BOWSER-MORNER'S EXPERIENCE WITH STATE RMP PROGRAMS

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ABSTRACT

The radon chamber at Bowser-Morner has been used to perform blind exposures of radon measuring devices for the Radon Measurement Proficiency (RMP) program in New Jersey for over two years, and for the RMP program in Pennsylvania for over one year. Because the chamber is in operation approximately 50 weeks each year, clients are able to schedule RMP exposures and complete the RMP process with little waiting. On the average it has taken participants between three and four weeks to complete the RMP process. Participants have passed the RMP tests at the average rate of 91.3%. The average of the individual relative errors (IRE's) of all test devices or monitors has been -2.5%. This value of IRE, and the distributions of IRE's, indicate that there is no significant bias between Bowser-Morner's chamber values and the measurements of the participants taken as a group.

RMP PROGRAM IN NEW JERSEY

The New Jersey Department of Environmental Protection and Energy (DEPE) has for several years had an RMP program that is independent of the EPA's program. The procedure that Bowser-Morner uses to conduct an RMP test for a New Jersey licensee consists of the following steps:

(1) The participant obtains an application from the DEPE titled "Application for New Jersey Radon Measurement Proficiency Program," including "Attachment I, Analysis Reporting Form."

(2) The participant contacts Bowser-Morner personnel to schedule a time for the RMP test, after which Bowser-Morner prepares and sends (usually by FAX) a work agreement to the participant.

(3) The participant ships or takes to Bowser-Morner either five passive devices or one continuous monitor, the completed application form, the signed work agreement, and a check for the amount specified in the work agreement.

(4) Bowser-Morner exposes the devices, or monitor, in the radon chamber to a condition that is unknown to the participant, and returns the devices or monitor to the participant with the Analysis Reporting Form containing the dates and times of the exposure, and the background gamma-ray exposure rate.

(5) The participant must report the measured value(s) within two weeks of the end of the chamber exposure to Bowser-Morner on the Analysis Reporting Form; for a monitor, one and only one value is must be reported.

(6) Bowser-Morner reports to the DEPE and to the participant, within one week of receiving the completed Analysis Reporting Form from the participant, the chamber's target value, and whether or not the test was passed. Each device or monitor must have an absolute individual error of 25% or less, relative to the target value, in order for the test to pass.

(7) If the test was failed, the participant may schedule a retest with Bowser-Morner, which will be conducted at no charge; the participant is urged to determine the cause of the failure and take corrective action before performing the retest.

One exception to the above procedure relates to the exposure of alpha-track devices or long-term electret ion chamber devices. These devices are usually exposed to an elevated concentration in the neighborhood of 110 pCi/L for a few days to simulate a more typical indoor exposure for a period of 90 days. Because this is generally known, in order to conduct a test that is "blind," the actual length of the exposure is not revealed to the participant. Instead, the participant is given an assumed exposure time (for example, 100 days) for the calculation of the measurement, and the chamber's target value is adjusted accordingly.

During the period from January, 1994 through June, 1996, Bowser-Morner has conducted 111 RMP tests for New Jersey licensees. A statistical summary of the results of these tests is presented in Table 1. The results for all device types were that 103 tests, or 92.8%, passed with an average individual relative error (IRE) of -2.0%. Of the eight tests that failed, one was a retest. Seven out of eight, or 87.5%, of the retests passed, one of which was a "second retest."

The results in Table 1 are divided into the following five device categories: (1) AC/LS is primarily for tests of charcoal canisters, but also includes a few tests of charcoal liquid scintillation devices, (2) ES/EL is primarily for tests of short-term electret ion chamber devices, but also includes a few tests of long-term devices, (3) AT is for tests of alpha-track devices, (4) CR is for tests of continuous radon monitors, and (5) WL is for tests of continuous radon progeny (or Working Level) monitors. Charcoal devices passed at the rate of 86.4%, with an average IRE of 0.6%. Electret ion chamber devices passed at the rate of 91.5%, with an average IRE of -3.1%. Only two tests were conducted with alpha-track devices, and they both passed with an average IRE of -3.2%. All 36 tests conducted with continuous radon monitors passed with an average IRE of -3.3%. Three out of four tests (75.0%) with continuous radon progeny monitors passed, including one retest, with an average IRE of 8.6%. This IRE value is significantly larger than zero due to a high measurement from one monitor.

Table 1. Summary of New Jersey RMP Tests

Device Type	Number Passed	Number Failed	Total Tests	Percent Passed	Average IRE (%)
AC/LS	19[a]	3[b]	22	86.4%	0.6%
ES/EL	43[c]	4	47	91.5%	-3.1%
AT	2	0	2	100.0%	-3.2%
CR	36	0	36	100.0%	-3.3%
WL	3[b]	1	4	75.0%	8.6%
TOTAL	103	8	111	92.8%	-2.0%

[a] Includes two retests.
[b] Includes one retest.
[c] Includes four retests.

RMP PROGRAM IN PENNSYLVANIA

Over one year ago, the Pennsylvania Department of Environmental Resources (DER) approved the use of blind exposures in Bowser-Morner's radon chamber as a substitute for the EPA RMP program. The procedure used by Bowser-Morner to conduct these RMP tests is essentially the same as that used for the New Jersey program, with the exception that the DER has no application form and no specific requirements regarding the time allowed for the participant to report results to Bowser-Morner or for Bowser-Morner to report to the DER. Bowser-Morner requires the participant to submit the measured values in writing and urges the participant to meet the same timing requirements as those used in the New Jersey program.

Through June, 1996, Bowser-Morner has conducted 39 RMP tests for Pennsylvania licensees. A statistical summary of the results of these tests is presented in Table 2. The results for all device types were that 34 tests, or 87.2%, passed with an average IRE of -3.7%. Of the five tests that failed, four were retested and all four passed.

Only two tests were conducted with charcoal devices, and both passed with an average IRE of -0.5%. Electret ion chamber devices passed at the rate of 81.5%, with an average IRE of -4.1%. No tests were conducted with alpha-track devices. All nine tests conducted with continuous radon monitors passed with an average IRE of -0.5%. Only one test was conducted with a continuous radon progeny monitor, which passed with an IRE of -6.9%.

Table 2. Summary of Pennsylvania RMP Tests

Device Type	Number Passed	Number Failed	Total Tests	Percent Passed	Average IRE (%)
AC/LS	2	0	2	100.0%	-0.5%
ES/EL	22[a]	5	27	81.5%	-4.1%
AT	0	0	0		
CR	9	0	9	100.0%	-0.5%
WL	1	0	1	100.0%	-6.9%
TOTAL	34	5	39	87.2%	-3.7%

[a] Includes four retests.

RMP RESULTS FOR BOTH STATES

A statistical summary of the results of RMP tests for both New Jersey and Pennsylvania is presented in Table 3. For all device types, 137 of 150 tests (91.3%) passed with an average IRE of -2.5%. Of the 24 tests conducted with charcoal devices 21 tests (87.5%) passed with an average IRE of 0.6%. A distribution of the IRE's for all of the charcoal devices involved in these tests is presented in the form of a bar graph in Figure 1. The graph consists of twelve bars, ten of which represent the numbers of devices whose IRE's fell into the ranges of -25% to -20%, -20% to -15%, etc. The two bars on the low and high extremes represent the numbers of devices whose IRE's were less than -25% and greater than 25%, respectively. One would expect the IRE's to exhibit a Gaussian distribution centered at 0%, unless there is a bias between the charcoal laboratories and Bowser-Morner's radon

laboratory. The graph in Fig. 1 indicates the expected distribution. The bars at the positive and negative extremes are due to one test of five devices that failed high and two tests of five devices each that failed low.

Of the 74 tests that were conducted with electret ion chamber devices, 65 tests (87.8%) passed with an average IRE of -3.5%. A distribution of the IRE's for the devices involved in these tests is presented in Fig. 2. This distribution and the negative value of the average IRE indicate a slight bias between these devices and Bowser-Morner's chamber target values. At some point during the period of time covered by these tests, the manufacturer of the electret ion chamber devices adjusted the calibration factors for these devices, the effect of which was to decrease this bias. Since this change in the calibration factors, there has likely been a shift of the distribution of IRE's to the right, or to the positive values. This shift may be the reason why the distribution looks somewhat asymmetric.

Only two tests were performed using alpha-track devices. Both of these tests were for New Jersey licensees, and their results are discussed above. A distribution of the IRE's for the devices in these tests is presented in Fig. 3. The number of devices involved in these tests is too small to draw any conclusions from the distribution in Fig. 3; however, it is included here for completeness.

Of the 45 tests that were conducted with continuous radon monitors, all 45 (100%) passed with an average IRE of -2.8%. A distribution of the IRE's for these continuous monitors is presented in Fig. 4. Although over half of the tests (24) had IRE's that fell between -5% and 5%, the overall distribution of IRE's is skewed to the negative side of zero. It is difficult to draw any meaningful conclusions from the appearance of the distribution, because there were only 21 tests whose IRE's were outside of the range of ±5%. Perhaps when more data become available, the distribution will appear more like a Gaussian distribution.

Table 3. Summary of RMP Tests for Both States

Device Type	Number Passed	Number Failed	Total Tests	Percent Passed	Average IRE (%)
AC/LS	21[a]	3[b]	24	87.5%	0.6%
ES/EL	65[c]	9	74	87.8%	-3.5%
AT	2	0	2	100.0%	-3.2%
CR	45	0	45	100.0%	-2.8%
WL	4[b]	1	5	80.0%	5.5%
TOTAL	137	13	150	91.3%	-2.5%

[a] Includes two retests.
[b] Includes one retest.
[c] Includes eight retests.

Only five tests were performed using continuous radon progeny monitors. Four tests (80.0%) passed with an average IRE of 5.5%. The distribution of IRE's for these monitors is presented in Fig. 5. The number of monitors involved in these tests is too small to draw any conclusions from the distribution in Fig. 5.; however, it is included here for completeness. The IRE's for four of the tests were well distributed in the range of ±10%. One test that failed high caused the average IRE to be significantly different from zero.

TIME REQUIRED FOR THE RMP PROCESS

Bowser-Morner's radon chamber is in operation approximately 50 weeks each year. Participants can generally schedule RMP tests with little waiting. In order to assess the time required to complete the RMP process, four parameters were identified: (1) T_1 is the number of days from the time that Bowser-Morner sent a work agreement to the participant to the time that the exposure for the RMP test began; (2) T_2 is the number of days from the end of the RMP exposure to the time that Bowser-Morner received the measured value(s) from the participant; (3) T_3 is the number of days from the time that Bowser-Morner received the measured value(s) from the participant to the time that Bowser-Morner sent a report of the results of the test to the State and to the participant; and (4) T_4 is the sum of T_1, T_2, and T_3, or the number of days that it took to go through the RMP process. Missing in T_4 is the number of days of the chamber exposure, which is usually two days but could be as long as seven to fourteen days for alpha-track devices and long-term electret ion chamber devices.

The value of T_1 should be an indicator of how long it has taken participants to get an RMP test scheduled into the Bowser-Morner chamber; however, this assumes that (1) Bowser-Morner sends a work agreement quickly after a participant requests an RMP test and (2) the participant sends the test devices or monitor to Bowser-Morner right away after receiving the work agreement. In many cases, these two conditions have been met; however, there have been instances where a work agreement was not sent to the participant right away, and cases where the participant has significantly delayed sending the devices or monitor to Bowser-Morner after receiving the work agreement. Regardless, T_1 is a reasonable indicator of the time that it has taken participants to get an RMP test started in the Bowser-Morner chamber. A distribution of T_1 is shown in Fig. 6 as a bar graph with the length of each bar representing the number of tests in the appropriate time period. The time periods are broken down into the following seven ranges: 0 - 4 days, 5 - 9 days, 10 - 14 days, 15 - 19 days, 20 - 24 days, 25 - 39 days, and greater than 39 days. Through June, 1996, there were 144 tests for which the value of T_1 could be identified from Bowser-Morner's records. The distribution in Fig. 6 indicates that the most frequent value of T_1 was in the range of zero to four days. The average value of T_1 was 11.2 days.

Bowser-Morner usually ships RMP test devices to participants on the day that they come out of the chamber. Therefore, T_2 consists of the time that it has taken to ship the devices to the participant, plus the time it has taken the participant to analyze the results and report to Bowser-Morner in writing. A distribution of T_2 is shown in Fig. 7 as a bar graph similar to the one in Fig. 6. The distribution in Fig. 7 indicates that the most frequent value of T_2 was in the range of five to nine days. The average value of T_2 was 7.3 days.

Because participants are often trying to meet a deadline for license renewal, Bowser-Morner strives to report results of RMP tests to the appropriate State agencies as quickly as possible. A distribution of T_3 is shown in Fig. 8 as a bar graph similar to the one in Fig. 6. The distribution in Fig. 8 indicates that the most frequent value of T_3 was in the range of zero to four days. The average value of T_3 was 3.0 days.

A distribution of T_4 is shown in Fig. 9 as a bar graph similar to the one in Fig. 6. The distribution in Fig. 9 indicates that the most frequent value of T_4 was in the range of fifteen to nineteen days. The average value of T_4 was 21.6 days. This is a reasonable indicator that on the average it has taken participants approximately 3 weeks, plus the chamber exposure time of two or more days, to go through the RMP process.

In several of the few instances when an RMP test was failed, the participants discovered some problem in the sample analysis or data handling that caused one or more values of IRE to be outside the range of ±25%. In each of these cases, the participant was able to correct the problem, quickly schedule a retest and pass the RMP test. One example of how quickly retests can be scheduled and conducted involves a participant whose initial test failed, and whose first retest also failed. Only seventeen days elapsed between the dates of the reports of the results to the State for the initial test and the first retest, both of which failed. The participant then conducted an investigation, discovered and corrected a problem, and performed a second retest. Twenty-eight days elapsed between the reports to the State for the first retest and the second retest which passed.

CONCLUSIONS

Participants in the RMP exposures that Bowser-Morner has conducted for New Jersey and Pennsylvania have passed at a high rate, 91.3%. The average IRE of -2.5%, and the distributions of the IRE values, indicate that no significant bias exists between Bowser-Morner's chamber target values and the participants' measured values as a group. Participants have been able to complete the RMP process in a reasonable length of time; the average time being approximately 3 weeks plus the chamber exposure time. Bowser-Morner's experience with the RMP tests for New Jersey and Pennsylvania indicates that the "device performance test" portion of EPA's RMP program can be effectively performed in the private sector.

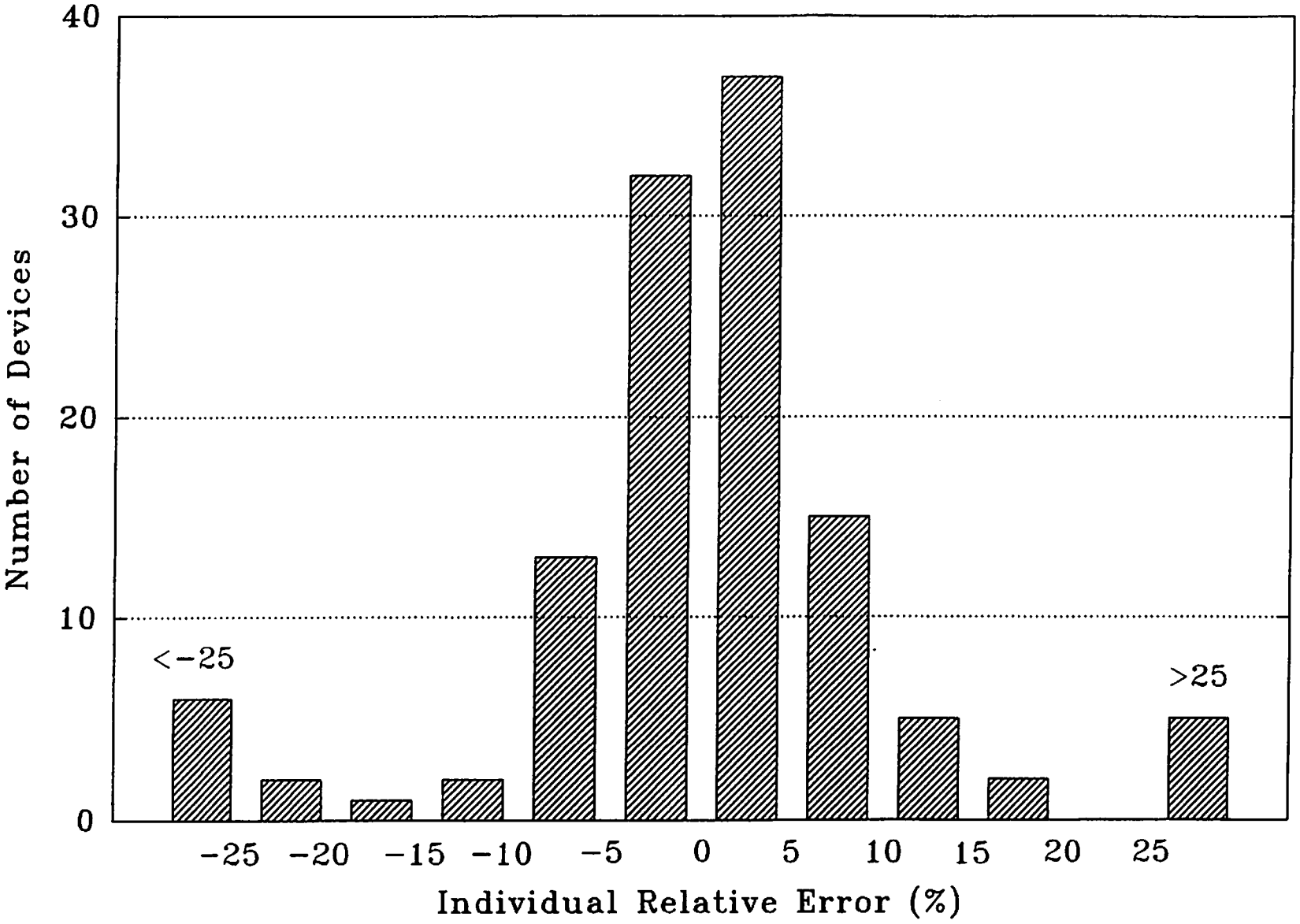

Fig. 1. Distribution of Relative Errors for Charcoal Devices

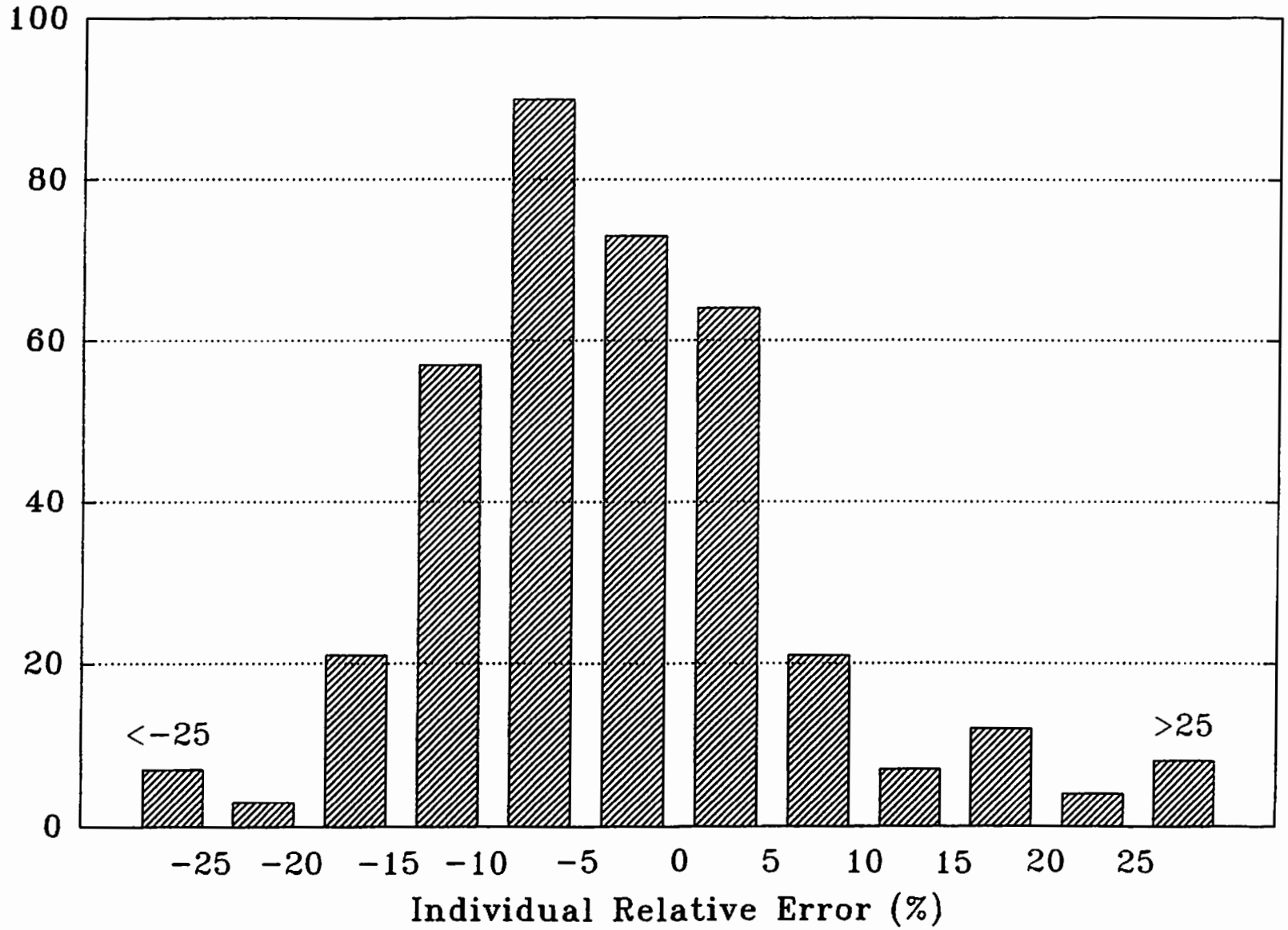

Fig. 2. Distribution of Relative Errors for Electret Devices

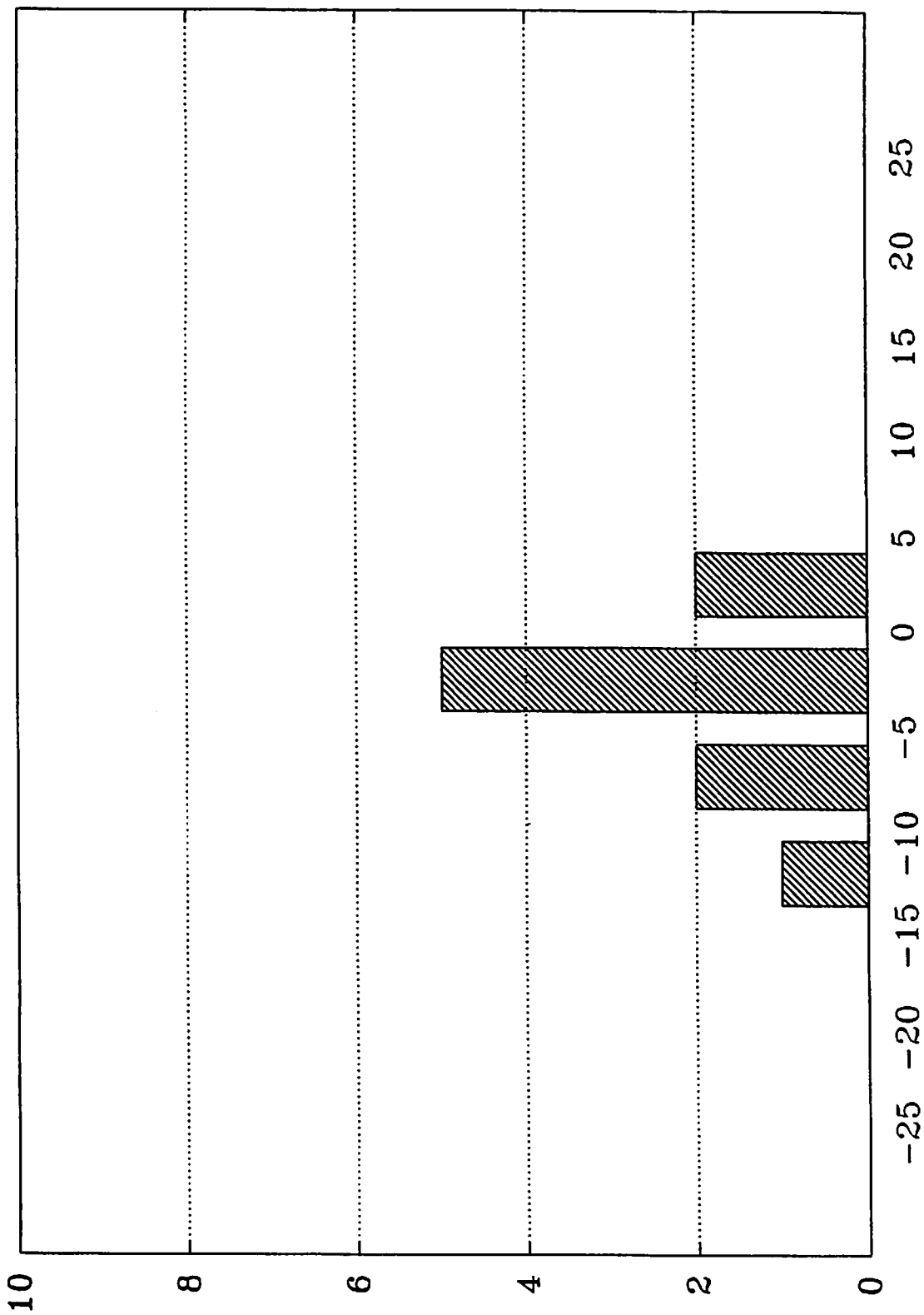

Fig. 3. Distribution of Relative Errors for Alpha-Track Devices

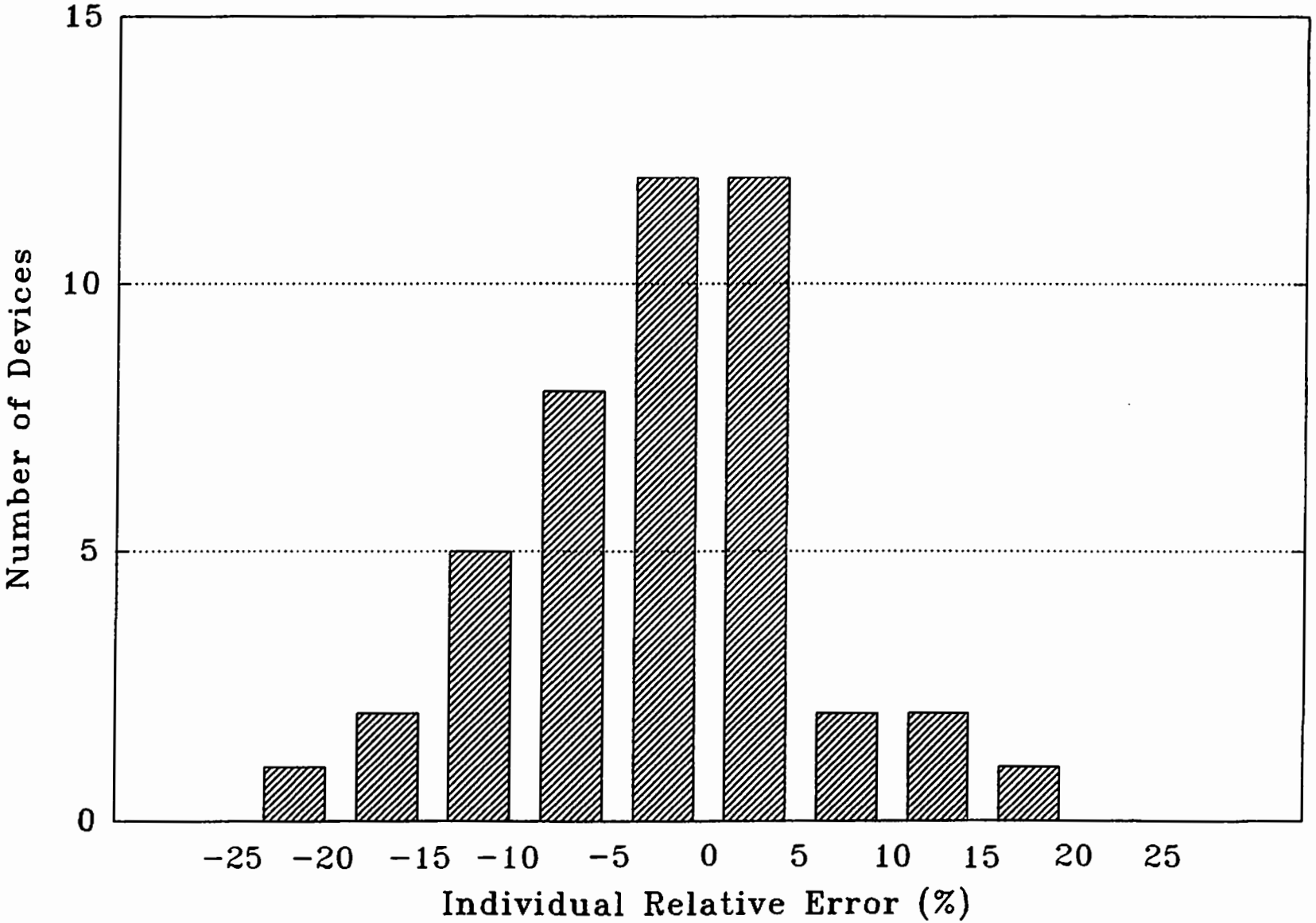

Fig. 4. Distribution of Relative Errors for Continuous Radon Monitors

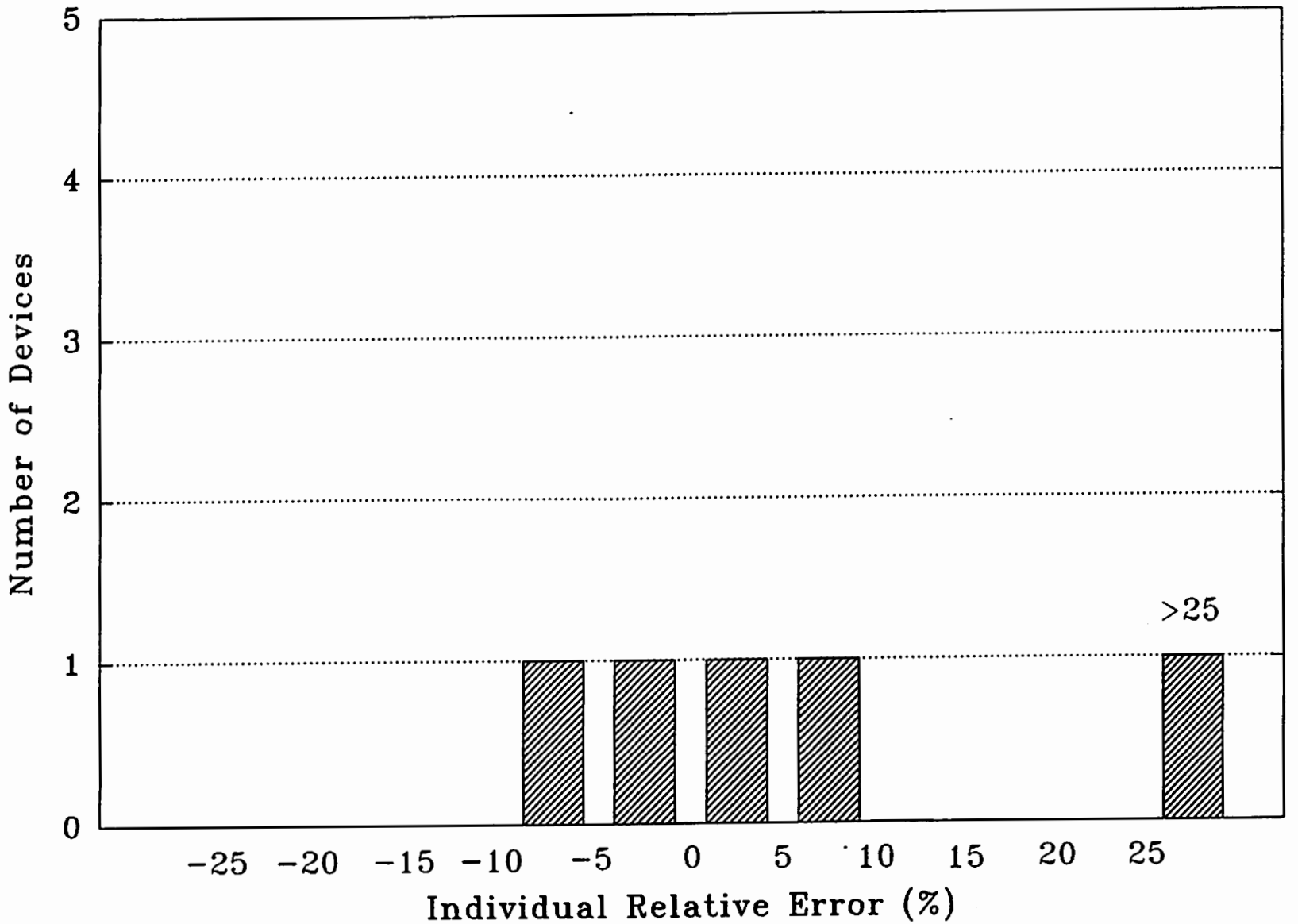

Fig. 5. Distribution of Relative Errors for Radon Progeny Monitors

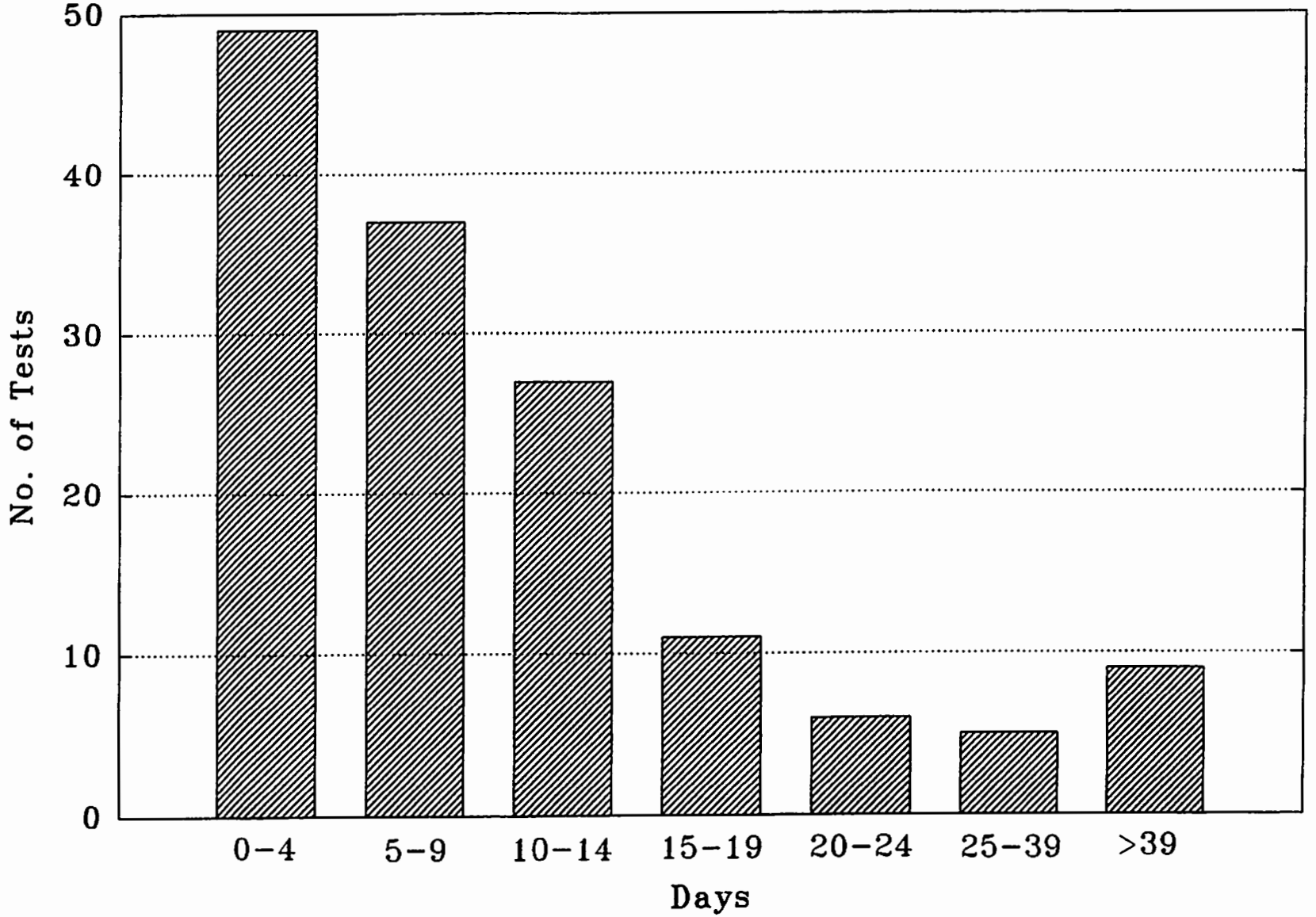

Fig. 6. Distribution of Time from Work Agreement to Start of Exposure

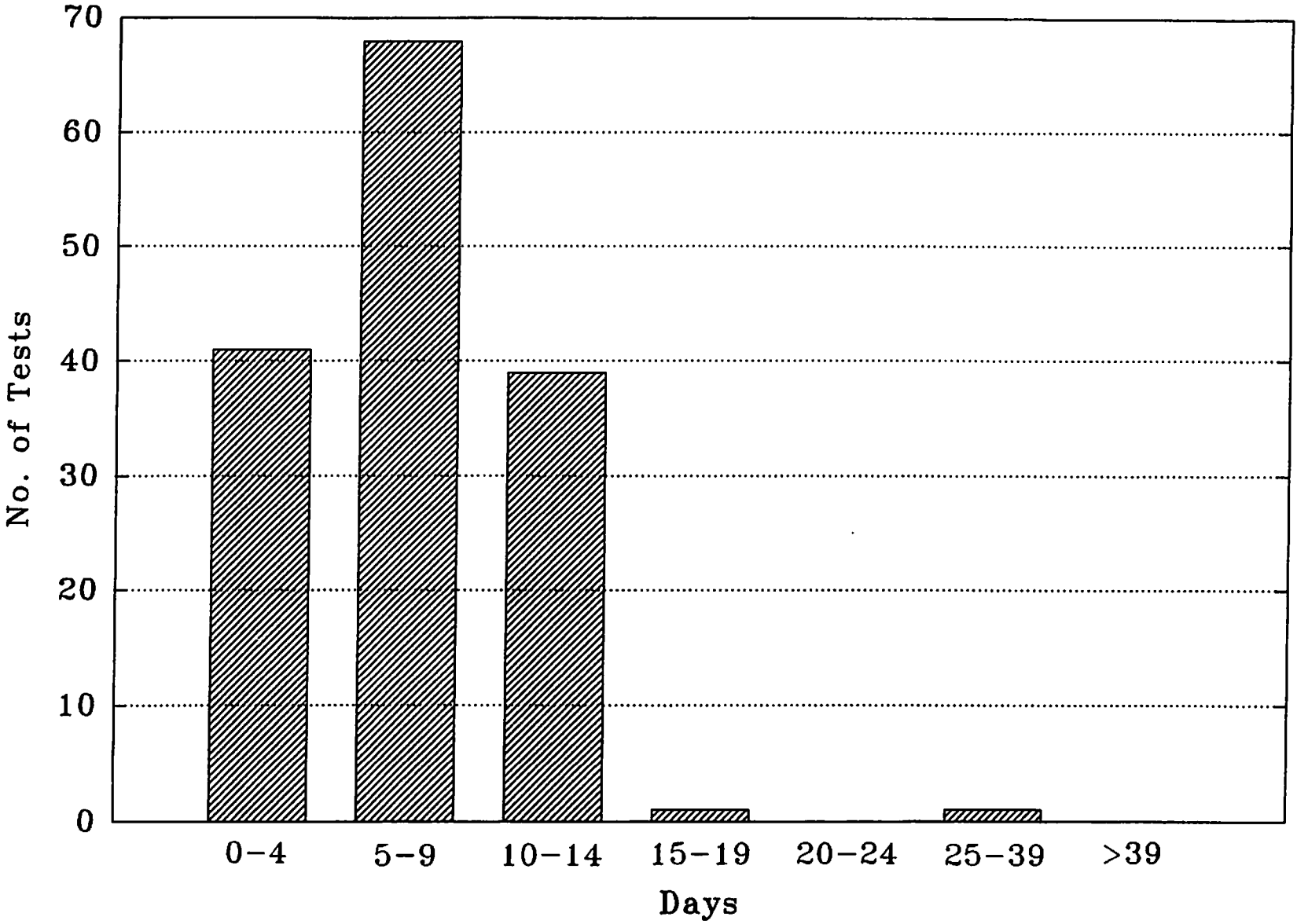

Fig. 7. Distribution of Time from End of Exposure to Receipt of Measurement Values

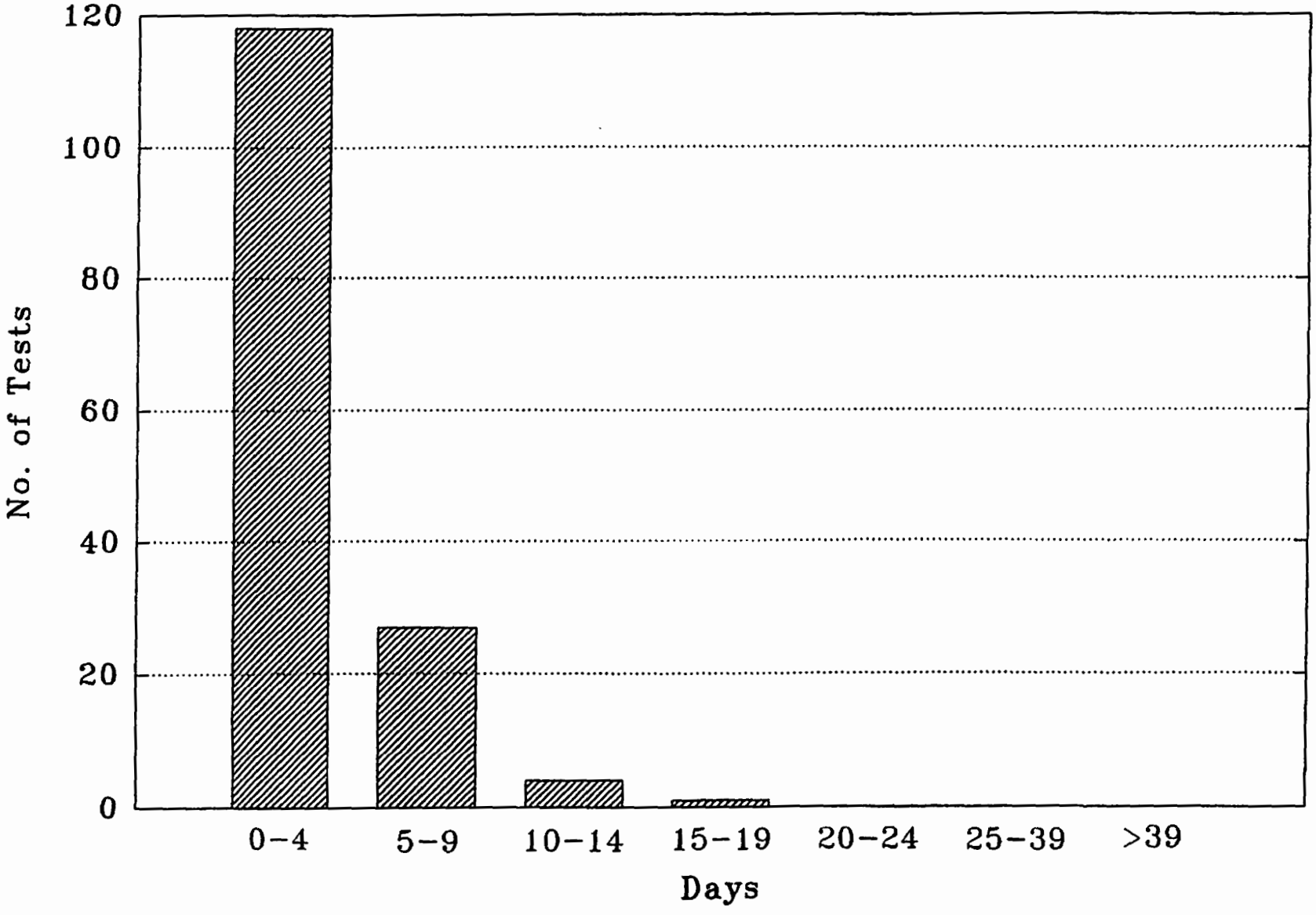

Fig. 8. Distribution of Time from Receipt of Measurement Values to Mailing Report to State

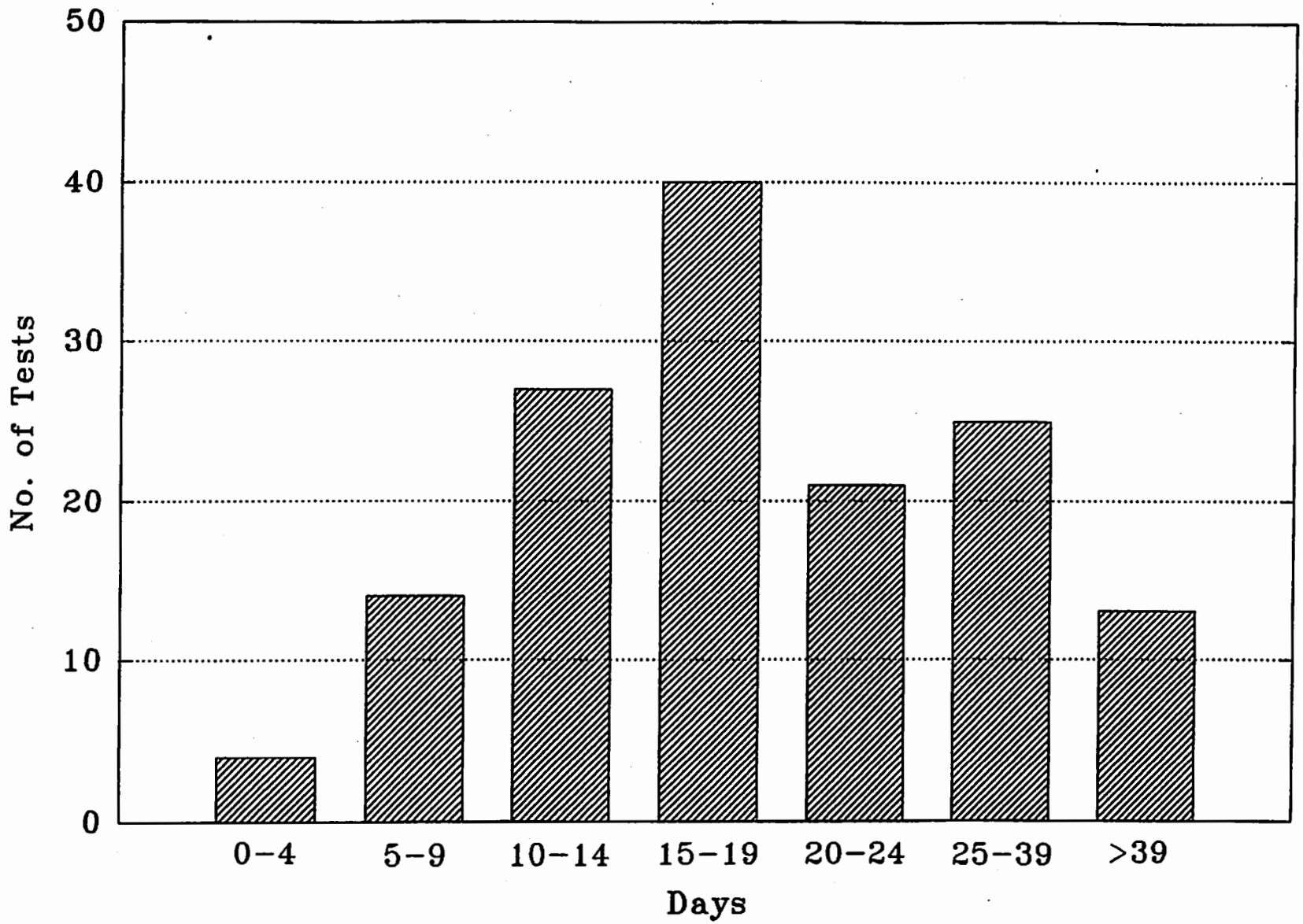

Fig. 9. Distribution of Time from Work Agreement to Mailing Report to State