



Standard Practice for Drafting Impact Test Requirements In Thermoplastic Pipe And Fittings Standards¹

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^{e1} NOTE—Keywords editorially added in November 2003.

1. Scope

1.1 This practice describes a procedure for setting up impact test requirements on the basis of test data obtained by Test Method D 2444.

1.2 This practice is applicable to thermoplastic pipe and fittings.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2444 Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)²

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *binomial probability equation*—the equation that defines the chance for exactly r specimens to pass, when n are tested, given p , the chance that a single specimen chosen at random will pass. It is expressed as follows:

$${}_r P_n = \frac{n!}{r!(n-r)!} p^r (1-p)^{n-r} \quad (1)$$

NOTE 1—The factorial of zero is one.

3.1.2 *binomial test*—a test that has only two possible results (for example, pass or fail, heads or tails, true or false).

3.1.3 *mean strength*—the average strength of the total population (see Note 2).

¹ This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.40 on Test Methods.

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² *Annual Book of ASTM Standards*, Vol 08.04.

3.1.4 *OC curve (operating characteristic curve)*—a graph that illustrates the chance of success or failure when a given specification format is employed, given any quality level from 0 to 1 (0 to 100 % passing in the lot from which test specimens are selected).

3.1.5 *probability graph paper*—commercially available graph paper that provides straight-line plots when the distribution of attributes is normal. For a discussion on the use of probability graph paper, see Test Method D 2444 Appendix X2.

3.1.6 *specification format*—the rules set forth by the test requirement, including the number of specimens to be tested and the minimum acceptable number of passes.

3.1.7 *standard deviation*—a statistical term that relates to the size of the expected variation in test results.

NOTE 2—The terms “mean,” “normal distribution,” and “standard deviation” are dealt with in elementary statistics textbooks.

4. Summary of Practice

4.1 Round-robin tests of representative pipe and fittings specimens are performed to identify the energy levels at which 90 % or more of the specimens in acceptable lots will pass. A preferred test format is listed. The B-tup and the V-block holder, and room-temperature conditioning and tests are preferred choices.

5. Significance and Use

5.1 This practice is used for drafting impact test specification requirements, and it presupposes no special familiarity with statistical methods. It provides for specification values that will pass acceptable lots with a high degree of certainty. The impact test requirement is intended to discriminate between acceptable materials and manufacturing methods and those which are not; it is not a simulated service test.

6. Procedure

6.1 Test thermoplastic pipe or fittings specimens in accordance with Test Method D 2444, and plot the test results on probability graph paper.

6.2 It will be clear, from the probability paper plot, that the energy level where 98 % or 99 % of all specimens would pass will be low. On the one hand, when the test format requires that five of five, or six of six, or nine or ten of ten tested shall pass, or the lot rejected, then the specified energy levels must correspond to these levels (see Fig. 1, the operating characteristic (OC) curve for the "nine or ten of ten" test format). On the other hand, five of five, six of six, and nine or ten of ten tests at low energy levels will not screen marginal or poor lots effectively. (See Fig. 1 again).

6.3 A format which will accept reliably when 90 % or more of the specimens in acceptable lots would pass, and reject reliably when 60 % or fewer would pass, is as follows:

6.3.1 "X.X Test ten specimens. When nine or ten pass, accept the lot. When six or fewer pass, reject the lot. When seven or eight pass, test ten additional specimens. When 17 or more of 20 pass, accept the lot. When 13 or fewer of 20 pass, reject the lot. When 14, 15, or 16 pass, test 20 additional specimens. When 32 or more of 40 pass, accept the lot. When 31 or fewer pass, reject the lot."

6.3.2 The OC curve for this format is illustrated in Fig. 2.

6.4 *Specimen Length*—The pipe specimen length should be 6 in. (150 mm) ± ¼ in. (6mm).

6.5 *Choice of Tup and Holder*—The B tup is preferred. It provides a good compromise between energy concentration in the specimen (and therefore reduced test energy levels), and resistance to damage in service. The V-block holder is preferred for pipe specimens; it provides for greater energy concentration, and for failures in a range of thin-walled specimens which would merely flatten on the flat-plate holder.

6.6 *Test Conditions*—Room-temperature tests are preferred. They can be performed by the manufacturer on a timely basis, so that the size of questionable or defective inventories is minimized. Binomial tests are relatively crude, unless large numbers of specimens are subjected to test. The expense and inconvenience of low-temperature conditioning render it a poor choice (study Fig. 1 together with a data plot performed in accordance with Test Method D 2444 to fully grasp the merits of this statement).

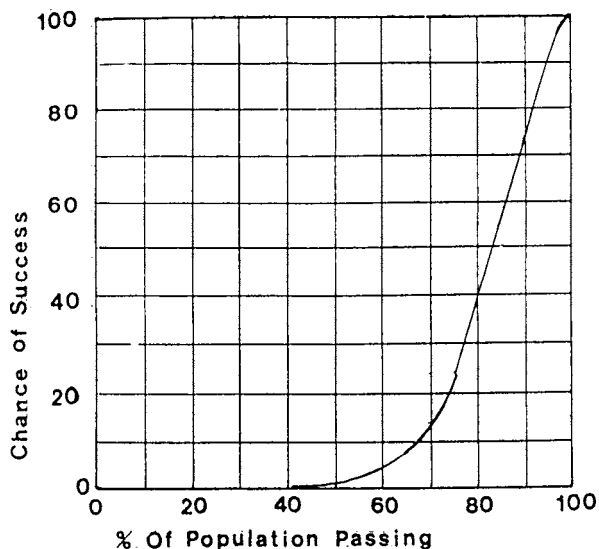


FIG. 1 O.C. Curve for Nine or Ten of Ten

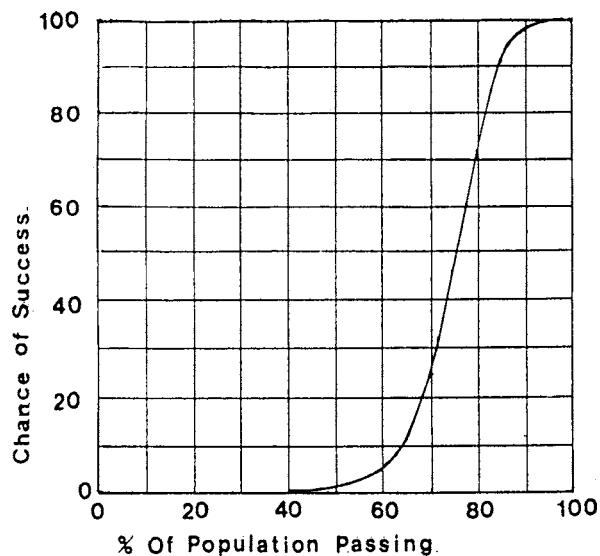


FIG. 2 O.C. Curve for Section 6.3

7. Multiple-Product Standards

7.1 Many thermoplastic pipe and fittings specifications list large numbers of products. Test Method D 2444 requires that at least 100 test specimens shall be employed for each single test run in order that the impact properties can be measured with useful accuracy. The cost of round-robin tests on each size of the products in the standard may approach or exceed the value of the information to be obtained.

7.2 Testing costs can be significantly reduced by performing preliminary tests on the largest sizes listed, to determine whether or not a cut-off point exists above which all specimens will pass at an energy level of 300 ft-lbf (407 J) (ordinarily the highest test energy level listed in a thermoplastic pipe or fittings impact test requirement).

7.2.1 Following these tests, a limited number of representative sizes can be selected, and round-robin testing performed.

7.2.2 The results of these tests are analyzed. List the energy levels where the failure level was 10 % for each size tested, and divide the energy levels by the specimen volumes in cubic inches. Plot the results against the specimen outside diameters, and label the points if it is a multiple SDR specification. In a specification which included 25 sizes of pipe, and seven SDR series, for example, three sizes each of three different SDR series of pipe might be tested preliminarily. The points for each SDR series would be connected with a curve, and from the plots the appropriate trial energy levels for six untested sizes and SDR's calculated.

7.3 One hundred test specimens of each of the six untested sizes would be prepared, and subjected to test. If 85 to 95 specimens in each lot passed, the degree of correlation would be good.

7.4 Depending upon the degree of correlation obtained, proceed to calculate the test energy levels for each untested size, factor all energy levels back by an appropriate amount and draft the test specification proposal, or else conduct additional tests.

7.5 The tup weight and style listed in the proposal should be the same as that used for the preliminary tests.