INTERNATIONAL STANDARD ISO 3302

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Rubber — Dimensional tolerances of solid moulded and extruded products

Caoutchouc — Tolérances dimensionnelles des produits compacts moulés et extrudés

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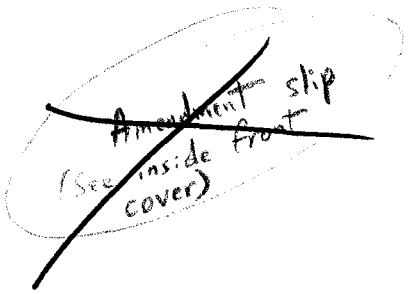

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3302 was drawn up by Technical Committee ISO/TC 45, *Rubber and rubber products*, and was circulated to the Member Bodies in May 1975.

It has been approved by the Member Bodies of the following countries :

Australia	India	Spain
Austria	Ireland	Sri Lanka
Belgium	Italy	Sweden
Brazil	Mexico	Switzerland
Bulgaria	Netherlands	Turkey
Canada	New Zealand	United Kingdom
Czechoslovakia	Poland	U.S.A.
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France	Romania	Yugoslavia
Germany	South Africa, Rep. of	

No Member Body expressed disapproval of the document.

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Rubber — Dimensional tolerances of solid moulded and extruded products

0 INTRODUCTION

0.1 *Section One* : Mouldings

The dimensional tolerances stated in this International Standard may be wider than those used in some other engineering practice. The following considerations apply :

1) All rubber shows some shrinkage after moulding, and allowance for this is made in the mould design. The amount of shrinkage is dependent on the rubber and mix used, but also varies from batch to batch of the same mix. Products made from silicone rubbers, fluorocarbon rubbers and polyacrylates are subject to large shrinkage; therefore, classes M1 and M2 tolerances (sub-clause 1.1) are very difficult to obtain.

2) Non-rubber parts bonded to the rubber will affect the shrinkage and, therefore, the practicable tolerances.

3) Moulds are made in various ways depending on the type of product and the accuracy demanded. In general, the product can be no more accurate than the mould, and the greater the degree of accuracy demanded, the more expensive become the moulds and their maintenance.

4) Care should be taken in applying the standard tolerances to products having wide sectional variations.

5) In cases where the rubber product is unavoidably distorted during removal from the mould, the dimensions of the products may be affected, and special allowance may be needed.

0.2 Section Two : Extrusions

Extruded rubber products require greater tolerances in manufacture than those produced by moulding since, after being forced through a die, swelling of the rubber takes place, and during subsequent vulcanization shrinkage and deformation usually occur.

Deformation can be reduced by the use of supports during vulcanization, the nature of the support depending on the section being produced and the degree of control required. These characteristics control the class of tolerance applicable to given dimensions.

When particular physical properties are required in the product, it may not always be possible to provide these in a compound which is capable of extrusion to close tolerances, and it is advisable, in these circumstances, that consultation should take place between the interested parties. In general, the softer vulcanizates (i.e. of hardness below 50 IRHD) need greater tolerances than the harder ones.

The tolerances chosen for use in any particular application should take into account the dimensional changes occurring after extrusion and vulcanization; these will depend on the nature of the rubber and mix used.

In the case of certain synthetic rubbers, extrusion class E1 tolerances (table 2) are not directly obtainable.

The closer tolerance classes should not be demanded unless the application requires it and should be restricted only to those dimensions which are critical. The greater the degree of accuracy demanded, the closer the control which must be exercised during manufacture, and hence the dearer the product becomes.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the dimensional tolerances of solid moulded and extruded rubber products.

1.1 Section One : Mouldings

1.1.1 Section One of this International Standard establishes four classes of tolerance for fixed and closure dimensions (see 3.1 and 3.2) for products moulded in solid rubber, namely :

1.1.1.1 Class M1 for precision mouldings.

Such mouldings require precision moulds, fewer cavities per mould, close mix controls, etc., which result in high cost. Optical comparators or other similar measuring devices may be required to minimize distortion of the rubber by the measuring instrument. This type of part requires expensive control and inspection procedures and very frequently some machining after moulding.

1.1.1.2 Class M2 for high quality mouldings involving much of the close control required for class M1.

1.1.1.3 Class M3 for good quality mouldings.

1.1.1.4 Class M4 for mouldings where dimensional control is non-critical.

1.1.2 It also prescribes the relevant conditions for the measurement of dimensions.

It does not apply to precision toroidal sealing rings.

1.2 Section Two : Extrusions

1.2.1 Section Two of this International Standard establishes eleven classes of tolerance for extrusions in solid rubber, related to particular ranges of dimensions, namely :

1.2.1.1 Three classes of tolerance on nominal cross-sectional dimensions of unsupported extrusions :

E1 high quality,

E2 good quality,

E3 non-critical.

1.2.1.2 Three classes of tolerance on nominal cross-sectional dimensions of mandrel-supported extrusions :

EM1 precision,

EM2 high quality,

EM3 good quality.

1.2.1.3 Two classes of tolerance on outside dimensions (normally diameters) of surface-ground extrusions (tubing) together with two classes of tolerance on wall thickness of these extrusions :

EG1 and EW1 precision,

EG2 and EW2 good quality.

1.2.1.4 Three classes of tolerance for the cut length of extrusions, and three classes of tolerance on the thickness of cut sections of extrusions :

L1 and EC1 precision,

L2 and EC2 good quality,

L3 and EC3 non-critical.

1.2.2 It also prescribes the relevant conditions for the measurement of dimensions.

2 REFERENCES

ISO/R 471, *Standard atmospheres for the conditioning and testing of rubber test pieces.*

ISO 2230, *Vulcanized rubber — Guide to storage.*

ISO 4648, *Rubber, vulcanized — Determination of dimensions of test pieces and products.*[1)]

1) At present at the stage of draft.

SECTION ONE : MOULDING

3 DEFINITIONS

In moulding of a rubber product, more rubber is used than is required to fill the cavity, and the excess is flashed. This flash tends to prevent the mould sections from fully closing and thus affects the finished part dimensions.

NOTE – For products moulded by transfer or injection, it is possible to regard all dimensions as fixed.

Two sets of tolerances, F and C, are given and are defined below.

3.1 fixed dimensions (F) : Dimensions which are not affected by deforming influences like flash thickness or lateral displacement of different mould parts (upper and lower parts or cores). See the figure, dimensions *w*, *x* and *y*.

3.2 closure dimensions (C) : Dimensions which can be altered by variation in the flash thickness or lateral displacement of different mould parts. See the figure, dimensions *s*, *t*, *u* and *z*.

NOTE – The dimensions in 3.1 and 3.2 can only be toleranced in so far as they are independent of each other.

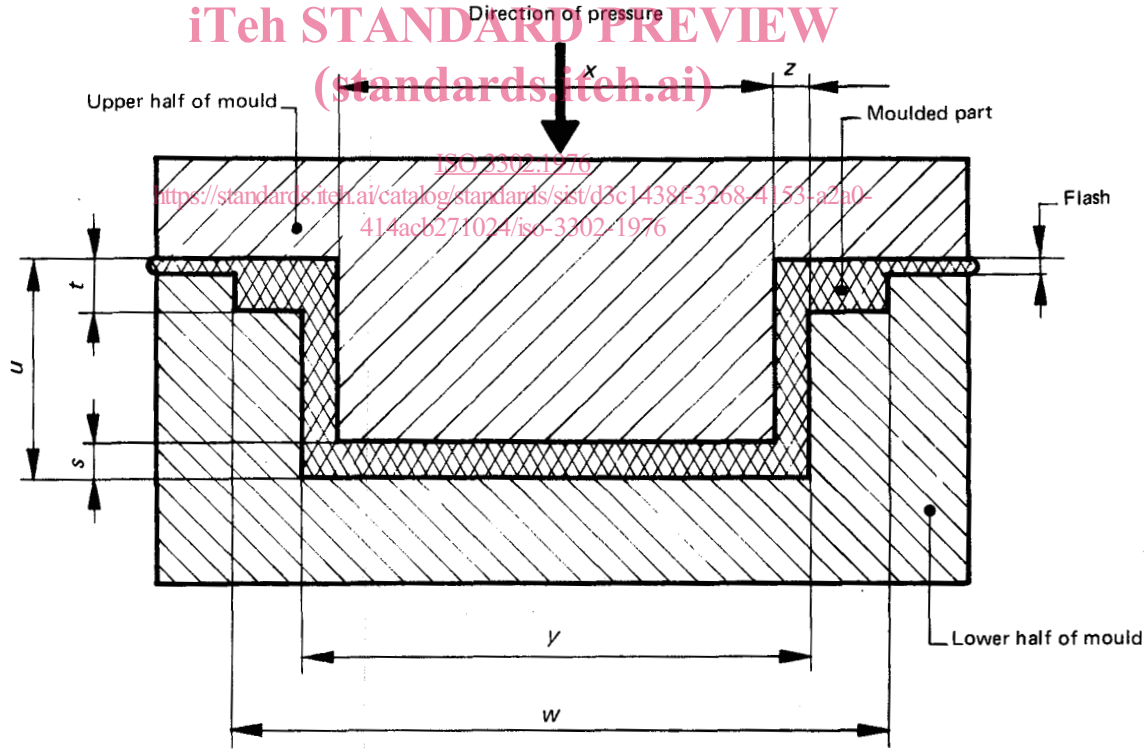

FIGURE – **Compression mould and moulded part**
(diagrammatic)

4 TOLERANCES

The tolerances to apply shall be chosen from the four classes of tolerance described in clause 1, by agreement between the interested parties.

Standard tolerances are given in table 1. Fixed tolerances (F) are related by size to each dimension, but all closure tolerances (C) are determined by the largest closure dimension (u).

Closer tolerances than class M1 can be agreed between the interested parties, if required.

Since the dimensions of a particular product may not all require the same class of tolerance, different dimensions on the same drawing can refer to different tolerance classes. Class M4 tolerances are to be used when the drawing does not indicate a required tolerance class.

A change of tolerances in either direction may be agreed between the interested parties, so that, for example, the permissible tolerance of $\pm 0{,}35$ may also be stated as $^{+0{,}2}_{-0{,}5}$ or $^{+0{,}7}_{0}$ or $^{0}_{-0{,}7}$, etc.

5 MEASUREMENT OF DIMENSIONS

Measurements of dimensions shall not be made until 16 h have elapsed after the moulding operation, this minimum time being extended to 72 h in case of dispute. Measurements shall be completed within 3 months after the date of despatch to the purchaser or before the moulding is put into use, whichever is the shorter time. Measurements shall be made after conditioning at a temperature of 23 °C, in accordance with ISO/R 471, other than by specific agreement between the interested parties. Care shall be taken to ensure that the mouldings are not subjected to adverse storage conditions[1] and that they are not distorted during measurement.

According to circumstances, measurements may be made using one or more of the following types of instrument :

5.1 A **micrometer dial-gauge** whose plunger shall not exert a pressure on the rubber greater than 21 kPa[2)3)].

5.2 A suitable **optical measuring instrument**.

5.3 **Gauges** for upper and lower limits appropriate to the dimensions being measured.

TABLE 1 — **Tolerances for moulded products***

Values in millimetres

Nominal dimension**		Class M1		Class M2		Class M3		Class M4
above	up to	F ±	C ±	F ±	C ±	F ±	C ±	F and C ±
0	6,3	0,10	0,10	0,15	0,20	0,25	0,40	0,50
6,3	10	0,10	0,15	0,20	0,20	0,30	0,50	0,70
10	16	0,15	0,20	0,20	0,25	0,40	0,60	0,80
16	25	0,20	0,20	0,25	0,35	0,50	0,80	1,00
25	40	0,20	0,25	0,35	0,40	0,60	1,00	1,30
40	63	0,25	0,35	0,40	0,50	0,80	1,30	1,60
63	100	0,35	0,40	0,50	0,70	1,00	1,60	2,0
100	160	0,40	0,50	0,70	0,80	1,30	2,0	2,5
160	–	0,3 %	***	0,5 %	***	0,8 %	***	1,5 %***

* Tolerances are based on the R 10 series of preferred numbers.

** Nominal dimensions are based on the R 5 series of preferred numbers.

*** Tolerances for C above nominal dimension 160 shall be agreed between the interested parties and expressed as a percentage.

1) See ISO 2230.

2) 1 kPa = 1 kN/m^2

3) See ISO 4648.

SECTION TWO : EXTRUSIONS

6 TOLERANCES

The tolerances to be applied shall be chosen from the classes of tolerances described in clause 1.

Standard tolerances of the various classes are given in tables 2 to 7.

Since the dimensions of a particular product may not all require the same class of tolerance, different dimensions on the same drawing can refer to different tolerance classes. When dimensions on drawings of a particular product do not indicate a required tolerance class, the largest tolerances given in the related table shall be considered to apply.

In any extruded cross-section, the dimensions of only two of the three variables (i.e. inside dimensions, outside dimensions and wall thickness) can be toleranced to control the dimensions of the cross-section.

A change of tolerances in either direction may be agreed between the interested parties, so that, for example, the permissible tolerance of ± 0,35 may also be stated as $^{+\,0,2}_{-\,0,5}$ or $^{+\,0,7}_{0}$ or $^{0}_{-\,0,7}$, etc.

6.1 Unsupported extrusions

The tolerances on the cross-sectional dimensions of unsupported extrusions are given in table 2.

For central hollow extrusions or extrusions having a complex section, a certain amount of collapse may occur during vulcanization. It is possible to limit or prevent this collapse by putting the extrusions on mandrels or on formers. The amount of the permitted deformation of the section shall be stated by the purchaser.

NOTE – Special consideration of tolerances will be necessary for a vulcanizate with a low hardness and high tensile strength (for example natural rubber gum vulcanizate).

6.2 Mandrel-supported extrusions

When internal dimensions of hollow extrusions (normally tubing) intended for subsequent use as cut rings or washers are required to a closer tolerance than can be obtained by unsupported vulcanization, vulcanizing may be carried out on mandrels. Shrinkage usually occurs when the product is removed from the mandrel so that the resulting size of the mandrel-supported dimension is smaller than the mandrel size. The amount of shrinkage depends on the type of mix used. The length of extrusion is limited by this method.

The tolerances on mandrel-supported internal dimensions are given in table 3; all other dimensions shall be in accordance with table 2.

TABLE 2 – **Tolerances on cross-sectional dimensions***

Values in millimetres

Nominal dimension		Class E1	Class E2	Class E3
above	up to	±	±	±
0	2,5	0,20	0,35	0,50
2,5	4,0	0,25	0,40	0,70
4,0	6,3	0,35	0,50	0,80
6,3	10,0	0,40	0,70	1,00
10	16	0,50	0,80	1,30
16	25	0,70	1,00	1,60
25	40	0,80	1,30	2,00
40	63	**	1,60	2,50
63	100	**	2,00	3,20

* Nominal dimensions and tolerances are based on the R 5 and R 10 series of preferred numbers respectively.

** Tolerances shall be agreed between the interested parties.

TABLE 3 – **Tolerances on internal dimensions of mandrel-supported extrusions***

Values in millimetres

Nominal dimension		Class EM1	Class EM2	Class EM3
above	up to			
0	4	$^{0}_{-\,0,20}$	$^{0}_{-\,0,20}$	$^{0}_{-\,0,35}$
4	6,3	$^{0}_{-\,0,20}$	$^{0}_{-\,0,25}$	$^{0}_{-\,0,40}$
6,3	10	$^{0}_{-\,0,25}$	$^{0}_{-\,0,35}$	$^{0}_{-\,0,50}$
10	16	$^{0}_{-\,0,35}$	$^{0}_{-\,0,40}$	$^{0}_{-\,0,70}$
16	25	$^{0}_{-\,0,40}$	$^{0}_{-\,0,50}$	$^{0}_{-\,0,80}$
25	40	$^{0}_{-\,0,50}$	$^{0}_{-\,0,70}$	$^{0}_{-\,1,00}$
40	63	$^{0}_{-\,0,70}$	$^{0}_{-\,0,80}$	$^{0}_{-\,1,30}$
63	100	$^{0}_{-\,0,80}$	$^{0}_{-\,1,00}$	$^{0}_{-\,1,60}$

* Nominal dimensions and tolerances are based on the R 5 and R 10 series of preferred numbers respectively.

6.3 Surface-ground extrusions

6.3.1 The tolerances on the outside dimensions (usually diameter) of surface-ground extrusions (normally tubing) are given in table 4.

NOTE — These tolerances are applicable to rings cut from surface-ground tubing.

TABLE 4 — **Tolerances on outside dimensions of surface-ground extrusions***

Values in millimetres

Nominal dimension		Class EG1 ±	Class EG2 ±
above	up to		
0	4,0	0,10	0,20
4,0	6,3	0,10	0,20
6,3	10	0,15	0,25
10	16	0,20	0,35
16	25	0,20	0,40
25	40	0,25	0,50
40	63	0,35	0,70
63	100	0,40	0,80
100	160	0,50	1,00

* Nominal dimensions and tolerances are based on the R 5 and R 10 series of preferred numbers respectively.

6.3.2 The tolerances on the wall thickness of surface-ground extrusions (normally tubing) are given in table 5.

NOTE — For combined use of tables 3, 4 and 5, see fourth paragraph of clause 6.

TABLE 5 — **Tolerances on wall thickness of surface-ground extrusions***

Values in millimetres

Nominal dimension		Class EW1 ±	Class EW2 ±
above	up to		
0	4	0,10	0,20
4	6,3	0,15	0,20
6,3	10	0,20	0,25
10	16	0,20	0,35
16	25	0,25	0,40

* Nominal dimensions and tolerances are based on the R 5 and R 10 series of preferred numbers respectively.

6.4 Cut lengths

The tolerances on the cut length of extrusions are given in table 6.

NOTE — Special consideration of tolerances will be necessary for a vulcanizate with a low hardness and high tensile strength (for example natural rubber gum vulcanizate).

TABLE 6 — **Tolerances on cut length of extrusions***

Values in millimetres

Nominal length		Class L1 ±	Class L2 ±	Class L3 ±
above	up to			
0	40	0,7	1,0	1,6
40	63	0,8	1,3	2,0
63	100	1,0	1,6	2,5
100	160	1,3	2,0	3,2
160	250	1,6	2,5	4,0
250	400	2,0	3,2	5,0
400	630	2,5	4,0	6,3
630	1 000	3,2	5,0	10,0
1 000	1 600	4,0	6,3	12,5
1 600	2 500	5,0	10,0	16,0
2 500	4 000	6,3	12,5	20,0
4 000		0,16 %	0,32 %	0,50 %

* Nominal length and tolerances are based on the R 5 and R 10 series of preferred numbers respectively.

6.5 Cut sections

The tolerances on thickness of cut sections (for example rings, washers, disks, etc.) are given in table 7.

NOTES

1 Tolerance for classes EC1 and EC2 can be obtained only for lathe-cut sections.

2 Special consideration of tolerances will be necessary for a vulcanizate with a low hardness and high tensile strength (for example natural rubber gum vulcanizate).

TABLE 7 — **Tolerances on thickness of cut sections***

Values in millimetres

Nominal thickness		Class EC1 ±	Class EC2 ±	Class EC3 ±
above	up to			
0,63	1,00	0,10	0,15	0,20
1,00	1,60	0,10	0,20	0,25
1,60	2,50	0,15	0,20	0,35
2,50	4,00	0,20	0,25	0,40
4,00	6,30	0,20	0,35	0,50
6,30	10	0,25	0,40	0,70
10	16	0,35	0,50	0,80
16	25	0,40	0,70	1,00

* Nominal thickness and tolerances are based on the R 5 and R 10 series of numbers respectively.

7 MEASUREMENT OF DIMENSIONS

Measurements of dimensions shall not be made until 16 h have elapsed after vulcanization, this minimum time being extended to 72 h in case of dispute. Measurements shall be completed within 3 months after the date of despatch to the purchaser, or before the extrusion is put into use, whichever is the shorter time. Measurements shall be made after conditioning at a temperature in accordance with ISO/R 471, unless otherwise agreed by the interested parties. Care shall be taken to ensure that the extrusions are not subjected to adverse storage conditions[1] and that they are not distorted during measurement.

According to circumstances, measurements may be made using one or more of the following types of instrument :

7.1 A **micrometer dial-gauge**, the plunger of which shall not exert a pressure on the rubber greater than 21 kPa[2][3].

7.2 A suitable **optical measuring instrument.**

7.3 **Fixed gauges** for upper and lower limits appropriate to the dimensions being measured.

1) See ISO 2230.

2) 1 kPa = 1 kN/m^2

3) See ISO 4648.