INTERNATIONAL STANDARD

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Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method

Tubes en matières thermoplastiques — Détermination de la résistance aux chocs extérieurs — Méthode autour du cadran

Reference number
ISO 3127:1994(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 3127 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties*.

This second edition cancels and replaces the first edition (ISO 3127:1980), which has been technically revised.

Annexes A and B of this International Standard are for information only.

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Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method

1 Scope

This International Standard specifies a method for the determination of the resistance to external blows of thermoplastics pipes of circular cross-section; it is called the round-the-clock method.

This method is applicable to isolated batches of pipe tested at 0 °C (information is also given for sampling from the continuous production of pipe).

NOTE 1 If testing below 0 °C is required, a temperature of – 20 °C is recommended.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 true impact rate (TIR): The total number of failures divided by the total number of blows, as a percentage, as if the whole batch had been tested.

NOTE 2 In practice, test pieces are drawn at random from the batch and the result is only an estimate of the TIR for that batch.

2.2 failure: Unless otherwise specified in the product standard, shattering or any crack or split on the inside of the pipe that was caused by the impact and that can be seen by the naked eye (lighting devices may be used to assist in examining the specimens).

Indentation of the test piece is not considered a failure.

3 Principle

Test pieces are subjected to blows from a falling striker, of specified mass and shape, dropped from a known height onto specified positions around the circumference of the test piece. The true impact rate (TIR) of the batch, or production run from an extruder, is estimated.

The severity of this test method can be adjusted by changing the mass of the striker and/or by changing the drop height. It is not technically correct to vary the severity of the test by choosing values of the TIR other than those specified below.

The maximum value acceptable for the TIR is taken to be 10 %.

NOTE 3 It should be appreciated that a completely definitive result can be reached only by testing the whole batch, but in practice a balance is necessary between the statistical possibility of a definitive result and the cost of further testing.

4 Apparatus

4.1 Falling-weight testing machine, incorporating the following basic components (see figure 1).

4.1.1 Main frame, with guide rails or a guiding tube rigidly fixed in the vertical position, to accommodate a striker (4.1.2) and release it to fall vertically and freely. When calibrated, the speed of the striker at the moment of impact shall be not less than 95 % of the theoretical speed.

4.1.2 Striker, having a nose comprising all or part of a hemisphere, combined with a cylindrical stem at least 10 mm long, and having dimensions conforming to figure 2 and table 1, depending upon the mass of the striker. The mass of the striker, including any associated weights, shall be selected from the values given in table 2. Below the stem, the nose shall be of steel with a minimum wall thickness of 5 mm and the striking surface shall be free from visible imperfections such as scratches or dents which may influence the results.

Dimensions in metres

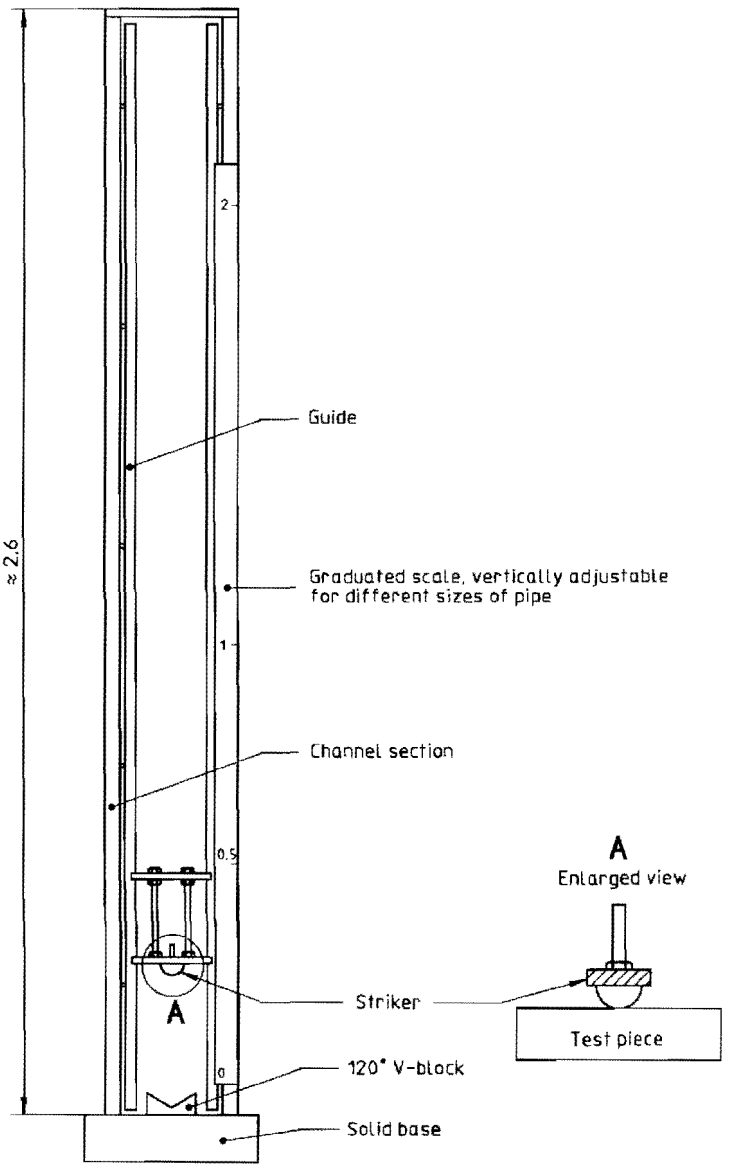
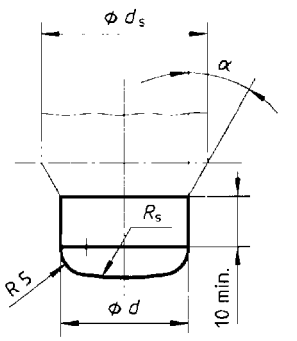
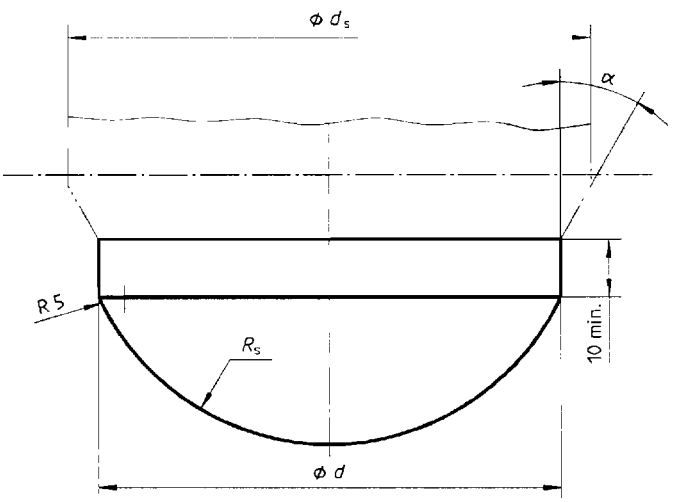


Figure 1 — Diagrammatic representation of impact-testing machine

Dimensions in millimetres



a) Type d25 (for strikers of mass 0,5 kg and 0,8 kg)



b) Type d90 (for strikers of mass equal to or greater than 1kg)

Figure 2 — Noses of the strikers (see table 1)

Strikers with 0,5 kg and 0,8 kg mass shall have a type d25 nose. Strikers with greater masses shall have a type d90 nose.

Table 1 — Dimensions for the nose of the striker

Dimensions in millimetres

Type	R_s	d ± 1	d_s	$\alpha°$
d25	50	25	free	free
d90	50	90	free	free

Table 2 — Recommended masses of strikers

Masses in kilograms

0,5	1,6	4,0	10,0
0,8	2,0	5,0	12,5
1,0	2,5	6,3	16,0
1,25	3,2	8,0	

NOTE — The permissible tolerance on the mass of a striker shall be ± 0,5 %.

4.1.3 Rigid test support, consisting of a 120° V-block at least 200 mm long, positioned so that the vertical projection of the point of impact of the falling striker is within 2,5 mm of the axis of the V-block (see figure 1).

4.1.4 Release mechanism, such that the striker can fall from a variable height which can be adjusted to any height up to at least 2 m, as measured from the top surface of the test piece, with an accuracy of ± 10 mm.

5 Test pieces

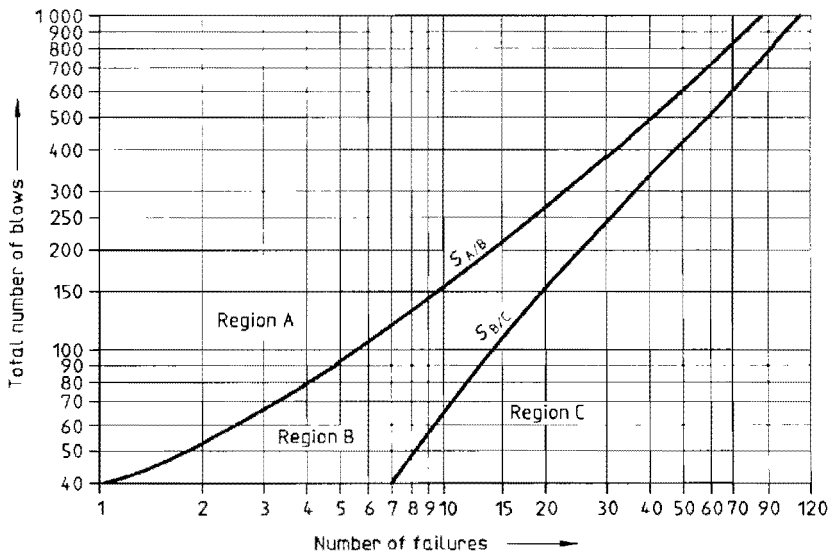
Test pieces of length 200 mm ± 10 mm shall be cut from pipe selected at random from the batch, or the production run from an extruder.

The cut ends shall be square to the axis of the pipe, clean and free from damage.

For pipes with outside diameters greater than 40 mm, a straight line shall be drawn along the length of each test piece at a random position. Further lines shall be drawn at equal distances around the pipe so that each test piece has the number of lines given in table 3. The number of blows required is given in clause 6. For pipes with outside diameters less than or equal to 40 mm, only one blow per test piece shall be made.

Table 3 — Number of equidistant lines to be drawn on test pieces

Nominal outside diameter of pipe mm	Number of equidistant lines to be drawn
≤ 40	—
50	3
63	3
75	4
90	4
110	6
125	6
140	8
160	8
180	8
200	12
225	12
250	12
280	16
≥ 315	16



Boundaries between regions are calculated using the following equations:

$$S_{A/B} = np - 0,5 - u\sqrt{np(1-p)}$$

$$S_{B/C} = np + 0,5 + u\sqrt{np(1-p)}$$

where

u = 1,282 (10 % one-sided)

p = 0,10 (TIR)

n number of blows

NOTE — It is necessary to have achieved at least 25 blows without failure before the test is discontinued.

Figure 3 — Number of test pieces for 10 % TIR (at 90 % confidence level)

Table 4 — Number of blows and failures

Number of blows	Number of failures		
	Accept	Continue test	Reject
25	0	1 to 3	4
26	0	1 to 4	5
27	0	1 to 4	5
28	0	1 to 4	5
29	0	1 to 4	5
30	0	1 to 4	5
31	0	1 to 4	5
32	0	1 to 4	5
33	0	1 to 5	6
34	0	1 to 5	6
35	0	1 to 5	6
36	0	1 to 5	6
37	0	1 to 5	6
38	0	1 to 5	6
39	0	1 to 5	6
40	1	2 to 6	7
41	1	2 to 6	7
42	1	2 to 6	7
43	1	2 to 6	7
44	1	2 to 6	7
45	1	2 to 6	7
46	1	2 to 6	7
47	1	2 to 6	7
48	1	2 to 6	7
49	1	2 to 7	8
50	1	2 to 7	8
51	1	2 to 7	8
52	1	2 to 7	8
53	2	3 to 7	8
54	2	3 to 7	8
55	2	3 to 7	8
56	2	3 to 7	8
57	2	3 to 8	9
58	2	3 to 8	9
59	2	3 to 8	9
60	2	3 to 8	9
61	2	3 to 8	9
62	2	3 to 8	9
63	2	3 to 8	9
64	2	3 to 8	9
65	2	3 to 9	10
66	2	3 to 9	10
67	3	4 to 9	10
68	3	4 to 9	10
69	3	4 to 9	10
70	3	4 to 9	10
71	3	4 to 9	10
72	3	4 to 9	10
73	3	4 to 10	11
74	3	4 to 10	11

Number of blows	Number of failures		
	Accept	Continue test	Reject
75	3	4 to 10	11
76	3	4 to 10	11
77	3	4 to 10	11
78	3	4 to 10	11
79	3	4 to 10	11
80	4	5 to 10	11
81	4	5 to 11	12
82	4	5 to 11	12
83	4	5 to 11	12
84	4	5 to 11	12
85	4	5 to 11	12
86	4	5 to 11	12
87	4	5 to 11	12
88	4	5 to 11	12
89	4	5 to 12	13
90	4	5 to 12	13
91	4	5 to 12	13
92	5	6 to 12	13
93	5	6 to 12	13
94	5	6 to 12	13
95	5	6 to 12	13
96	5	6 to 12	13
97	5	6 to 12	13
98	5	6 to 13	14
99	5	6 to 13	14
100	5	6 to 13	14
101	5	6 to 13	14
102	5	6 to 13	14
103	5	6 to 13	14
104	5	6 to 13	14
105	6	7 to 13	14
106	6	7 to 14	15
107	6	7 to 14	15
108	6	7 to 14	15
109	6	7 to 14	15
110	6	7 to 14	15
111	6	7 to 14	15
112	6	7 to 14	15
113	6	7 to 14	15
114	6	7 to 15	16
115	6	7 to 15	16
116	6	7 to 15	16
117	7	8 to 15	16
118	7	8 to 15	16
119	7	8 to 15	16
120	7	8 to 15	16
121	7	8 to 15	16
122	7	8 to 15	16
123	7	8 to 16	17
124	7	8 to 16	17

6 Sampling to confirm value of TIR on isolated batches

If the number of failures from a sample falls into region A of figure 3 (for a TIR of less than or equal to 10 %), then reasonable confirmation is obtained that the batch has a TIR less than or equal to the specified level.

If the number of failures falls into region C, the batch can be judged to have a TIR greater than the specified value.

If the number of failures falls into region B, in general further test pieces should be taken so that a decision can be reached. However, attention is drawn to annex A for further deta ls.

The decision shall be made by using the cumulative result of all the test pieces examined from the batch under consideration.

7 Conditioning

The test pieces shall be conditioned in a liquid bath or in air at the temperature of 0 °C ± 1 °C for at least the period given in table 5.

In case of dispute over the results, a liquid bath shall be used.

Test pieces with wall thickness up to 8,6 mm shall be tested within 10 s of their removal from air conditioning or within 20 s of their removal from liquid conditioning, as applicable.

Test pieces with wall thickness greater than 8,6 mm shall be tested within 20 s of their removal from air conditioning or within 30 s of their removal from liquid conditioning, as applicable.

If this interval is exceeded, the test piece shall be returned immediately to the conditioning unit for reconditioning for a minimum period of 5 min.

Table 5 — Conditioning period

Wall thickness e mm	**Conditioning period** min	
	Liquid bath	Air
$e \leq 8,6$	15	60
$8,6 < e \leq 14,1$	30	120
$e > 14,1$	60	240

For pipes with smooth inside and outside surfaces, the wall thickness of the pipe to be tested shall be the total wall through the pipe section.

For pipes which are corrugated or ribbed externally, the wall thickness is the thickest wall of the pipe cross-section.

8 Procedure

The mass of the falling striker and the drop height appropriate to the pipe size shall be as specified in the appropriate product standard.

For pipes of outside diameter 40 mm or less, subject the test piece to a single blow.

For pipes of outside diameter greater than 40 mm, subject the test piece to a blow by allowing the striker to fall on one of the marked lines. If the test piece passes the test, rotate it in the V-block to the next marked line and again subject it to a blow from the falling striker, after reconditioning if necessary (see clause 7).

When the pitch of the corrugated or ribbed pipe is over 0,25 times the shaft diameter d, ensure that the test piece is struck on the top of the corrugation or the rib.

Continue this procedure until the test piece fails the test or until all marked lines have received one blow.

If required, carry out the test on subsequent test pieces, subjecting each one to a single blow.

9 Expression of results

The result shall be expressed as A, B or C for the batch or the production run from an extruder, as follows:

A if the TIR is below 10 %;

B if no decision can be made on the basis of the number of test pieces used (however, see A.3);

C if the TIR is greater than 10 %.

NOTE 4 The number of failed test pieces, as compared to the total number of blows, should not be expressed as a percentage, to avoid confusion with the TIR of which the percentage is only an estimate.

10 Test report

The test report shall include the following:

a) full identification of the pipe under test (application, material, dimensions, etc.);

b) a reference to this International Standard, i.e. ISO 3127;

c) description of isolated batch or continuous production from which the test pieces were sampled;

d) the number of test pieces;

e) the test temperature, in degrees Celsius;

f) the mass of the striker, in kilograms;

g) the diameter of the hemispherical surface of the striker;

h) the number of failed test pieces;

i) the total number of blows;

j) the results as A, B or C (see clause 9);

k) any factors which may have affected the results, such as any incidents or operating details not specified in this International Standard;

l) the date of the test, the laboratory and operator.

Annex A

(informative)

Evaluation of results from isolated batches

A.1 Scope

This annex provides information on the evaluation of results from isolated batches of pipe and on the use of figure 3. It also suggests a procedure for sampling and testing from continuous production.

A.2 Reliability of claims of TIR

The decision on the number of test pieces to be taken as a sample from an isolated batch should be made with the following consideration kept in mind. In general, the precision and accuracy of the test method is poor according to statistical laws.

This is illustrated by the following examples:

— if, on testing to confirm a claim of 10 % TIR on a sample taken at random from a batch, one test piece fails out of 100 blows, this result can only be interpreted as meaning that the batch has a TIR of between 0,1 % and 3,9 % (with 90 % confidence);

— if 5 test pieces fail out of 100 blows, this indicates that the batch has a TIR of between 2,5 % and 9,1 % (with 90 % confidence);

— if 9 test pieces fail out of 100 blows, this indicates that the batch has a TIR of between 5,5 % and 13,8 % (with 90 % confidence).

A.3 Isolated batches with a third-party quality mark

A.3.1 The procedure given in A.3.2 is applicable in the case where independent certification and monitoring are applied.

A.3.2 If an isolated batch is claimed to have a TIR of 10 % or less and this claim is supported by a quality mark, this can be confirmed as follows:

— If the number of failures from a sample falls into region A of figure 3, then reasonable confirmation is obtained that the batch does have a TIR of less than 10 %;

— If the number of failures falls into region B, subsequent measurements must fall into region A for the TIR to be confirmed;

— if the number of failures falls into region C, the claim given by the quality mark is not confirmed.

EXAMPLE

A test is made on a sample to confirm a claim of a TIR of less than or equal to 10 %:

— if after 100 blows there are 13 or fewer failures, reasonable confirmation is obtained that this batch has a TIR of less than or equal to 10 %;

— If 14 or more failures occur, the claim made by the quality mark is not confirmed.

A.4 Isolated batches without a third-party quality mark

If an isolated batch is claimed to have a TIR of 10 % or less but has no quality mark, this claim may be confirmed as follows:

— If the number of failures from a sample falls into region A of figure 3, then reasonable confirmation is obtained that the batch has a TIR of less than or equal to 10 %;

— If the number of failures falls into region C, the batch can be judged to have a TIR of greater than 10 %;

— if the number of failures falls into region B, further test pieces should be taken so that a decision can be reached; this decision is made by considering the cumulative result of all the test pieces which were impact tested.

EXAMPLE

A test is made on a sample to confirm a claim of a TIR of less than or equal to 10 %:

— if after 100 blows there are not more than 5 failures, reasonable confirmation is obtained that this batch has a TIR of less than or equal to 10 %;

— if 14 or more failures occur, the batch can be judged to have a TIR of greater than 10 %;

— if 6 to 13 failures occur, further blows have to be made so that a decision can be reached (e.g. if after a further 50 blows there have been a total of 20 failures, the batch can be judged to have a TIR of greater than 10 %).

A.5 Suggested sampling procedure for continuous production

A.5.1 At the commencement of a production run sufficient test pieces should be impact tested to demonstrate that the pipe has a TIR of equal to or less than 10 %.

A.5.2 Thereafter, at intervals not exceeding 8 h, sufficient test pieces should be taken to ensure that at least 25 impacts may be made.

A.5.3 If no failures occur in the sample taken in accordance with A.5.2, production may proceed.

A.5.4 In the event of a failure occurring in the sample taken in accordance with A.5.2, further test pieces should be tested until a positive pass or fail decision is reached (i.e. the number of failures is in either region A or C).

Annex B

(informative)

Unplasticized poly(vinyl chloride) (PVC-U) pressure pipe — Determination of resistance to external blows

B.1 Test method

The test method specified in clause 8 may be used. The mass of the falling striker and drop height as given in table B.1 should be used.

B.2 Resistance to external blows at 0 °C

The TIR should not exceed 10 % (see figure 3) when the pipe is tested under the conditions given in table B.1.

Table B.1 — Requirements for the falling-weight impact test at 0 °C

Nominal outside diameter of pipe	M level			H level		
	kg	m	N·m	kg	m	N·m
20	0,5	0,4	2	0,5	0,4	2
25	0,5	0,5	2,5	0,5	0,5	2,5
32	0,5	0,6	3	0,5	0,6	3
40	0,5	0,8	4	0,5	0,8	4
50	0,5	1,0	5	0,5	1,0	5
63	0,8	1,0	8	0,8	1,0	8
75	0,8	1,0	8	0,8	1,2	10
90	0,8	1,2	10	1,0	2,0	20
110	1,0	1,6	16	1,6	2,0	32
125	1,25	2,0	25	2,5	2,0	50
140	1,6	1,8	29	3,2	1,8	58
160	1,6	2,0	32	3,2	2,0	64
180	2,0	1,8	36	4,0	1,8	72
200	2,0	2,0	40	4,0	2,0	80
225	2,5	1,8	45	5,0	1,8	90
250	2,5	2,0	50	5,0	2,0	100
280	3,2	1,8	58	6,3	1,8	113
315	3,2	2,0	64	6,3	2,0	126
355	3,2	2,0	64	6,3	2,0	126
400	3,2	2,0	64	6,3	2,0	126
450	3,2	2,0	64	6,3	2,0	126

ICS 23.040.20

Descriptors: pipes (tubes), plastics products, thermoplastic resins, plastic tubes, tests, impact tests, determination, shock resistance, test equipment

Price based on 11 pages