OAK RIDGE NATIONAL LABORATORY
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June 10, 1983

Mr. Gunter Arndt
Mechanical-Structural Engineering Branch
Division of Engineering Technology
NL 238
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Gunter:

This letter summarizes our progress on the Containment Leak Rate Testing Investigations (FIN. No. B0489) Program for the Month of May 1983.

Technical Highlights

A review of the document ANSI/ANS-56.8-1981, entitled "Containment System Leakage Testing Requirements," has been completed. This standard is an updated version of the standard ANSI N45.4-1972 entitled "Leakage Rate Testing of Containment Structures for Nuclear Reactors." As this standard was generated by the nuclear industry, it was reviewed with regard to its compatibility with the NRC requirements in Appendix J of 10CFR50. A few of the more pertinent findings follows.

The new ANSI standard represents a significant updating of the earlier version. The earlier version was referenced without any noted exceptions in Appendix J but the newer version with its expanded format and increased detail has elicited comments from the NRC in several areas. Because Appendix J is being reviewed so that it may be revised to deal only with the general aspects of leak rate testing, all exceptions taken by the NRC to the ANSI standard will be dealt with in a Regulatory Guide. The Regulatory Guide has already begun to take shape and some recommended guidelines have been prepared for 25 areas. Some of these recommendations will be discussed below.

The ANSI standard provides detailed guidance for the conduct of leak rate testing. Technical guidance is provided regarding test frequency, pressure, duration, verification testing, local leak testing, and reporting requirements. Each of these areas was reviewed in the Technical Highlights for April 1983 in light of the proposed revision to Appendix J requirements. Portions of the April highlights will be summarized here as they are of importance in this review also.

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According to the test frequency specified in the ANSI standard, the first periodic test occurs at the first refueling shutdown but not more than three years after the preoperational test and tests thereafter occur at intervals not to exceed five years. This frequency is comparable to the NRC frequency except the NRC requests a maximum interval of four years. The available data indicated that the utilities conducted Type A tests every three to four years with few exceptions. Although most of these tests were successfully completed, many required repairs or corrections to Type B and C leak paths. Therefore an increase in the Type A test interval is not warranted. However, the Type B and C test intervals should be closely examined and adjusted so that Type A tests rarely fail due to Type B and C leaks. The proposed revision to Appendix J purports to do this. In any event, the maximum test interval of four years seems sufficient.

The ANSI standard does not mention reduced pressure testing, although Appendix J does. The difficulty in validating extrapolation equations and the potential for changing leakage characteristics with time seem to have reduced the interest in reduced pressure testing to practically none. The elimination of reduced pressure testing from the ANSI standard is felt to be representative of industry opinion.

Type A test duration is a subject of much discussion. The ANSI standard requires a minimum test of eight hours duration and at least 20 sets of data points at approximately equal intervals. Several industry sources have shown that these criteria are more than adequate. However, the discussion of this and other duration criteria continues. Most likely, some minimum time criteria will be used as well as a quality of data indication. This issue is expected to be resolved soon.

Because verification testing is an integral part of leak rate testing, more attention should be given to it in Chapter 5 of the ANSI standard. Acceptance criteria and reporting requirements for verification testing are included in the standard, but no discussion of the test as a procedure is provided (except briefly in Appendix C of the ANSI standard). It should be noted that none of the Appendices are considered as part of the ANSI standard. Also the duration of verification tests should probably be coupled to a minimum time period and a minimum number of data sets.

Local leak testing techniques are well specified in the ANSI standard. The review of the test data indicated Type A test problems were almost always caused by Type B and C leak paths, which indicates that the B and C test programs should be improved. Because of the numerous exemption requests and questions concerning air lock testing, the test schedule contained in ANSI/ANS-56.8-1981 should reflect the updated thinking of the NRC as presented in the proposed revision to Appendix J. Provision should be made in either the regulatory documents (Appendix J or the Regulatory Guide) or the ANSI standard for modifying the frequency of Type B and C tests based on the failure rate. Documentation of "as-found" leakage rates would also prove beneficial.

The reporting requirements specified in Section 5.8 of the ANSI document are adequate. Steps should be taken to ensure that the test backup data listed

in Section 5.8.8 remain available. Results of the "as-found" condition should be reported as well as the "as-left" condition.

The ANSI standard requires use of the absolute test method, although the reference vessel method is described (but not endorsed) in Appendix A of the standard. Analysis of test reports revealed that only 4 tests out of 49 total tests were conducted with the reference vessel method only. Of the remaining 45 tests, 43 represented the absolute test method only, and 2 represented both methods. With the possibility of inherent errors in the reference vessel method due to time-lags in the system's response and the high probability of shorter duration tests, the reference vessel method should not be endorsed.

There are three generally used data analysis techniques: the total time method, the point to point method, and the mass plot method. Review of the available test reports revealed that the total time method was used approximately 80 percent of the time, with the mass plot method being used 48 percent of the time and the point to point method being used 35 percent of the time. The percentages do not sum to 100 percent because many utilities use more than one analysis method. The method that appears to have the most stability and logically direct means of analyzing the data is the mass plot method. The advantages of this method have been discussed elsewhere, and the ANSI standard endorses it as the approved method. All three techniques are described in Appendix A of the standard.

The required number of sensors is not a specified quantity in the ANSI standard, except for the minimum quantity. Sufficient temperature sensors are required such that no one sensor has greater than ten percent of the containment volume assigned to it. At least three dewpoint temperature (or vapor pressure) sensors are required, and at least one pressure sensor is required during the test. Figures 1, 2, and 3 indicate the number of temperature sensors, vapor pressure sensors, and pressure sensors, respectively, as indicated in the test reports. The bars in Figure 1 indicate a range of sensors and show that over 50 percent of the tests were conducted using 20 to 25 temperature sensors. Figure 2 indicates that most tests were conducted with 6 vapor pressure sensors and Figure 3 shows that most tests were conducted with either 1 or 2 pressure sensors only. Judging from the recorded data values, the spatial variation of temperature over an entire test was less than 5° K, and there appeared to be sufficient sensors to measure temperature and vapor pressure. However, it is difficult to state that one or even two pressure sensors is sufficient. Data were not available to allow a firm conclusion to be drawn regarding multiple pressure sensors. At least one observer has argued that multiple pressure sensors are needed. Therefore additional consideration will be given to using multiple pressure sensors.

Also, weighting factors for the sensors are not defined in the ANSI standard. Although these factors are generally understood to be volume fractions determined by an assessment of the amount of volume a particular sensor is assumed to represent, no clear, consise, and authoritative technique is known to be available. This oversight should be addressed in the ANSI standard.

The stabilization period called for in ANSI/ANS-56.8-1981 is intended to allow the containment environmental conditions (temperature, pressure, etc.) to come to some sort of equilibrium. Conditions are allowed to stabilize for at least four hours after the test pressure has been reached, and stabilization of the containment atmosphere is based solely on the stability of the average air temperature readings. A definition of containment stabilization needs to be developed and should be based on more than the containment average air temperature. At the very least, individual sensor readings of pressure, vapor pressure, and temperature should be consulted to determine containment stability.

One major point of contention for some concerns the equation in Section 5.7.3 of the ANSI standard. This is an equation for approximating the mass of air in the containment at a particular time. Another equation has been proposed as being more correct (see November and December 1982 Technical Highlights). Final evaluation of these equations has not been made but it appears that the ANSI equation is adequate for the data studied so far. One note about the presentation of the equation in the standard is in order. As presented in Section 5.7.3, the equation for calculating the air mass represents English units only. Use of the equation with variables having SI units will result in an error due to the constant "144" which is an English units conversion factor. Because the equation symbols are defined in Section 5.7.1 with both English and SI units, it seems reasonable that the air mass equation should be presented in a form(s) applicable to each system of units.

Furthermore, the definition of the gas constant "R" in Section 5.7.1 is not consistent with respect to the specified units. The value of "R" in English units is given as 53.35 ft lbf/lbm °R which is a specific value that includes the molecular weight of air. The supposedly corresponding value in SI units is given as 8.3144 joules/gm-mole °K which is a universal value that does not include the molecular weight of air. Both values are correct but they represent different definitions of the R value. Both values should be presented as either specific (including the molecular weight of air) or universal (without the molecular weight of air).

And finally, several revisions are necessary to some of the Appendices in order to correct typographical errors and to increase clarity. These corrections have been discussed elsewhere in considerable detail so they will not be presented here.

Review of the ANSI standard, Appendix J, and the draft Regulatory Guide will continue in the next reporting period. Analysis of comments obtained under the EXTRAN subcontract, as well as other comments, concerning leak testing requirements will continue.

Expenditures

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Expenditure ($K)	7.2	8.9	7.8	8.9	9.2	9.4	7.5	7.8*
Cumulative ($K)**	14.2	23.1	30.9	39.8	49.0	58.4	65.9	73.7

*Estimated
**Program Total

Sincerely yours,

D. J. Naus

DJN:ege

Enclosure

cc: J. R. Dougan

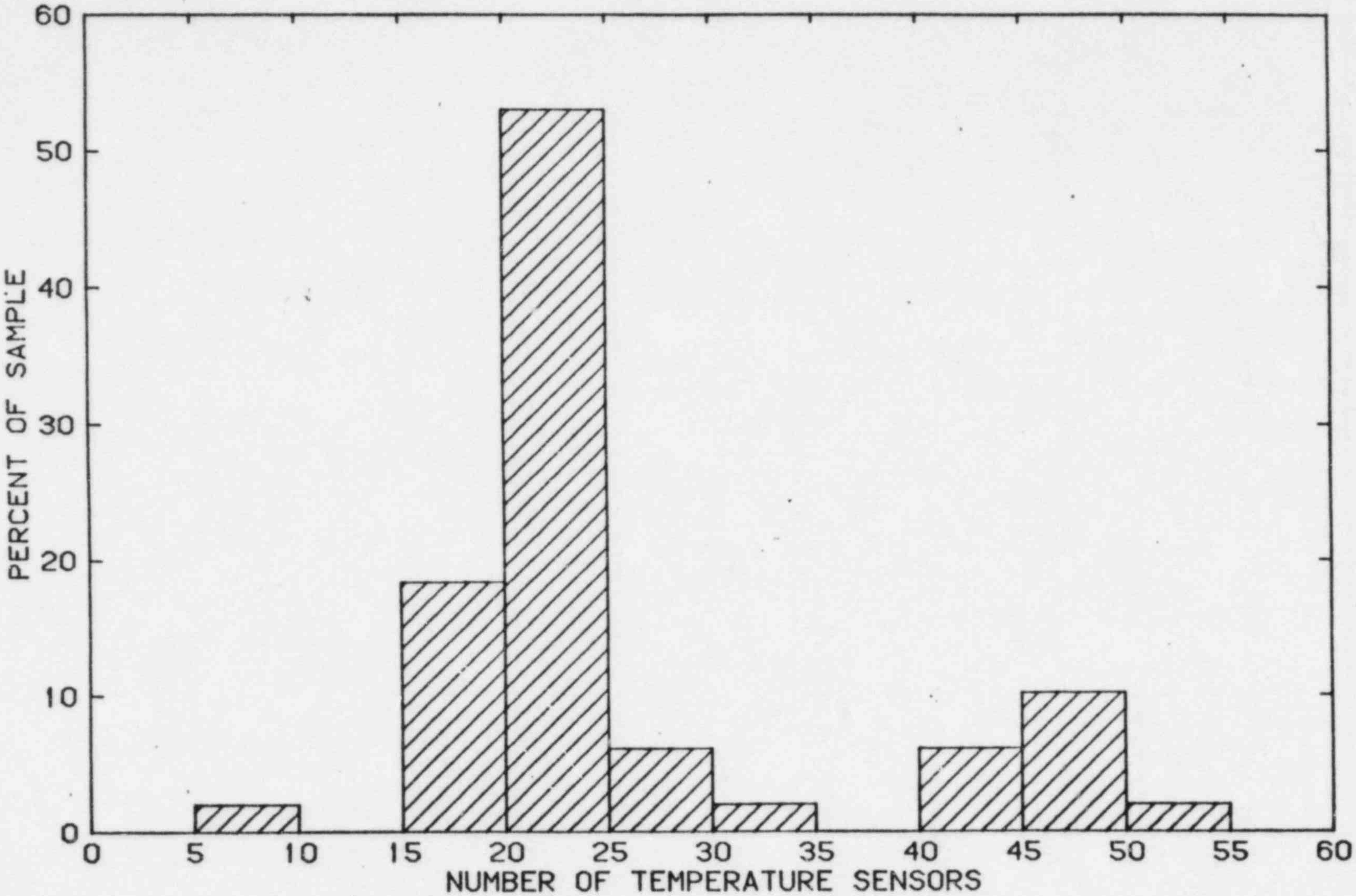

Figure 1. Number of temperature sensors per test.

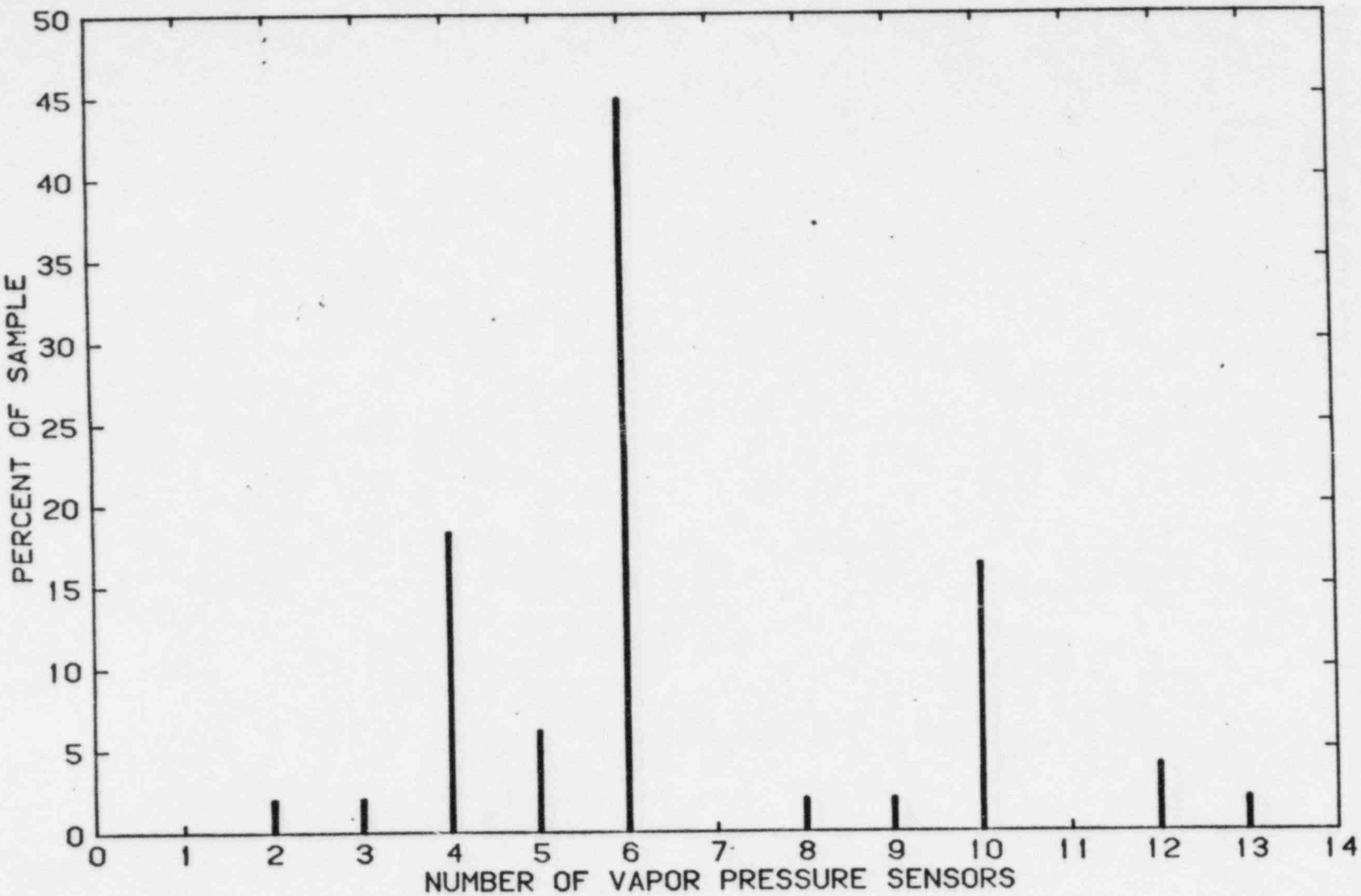

Figure 2. Number of vapor pressure sensors per test.

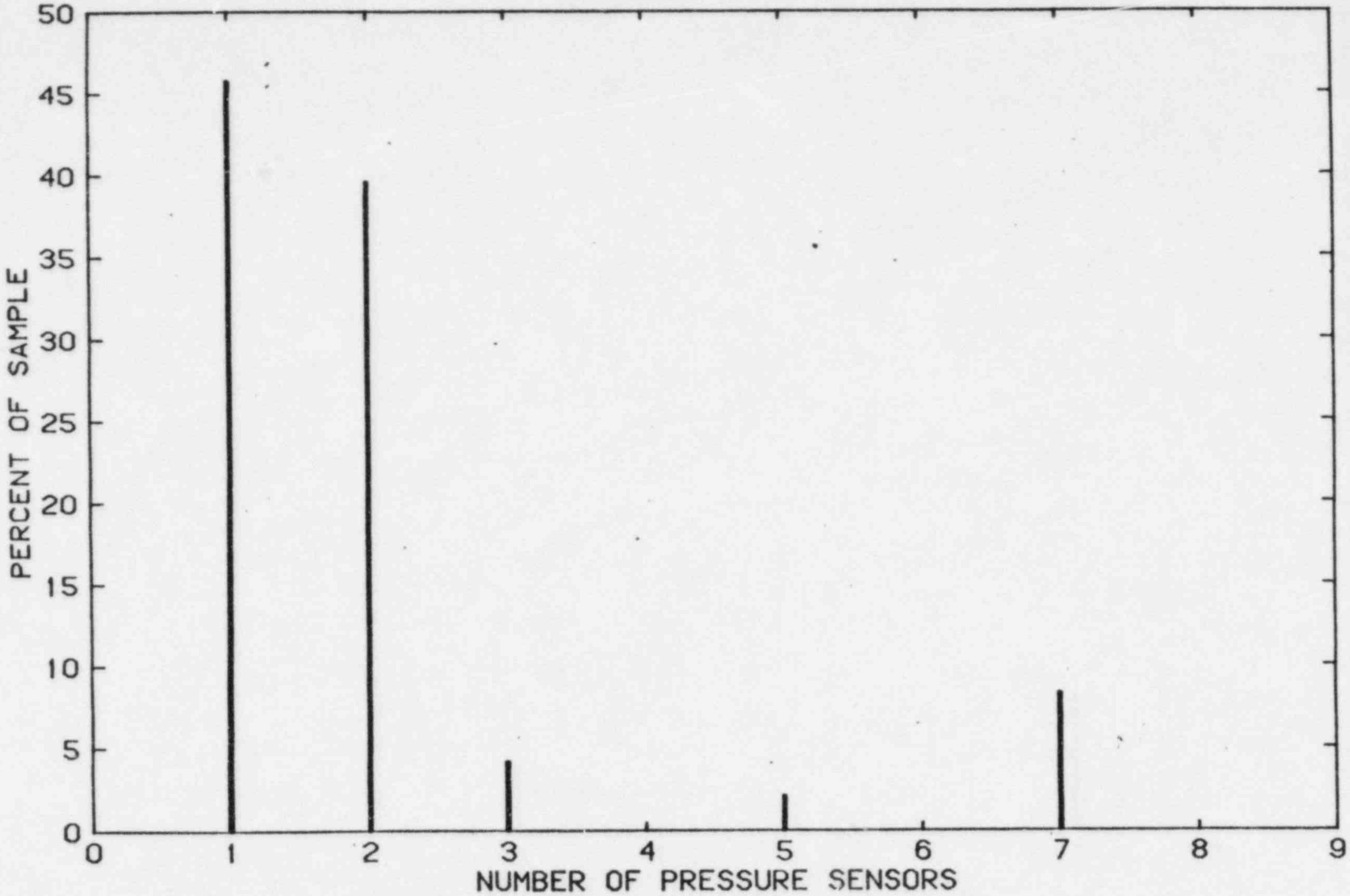

Figure 3. Number of pressure sensors per test.

6/15/83

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REMARKS

F.Y.I.

ORNL letters of June 9, 10, 1983

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Rey/Blatt leak test comments (w/o proprietary rewrite of ANS 56.8)

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