Standard tolerance for die casting products

Linear Dimensions: Standard Tolerances

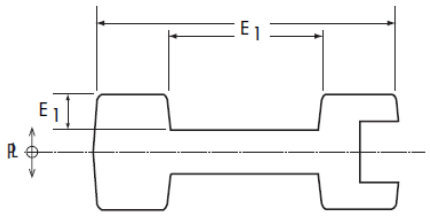


Table S-4A-1 Tolerances for Linear Dimensions (Standard)

In inches, two-place decimals (.xx); In millimeters, single-place decimals (.x)

	Casting Alloys			
Length of Dimension "E_1"	Zinc	Aluminum	Magnesium	Copper
Basic Tolerance up to 1" (25.4mm)	±0.010 (±0.25 mm)	±0.010 (±0.25 mm)	±0.010 (±0.25 mm)	±0.014 (±0.36 mm)
Additional Tolerance for each additional inch over 1" (25.4mm)	±0.001 (±0.025 mm)	±0.001 (±0.025 mm)	±0.001 (±0.025 mm)	±0.003 (±0.076 mm)

Note: Because dies wear over the course of producing castings, it should be noted that the number of shots on a die prior to repair or replacement will be less for tighter casting tolerances and greater for wider casting tolerances.

Linear Dimensions: Precision Tolerances

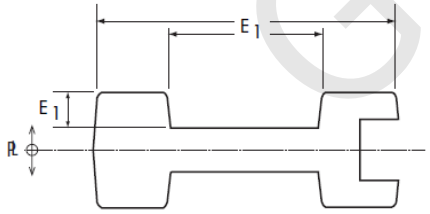


Table P-4A-1 Tolerances for Linear Dimensions (Precision)

In inches, three-place decimals (.xxx); In millimeters, two-place decimals (.xx)

	Casting Alloys			
Length of Dimension "E_1"	Zinc	Aluminum	Magnesium	Copper
Basic Tolerance up to 1" (25.4mm)	±0.002 (±0.05 mm)	±0.002 (±0.05 mm)	±0.002 (±0.05 mm)	±0.007 (±0.18 mm)
Additional Tolerance for each additional inch over 1" (25.4mm)	±0.001 (±0.025 mm)	±0.001 (±0.025 mm)	±0.001 (±0.025 mm)	±0.002 (±0.05 mm)

Note: Because dies wear over the course of producing castings, it should be noted that the number of shots on a die prior to repair or replacement will be less for tighter casting tolerances and greater for wider casting tolerances.

Parting Line: Standard Tolerances

Parting Line Tolerance is the maximum amount of die separation allowed for the end product to meet specified requirements of form, fit and function. This is not to be confused with Parting Line Shift Tolerance which is the maximum amount die halves shift from side to side in relation to one another.

Parting Line Tolerance is a function of the surface area of the die from which material can flow from one die half to the other. This is also known as Projected Area.

Projected Area is always a plus tolerance since a completely closed die has 0 separation. Excess material and pressure will force the die to open along the parting line plane creating an oversize condition. The excess material will cause the part to be thicker than the ideal specification and that is why Projected Area only has plus tolerance. It is important to understand that Table S-4A-2 (Projected Area Tolerance) does not provide Parting Line Tolerance by itself. Part thickness or depth must be factored in to give a true idea of Parting Line Tolerance. Parting Line Tolerance is a function of part thickness perpendicular to the Projected Area plus the Projected Area Tolerance.

Example: An aluminum die casting has 75 in_2 (483.9 cm_2) of Projected Area on the parting die plane. From table S-4A-2, Projected Area Tolerance is +0.012. This is combined with the total part thickness tolerance from table S-4A-1 to obtain the Parting Line Tolerance.

The total part thickness including both die halves is 5.00 in. (127 mm) which is measured perpendicular to the parting die plane (dimension "E2 E1"). From table S-4A-1, the Linear Tolerance is ±0.010 for the first inch and ±0.001 for each of the four additional inches. The Linear Tolerance of ±0.014 inches is combined with the Projected Area Tolerance of +0.012 to yield a Standard Parting Line Tolerance of +0.026/-0.014 in. or in metric terms ±0.35 mm from Linear Tolerance table S-4A-1 plus +0.30 mm from Projected Area Tolerance table S-4A-2 = +0.65/-0.35 mm.

Table S-4A-2 Parting Line Tolerances (Standard) – Added to Linear Tolerances

Projected Area of Die Casting inches^2 (cm^2)	Casting Alloys (Tolerances shown are "plus" values only)			
	Zinc	Aluminum	Magnesium	Copper
up to 10 in^2 (64.5 cm^2)	+0.0045 (+0.114 mm)	+0.0055 (+0.14 mm)	+0.0055 (+0.14 mm)	+0.008 (+0.20 mm)
11 in^2 to 20 in^2 (71.0 cm^2 to 129.0 cm^2)	+0.005 (+0.13 mm)	+0.0065 (+0.165 mm)	+0.0065 (+0.165 mm)	+0.009 (+0.23 mm)
21 in^2 to 50 in^2 (135.5 cm^2 to 322.6 cm^2)	+0.006 (+0.15 mm)	+0.0075 (+0.19 mm)	+0.0075 (+0.19 mm)	+0.010 (+0.25 mm)
51 in^2 to 100 in^2 (329.0 cm^2 to 645.2 cm^2)	+0.009 (+0.23 mm)	+0.012 (+0.30 mm)	+0.012 (+0.30 mm)	—
101 in^2 to 200 in^2 (651.6 cm^2 to 1290.3 cm^2)	+0.012 (+0.30 mm)	+0.018 (+0.46 mm)	+0.018 (+0.46 mm)	—
201 in^2 to 300 in^2 (1296.8 cm^2 to 1935.5 cm^2)	+0.018 (+0.46 mm)	+0.024 (+0.61 mm)	+0.024 (+0.61 mm)	—

For projected area of die casting over 300 in^2 (1935.5 cm^2), consult with your die caster.

Parting Line Shift: Standard Tolerance

Example: Parting Line Shift Tolerance

The cavity area at the parting line is 75 inches squared. From Table S-4A-6, the Projected Area Parting Line Shift Tolerance is ± 0.006 (±0,152 mm). This is added to the Linear Tolerance from table S/P-4A-1.

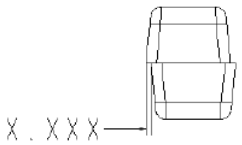


Table S-4A-6: Parting Line Shift Tolerance (Excluding unit dies)

Projected Area of Die Casting inches ² (cm ²)	Additional Tolerance inches (mm)
up to 50 in ² (322.6 cm ²)	±.004 (±.102 mm)
51 in² to 100 in ² (329.0 cm ² to 645.2 cm ²)	±.006 (±.152 mm)
101 in² to 200 in ² (651.6 cm ² to 1290.3 cm ²)	±.008 (±.203 mm)
201 in² to 300 in ² (1296.8 cm ² to 1935.5 cm ²)	±.011 (±.279 mm)
301 in² to 500 in ² (1941.9 cm ² to 3225.8 cm ²)	±.016 (±.406 mm)
501 in² to 800 in ² (3232.3 cm ² to 5161.3 cm ²)	±.020 (±.508 mm)
801 in² to 1200 in ² (5167.7 cm ² to 7741.9 cm ²)	±.025 (±.635 mm)

Draft Requirements: Standard Tolerances

In the case of an inside surface for an aluminum cast part, for which the constant "C" is 30 (6 mm), the recommended Standard Draft at three depths is:

Depth	Draft Distance	Draft Angle
in. (mm)	in. (mm)	Degrees
0.1 (2.50)	0.010 (0.250)	6°
1.0 (25)	0.033 (0.840)	1.9°
5.0 (127)	0.075 (1.890)	0.85°

Calculation for Draft Distance

$$D = \frac{\sqrt{L}}{C}$$

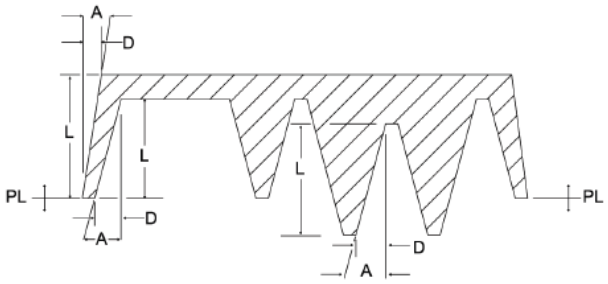
Calculation for Draft Angle

$$A = \frac{\left(\frac{D}{L}\right)}{0.01746} \quad \text{OR} \quad \frac{57.2738}{C\sqrt{L}}$$

To achieve lesser draft than normal production allows, Precision Tolerances maybe specified (see opposite page).

Where:

- **D**= Draft in inches
- **L**= Depth or height of feature from the parting line
- **C**= Constant, from table S-4A-7, is based on the type of feature and the die casting alloy
- **A**= Draft angle in degrees Draft



Drawing defines draft dimensions for interior and exterior surfaces and total draft for holes (draft is exaggerated for illustration).

Draft Requirements: Standard Tolerances

Table S-4A-7: Draft Constants for Calculating Draft and Draft Angle

Values of Constant "C" by Features and Depth (Standard Tolerances)

Alloy	Inside Wall For Dim. in inches (mm)	Outside Wall For Dim. in inches (mm)	Hole, Total Draft for Dim. in inches (mm)
Zinc/ZA	50 (9.90 mm)	100 (19.80 mm)	34 (6.75 mm)
Aluminum	30 (6.00 mm)	60 (12.00 mm)	20 (4.68 mm)
Magnesium	35 (7.00 mm)	70 (14.00 mm)	24 (4.76 mm)
Copper	25 (4.90 mm)	50 (9.90 mm)	17 (3.33 mm)

Cored Holes for Cut Threads: Standard Tolerances

Cored holes for cut threads are cast holes that require threads to be cut (tapped) into the metal. The table below provides the dimensional tolerances for diameter, depth and draft for each specified thread type (Unified and Metric Series). When required, cored holes in Al, Mg, Zn and ZA may be tapped without removing draft. This Standard Tolerance recommendation is based on allowing 85% of full thread depth at the bottom D2 (small end) of the cored hole and 55% at the top D1 (large end) of the cored hole. A countersink or radius is also recommended at the top of the cored hole. This provides relief for any displaced material and can also serve to strengthen the core.

Threads extend through the cored hole as by Y. X shows the actual hole depth. As with the countersink at the top of the hole, the extra hole length provides relief for displaced material and allows for full thread engagement. Tolerances below apply to all alloys.

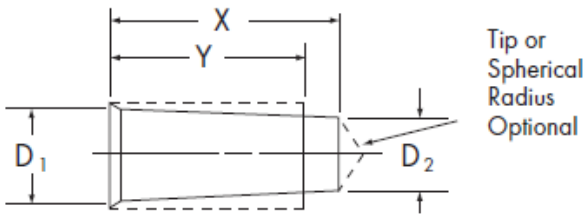


Table S-4A-9: Cored Holes for Cut Threads (Standard Tolerances) – Unified Series and Metric Series

Unified Series/ Class	Hole Diameter D_1, Max.	Hole Diameter D_2, Min.	Thread Depth Y, Max.	Hole Depth X, Max.
	inches	inches	inches	inches
6-32, UNC/2B, 3B	0.120	0.108	0.414	0.508
6-40, UNF/2B	0.124	0.114	0.345	0.420
8-32, UNC/2B	0.146	0.134	0.492	0.586
8-36, UNF/2B	0.148	0.137	0.410	0.493
10-24, UNC/2B	0.166	0.151	0.570	0.695
10-32, UNF/2B	0.172	0.160	0.475	0.569
12-24, UNC/2B	0.192	0.177	0.648	0.773
12-28, UNF/2B	0.196	0.182	0.540	0.647
1/4A-20, UNC/1B, 2B	0.221	0.203	0.750	0.900
1/4A-28, UNF/1B, 2B	0.230	0.216	0.500	0.607
5/16-18, UNC/1B, 2B	0.280	0.260	0.781	0.948
5/16-24, UNF/1B, 2B	0.289	0.273	0.625	0.750
3/8-16, UNC/1B, 2B	0.339	0.316	0.938	1.125
3/8-24, UNF/1B, 2B	0.351	0.336	0.656	0.781
7/16-14, UNC/1B, 2B	0.396	0.371	1.094	1.308
7/16-20, UNF/1B, 2B	0.409	0.390	0.766	0.916
1/2-13, UNC/1B, 2B	0.455	0.428	1.250	1.481
1/2-20, UNF/1B, 2B	0.471	0.453	0.750	0.900
9/16-12, UNC/1B, 2B	0.514	0.485	1.406	1.656
9/16-18, UNF/1B, 2B	0.530	0.510	0.844	1.010
5/8-11, UNC/1B, 2B	0.572	0.540	1.563	1.835
5/8-18, UNF/1B, 2B	0.593	0.573	0.781	0.948
3/4A-10, UNC/1B, 2B	0.691	0.657	1.688	1.988
3/4A-16, UNF/1B, 2B	0.714	0.691	0.938	1.125
7/8-9, UNC/1B, 2B	0.810	0.772	1.750	2.083
7/8-14, UNF/1B, 2B	0.833	0.808	1.094	1.308
1-8, UNC/1B, 2B	0.927	0.884	2.000	2.375
1-12, UNF/1B. 2B	0.951	0.922	1.250	1.500

Metric Series Thread Size Ⓐ	Hole Diameter D_1, Max.	Hole Diameter D_2 Min.	Thread Depth Y, Max.	Hole Depth X, Max.
	mm	mm	mm	mm
M3.5 X 0.6	3.168	2.923	7.88	9.68
M4 X 0.7	3.608	3.331	9.00	11.10
M5 X 0.8	4.549	4.239	11.25	13.65
M6 X 1	5.430	5.055	13.50	16.50
M8 X 1.25	7.281	6.825	18.00	21.75
fM8 X 1	7.430	7.055	14.00	17.00
M10 X 1.5	9.132	8.595	22.50	27.00
fM10 X 0.75	9.578	9.285	10.00	12.25
fM10 X 1.25	9.281	8.825	20.00	23.75
M12 X 1.75	10.983	10.365	27.00	32.25
fM12 X 1	11.430	11.055	15.00	18.00
fM12 X 1.25	11.281	10.825	18.00	21.75
M14 X 2	12.834	12.135	31.50	37.50
fM14 X 1.5	13.132	12.595	24.50	29.00
fM15 X 1	14.430	14.055	15.00	18.00
M16 X 2	14.834	14.135	32.00	38.00
fM16 X 1.5	15.132	14.595	24.00	28.50
fM17 X 1	16.430	16.055	15.30	18.30
fM18 X 1.5	17.132	16.595	24.30	28.80
M20 X 2.5	18.537	17.675	40.00	47.50
fM20 X 1	19.430	19.055	15.00	18.00
fM20 X 1.5	19.132	18.595	25.00	29.50
fM22 X 1.5	21.132	20.595	25.30	29.80
M24 X 3	22.239	21.215	48.00	57.00
fM24 X 2	22.834	22.135	30.00	36.00
fM25 X 1.5	24.132	23.595	25.00	29.50
fM27 X 2	25.834	25.135	33.75	39.75
M30 X 3.5	27.941	26.754	60.00	70.50

f = Fine Pitch Series

Additional Considerations for Large Castings

1 Fillet Radii:

1.1: Definition: Wall thickness is the distance between two parallel or nearly parallel surfaces. Wall thickness may vary depending on the application of draft. Wall thickness should be maintained as uniform as possible. A general guideline would be to keep the range of thickness within 2X of the thinnest wall. A second guideline is to keep the wall as thin as possible to meet the castings functional requirements.

1.2: General: 0.14" (3.5mm (+/- 0.5mm) **1.2.1 Deviations:** from the nominal condition are based upon product function and manufacturing process requirements.

2 Radii:

2.1 Fillet Radii: 2.1.1 General: 0.14" (+0.08/-0.04") [3.5mm (+2.0mm/-1.0mm)]

2.1.1.1 Deviations: from the nominal condition are based upon product function and manufacturing process requirements.

2.1.2 Minimum: 0.060″ (1.5mm)

2.2 Corner Radii:2.2.1 General: 0.060″ (+0.08/-0.04″) [1.5mm (+2mm/-1mm)]

2.2.1.1 Deviations: from the nominal condition are based upon product function and manufacturing process requirements.

2.2.2 Minimum: 0.020″ (0.5mm)

3 Cores:

3.1 Guidelines: Cores should be used to minimize machining stock, and should be pulled perpendicular to each other. Use stepped cores where possible to minimize finish stock, reduce heavy sections, and minimize porosity.

3.2 Minimum: Cored hole diameter to be 0.25″ (6.0mm) in and parallel to the direction of die draw.

3.3 For holes Less Than: 0.50″ (12.5mm) diameter the core hole length to diameter (L/D) ratio should not exceed 4:1.

3.4 For Holes Greater Than: 0.50″ (12.5mm) diameter the core pin length to diameter (L/D) ratio should not exceed 10:1

Ejector Pin Bosses:

Surface Geometry:6.2.1: 0.06″ (1.5mm) raised to 0.03″ (0.8mm) depressed.

7 Trimming & Cleaning:

7.1 Parting Lines:7.1.1 Trim Ribs-Gate and Parting Line: 0.12″ maximum (1.5mm)**7.1.2 Gates & Overflows:** 0-0.059″ (0-1.5mm)**7.1.3 Flash:** As specified in normal standard.

7.2 Cored Holes: 0-0.02″ (0-0.5mm)

7.3 Openings:7.3.1: 0-0.06″ (0-1.5mm) at the finish machined face**7.3.2:** 0-0.03″ (0-0.8mm) on as-cast surfaces**7.3.3:** 0-0.01″ (0-2.5mm) of corner radii

7.4 Corners - Sharp: Not removed.

7.5 Ejector Pin Flash (Max. Projection):7.5.1: 0-0.12" (0-3.0mm) on machined surfaces. **7.5.2:** 0-0.04" (0-1.0mm) on as-cast surfaces.

7.6 Machined Surfaces: 0.12" (0-0.3mm) max.

7.7 Seam Lines: 0-0.02" (0-0.5mm)

7.8 Negative trim (shearing): condition is allowed when the nominal wall thickness is maintained.

Engineering & Design: Additional Specification Guidelines

Acceptable Ejector Pin Marks

Ejector pin marks on most die castings may be raised or depressed .015" (.381 mm). Raised ejector pin marks are preferred for optimum production. Larger castings may require additional ejector pin tolerances for proper casting ejection.

Ejector Pin Flash

Ejector pin marks are surrounded by a flash of metal. Normally, ejector pin flash will not be removed, unless it is objectionable to the end use of the part.

Alternatively, ejector pin flash may be specified as crushed or flattened.

In the case of either nonremoval or crushing/flattening, flash may flake off in use.

Complete removal of ejector pin marks and flash by machining or hand scraping operations should be specified only when requirements justify the added expense.

With each die casting cycle, the die opens and the ejector plate in the ejector half of the die (Fig. A) automatically moves all ejector pins forward (Fig. B), releasing the casting from the die. Then, the die casting is removed from the die manually or mechanically.

5 Metal Extension (Flash) Removal

Guidelines to Extent of Removal

The table below provides a guide to the types of die casting metal extension (flash) which occurs in typical die castings and the amount of metal extension material which remains after (1) degating (removal of any gates and runners from the casting), and (2) commercial trimming of die casting metal extension.

Note that in some instances, where special surface finish characteristics are not involved, the most economic method of degating and metal extension (flash) removal may include a tumbling or vibratory deburring operation.

Guide to Nominal Metal Remaining by Type of Extension

	Type of Metal Extension and Nominal Amount Remaining After Degating and Trimming				
Operation Description	Thick Gates & Overflows > 0.12" (3.0 mm)	Thin Gates & Overflows ≤ 0.12" (3.0 mm)	Parting Line and Seam Line Metal Extension	Metal Extension in Cored Holes	Sharp Corners
After Degating Nominal Flash Remaining	Rough within 0.12" (3.0 mm)	Rough within 0.12" (3.0 mm)	Excess Only Broken Off	Not Removed	Not Removed
After Commercial Trimming* Nominal Extension Emaining	Within 0.06" (1.59 mm)	Within 0.03" (0.8 mm)	Within 0.015" (0.38 mm)	Removed within 0.010" (0.25 mm)	Not Removed

** "Commercially trimmed" does not include additional operations to remove loose material. For very heavy gates and overflows, consult your die caster.*

Surface Finish, As-Cast

General Guidelines for As Cast Surface Finish on Die Cast Parts

The specification of external surface finish requirements is desirable for selected die casting applications and, in the case of some decorative parts, essential.

The purpose of the guidelines presented here is to classify as-cast surface finish for die castings into a series of grades so that the type of as-cast finish required may be addressed and defined in advance of die design.

These guidelines should be used for general type classification only, with final surface finish quality requirements specifically agreed upon between the die caster and the customer.

The first four classes listed relate to cosmetic surfaces. Classfive relates to selected surface areas where specified surface finish limitations are required.

As-Cast Surface Finish Classifications and Final Finish or End Use

Class	As-Cast Finish	Final Finish or End Use
1 Utility Grade	No cosmetic requirements. Surface imperfections (cold shut, rubs, surface porosity, lubricant build-up, etc.) are acceptable	Used as-cast or with protective coatings; Anodize (non-decorative) Chromate (yellow, clear)
2 Functional Grade	Surface imperfections (cold shut, rubs, surface porosity, etc.), that can be removed by spot polishing or can be covered by heavy paint, are acceptable.	Decorative Coatings: Lacquers Enamels Plating (Al) Chemical Finish Polished Finish
3 Commercial Grade	Slight surface imperfections that can be removed by agreed upon means are acceptable.	Structural Parts (high stress areas) Plating (Zn) Electrostatic Painting Transparent Paints
4 Consumer Grade	No objectionable surface imperfections. Where surface waviness (flatness), noted by light reflection, is a reason for rejection special agreement should be reached with the die caster.	Special Decorative Parts
5 Superior Grade	Surface finish, applicable to limited areas of the casting and dependent on alloy selected, to have a maximum value in micro inches as specified on print.	O-Ring Seats or Gasket Areas

7 Die Cast Lettering and Ornamentation

Lettering, medallions, logotypes, trademarks and a range of identification symbols may be reproduced on the surfaces of die cast parts.

Such as-cast ornamentation may be raised or depressed, but note that raised lettering will result in lower die construction costs and reduced die maintenance over the life of the die.

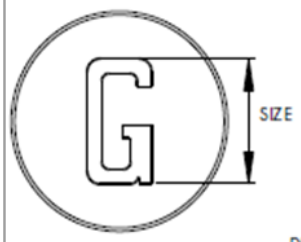
Raised lettering on a depressed panel can be an economical substitute for depressed letters, as shown in the illustration below.

Cast-in Lettering/Ornamentation Guidelines

In addition to the avoidance of depressed lettering or symbols in the casting surface, the following guidelines will achieve the most satisfactory results. The terms used refer to the illustrations below.

1. *The Line Thickness (or "face") of any letter to be clearly cast should be 0.010 in. (0.254 mm) or greater.*
2. *The Height (or raised dimension) of a cast letter or symbol should be equal to or less than the line thickness.*
3. *The Draft Angle should be greater than 10°.*
4. *Letters or symbols containing fine serifs or delicate lines cannot be expected to die cast cleanly.*

Sample Letter or Symbol



Three Alternative Die Cast Effects

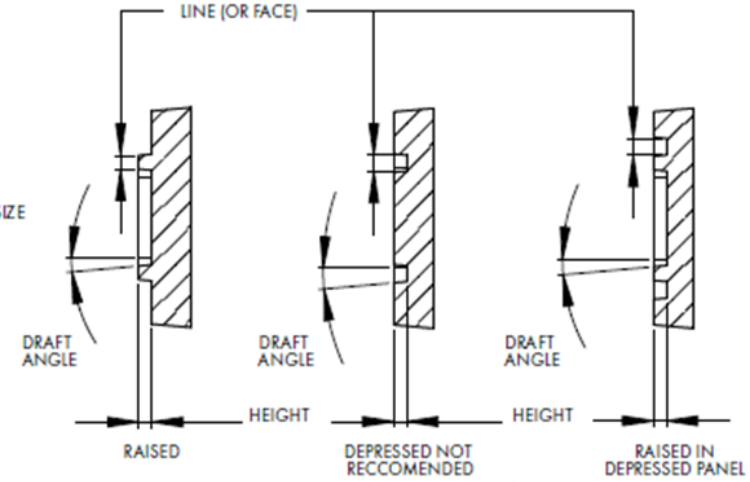


Fig. 1a | Fig. 2a | Fig. 2a

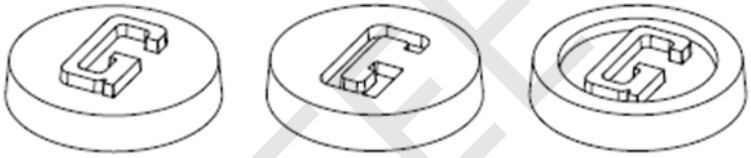


Fig. 1b | Fig. 2b | Fig. 2b