test is thought to be more indicative of long term exposure to occupants and thus health risk, assuming that radiation carcinogenicity is accumulative.

The passive samplers use a plastic film which accumulates visible tracks when exposed to alpha radiation, as from the radioactive decay of radon and its progeny. The film is isolated from the environment by a filter designed to pass only inert gases and have an integrated working range of 0.4 to 60,000 (pCi/l)-month. See Table II and references 8 and 9 for a description of the samplers and their calibration.

Integrated radon dose is determined by counting tracks, and therefore all readings have an associated statistical counting error. The relative error will be larger for smaller radon concentrations (track densities), see Figure 3, and smaller if a larger area of film is read (at a corresponding increase in cost). All samplers in the RSDP were read to an accuracy of 4 (pCi/l)-month. The median counting standard deviation was 31%.

Passive samplers were deployed in the field by an instrumentation contractor. Samplers were mounted in conditioned space in a major common area on the first floor (living room, family room, or dining room) at a level out of reach of children and pets. Care was taken so that the samplers were not near windows, doors, or heating or heat exchanger vents. The dates of deployment and removal were recorded. At the end of a three month period, the samplers were returned for analysis in mailers provided by BPA.

V. MONITORING RESULTS

The results of the radon measurements are summarized in Tables III and IV, and Figures 4 through 9 for the sample as a whole and for a number of subsamples by state and climate zones (as defined for the MCS (2)). Arithmetic means and standard deviations were computed for each sample. Medians were also computed as a measure of central tendency, and geometric means were computed because of the non-gausian shape of the distribution.

MCS and control dwellings were compared for the various samples to determine the effects of the MCS on indoor air quality. Differences in mean radon concentrations were assessed for statistical significance using Z scores. The results of these comparisons are summarized in Table IV. Differences in means were considered to be statistically significant for $Z > 1.96$ ($P < 0.05$), where:

$$Z = (X_1 - X_2)/(\sigma_1^2/N_1 + \sigma_2^2/N_2)^{0.5}$$

and:

X_i = mean for sample i

σ_i = standard deviation for mean of sample i

N_i = number of observations in sample i.

This determination of statistical significance provided only an approximate assessment because of the non-gausian shape of the distribution and should not be treated as entirely accurate. Non-parametric statistics will be used in further analysis.

Frequency distributions of radon concentration are given in Figures 4 through 9 for the entire sample and by climate zone. These were computed for 0.5 pCi/l bins from 0 ppm to 40 pCi/l, and include all observations.

VI: DISCUSSION

It can be seen from Tables III and IV and Figures 4 through 9 that the geometric mean of all homes tested was 1.37 pCi/l and that sixteen percent of all homes tested exceeded the BPA action level of 5 pCi/l. Furthermore, the geometric mean for MCS homes was slightly greater than for control homes, although this difference was not statistically significant (approximate assessment).

A (approximately) statistical significant difference was not observed between MCS and control homes for any climate zone or any state except Washington. In that state the MCS geometric mean exceeded the control by 35 percent, and the overall geometric mean was a relatively low 0.91 pCi/l, although ten percent of homes exceeded the BPA action level of 5 pCi/l. For Idaho and Montana the average concentration in control homes was greater than that in MCS homes.

A (approximately) statistical significant difference was observed between climate zone 1 and both climate zones 2 and 3, and between the state of Washington and the states of Idaho and Montana when both MCS and control homes were considered.

The above comparisons indicate that, for the RSDP dwellings, indoor radon concentrations was generally a function of the location of the home and not a function of whether the home was constructed to the MCS or to current practice. This result is consistent with several earlier studies (10). Concentrations were generally greater for the climate zones and states east of the Cascades.

Estimates of heating season average infiltration rate inferred from pressurization measurements of leakage area are being made for all RSDP homes and will be reported in succeeding reports. AAHX flow rates and balance have been measured and reported (11). MCS and control homes were projected to have equivalent infiltration rates, based upon assumed natural rates and forced ventilation of the MCS homes with AAHX's. Correlations will be investigated between radon concentrations and overall infiltration rate and AAHX operation. These will indicate:

1. How well indoor radon concentration and overall infiltration rate are correlated (single variable correlation);

2. How effective the forced ventilation by AAHX used in the MCS homes was in reducing indoor radon concentration (separate single variable correlations for MCS and control homes);

3. How much effect poor heat exchanger balance had on indoor radon concentration (single variable correlation).

VII: SUMMARY CONCLUSIONS

1. The geometric mean 3-month (heating season) radon concentration observed for all 289 dwellings was 1.37 pCi/l.

2. The geometric mean radon concentration observed for MCS dwellings was eight percent higher than for control dwellings, but the result was not statistically significant ($P < 0.05$). Statistically significant differences in means were not observed between MCS and control dwellings for any climate zone or state except Washington (MCS levels 35 percent higher). Control dwellings in Idaho and Montana had higher levels of radon than did corresponding MCS dwellings, although the result was not statistically significant.

3. Statistically significant ($P < 0.05$) differences in means were observed between climate zone 1 and both zones 2 and 3, and between Washington and both Idaho and Montana, with the later having higher concentrations.

4. These results indicate that for the RSDP, building location was a much more important determinant of indoor radon concentration than was use of non-use of the MCS. This in not too surprising because the MCS dwellings were mechanically ventilated using an AAHX so as to have a similar air exchange rate as control dwellings. Actual study of radon concentration as a function of natural and forced infiltration will be done when the required data is available in 1986

5. The remaining 3-month radon measurements (approximately 60 percent more) and 12-month radon measurements will be reported in 1986.

VIII FURTHER ANALYSIS

Further analysis of these issues could be done on the following topics:

1. Correlation of indoor radon concentration and air exchange rates.

2. Correlation of indoor radon concentration and radon source strengths; it may be possible to evaluate sites before construction by monitoring radon in soil gases so that appropriate mitigation strategies can be incorporated into the design.

3. Effectiveness of subsoil depressurization in reducing indoor radon concentrations for Pacific Northwest soils and construction.

IX: REFERENCES

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Portland, Oregon 97208
(503) 230-5131

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(503)222-5161

3. "Exposures From the Uranium Series with Emphasis on radon and Its Daughters"; National Council on Radiation Protection and Measurements Report No. 77; March 15, 1984; pg 2.

4. "Final Environmental Impact Statement for the Expanded Bonneville Power Administration Residence Weatherization Program"; DoE/EIS 0095F; September, 1984; pg. 18.

5. Ciff, Niles, and Brown; "The Incidence and Origin of Radon and Its Decay Products in Buildings"; National Radiological Protection Board; February 1984.

6. R.S. Eaton & A. Scott; "Recent Progress in Canada in the Understanding of Radon Transport Into Housing, A Radon Index Number"; International Seminar on Indoor Exposure to Natural Radiation; Capri, Italy; October 1983.

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8. Alter, H. and Fleischer, R.; "Passive Integrating Radon Monitor for Environmental Monitoring"; Health Physic, 40(May); pg 693; 1981.

9. Oswald, R. and Alter, H.; "Calibration of Track Etch Radon Detectors"; unpublished internal report, Terredex Corporation; July, 1983.

10. Nero, A. et al; "Radon Concentrations and Infiltration Rates Measured in Conventional and Energy-Efficient Houses"; Lawrence Berkeley Laborotories; LBL-13415; Sept. 1981.

11. Reiland, McKinstry, and Thor; "Preliminary Air-to-air Heat Exchanger Test Results for the Residential Standards Demonstration Program"; RSDP Program Results Report No. 2; BPA; September, 1985.

TABLE I: Site Distribution

Case	MCS	Control	Total
All	143	146	289
Zone 1	56	74	130
Zone 2	35	18	53
Zone 3	52	54	106
Idaho	37	17	54
Montana	40	48	88
Oregon	7	20	27
Washington	59	61	120

TABLE II: Passive Sampler Characteristics

Trade Name/Model	Track-Etch
Manufacturer Address	Terradex 460 North Wiget Lane Walnut Creek, CA 94598
Contact	Dr. H. Wald Alter
Telephone	(415) 938-2545
Collection Mechanism	Alpha particle sensitive film
Sampling Time	At least 1 month
Range	0.4 - 60,000 (pCi/l)-month
Sensitivity	0.2-1.0 pCi/l-month
Accuracy	
Cost	$16.50 each for 4.0 pCi/l-month $33 each for 1.0 pCi/l-month $66 each for 0.2 pCi/l-month
Analysis Requirements	Count number of alpha particles on developed film. Must be done by Terradex.
Analysis Cost	Included in purchase price.

TABLE III: Summary of RSDP Radon Measurements

Case	N	Arithmetic Mean	Arithmetic Std Dev	Geometric Mean	Median	N >5 pCi/l
All	289	3.0	4.2	1.37	1.5	46 (16%)
MCS	143	3.0	4.1	1.42	1.7	24 (17%)
Control	146	2.9	4.4	1.32	1.2	22 (15%)
Zone 1	130	1.3	3.0	0.58	0.5	7 (5%)
Zone 2	53	3.7	4.3	2.37	2.0	10 (19%)
Zone 3	106	4.6	4.7	3.15	3.3	29 (27%)
ID	54	4.7	6.2	2.45	2.2	15 (28%)
MT	88	4.2	4.1	1.34	3.2	19 (22%)
OR	27	1.1	1.0	0.79	0.7	0 (0%)
WA	120	1.8	3.1	0.91	0.5	12 (10%)
Zone 1, MCS	56	1.4	2.5	0.58	0.45	5 (9%)
Zone 1, Cont.	74	1.2	3.3	0.58	0.5	2 (3%)
Zone 2, MCS	35	3.9	4.6	2.24	2.1	7 (20%)
Zone 2, Cont.	18	3.2	3.8	2.03	1.8	3 (17%)
Zone 3, MCS	52	4.1	4.5	2.77	3.0	12 (23%)
Zone 3, Cont.	54	5.1	4.9	3.56	3.5	17 (31%)
ID MCS	37	3.8	5.4	2.00	1.6	8 (22%)
ID Cont.	17	6.7	7.1	3.85	3.4	7 (41%)
MT MCS	40	3.4	2.5	2.56	2.8	7 (18%)
MT Cont.	48	4.7	4.9	5.39	3.3	12 (25%)
OR MCS	7	1.3	-	-	1.1	0 (0%)
OR Cont.	20	1.8	-	-	0.6	0 (0%)
WA MCS	59	2.4	4.0	0.81	0.6	9 (15%)
WA Cont.	61	1.1	1.4	0.60	6.3	3 (5%)

TABLE IV: Statistical Significance of Means Comparisons

Dist. 1	Dist. 2	Z
MCS	Control	0.18
Zone 1	Zone 2	4.6
Zone 1	Zone 3	6.28
Zone 2	Zone 3	1.2
Idaho	Montana	0.53
Idaho	Washington	3.3
Montana	Washington	4.6
Zone 1 MCS	Zone 1 Control	0.39
Zone 2 MCS	Zone 2 Control	0.59
Zone 3 MCS	Zone 3 Control	1.1
Idaho MCS	Idaho Control	1.5
Mont. MCS	Mont. Control	1.6
Ore. MCS	Ore. Control	–
Wash. MCS	Wash. Control	2.4

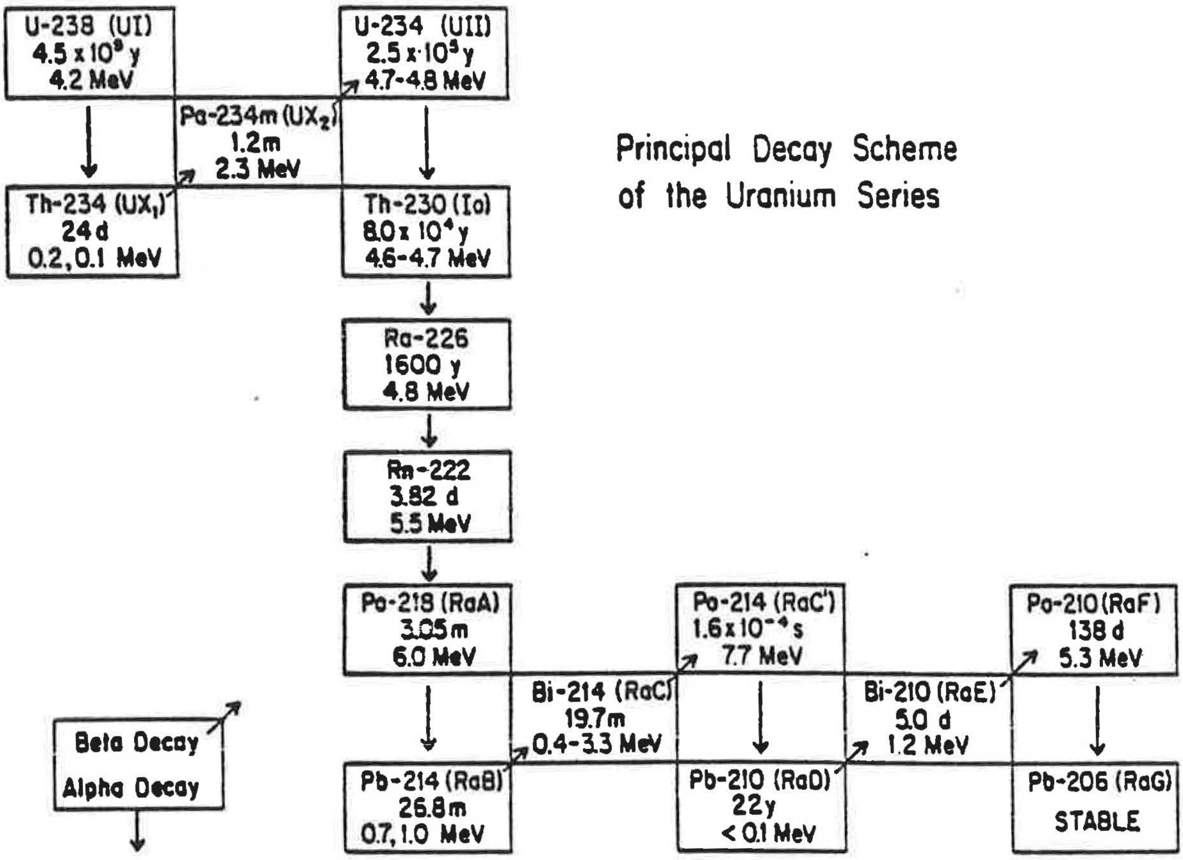

Figure 1: Radon Decay Chain.

Radon Standards and Guidelines

Organization	Recommended Maximum Radon Level	Comments
U.S. Mine Safety & Health Administration	16 pCi/l	Regulation for Miners
National Council on Radiation, Protection, and Measurement	8 pCi/l	Recommended Action Level for general population
BPA	5 pCi/l	Action Level for Residential Weatherization Program.
Environmental Protection Agency	4 pCi/l	Indoor radon in homes built on sites contaminated by uranium processing.
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)	2 pCi/l	Recommended exposure level in commercial buildings and residences

Figure 2: Summary of Radon Standards and Guidelines

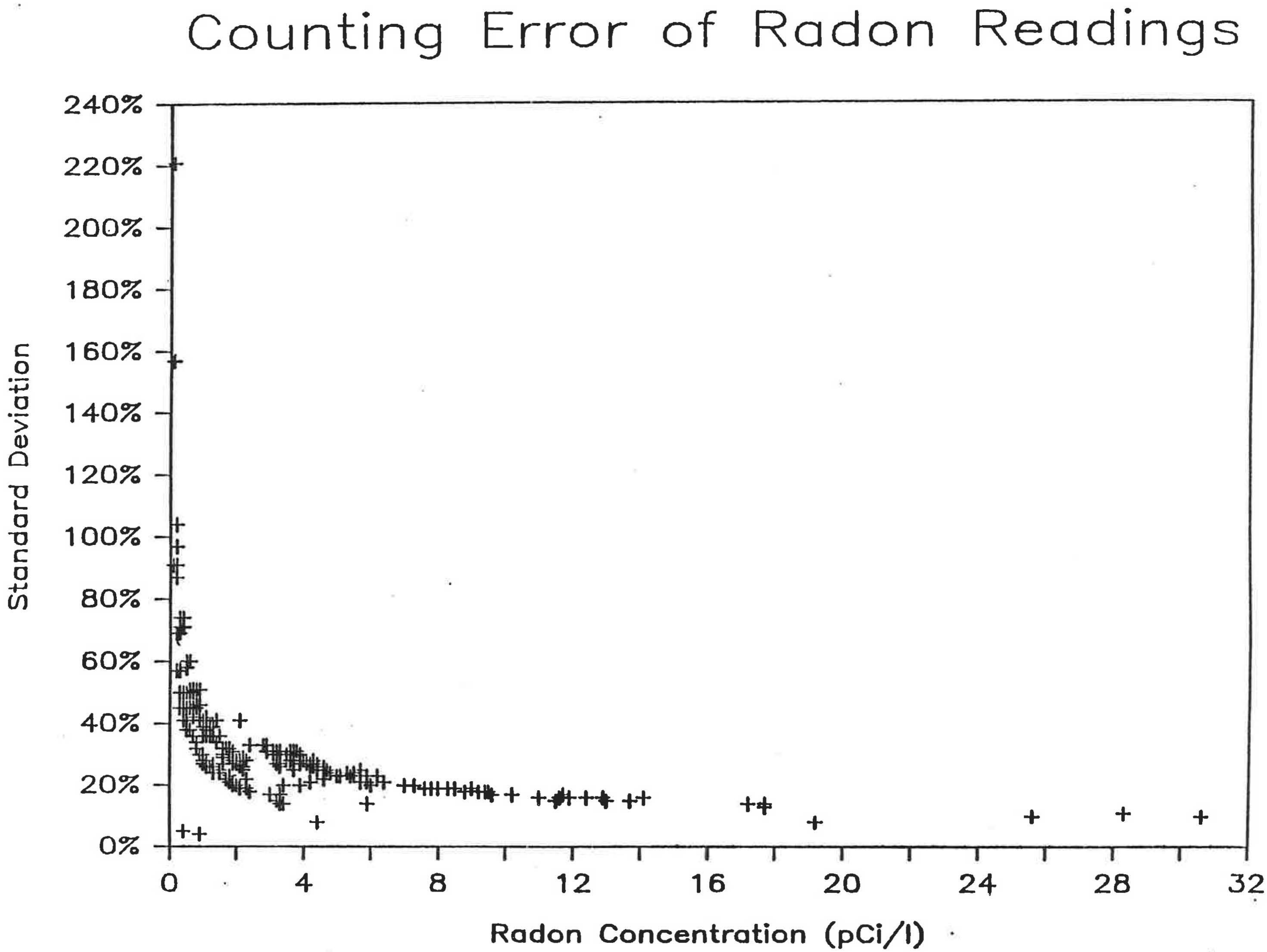

Figure 3: Statistical Reading Error for Sampler as a Function of Reading

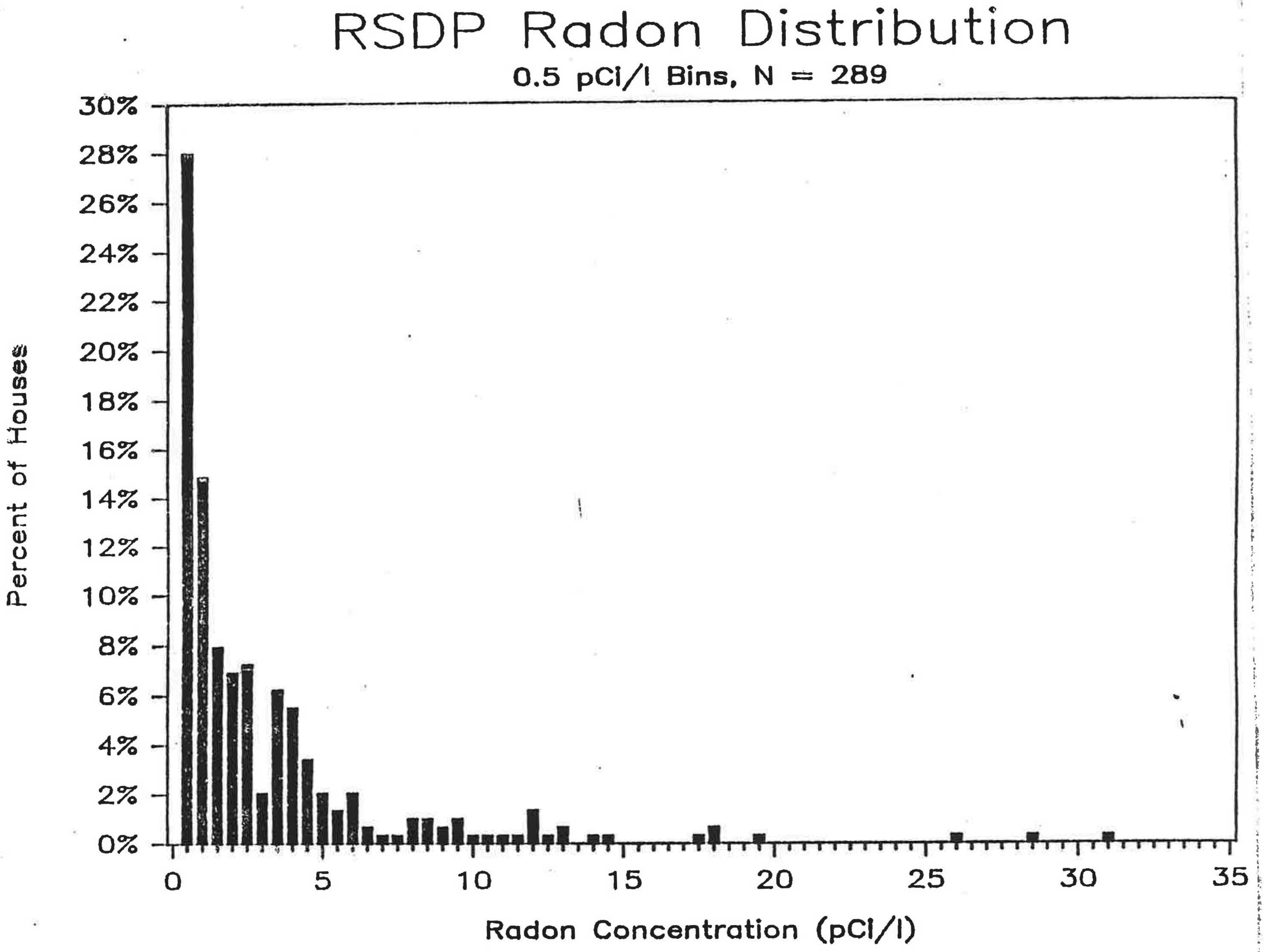

Figure 4: Distribuition of Radon Concentrations for All Dwellings.

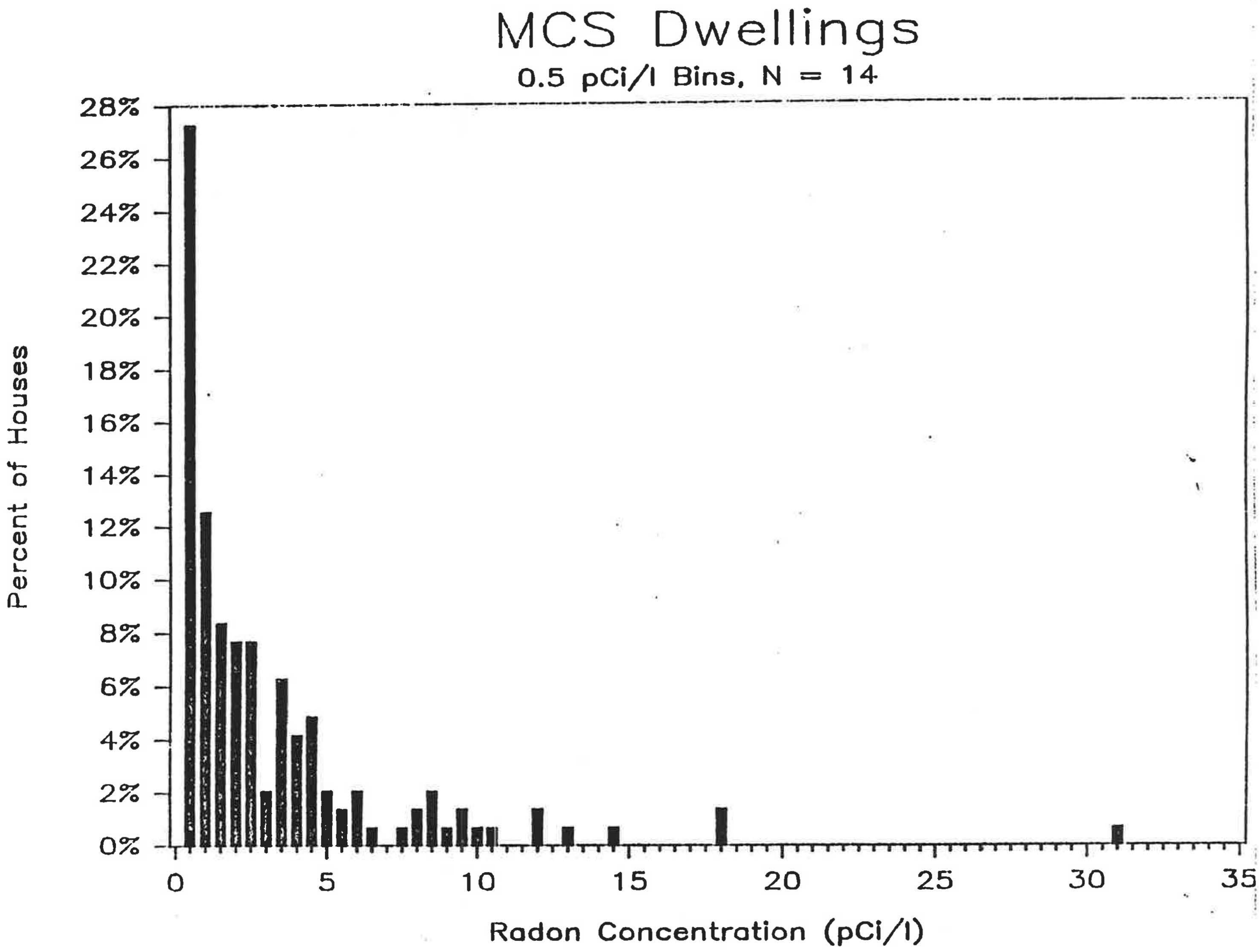

Figure 5: Distribution of Radon Concentrations for All MCS Dwellings.

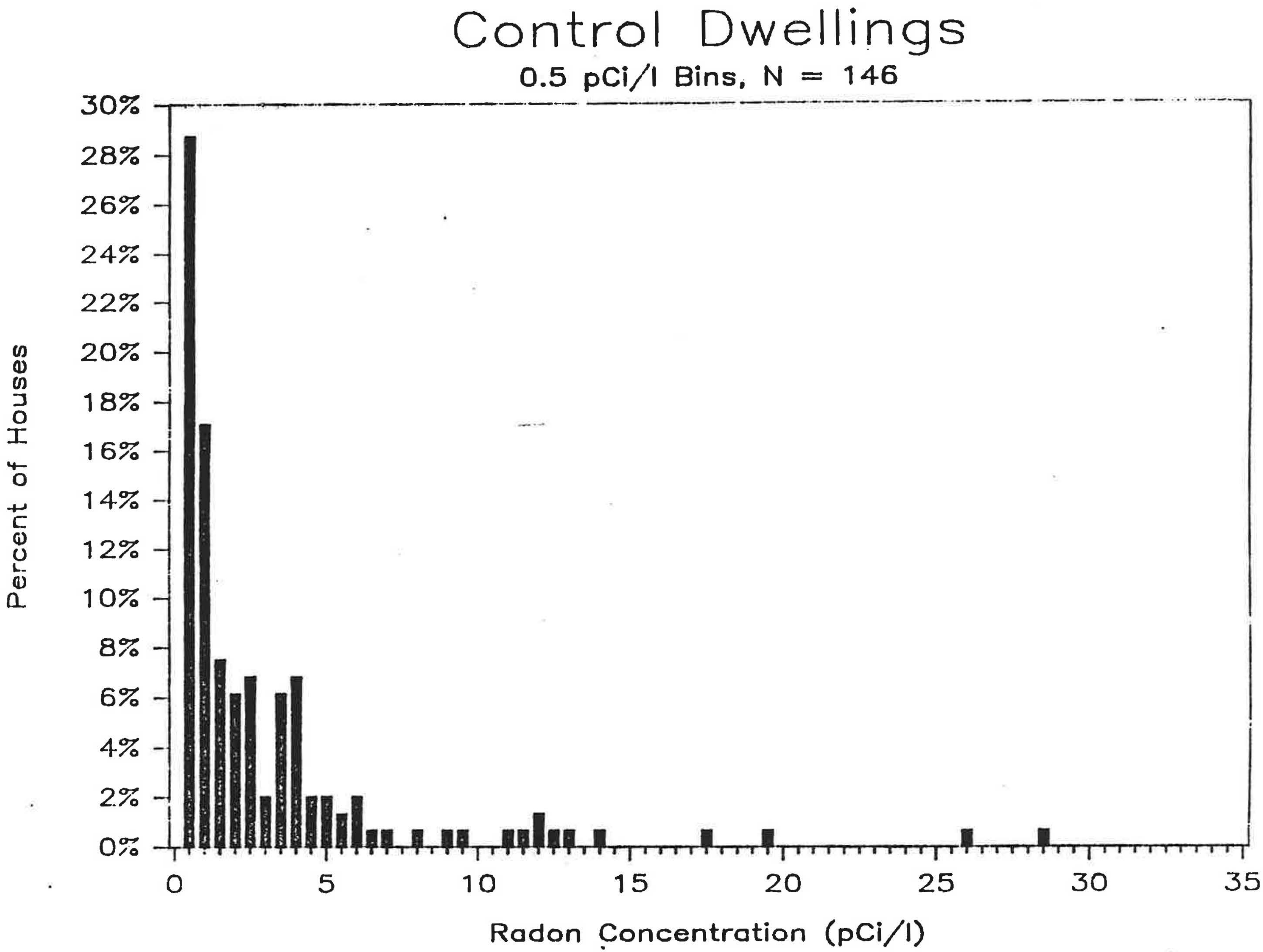

Figure 6: Distribution of Radon Concentrations for All Control Dwellings.

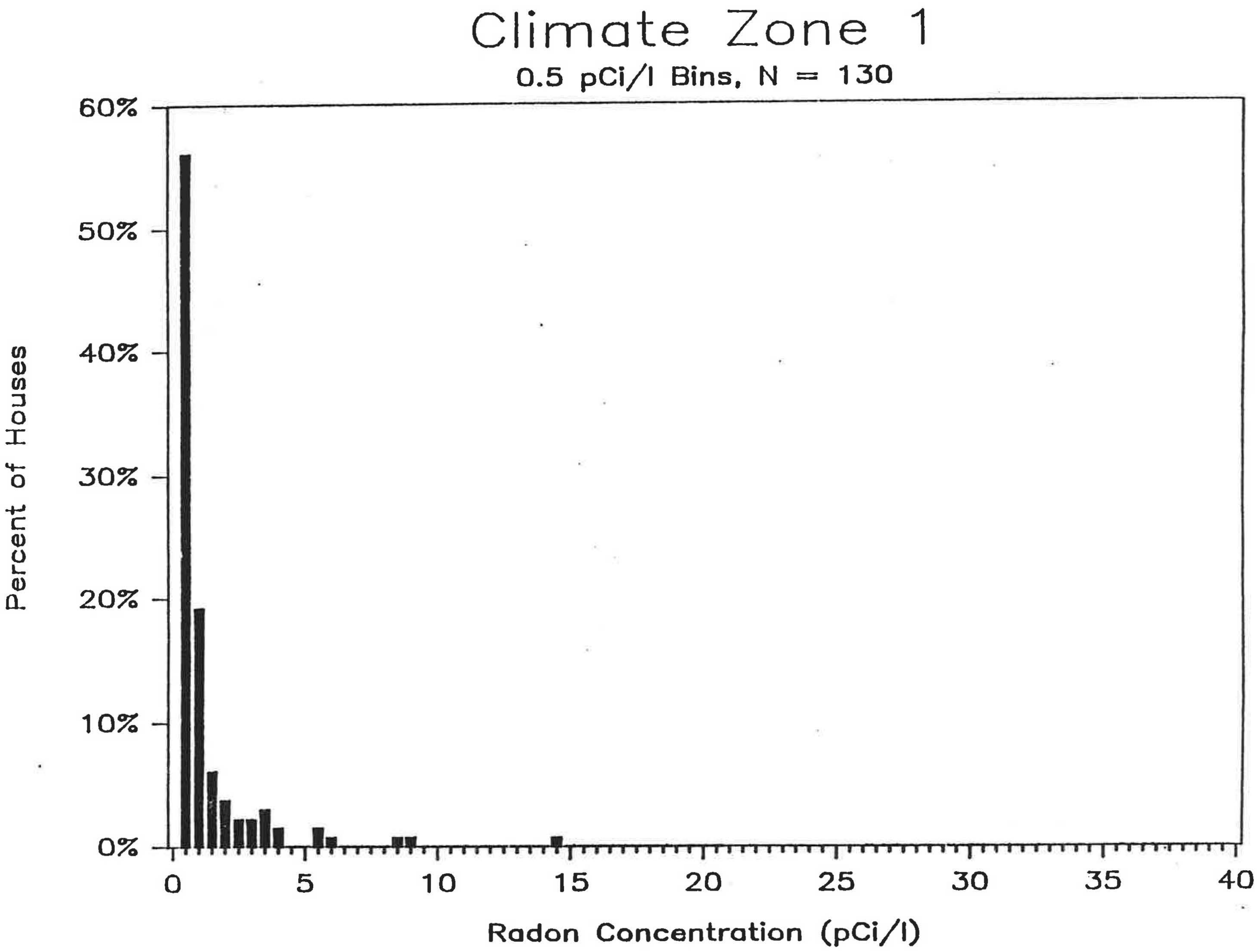

Figure 7: Distribution of Radon Concentrations for Zone 1 Dwellings.

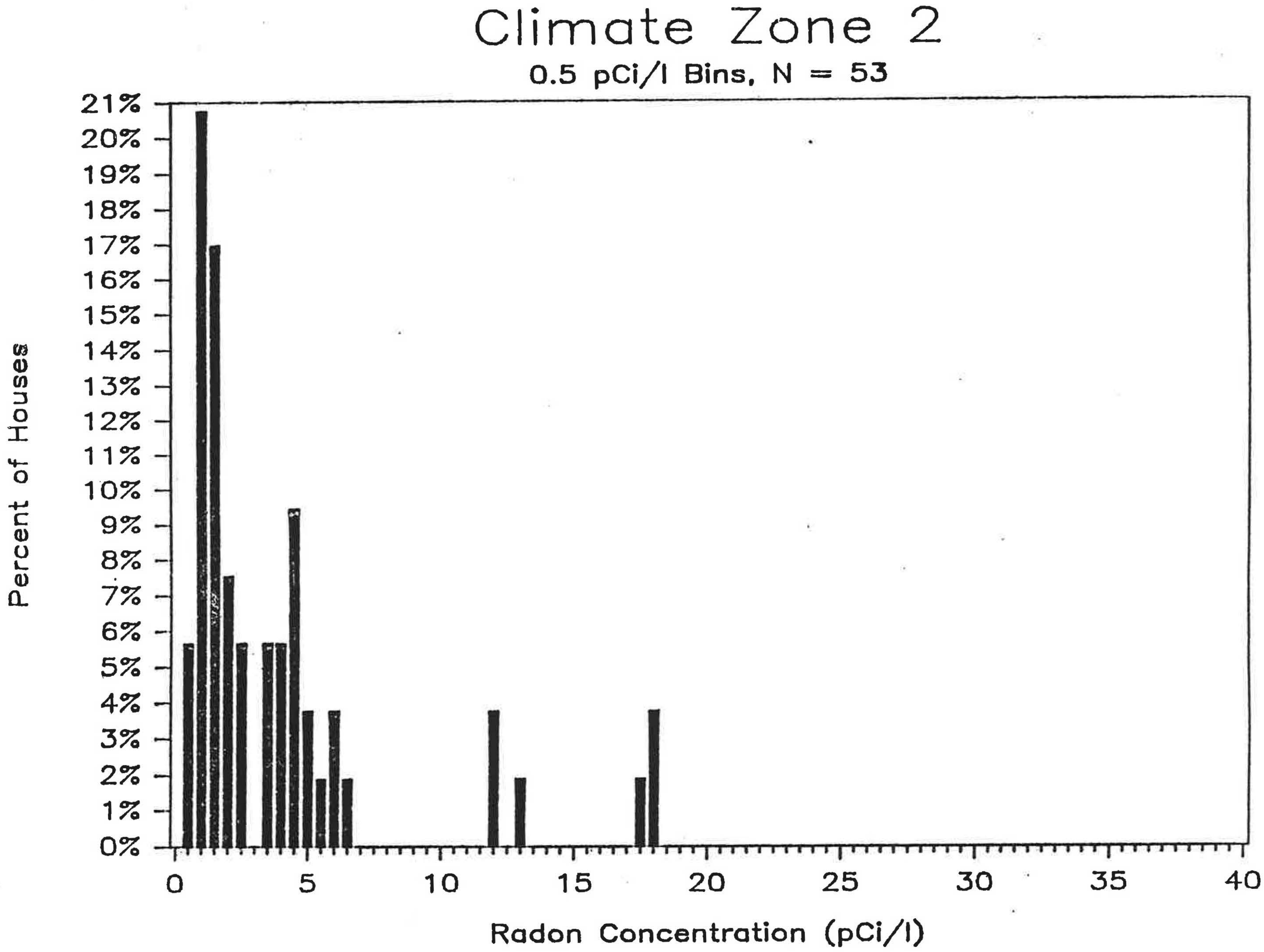

Figure 8: Distribution of Radon Concentrations for Zone 2 Dwellings.

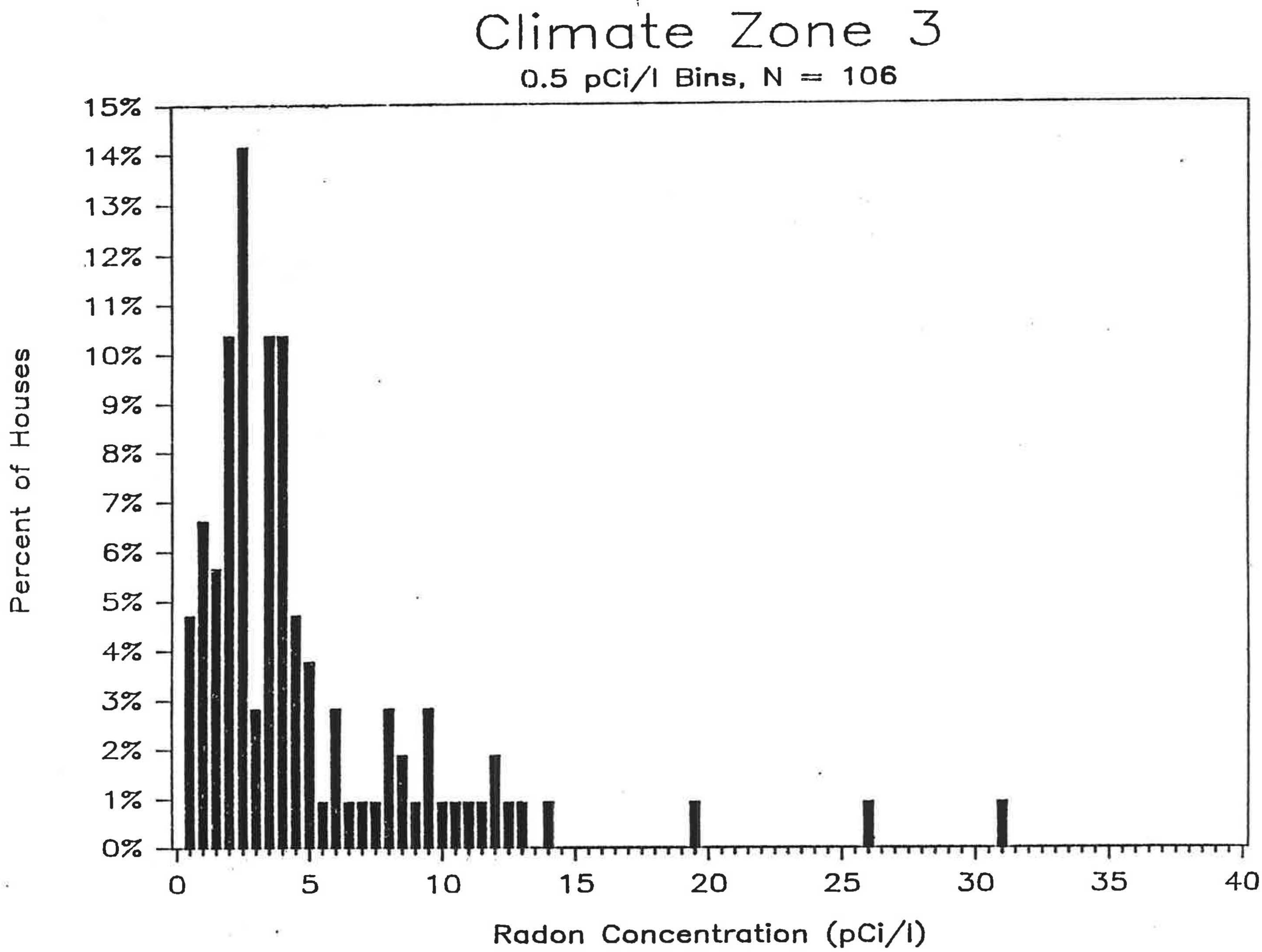

Figure 9: Distribuition of Radon Concentrations for Zone 3 Dwellings.

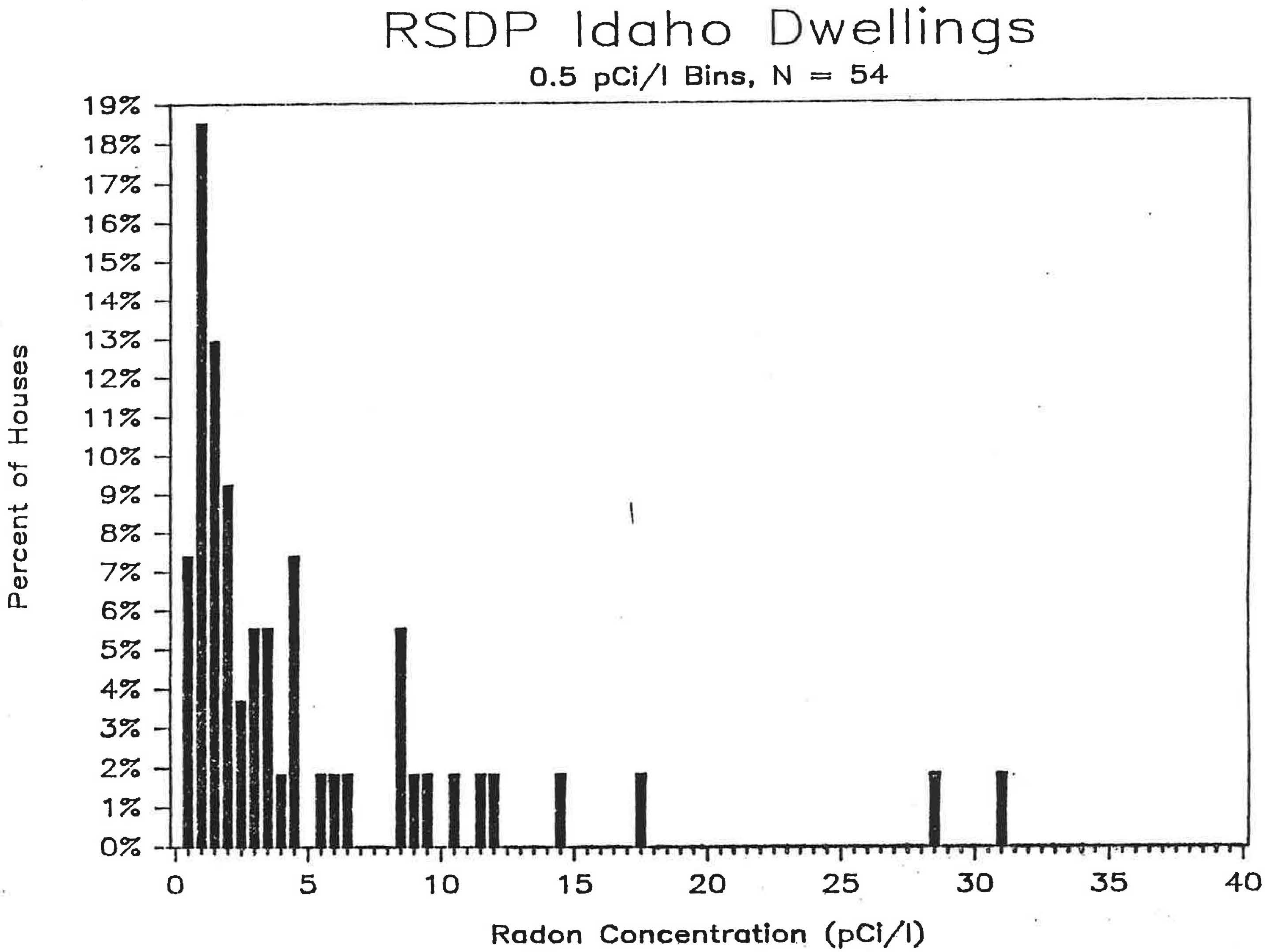

Figure 10: Distribution of Radon Concentrations for Idaho.

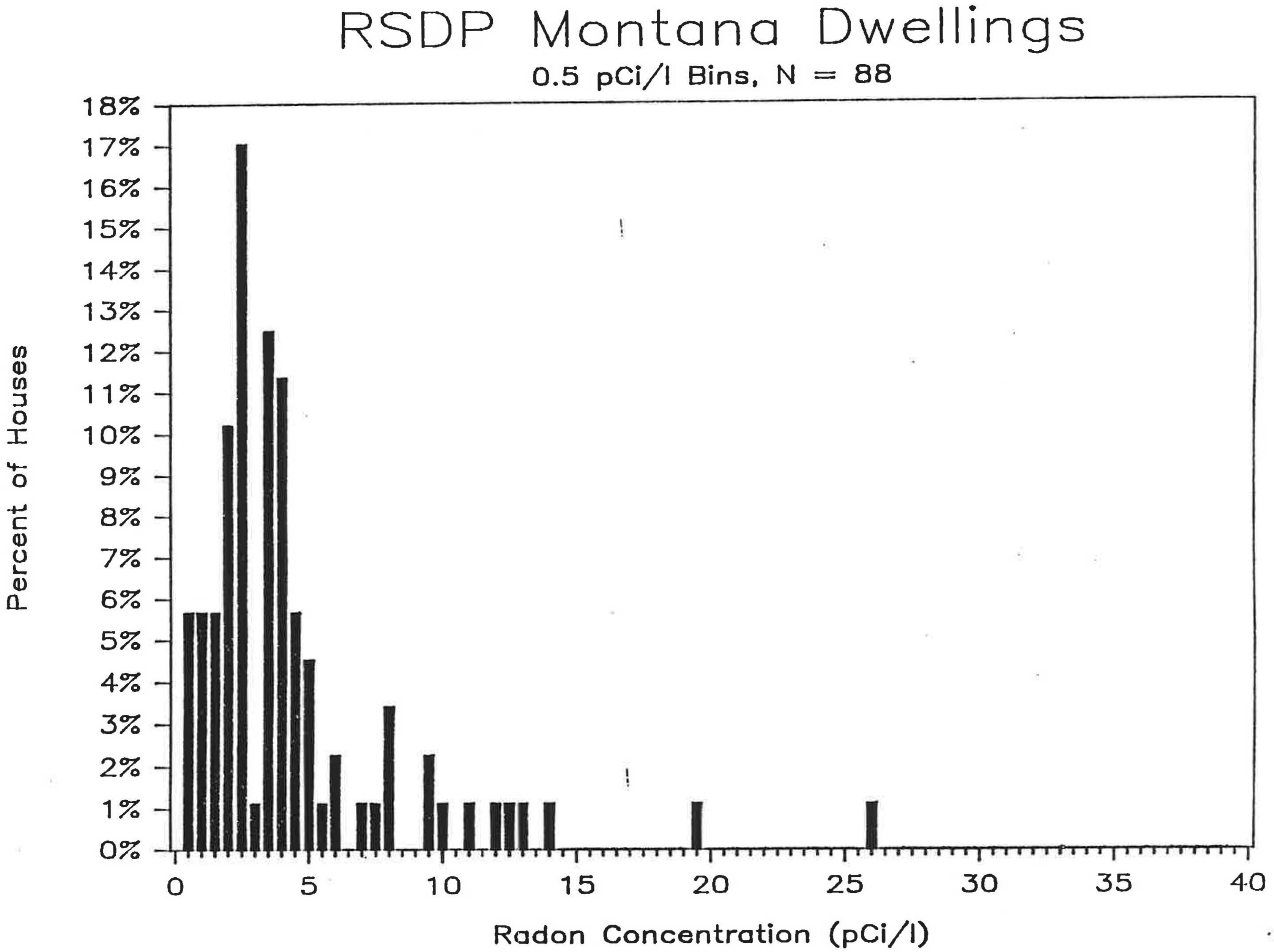

Figure 11: Distribuition of Radon Concentrations for Montana.

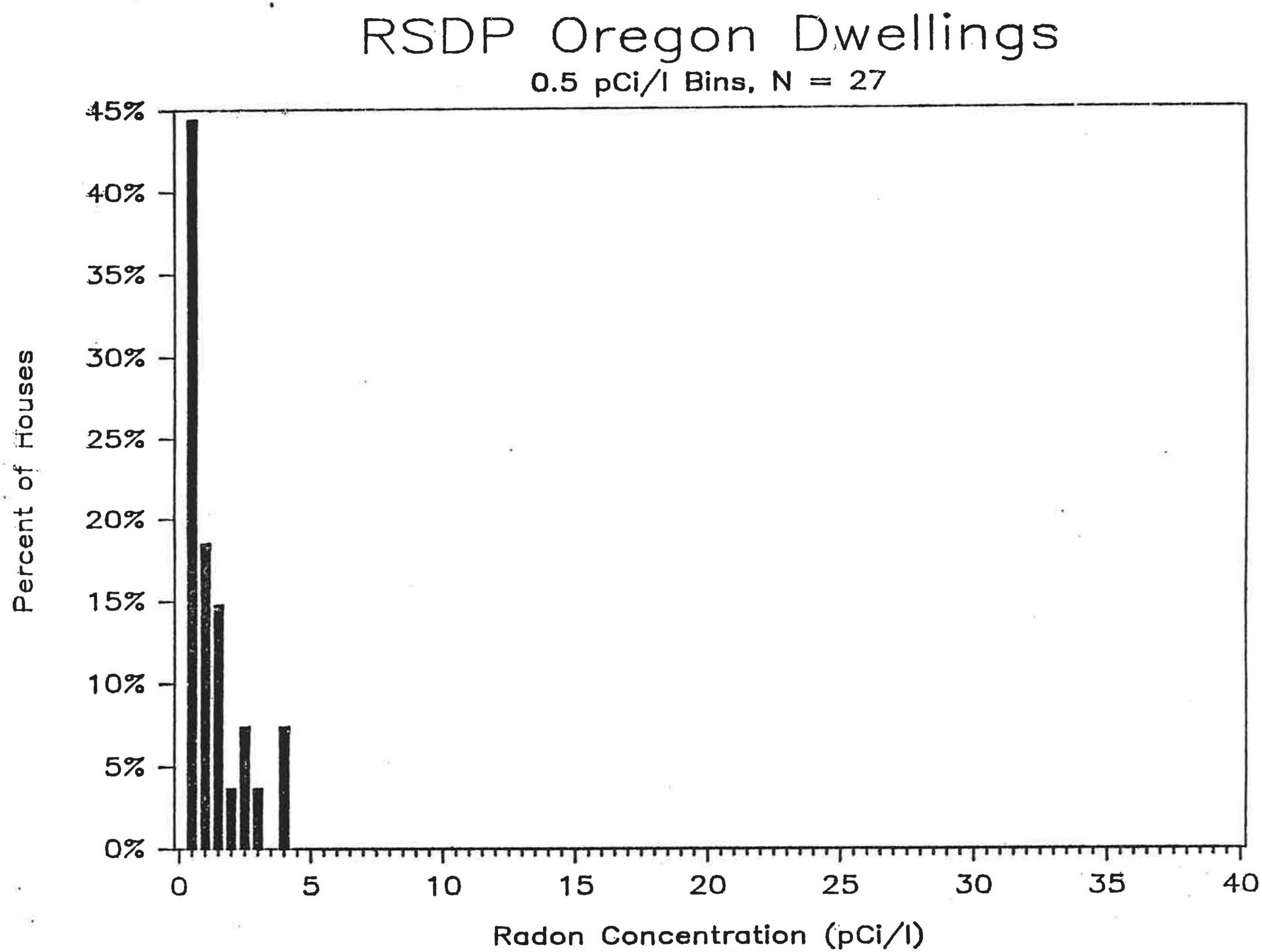

Figure 12: Distribuition of Radon Concentrations for Oregon.

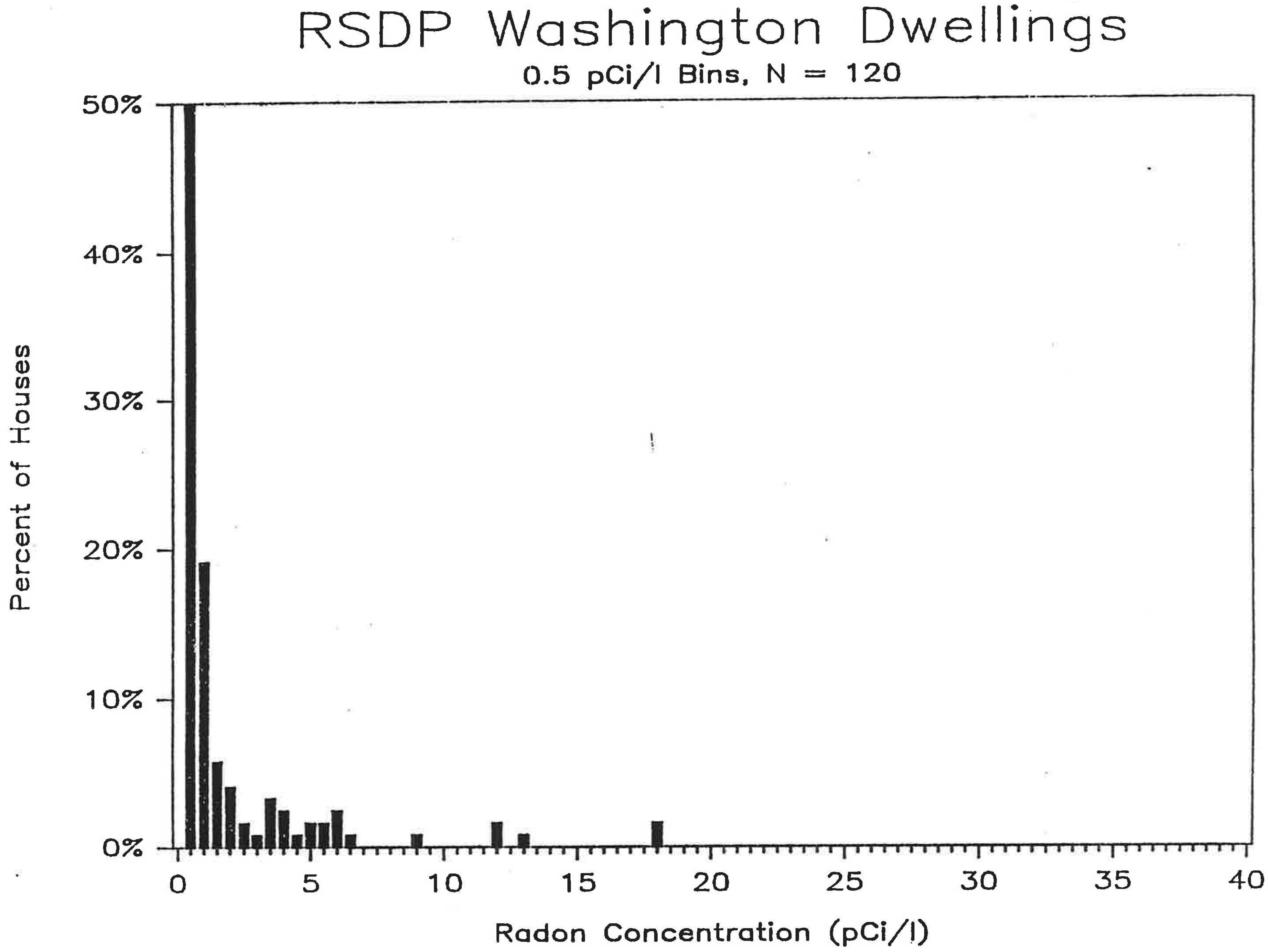

Figure 13: Distribution of Radon Concentrations for Washington.

APPENDIX

This appendix contains site-by-site primary data used in the analysis contained in this report. The following column abbreviations have been used:

St:.......State: 1 = Idado
2 = Montana
3 = Oregon
4 = Washington

Zn:.......Climate zone

MP:.......Matching: 1 = matched pair
2 = unmatched

MCS:......Dwelling type: 1 = MCS dwelling
2 = Control dwelling

S/M:......Dwelling type: 1 = single family
2 = multi-family

pCi/l:....Three month average first floor radon concentration (pCi/l)

%SD:......Statistical reading error (as determined during detector analysis as percent standard deviation.

St	Zn	MP	MCS	S/M	Serial	pCi/l	%SD
1	1	2	2	1	344451	3.4	14
1	1	2	2	1	344490	28.3	11
1	1	1	1	1	344464	1	39
1	1	2	1	1	344471	0.7	45
1	1	1	1	1	344455	3	17
1	1	2	1	1	344467	14.1	16
1	1	2	1	1	344477	0.4	71
1	1	2	1	1	344469	1.6	27
1	1	2	1	1	344553	8.3	19
1	1	1	1	1	344552	0.3	71
1	1	2	2	1	344466	3.3	31
1	1	1	2	1	344488	2.2	29
1	1	2	1	1	344554	5.4	23
1	1	2	1	1	344472	0.5	50
1	2	1	1	1	344597	0.6	38
1	2	2	1	1	344675	1.2	26
1	2	2	2	1	344456	0.6	60
1	2	2	1	1	344493	1.9	31
1	2	2	1	1	344478	4.2	21
1	2	2	1	1	344768	3.3	27
1	2	2	2	1	344206	4.4	27
1	2	2	2	1	344203	1.6	29
1	2	2	1	1	344752	1.5	24
1	2	2	1	1	344784	1.1	27
1	2	2	1	1	344202	0.6	50
1	2	2	1	1	344474	2.1	28
1	2	2	1	1	344594	1.4	34
1	2	2	1	1	344215	0.9	46
1	2	2	1	1	344562	1.1	38
1	2	2	2	1	344590	0.9	41
1	2	2	1	1	344458	4.4	8
1	2	2	2	1	344207	1.3	39
1	2	1	2	1	344591	0.8	46
1	2	2	1	1	344767	4.1	27
1	2	2	2	1	344217	17.2	14
1	2	2	1	1	344791	0.2	69
1	3	2	1	1	344596	1.8	29
1	3	2	1	4	344533	1.4	41
1	3	2	1	1	344586	8.5	19
1	3	2	2	1	344563	5.9	14
1	3	2	1	1	344584	2.8	33
1	3	2	1	1	344576	1.6	30
1	3	2	1	1	344600	0.9	30
1	3	2	2	1	344560	9.2	18
1	3	2	2	1	344577	11.6	16
1	3	2	1	1	344574	6.4	21
1	3	2	2	1	344566	11.5	15
1	3	2	1	1	344581	10.2	17
1	3	2	1	1	344639	3.6	31
1	3	2	1	1	344571	30.6	10
1	3	2	1	1	344569	8.5	19
1	3	2	1	1	344582	1	41
1	3	2	2	1	344559	9	19
1	3	2	2	1	344556	2.9	31
2	3	2	1	1	343671	3.9	30
2	3	2	2	1	344334	7	20

St	Zn	MP	MCS	S/M	Serial	pCi/l	%SD
2	3	2	1	1	344317	2	28
2	3	2	2	1	344650	2.4	18
2	3	2	1	1	343674	2.1	28
2	3	2	2	1	344301	1.7	22
2	3	2	1	1	344677	2.3	19
2	3	2	1	1	344683	2.4	33
2	3	2	2	1	344625	2.4	18
2	3	2	2	1	344868	1.6	32
2	3	2	1	1	344690	3.2	15
2	3	2	1	1	344635	3.3	26
2	3	2	2	1	344311	3.3	31
2	3	2	2	1	344307	13	15
2	3	2	2	1	343664	3.6	28
2	3	2	2	1	344870	3.7	31
2	3	2	2	1	343666	0.7	51
2	3	2	2	1	344309	13.7	15
2	3	1	2	1	344319	3.9	20
2	3	1	1	1	344324	2.2	26
2	3	2	1	1	344678	2.4	18
2	3	2	2	1	343655	1.5	36
2	3	1	2	1	344660	4.2	27
2	3	2	2	1	343652	3.1	31
2	3	2	2	1	343641	3.7	31
2	3	2	2	1	343667	2.3	28
2	3	2	1	1	344645	2.1	19
2	3	2	2	1	344874	0.9	46
2	3	2	2	1	344642	3.2	31
2	3	2	2	1	344653	4	28
2	3	2	1	1	343663	0.5	41
2	3	2	2	1	344863	1.3	36
3	1	2	2	1	344450	3.8	31
3	1	2	2	1	344376	0.3	71
3	1	2	2	1	344367	1.9	28
3	1	2	1	1	344394	2.1	27
3	1	2	2	1	344371	0.5	58
3	1	2	2	1	344355	0.7	36
3	1	2	1	1	344422	3.6	31
3	1	2	1	1	344408	0.4	71
3	1	2	2	1	344365	0.3	57
3	1	2	1	1	344351	0.2	97
3	1	2	1	1	344417	1.3	36
3	1	2	2	1	344390	0.3	69
3	1	2	2	1	344378	0.5	58
3	1	2	2	1	344377	0.5	58
3	1	2	2	1	344399	0.8	45
3	1	2	2	1	344443	0.7	51
3	1	2	2	1	344400	0.5	58
3	1	2	2	1	344397	1.1	36
3	1	2	2	1	344438	2.9	33
3	1	2	2	1	344414	0.2	97
3	1	2	2	1	344418	1.2	36
3	1	2	1	1	344359	0.8	34
3	1	2	1	1	344388	1.1	28
3	1	2	2	1	344405	0.4	71
3	1	2	2	1	344381	2.1	41
3	1	2	2	1	344404	0.9	4

St	Zn	MP	MCS	S/M	Serial	pCi/l	%SD
4	1	2	2	1	343565	0.6	60
4	1	2	2	1	343633	0.2	91
4	1	2	2	1	344701	0.3	74
4	1	2	2	1	343605	0.3	57
4	1	2	2	1	343626	0.7	36
4	1	2	2	1	343577	0.8	51
4	1	2	2	1	344734	0.2	104
4	1	2	1	1	343694	0.3	57
4	1	2	2	1	343739	0.2	69
4	1	2	2	1	343617	0.2	69
4	1	2	2	1	343561	1	41
4	1	2	1	1	343738	0.3	71
4	1	2	2	1	343612	1.1	26
4	1	2	2	1	343574	0.9	46
4	1	2	2	1	344749	0.4	71
4	1	2	1	1	343635	0.2	57
4	1	2	2	1	343609	0.5	41
4	1	2	2	1	344730	0.2	97
4	1	2	2	1	343709	0.7	36
4	1	2	1	1	343591	0.3	50
4	1	2	1	1	373634	0.1	157
4	1	2	2	1	344724	0.1	221
4	1	2	2	1	344736	0.2	87
4	1	2	1	1	343594	0.3	45
4	1	2	1	1	344720	0.1	221
4	1	2	2	1	344745	1.3	36
4	1	2	2	1	344728	0.6	51
4	1	2	2	1	343589	6	20
4	1	2	2	1	344723	0.2	104
4	1	2	2	1	344741	0.4	71
4	1	2	2	1	343563	0.5	60
4	1	2	2	1	344707	1	36
4	1	2	1	1	343596	0.1	157
4	1	2	1	1	343627	0.3	57
4	2	2	2	1	344227	1.2	39
4	2	2	1	1	344774	5.7	25
4	2	2	2	1	344261	6.2	23
4	2	2	1	1	344788	0.8	32
4	2	2	2	1	344241	5.5	24
4	2	2	1	1	344770	1.3	26
4	2	1	2	1	344240	0.7	51
4	2	2	2	1	344254	0.8	46
4	2	2	1	1	344273	0.4	71
4	2	2	1	1	344685	1.3	24
4	2	2	2	2	344279	3.9	30
4	2	2	2	1	344245	0.7	51
4	2	2	1	1	344754	11.6	16
4	2	2	1	1	344757	2	20
4	2	2	1	1	344269	17.7	14
4	2	2	1	1	344778	2.1	19
4	2	2	1	1	344253	0.7	51
4	2	2	1	1	344761	3.1	30
4	2	2	2	1	344283	4.8	24
4	2	2	1	1	344773	3.3	14
4	2	2	1	1	344293	5.7	21
4	2	2	2	1	344246	2.2	28