Thermoplastics pipes

Test method for resistance to external blows by the round-the-clock method

English version of DIN EN 744

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ICS 23.040.20

Descriptors: Plastics, pipes, thermoplastics, impact resistance, testing.

Kunststoff-Rohrleitungs- und Schutzrohrsysteme; Rohre aus Thermoplasten; Prüfverfahren für die Widerstandsfähigkeit gegen äußere Schlagbeanpsruchung im Umfangsverfahren

European Standard EN 744:1995 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by CEN/TC 155.

The responsible German body involved in its preparation was the *Normenausschuß Kunststoffe* (Plastics Standards Committee).

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EN 744

April 1995

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English version

Plastics piping and ducting systems

Thermoplastics pipes

Test method for resistance to external blows by the round-the-clock method

Systèmes de canalisations et de gaines en plastiques; tubes thermoplastiques; méthode d'essai de la résistance aux chocs externes par la méthode du cadran

Kunststoff-Rohrleitungs- und Schutzsysteme; Rohre aus Thermoplasten; Prüfverfahren für die Widerstandsfähigkeit gegen äußere Schlagbeanpsruchung im Umfangsverfahren

This European Standard was approved by CEN on 1995-02-06.

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 744:1995 E

Foreword

This European Standard was prepared by CEN/TC 155 "Plastics piping systems and ducting systems" of which the secretariat is held by NNI.

This European Standard shall be given the status of a National Standard, either by publication of an identical text or by endorsement, at the latest by October 1995, and conflicting national standards shall be withdrawn at the latest by October 1995.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

This standard is based on ISO/DIS 3127:1992 "Unplasticized polyvinyl chloride (PVC) pipes for the transport of fluids - Determination and specification of resistance to external blows", prepared by the International Organization for Standardization (ISO). It is a modification of ISO/DIS 3127:1992 for reasons of applicability to other plastics materials and/or other test conditions and alignment with texts of other standards on test methods.

The modifications are:

- no pipe material is mentioned;
- test parameters, except those common to all plastics, are omitted;
- no material-dependent requirements are given;
- editorial changes have been introduced.

The material-dependent parameters and/or performance requirements are incorporated in the System Standard(s) concerned.

Annex A, which is informative, gives guidance on sampling.

No existing European Standard is superseded by this standard.

This standard is one of a series of standards on test methods which support System Standards for plastics piping systems and ducting systems.

1 Scope

This standard specifies a method for determining the resistance to external blows of thermoplastics pipes with circular cross sections by using the round-the-clock method.

The method is intended to be applied to isolated batches of pipe. For type testing and audit testing, 0 °C and/or -20 °C are applicable.

NOTE: Pipes made from polypropylene homopolymer (PP-H) which principally can not conform to impact requirements at 0 °C or lower temperatures are permitted to be tested at (23 ± 2) °C under the condition that PP-H pipes are intended for use for soil and waste discharge and bear an additional marking indicating that they are not to be installed below +5 °C.

2 Definition

For the purposes of this standard, the following definition applies.

True impact rate (TIR): The total number of failures divided by the total number of blows, in per cent, as if the whole batch had been tested.

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

3 Principle

Test pieces comprising cut lengths of pipe, representative of a batch or a production run from an extruder, are subjected to blows from a falling weight dropped from a specified height on to specified positions around the circumference of the pipe. The incidence of failure is estimated as the true impact rate (TIR) of the batch, or production run, where the maximum value for TIR is 10 %.

NOTE 1: The severity of this test method can be adjusted to suit different specification needs by changing the mass of the falling weight and/or by changing the fall height. It is not technically correct to vary the severity of the test by choosing other values of TIR than that specified in this method.

NOTE 2: It should be appreciated that a completely definitive result can only be reached 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.

NOTE 3: It is assumed that the following test parameters are set by the standard making reference to this standard:

a) the type of striker and striker mass [see b) of clause 4 and item a) of 7.1];

b) the drop height for the striker [see d) of clause 4 and 7.2, 7.3 and/or 7.4 as applicable];

c) the method of sampling [see 5.1 and c) of clause 9];

d) if appropriate, the number of test pieces to be used (see 5.2 and clause 7);

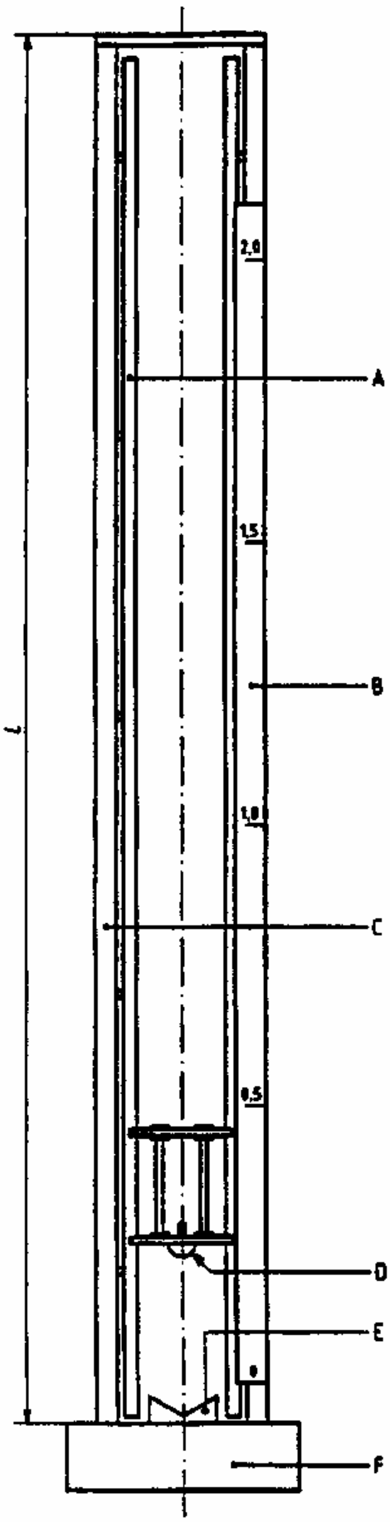
e) the test and conditioning temperature and the conditioning medium (see clause 6);

f) if applicable, any alternative or additional criterion for failure [see d) of 7.1].

4 Apparatus

A falling weight testing machine incorporating the following basic components (see figure 1):

a) **main frame**, with guide rails or a guiding tube rigidly fixed in the vertical position to accommodate a striker [see b)] and release it to fall vertically and freely such that the speed of the striker at the moment of hitting the pipe is not less than 95 % of the theoretical speed;



A Guide

B Graduated scale, vertically adjustable for different sizes of pipe

C Main frame

D Striker

E 120° vee-block

F Solid base

L 2,6 m approximately

Figure 1: Typical falling weight testing machine

b) **striker**, having a nose comprising all or part of a hemispherical form combined with a cylindrical stem at least 10 mm long and having dimensions conforming to table 1 and figure 2, depending upon the mass of the striker. The mass of the striker, including any associated weights, shall be selected from 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 imperfections which can influence the results.

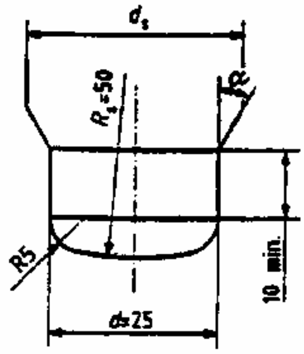
Table 1: Dimensions for the nose of the striker

Type	R_s mm	d mm	d_s	α
d25	50	25	*)	*)
d90	50	90	*)	*)
*) Not specified, to allow design freedom				

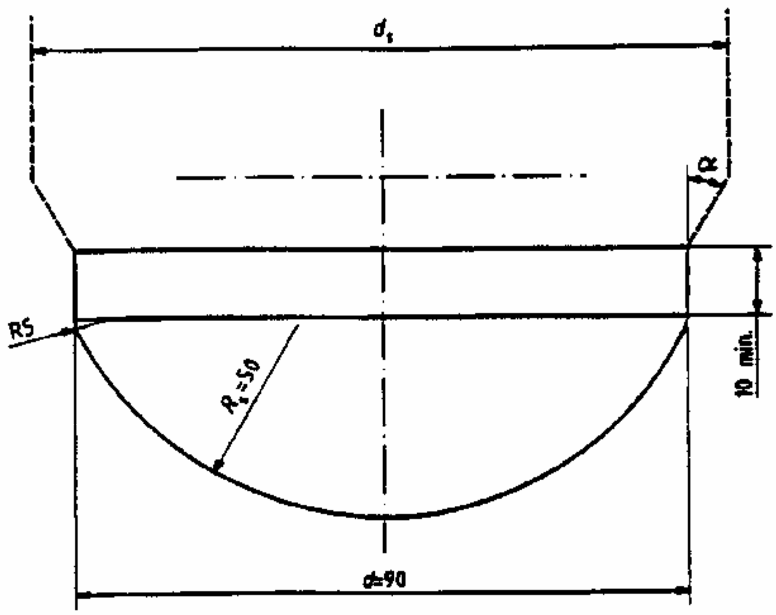
Table 2: Mass of strikers

Masses in kilograms

Mass of striker ± 0,005 kg			
Type d25	Type d90		
0,25 0,5 0,8	1,0 1,25 1,6 2,0 2,5	3,2 4,0 5,0 6,3 8,0	10,0 12,5 16,0



a) Type d25



b) Type d90

Dimensions in millimetres

Figure 2: Dimensions of strikers

c) **rigid test piece support**, consisting of a 120° vee-block at least 200 mm long, positioned so that the axis of the line of fall of the nose of the striker shall intersect the axes of the vee to within ± 2,5 mm (see figure 1).

The support construction shall be sufficiently rigid not to cushion the effect of the impact.

d) **release mechanism**, such that the falling weight can fall from a height which can be adjusted up to at least 2 m, as measured from the top surface of the test piece.

5 Test pieces

5.1 Preparation

The test pieces shall be cut from pipes selected at random from a batch or from a product run from an extruder.

For each test piece, the length shall be (200 ± 10) mm.

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 number of longitudinal lines conforming to table 3 shall be drawn with equidistant spacing around the pipe.

EXAMPLE: A straight line may be drawn along the length of the test piece at a random position. Further lines are drawn at successive equidistant intervals from one another (i.e. the last one is equidistant to the first one).

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

Nominal outside diameter d_n 1) mm	Number of equidistant lines to be drawn
$d_n \leq 40$	-
$40 < d_n \leq 63$	3
$63 < d_n \leq 90$	4
$90 < d_n \leq 125$	6
$125 < d_n \leq 180$	8
$180 < d_n \leq 250$	12
$250 < d_n \leq 355$	16
$355 < d_n$	24
1) For pipes with nominal diameters designated by other than d_n, their nominal size expressed in millimetres shall be taken in place of d_n.	

5.2 Number

Taking into account that the number of test pieces necessary will depend upon:

- any applicable product sampling requirements (see 5.1);
- the size of the pipe under test;
- whether or not each test piece may be subject to more than one impact (see table 3 and clause 7);
- the results obtained (see 7.5);

the number of test pieces shall be sufficient to enable at least one determination to be made in accordance with clause 8 (see table 5 and the equations 1 and 2) as to whether the results obtained lie in region A, B or C.

The number of test pieces shall enable at least 25 blows to be applied.

6 Conditioning

The test pieces shall be conditioned in a bath of water and ice or air for not less than the applicable period given in table 4.

In the case of dispute over results, for 0 °C a bath of water and ice shall be used, and for -20 °C air.

For testing at 0 °C, the conditioning temperature shall be (0 ± 1) °C or for testing at -20 °C, the conditioning temperature shall be (-20 ± 2) °C.

Table 4: Conditioning periods

Wall thickness e mm	Conditioning period min	
	Bath of water and ice	Air
$e \leq 8,6$	15	60
$8,6 < e \leq 14,1$	30	120
$14,1 < e$	60	240

7 Procedure

7.1 Conduct the procedures given in 7.2 to 7.5 inclusive in accordance with the following conditions, as applicable:

a) the striker [see b) of clause 4] shall have a mass selected from table 2 in accordance with the referring standard;

b) unless at least the environment for the test piece in the apparatus is maintained at the test temperature, each test piece shall be struck, one or more times as appropriate, within the following time interval after its removal from the conditioning environment:

1) 10 s for $d_n \leq 110$ mm;

2) 30 s for $110 < d_n \leq 200$ mm;

3) 60 s for $d_n > 200$ mm.

If the applicable interval is exceeded, the test piece may still be used if it is returned to the conditioning environment within 10 s of the end of the interval and reconditioned for not less than 5 min. Otherwise the test piece shall be fully reconditioned or discarded;

c) for corrugated or ribbed pipe, if the pitch of the corrugation or ribs is more than 0,25 times the diameter *d* of the stem of the striker nose (see figure 2), the test piece shall be positioned so that the initial impact of the striker will be on the top of a corrugation or a rib;

d) unless otherwise specified by the referring standard, consider as failure of the test piece shattering or any crack or split on the inside surface of the pipe that was caused by the impact and that can be seen without magnification: indentation of the test piece or a crease on the surface shall not be taken as a failure. Lighting devices may be used to assist in examining the test pieces. If criteria of failure other than those cited here are used, they shall be listed in the test report.

7.2 For pipes with a nominal outside diameter of 40 mm or less, subject each test piece to a single blow, using the appropriate mass of the falling striker and height of fall as specified in the referring standard, and record whether or not it failed [see d) of 7.1]. For all other pipe sizes, proceed in accordance with 7.3 unless the referring standard specifies testing by striking each test piece only once, in which case proceed in accordance with 7.4.

7.3 Subject a test piece to a blow by allowing the striker to fall from at least the specified height onto one of the marked lines (see 5.1 and note 3 to clause 3). If the test piece does not fail [see d) of 7.1] rotate it in the vee-block to the next marked line (see 5.1 and table 3) and again subject it to a blow from the falling striker, after re-conditioning if necessary [see clause 6 and b) of 7.1].

Continue this procedure until the test piece fails or until all marked lines have received one blow, and record the numbers of blows and any failure accordingly.

7.4 If so required by the referring standard, carry out the test on successive test pieces by subjecting each test piece to a single blow and referring to d) of 7.1.

7.5 Taking into account the total numbers of blows struck and failures observed, determine whether a type A or type C result can be obtained in accordance with clause 8. If so, report the results in accordance with clause 9. If not, continue testing in accordance with 7.1 to 7.4 until a type A or type C result is determined or testing is abandoned with a consequent type B result.

8 Expression of results

The results shall be expressed as A, B or C for the batch, or the production run from an extruder, by reference to table 5 or by calculation as follows.

Boundaries between regions are calculated using the following equations:

$$S_{A/B} = np - 0,5 - u[np(1 - p)]^{0,5} \qquad \ldots(1)$$

$$S_{B/C} = np + 0,5 + u[np(1 - p)]^{0,5} \qquad \ldots(2)$$

where:

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

p = 0,10 (TIR);

n is the number of blows.

NOTE 1: For convenience figure 3 may be used as follows:

a) the result is "A" if the TIR is below 10 %, as indicated by the number of failures observed being in region A of figure 3;

b) the result is "B" if no decision can be made on the basis of the number of test pieces used because the number of failures observed lies in region B of figure 3 (however see A.2 of annex A);

c) the result is "C" if the TIR is above 10 %, as indicated by the number of failures observed being in region C of figure 3.

NOTE 2: 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.

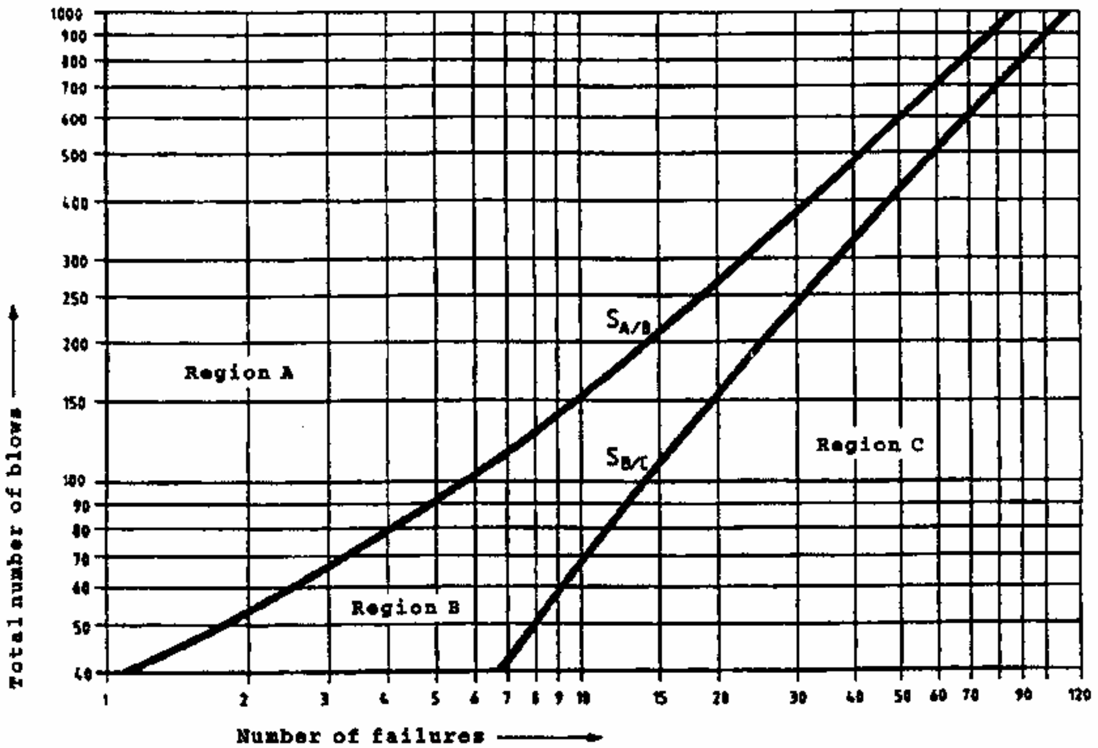


Figure 3: Number of test pieces for 10 % TIR (at 90 % confidence level)

Table 5: Expression of TIR at 10 % depending on the number of blows and failures

Number of blows*)	Number of failures		
	Region A Accept	Region B Continue test	Region C Reject
20 - 25	0	1- 3	4
26 - 32	0	1- 4	5
33 - 39	0	1- 5	6
40 - 48	1	2- 6	7
49 - 52	1	2- 7	8
53 - 56	2	3- 7	8
57 - 64	2	3- 8	9
65 - 66	2	3- 9	10
67 - 72	3	4- 9	10
73 - 79	3	4-10	11
80	4	5-10	11
81 - 88	4	5-11	12
89 - 91	4	5-12	13
92 - 97	5	6-12	13
98 -104	5	6-13	14
105	6	7-13	14
106 -113	6	7-14	15
114 -116	6	7-15	16
117 -122	7	8-15	16
123 -124	7	8-16	17

**) A minimum of 25 blows without failure shall be obtained before the test may be discontinued.*

9 Test report

The test report shall include the following information:

a) a reference to this standard and to the referring standard;

b) the full identification of the pipe (e.g. application, material, dimensions);

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

d) the number of test pieces;

e) the conditioniong details including temperature in degrees Celsius, time and medium;

f) the type of striker and its mass, in kilograms;

g) the total number of failed test pieces;

h) the total number of blows;

i) the result as A, B or C (see clause 8), and if applicable details of any alternative or additional criterion for failure (see 7.1 d) and f) of note 3 to clause 3);

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

k) the date of test.

Annex A (informative)

Evaluation of results from isolated batches

A.1 General

This annex provides information on the evaluation of results from isolated batches of pipe and the use of table 5, or, for values beyond those given in table 5, equations (1) and (2), as applicable (see clause 8). This annex also recommends a procedure for sampling and testing from continuous production (see A.4).

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.

Generally speaking, the precision of the test method is poor according to statistical laws. This is illustrated by the following examples:

- when testing to confirm a claim of 10 % TIR on a sample taken at random from a batch, if one test piece fails out of 100 blows, this indicates that the batch will have a TIR between 0,1 % and 3,9 % (with 90 % confidence);
- if five test pieces fail out of 100 blows, this indicates that the batch will have a TIR between 2,5 % and 9,1 % (with 90 % confidence);
- if nine test pieces fail out of 100 blows this indicates that the batch will have a TIR between 5,5 % and 13,8 % (with 90 % confidence).

A.2 Isolated batches with an independent quality mark

(see the part on conformity assessment of the applicable system standard)

A.2.1 The procedure detailed in A.2.2 makes use of the case where independent certification and monitoring is applied on the basis of the following assumptions:

a) if from a sample the number of failures falls into region A (see clause 8) (for TIR less than or equal to 10 %), then reasonable confirmation is obtained that the batch has a TIR equal to or less than the specified level;

b) if the number of failures falls into region C of table 5, the batch can be judged to have a TIR greater than the specified value;

c) if the number of failures falls into region B, generally further test pieces should be taken so that a decision can be reached. This decision is made by using the cumulative result of all the test pieces impacted from the batch under consideration.

A.2.2 If an isolated batch is claimed to have a TIR less than or equal to 10 % and this claim is supported by a quality mark, this can be confirmed as follows:

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

b) if the number of failures falls into region B, the number of failures from the next sample has to fall in region A;

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

EXAMPLE: Testing to confirm a claim of a TIR less than or equal to 10 %.

If the sample is large enough to allow use of 100 blows, the result is determined as follows:

a) if after testing involving 100 blows there are up to or including 13 failures, reasonable confirmation is obtained that this batch has a TIR less than or equal to 10 %;

b) if 14 or more failures occur, the claim given by the quality mark is not confirmed.

A.3 Isolated batches without a quality mark

(see the part on conformity assessment of the applicable system standard)

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

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

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

c) 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 struck.

EXAMPLE: Testing to confirm a claim of a TIR less than or equal to 10 %.

If the sample is large enough to allow use of 100 blows, the result is determined as follows:

a) if 5 or fewer failures occur the batch can be judged to have a TIR less than 10%;

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

c) if 6 to 13 failures occur, further blows are necessary for a decision to 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 greater than 10 %).

A.4 A recommended sampling procedure: continuous production

The following sampling procedure is recommended for continuous production:

a) at the commencement of a production run sufficient test pieces shall be impacted to demonstrate that the pipe has a TIR equal to or less than 10 % TIR in accordance with clause 8;

b) thereafter, at intervals not exceeding 8 h, sufficient test pieces shall be taken to ensure that at least 20 impact blows may be made;

c) if no failures occur in the sample taken in accordance with A.4, production may proceed;

d) in the event of a failure occurring, in the sample taken in accordance with A.4, further test pieces shall be tested until a pass or fail decision is reached in accordance with clause 8 (i.e. the number of failures shall be in region A or C respectively).