

**ASME Y14.31-2008**

# Undimensioned Drawings

**Engineering Drawing and Related Documentation Practices**

**AN AMERICAN NATIONAL STANDARD**



**The American Society of  
Mechanical Engineers**



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**ASME Y14.31-2008**

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# CONTENTS

Foreword .....	iv
Committee Roster .....	v
Correspondence With the Y14 Committee .....	vi
<b>1 General .....</b>	<b>1</b>
<b>2 Undimensioned Drawing.....</b>	<b>3</b>
<b>3 Applications.....</b>	<b>3</b>
<b>4 Media.....</b>	<b>3</b>
<b>5 Dimensional Accuracy Methods .....</b>	<b>3</b>
<b>6 Sheet Arrangement .....</b>	<b>4</b>
<b>7 Tolerances.....</b>	<b>4</b>
<b>8 Dimensions.....</b>	<b>5</b>
<b>9 Revisions.....</b>	<b>5</b>
<b>10 Flat Pattern Development.....</b>	<b>5</b>
<b>Figures</b>	
1 Undimensioned Drawing Contributors .....	7
2 Forming and Bending Line Examples .....	8
3 Brake Process Example .....	9
4 Hydro Process Example .....	10
5 Contour Definition Drawing Example .....	11
6 Printed Circuit Drawing Example .....	12
7 Wire Harness Drawing Example .....	13
8 Template Example .....	14
9 Extrusion Drawing Example .....	15
10 Art Layout Drawing Example .....	16
11 Assembly Drawing Example .....	17
12 Paint Configuration Drawing Example .....	18
13 Rotated Grid Lines .....	19
14 Dimensional Accuracy Points .....	20
15 Dimensional Accuracy Point Examples .....	21
16 Dimensional Accuracy Point Example on Roll Drawing Form .....	22
17 Registration Mark Examples .....	23
18 Common Reference for Split Views on Same Sheet .....	24
19 Common Reference for Split Views on Multiple Sheets .....	25
20 Trim After Forming Example .....	26
21 Bend Instructions Example .....	27
22 Flange Angle Examples .....	28
23 Variable Bend Angle Example .....	29
24 Joggle Material Displacement Example 1 .....	30
25 Joggle Material Displacement Example 2 .....	31
26 Hydro Joggle Example .....	32
27 Hydro Joggle Offset Example .....	33

# FOREWORD

Undimensioned Drawings is the type designation applied to engineering drawings prepared to a precise scale, from which the defined item and the supporting tooling are produced directly, by photographic or other processes. The drawing presents the engineering definition graphically rather than by use of numerical dimensions, although some dimensions may be included to establish a base when tolerances for specific features are smaller than those for surfaces controlled by the precision contour, and for verifying those surfaces controlled by the precision contour, and for verifying stability of the drawing material. The drawing may utilize flat patterns and similar processing information as necessary to economically present the definition.

Suggestions for improvement of this Standard are welcome. They should be sent to The American Society of Mechanical Engineers; Attn: Secretary, Y14 Standards Committee; Three Park Avenue; New York, NY 10016-5990.

This Standard was approved as an American National Standard on August 25, 2008.

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The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

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# UNDIMENSIONED DRAWINGS

## 1 GENERAL

### 1.1 Scope

This Standard establishes the requirements for undimensioned drawings that graphically define items with true geometry view(s) and predominantly without the use of dimensions.

### 1.2 Drawing Type Selection Considerations

The acceptance zone for an undimensioned drawing is the uniform boundary along the true profile or line on the undimensioned drawing [see Fig. 1, illustration (a)]. The line on the undimensioned drawing located at true profile is not probable due to contributors such as graphical tolerance, reproduction tolerance, or skill of the user. These contributors can move the acceptance zone resulting in a relaxed acceptance [see Fig. 1, illustration (b)]. This relaxed acceptance makes the undimensioned drawing equivalent to a tolerant gage per ASME Y14.43, accepting most part features that are within tolerance, rejecting most part features not within tolerance, accepting a small percentage of borderline out-of-tolerance features, and rejecting a small percentage of borderline within tolerance features. The effect of these contributors on item acceptance shall be considered before selecting this drawing type.

### 1.3 Figures

The figures in this Standard are intended only as illustrations to aid the user in understanding the practices described in the text. In some cases, figures show a level of detail as needed for emphasis; in other cases, figures were deliberately left incomplete to illustrate a concept or facet thereof. The presence or absence of figures has no bearing on the applicability of the stated requirement or practice.

### 1.4 Notes

Notes depicted in this Standard in capital letters reflect actual drawing entries. Notes in lower case letters are to be considered supporting data to the contents of this Standard and are, therefore, not intended for literal entry on drawings.

### 1.5 Units

In the drawing examples, the U.S. Customary units are featured. The SI units (International System of Units) could equally well have been used without prejudice to the principles established.

In the text, values are stated in U.S. Customary units and in the SI units. The U.S. Customary units shall be considered as the standard.

### 1.6 References

The following publications form a part of this Standard to the extent specified herein. A more recent revision may be used provided there is no conflict with the text of this Standard. In the event of a conflict between the text of this Standard and the references cited herein, the text of this Standard shall take precedence.

ASME Y14.3-2003, Multiview and Sectional View Drawings

ASME Y14.5M-1994, Dimensioning and Tolerancing

ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents

ASME Y14.43-2003, Dimensioning and Tolerancing Principles for Gages and Fixtures

Publisher: The American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990; ASME Order Department: 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300 ([www.asme.org](http://www.asme.org))

IPC-T-50G, Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-2221A, Generic Standard on Printed Board Design  
Publisher: Institute for Interconnecting and Packaging Electronic Circuits (IPC), 2215 Sanders Road, Northbrook, IL 60062 ([www.ipc.org](http://www.ipc.org))

L-P-519C, Plastic Sheet: Tracing, Glazed and Matte Finish

MIL-PRF-5480G, Data, Engineering and Technical: Reproduction

Publisher: Department of Defense, Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094 (<http://assist.daps.dla.mil/quicksearch/>)

### 1.7 Definitions

The following terms are defined as their use applies in this Standard.

#### 1.7.1 Bend Instruction

*bend instruction*: notation of the number of degrees and direction that a flange is formed relative to the surface upon which the bend instruction appears.

### 1.7.2 Bend Radius

*bend radius*: the inside radius of a formed part.

### 1.7.3 Bend Tangent Line

*bend tangent line*: the line at which the flat surface of a part becomes tangent to the radius of the bend (see Fig. 2).

### 1.7.4 Brake Process

*brake process*: a method of forming in which the punch is brought down on a flat pattern that is laid on the die, bending the sheet metal up and around the surface of the punch.

### 1.7.5 Center Line of Bend (CLB)

*center line of bend (CLB)*: a line half the distance between the bend tangents that indicates the straight line of contact where the brake press bar will strike the flat pattern to form the bend (see Fig. 3).

### 1.7.6 Common Reference

*common reference*: a reference line provided for use as a guide in coordinating the alignment of an item across multiple views or drawing sheets.

### 1.7.7 Comparator Drawing

*comparator drawing*: a drawing defining a 2D true profile, used for overlay validation viewing of items with a comparator checking machine.

### 1.7.8 Contour Definition Drawing

*contour definition drawing*: a drawing containing the mathematical, numeric, or graphic definition required to locate and define a contoured surface, also known as loft drawing.

### 1.7.9 Dimensional Accuracy Points

*dimensional accuracy points*: a set of points located in a rectangular pattern to establish a means of measuring horizontally, vertically, or diagonally across the drawing to validate dimensional accuracy.

### 1.7.10 Flange

*flange*: the portion of the item being bent.

### 1.7.11 Form Block Line (FBL)

*form block line (FBL)*: the line representing the intersection of the projected surfaces of the tool used for forming (see Fig. 4).

### 1.7.12 Grid Lines

*grid lines*: a pattern of perpendicular lines drawn to a precise scale across the face of the drawing to validate dimensional accuracy.

### 1.7.13 Hydro Process

*hydro process*: a method of forming in which the sheet metal is formed down over a die or form block by pressure applied through a rubber block affixed to the press ram.

### 1.7.14 Inside Mold Line (IML)

*inside mold line (IML)*: the line representing the intersection of the projected inside surfaces of a formed item (see Fig. 2).

### 1.7.15 Joggle

*joggle*: an offset displacement of material from its original plane or contour. Joggles are used to provide structural continuity between two adjacent surfaces.

### 1.7.16 Outside Mold Line (OML)

*outside mold line (OML)*: the line representing the projected outside surfaces of a formed item (see Fig. 2).

### 1.7.17 Principal Plane

*principal plane*: the flat surface of the item that flanges are developed from.

### 1.7.18 Printed Circuit Drawing

*printed circuit drawing*: a drawing defining the circuitry pattern that is etched, deposited, screened, or bonded to a base material.

### 1.7.19 Registration Mark

*registration mark*: a stylized pattern (symbol) that is used as a reference point for registration (IPC-T-50).

### 1.7.20 Reproduction

*reproduction*: a copy that duplicates the original. Reproductions may be either reproducible or non-reproducible, depending on the media (MIL-PRF-5480).

### 1.7.21 Template

*template*: a tool that is a dimensionally stable full size reproduction of an undimensioned drawing that defines the profile of an item.

### 1.7.22 Tolerant Gage

*tolerant gage*: accepts most part features that are within tolerance, rejects most part features not within tolerance, accepts a small percentage of borderline out-of-tolerance features, and rejects a small percentage of borderline within-tolerance features (ASME Y14.43).

### 1.7.23 True Geometry Views

*true geometry views*: views that show the actual shape description, and when it is a section view it shows the actual shape cut by the cutting plane (ASME Y14.3).

### 1.7.24 Undimensioned Drawing

*undimensioned drawing*: a drawing which defines an item graphically, predominantly without the use of dimensions.



### 1.7.25 Validation

*validation*: the process used by the producer of the template to check template accuracy.

### 1.7.26 Verification

*verification*: the process used by the user of the template to check template accuracy.

### 1.7.27 Wire Harness Drawing

*wire harness drawing*: a drawing defining the configuration and item identification of a wire harness assembly.

## 2 UNDIMENSIONED DRAWING

An undimensioned drawing graphically defines the item in true geometry view(s). Dimensions may be included to establish a defined nominal value with a tolerance that is a refinement from the tolerance applied to the undimensioned features. Items that are symmetrical shall be completely delineated. Features are presented full size, although some drawing types may be produced to a larger or smaller scale to provide appropriate details which will be returned to actual size for production use. A method(s) to validate the accuracy of the drawing or verify the accuracy of the template shall be provided. Drawings may be prepared by manual or electronic means.

## 3 APPLICATIONS

Undimensioned drawings are used for a variety of applications where the generation of templates is used to produce the items depicted. Undimensioned drawings are suitable for, but not limited to the following applications:

- (a) parts whose presentations involve a series of contours, and templates for tooling usage, e.g., compound curvature fairings (see Fig. 5)
  - (b) parts requiring art layout for fabrication such as printed circuit boards (see Fig. 6)
- NOTE: Requirements for the preparation of printed circuit boards are provided in IPC 2221.
- (c) wire harnesses (see Fig. 7)
  - (d) items that are developed as flat patterns, with or without forming (see Fig. 8)
  - (e) ply detail items for composite laminates
  - (f) extrusions and formed sheet metal sections, which require profiling operations (see Fig. 9)
  - (g) items requiring art layout for fabrication such as identification and instruction plates (see Fig. 10)
  - (h) items that lie in a flat plane and have a profusion of fastener attachments (see Fig. 11)
  - (i) paint configurations (see Fig. 12)

## 4 MEDIA

The design tolerance requirements and the method of manufacture will generally be determining factors when selecting presentation media. Drawings that require strength, durability, and dimensional stability shall be prepared on Class 1 polyester film in accordance with L-P-519. Reproductions that require accuracy shall be prepared on Class 3 polyester film in accordance with MIL-PRF-5480.

### 4.1 Temperature and Humidity

Accurate and stable undimensioned drawings shall be prepared and stored in an environmentally controlled area due to the effect of temperature and humidity on the media. The nominal value for temperature shall be 68°F (20°C) with a relative humidity of 50%. Compensation must be made for measurements made at other temperatures and humidity to ensure integrity of the data presented.

### 4.2 Storage

To maintain the accuracy and stability of undimensioned drawings, the media shall be rolled no smaller than an inside diameter of 3 in. (76 mm) when flat storage is not feasible.

### 4.3 Reproductions

The same environmental storage controls for undimensioned drawings should be applied to stable-base reproductions to extend the life of the media.

## 5 DIMENSIONAL ACCURACY METHODS

Dimensional accuracy methods shall be provided on the drawing to permit validation of the accuracy of the original drawing or verification of the reproduction. The dimensional references may be grid lines, dimensional accuracy points, or registration marks. Measurements shall be read from the center of the lines. The dimensional references shall not be altered for the life of the drawing.

### 5.1 Validation Criteria

Tolerances between dimensional references are as follows:

- (a) Grid Lines:
  - (1) grid unit:  $\pm 0.005$  in. (0.13 mm), noncumulative, diagonal:  $\pm 0.007$  in. (0.18 mm)
  - (2) total grid tolerance:  $\pm 0.010$  in. (0.25 mm), diagonal:  $\pm 0.014$  in. (0.36 mm)
- (b) Dimensional Accuracy Points:  $\pm 0.010$  in. (0.25 mm), noncumulative, diagonal:  $\pm 0.014$  in. (0.36 mm)
- (c) Registration Marks:  $\pm 0.005$  in. (0.13 mm), noncumulative, diagonal:  $\pm 0.007$  in. (0.18 mm)

Diagonal dimensional references need not be specified on the drawing.

## 5.2 Grid Lines

When used, grid lines shall be added and validated for accuracy before the drawing is started. The pattern of perpendicular lines shall be equally spaced at a nominal distance apart. Preferred grid line spacing is 5.000 in. (127 mm) or 10.000 in. (254 mm). Drawings with grid lines shall indicate directly or by reference the dimensions of the grid with a note such as GRID LINES 10.000 IN. (254 MM) ON CENTER. The pattern of grid lines may be parallel to the drawing borders or rotated at an appropriate angle to suit the presentation of the item (see Figs. 5 and 13). When grid lines are rotated, dimensional accuracy points are required independent of the grid for validation and verification. Portions of grid lines may be removed in areas where they interfere with the clarity or presentation of pictorial views. An area of approximately 1 in. (25.4 mm) diameter at the grid intersection points shall be retained.

## 5.3 Dimensional Accuracy Points

Dimensional accuracy points may be constructed as shown in Fig. 14. Dimensional accuracy points are frequently identified by terms such as, trammel points, grid check points, and material validation points. The type and size of dimensional accuracy points shall be consistent throughout the drawing and shall be placed in a rectangular pattern surrounding the item. A minimum set of four dimensional accuracy points shall be placed within the drawing border. Dimensional accuracy points shall be validated for accuracy. The horizontal and vertical dimensions between dimensional accuracy points shall be controlled directly or by reference. When controlled directly, extend arrows horizontally and vertically with dimensions indicating the distance to the adjacent dimensional accuracy points in the pattern (see Fig. 15). When the drawing exceeds the capabilities of the validation and verification process, a minimum set of six dimensional accuracy points shall be provided (see Fig. 16). The center dimensional accuracy point shall be constructed as shown in Fig. 14. The dimensional accuracy points shall be equally spaced horizontally and equally spaced vertically.

## 5.4 Registration Marks

Registration marks are used in place of a grid system on drawings depicting artwork type items. A minimum of three registration marks shall be placed in a right triangular pattern surrounding the artwork pattern (see Figs. 6 and 17).

# 6 SHEET ARRANGEMENT

When the size of an item requires splitting into multiple views, the break of the view shall take place near a

designated common reference. Each view shall be extended past the designated common references and end in a break line to indicate that the designated common reference is not the end of the item. Designated common references may coincide with grid lines and shall be identified with a note such as COMMON REFERENCE (see Figs. 18 and 19).

## 6.1 Split Views on Same Sheet

When views of the item are split on the same sheet, there shall be a minimum image overlap of 3 in. (76 mm) from the designated common reference (see Fig. 18).

## 6.2 Split Views on Multiple Sheets

When views of the item are split over multiple sheets, the views shall have a minimum image overlap of 3 in. (76 mm) from the designated common reference. Sheets may be positioned one above the other or side-by-side when designated common references are used. When two or more sheets are joined in this manner, a sheet arrangement diagram shall be provided on the first sheet to indicate the relative positions of the sheets and as an aid in selecting the sheet on which desired information is located (see Fig. 19).

# 7 TOLERANCES

## 7.1 Graphical Tolerances

All features of the item shown in the graphical representation shall be drawn to a tolerance of  $\pm 0.010$  in. (0.25 mm) of the actual size and location.

## 7.2 Item Tolerances

**7.2.1** For contour definition drawings, templates, and comparator drawings, the lines defining an undimensioned item shall be considered as being the true profile. Tolerances shall be applied to measurements taken from the center of each line.

**7.2.2** For wire harness drawings, the lines defining the center line of the wire harness shall be considered the true location and length. Plus or minus tolerances shall be specified on the drawing indicating the tolerance for the length of the wire harness.

**7.2.3** For printed circuit boards, the lines defining the conductors shall be considered the true location. Tolerances are based on the components grid pattern per IPC-2221.

## 7.3 Reproduction Tolerances

The tolerance for reproductions shall be determined by the accuracy required for manufacturing and inspection of the item and by the material used for reproduction. The undimensioned drawing shall indicate directly or by reference the reproduction requirements with a note placed near the title block of each sheet, such as:



FOR MANUFACTURING AND INSPECTION PURPOSES, THIS DRAWING SHALL BE REPRODUCED ON STABLE BASE MATERIAL.

## 8 DIMENSIONS

Dimensions shall be used for features held to tolerances different than those applicable to the undimensioned feature tolerances shown in the title block or notes. These features include but are not limited to:

- (a) hole sizes
- (b) joggle depths
- (c) flange widths
- (d) material thickness
- (e) angles
- (f) special joggle lengths

Dimensions shall be applied in accordance with ASME Y14.5M.

## 9 REVISIONS

When revisions are made to undimensioned drawings, they shall be incorporated into the drawing in accordance with the requirements of ASME Y14.35M.

## 10 FLAT PATTERN DEVELOPMENT

A flat pattern defines an item with all flanges and formed surfaces flattened into a single plane. Although this deals primarily with sheet metal items, flat patterns may be developed for composite plies, cloth, etc. The drawing should define an item without specifying manufacturing methods. However, the undimensioned drawing may be prepared to favor the use of specific methods of forming by specifying parameters and using terminologies which are method specific.

### 10.1 General Requirements

Basic presentation of a flat pattern is shown in Fig. 8. Flat patterns should be developed as monodetail drawings. Superimposed cross sections on the flat pattern or formed views are permitted to clarify the shape of the item.

**10.1.1 Brake Process Requirements.** When items with straight bend lines are formed using a brake process, the bend line is indicated as a center line of bend (CLB) (see Fig. 3). Items that are formed using a brake process shall have the majority of the flange bend instructions indicating bend up.

**10.1.2 Hydro Process Requirements.** When items with curved bend lines are formed using a hydro process over a forming block, the bend line is indicated as an inside mold line (IML) or form block line (FBL) (see Fig. 4). For manufacturing efficiency, multiple straight bend lines or a flange with a joggle may be formed using

a hydro process. Items that are formed using a hydro process shall have the majority of flange bend instructions indicating bend down.

### 10.2 Linework

Solid lines shall be used to define the periphery of the item. When excess material is shown for forming or tool tabs, indicate the trim line for the periphery after forming as a phantom line (see Fig. 20). Internal features such as cutouts or holes shall be shown as solid lines. Features such as electrical connector cutouts, flanged holes, stiffening beads, or dimples may be shown as center lines indicating the location for the forming tool. The IML, FBL, and CLB lines for flanges shall be shown as center lines. The outside mold line (OML) shall be a solid line, 0.50 in. (13 mm) in length, at each end of the part (see Fig. 20). Joggle lines shall be hidden lines.

### 10.3 Bend Instructions

The largest planar surface of the item is usually selected as the principal plane. The flanges of the item are developed from the principal plane. Bend instructions shall be within the principal plane. When the principal plane cannot contain the bend instructions, place the bend instructions outside and adjacent to the principal plane. When the flange to be bent is not apparent, add a note with a leader pointing to the flange to be bent, such as BEND THIS SURFACE (see Fig. 21).

(a) The forming direction shall be indicated by note: BUP (Bend Up) or UP for flanges formed up from the principal plane, and BDN (Bend Down) or DN for flanges formed down from the principal plane.

(b) A leader shall be directed from the bend instruction to the CLB, IML, or FBL line.

### 10.4 Flange Angles

Flange angles shall be specified as the number of degrees the flange is bent from the principal plane of the pattern. An optional method is to indicate the number of degrees the flange is bent from the 90-deg position using the terms OPEN or CLOSED. A flange bent more than 90 deg from the principal plane of the pattern is a closed angle and a flange bent less than 90 deg is an open angle (see Fig. 22).

EXAMPLES:

- (1) A flange bent 120 deg from the principal plane shall be specified as CLOSED 30°.
- (2) A flange bent 60 deg from the principal plane shall be specified as OPEN 30°.

**10.4.1 Flange Angles by Note.** Other options such as a note UNSPECIFIED ANGLES ARE 90° may be used, provided clarity is not impaired.

**10.4.2 Variable Flange Angles.** When the flange angle varies, the angle shall be specified at each end of the flange when the angular change is constant. When

the rate of change varies, the flange angle shall be specified at control points. The flange angle shall be indicated in the bend instructions as NOTED ANGLE (see Fig. 23).

### 10.5 Joggles

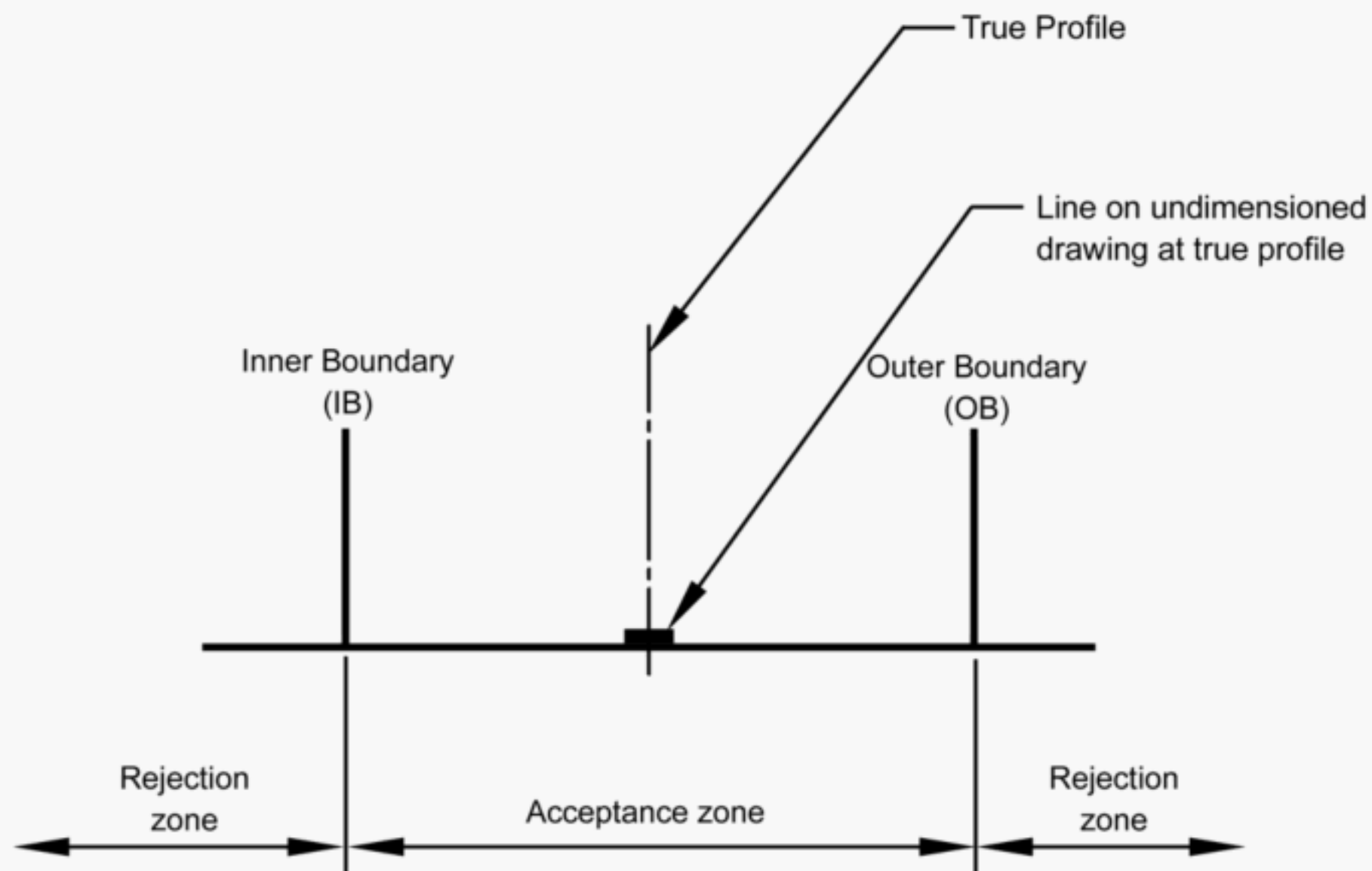
Joggle instructions shall indicate the direction of forming, depth, and length. JOG UP (Joggle Up) indicates a flange joggling upward from the callout, and JOG DN (Joggle Down) indicates a flange joggling downward from the callout. Compensation shall be made in the flat pattern development of joggled flanges for the flow of material during the forming process when the flange is to maintain a constant width or a particular shape.

Figures 24 and 25 illustrate methods of providing compensation for a simple joggle formed in a 90-deg flange. Joggle directions JOG UP or JOG DN shall be omitted when the direction of forming is indicated by the IML or FBL (see Fig. 26). The actual projected depth of a joggle that appears in the flat pattern development of the item depends on the number of degrees open or closed that are specified for the angle (see Fig. 27).

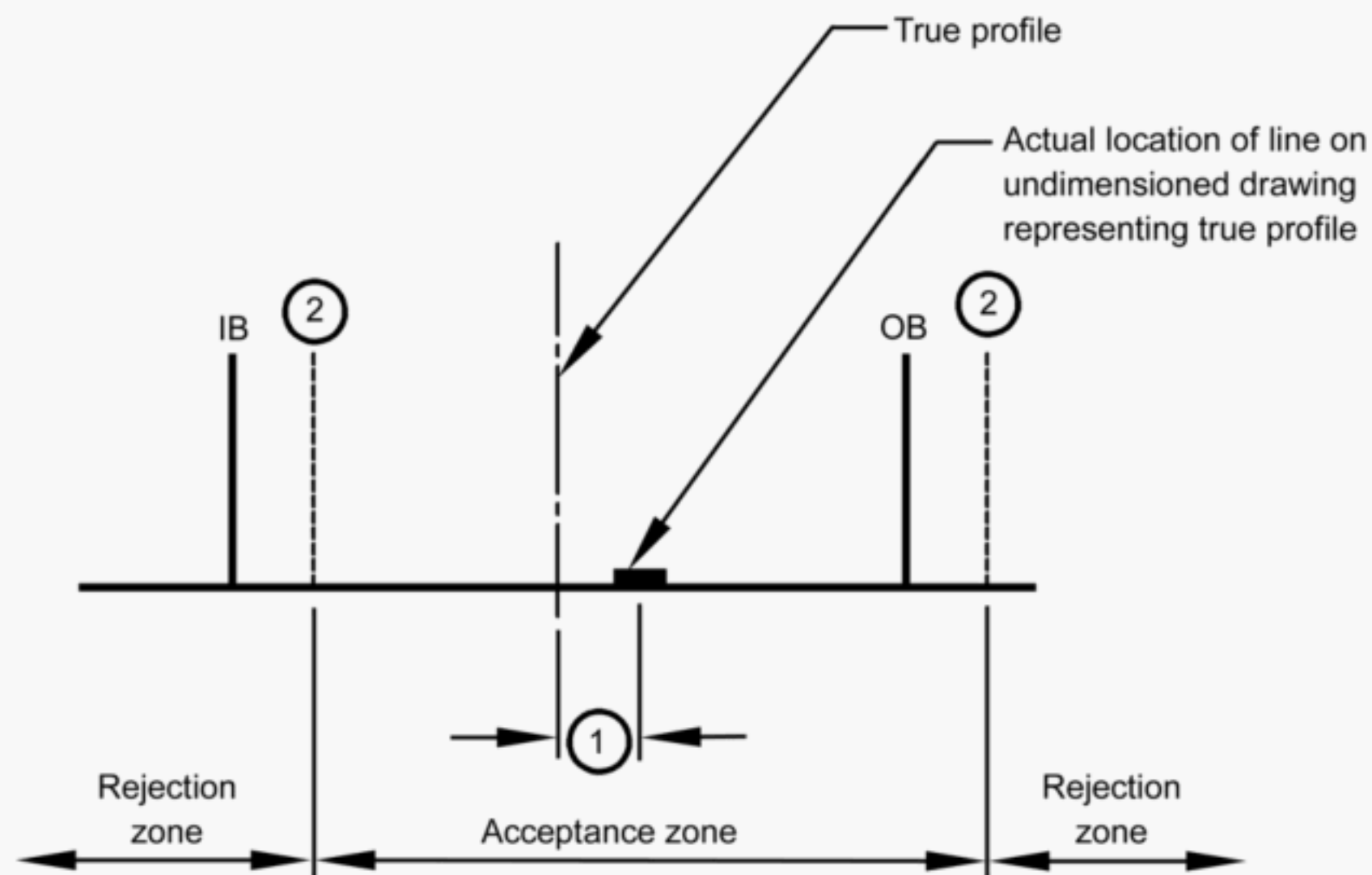
### 10.6 Design Information

Design information such as bend formulas, reliefs, etc., used to calculate the material displacement due to the use of specific forming processes, are defined in references available in standard design handbooks.



**Fig. 1 Undimensioned Drawing Contributors**

(a) Linework at true profile



(b) Linework at maximum allowed tolerance

- ① Shift from the true profile base on contributors such as graphical tolerance, reproduction tolerance, and skill of user. Shift may be towards the IB or OB.
- ② IB and OB shift based on actual location of the line on undimensioned drawing and moving the acceptance zone.

**Fig. 2 Forming and Bending Line Examples**

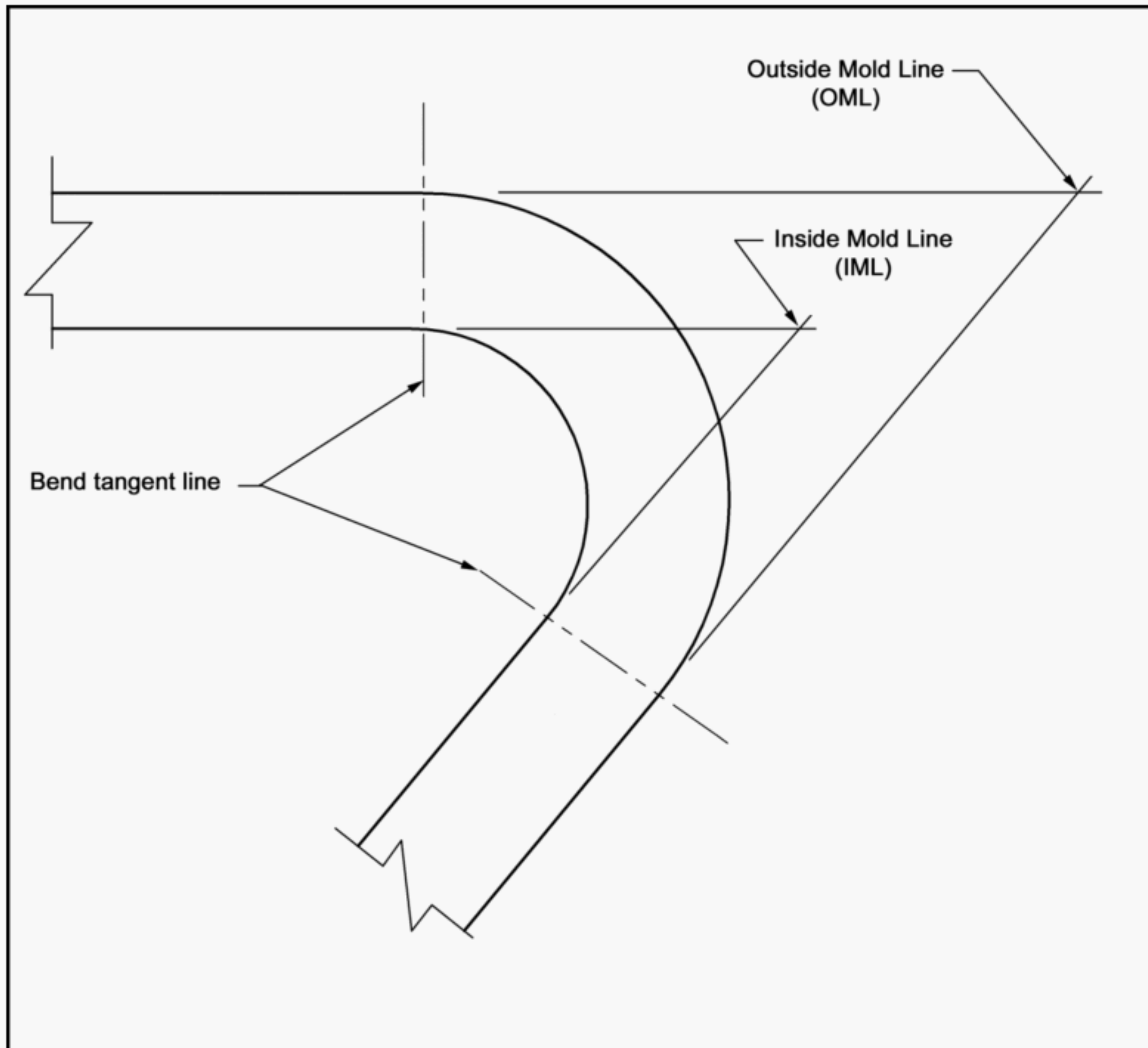
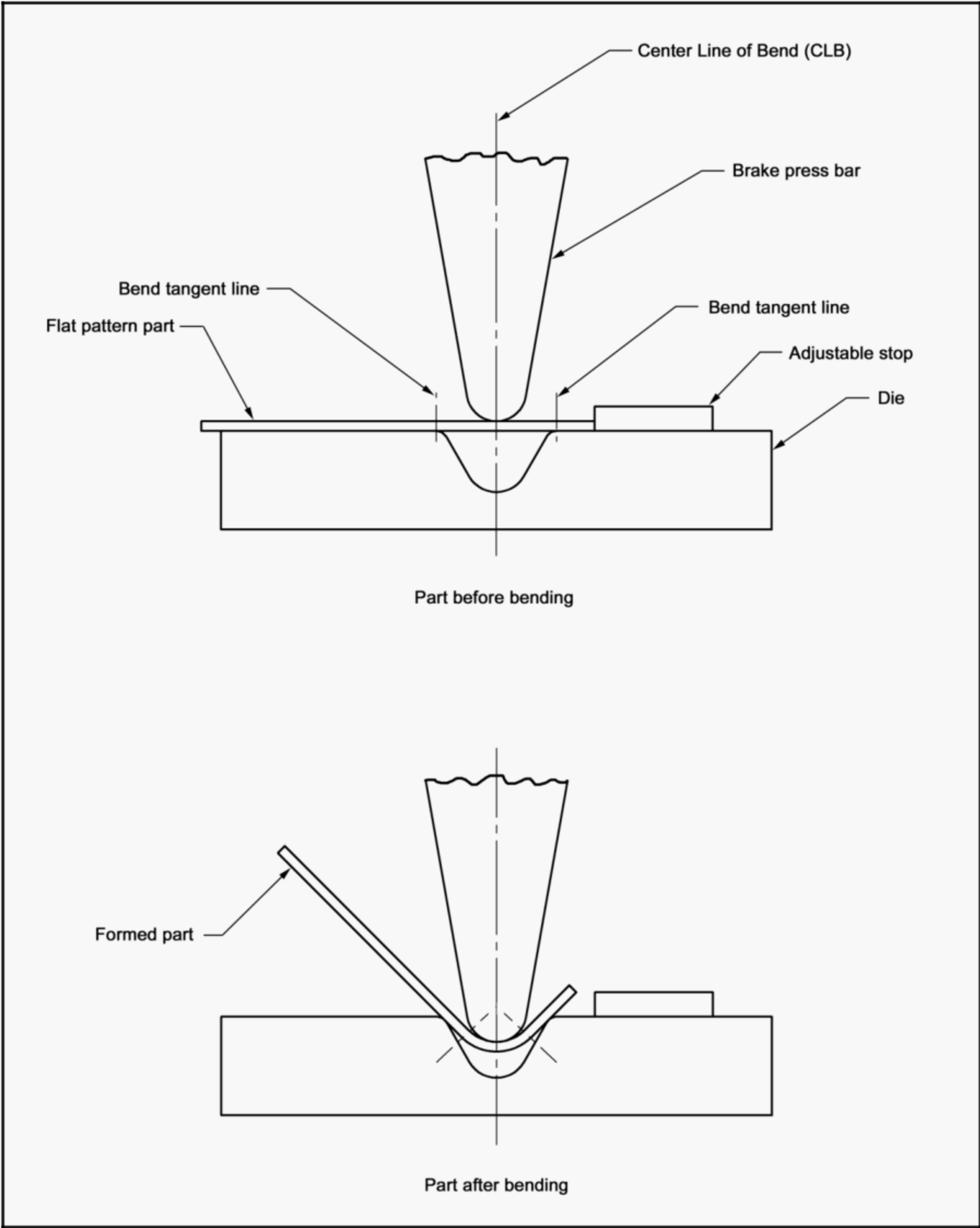


Fig. 3 Brake Process Example



**Fig. 4 Hydro Process Example**

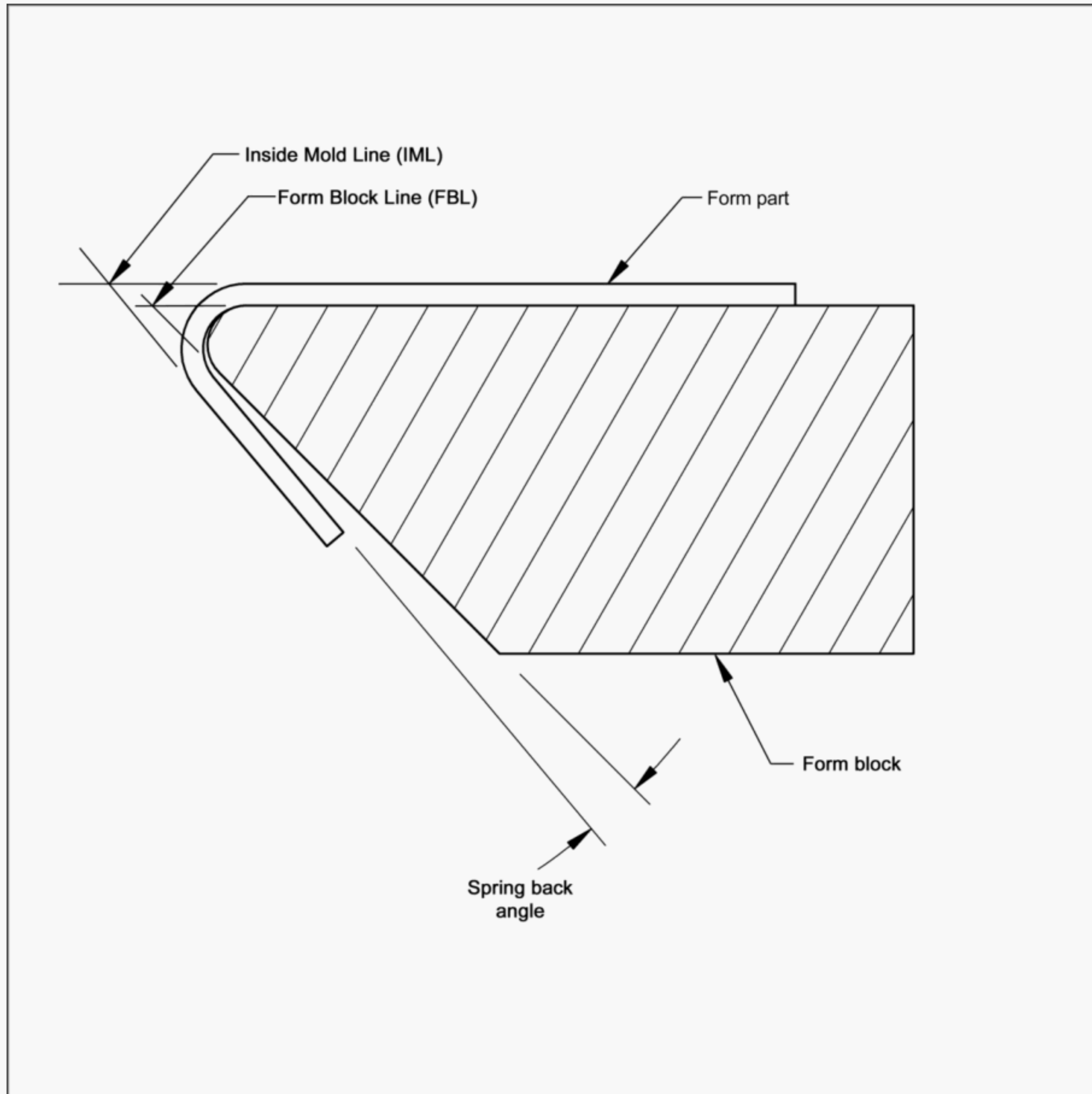


Fig. 5 Contour Definition Drawing Example

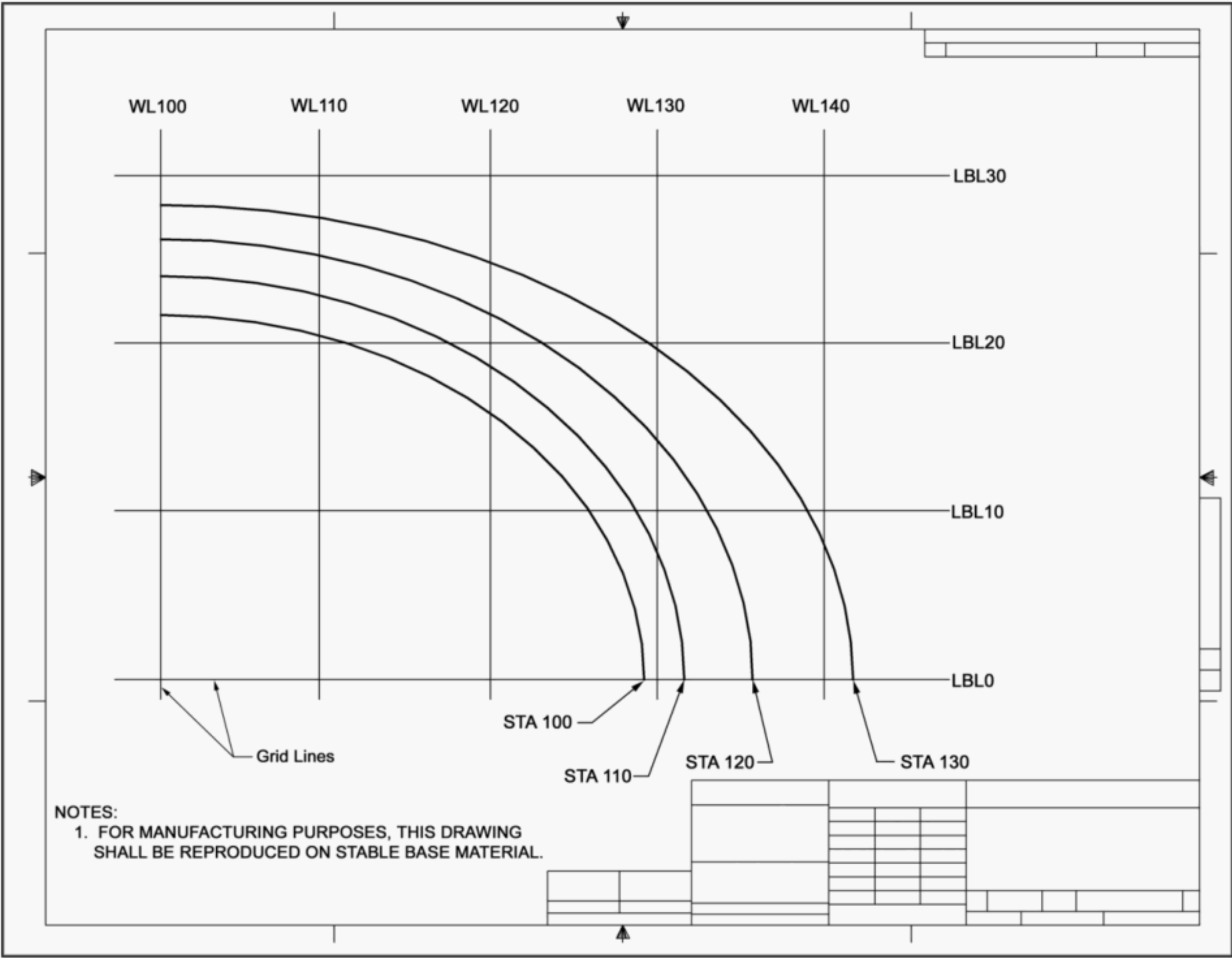


Fig. 6 Printed Circuit Drawing Example

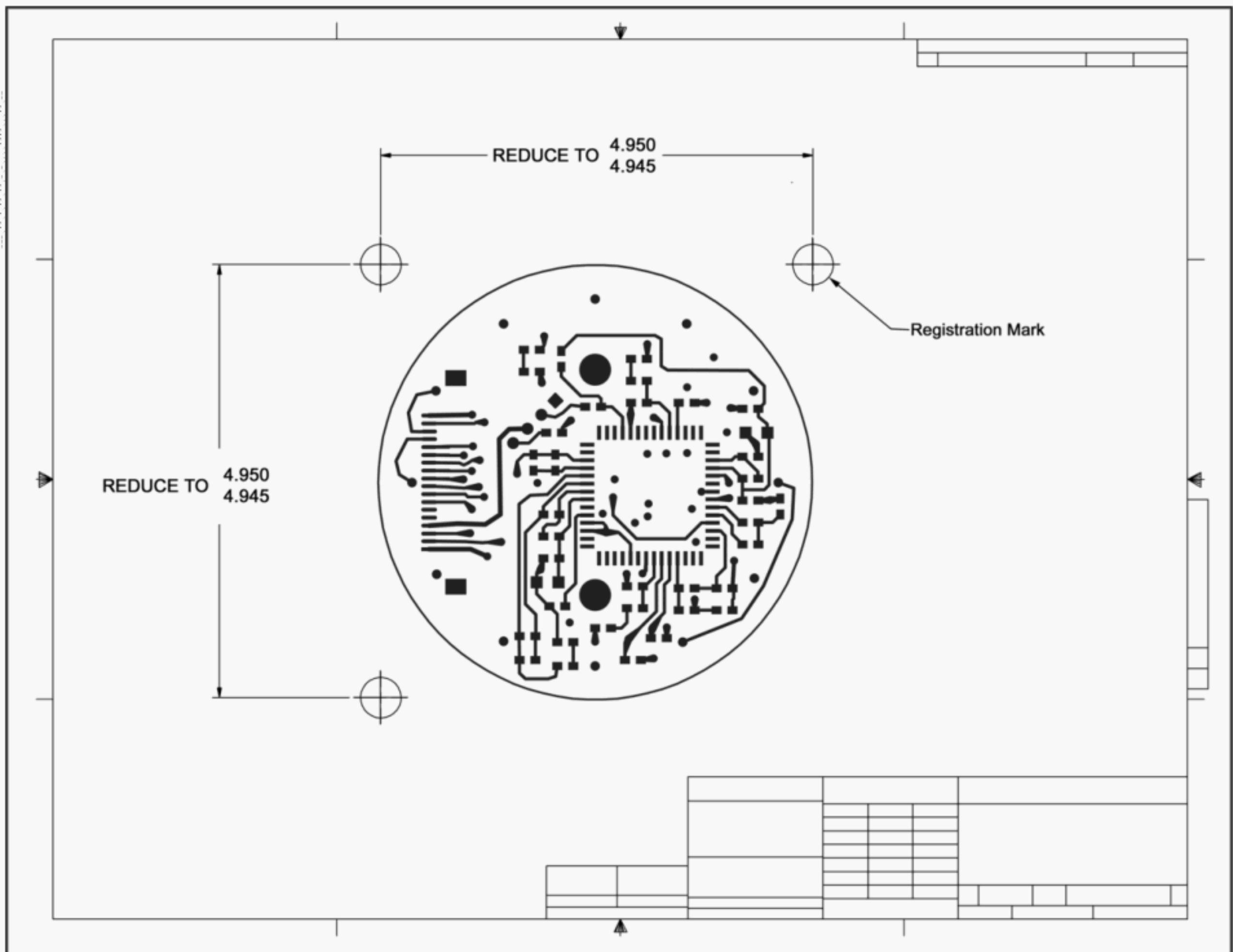
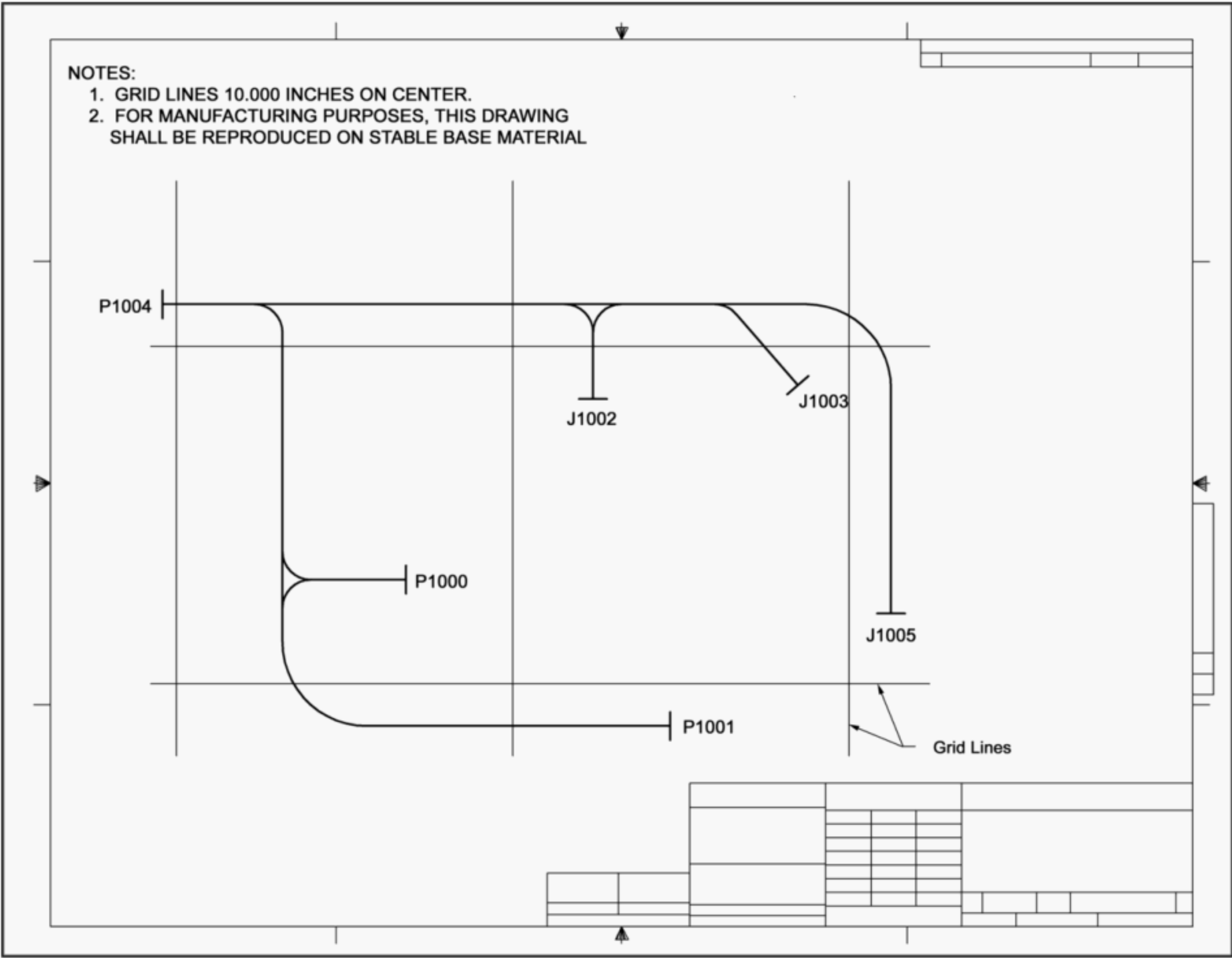
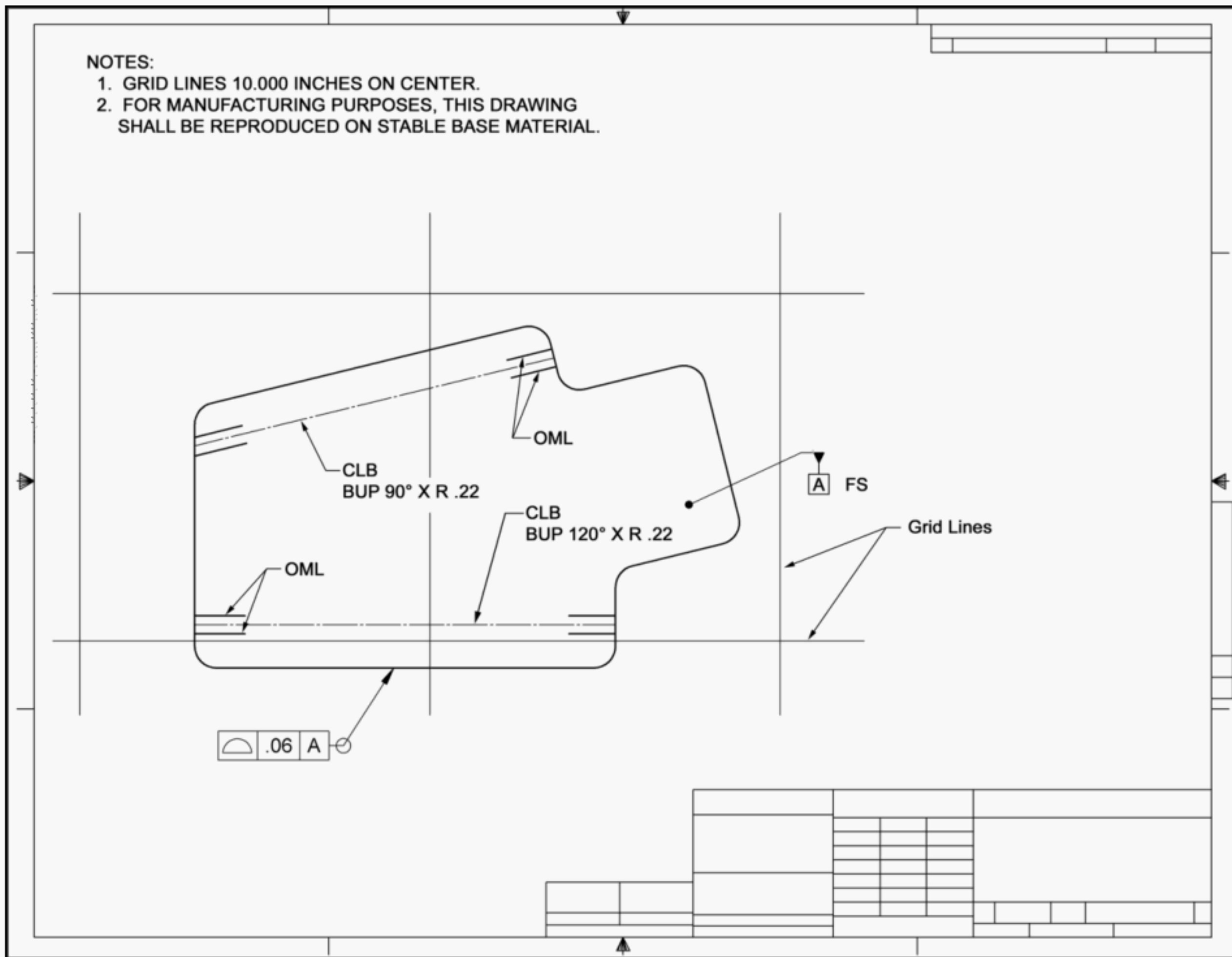




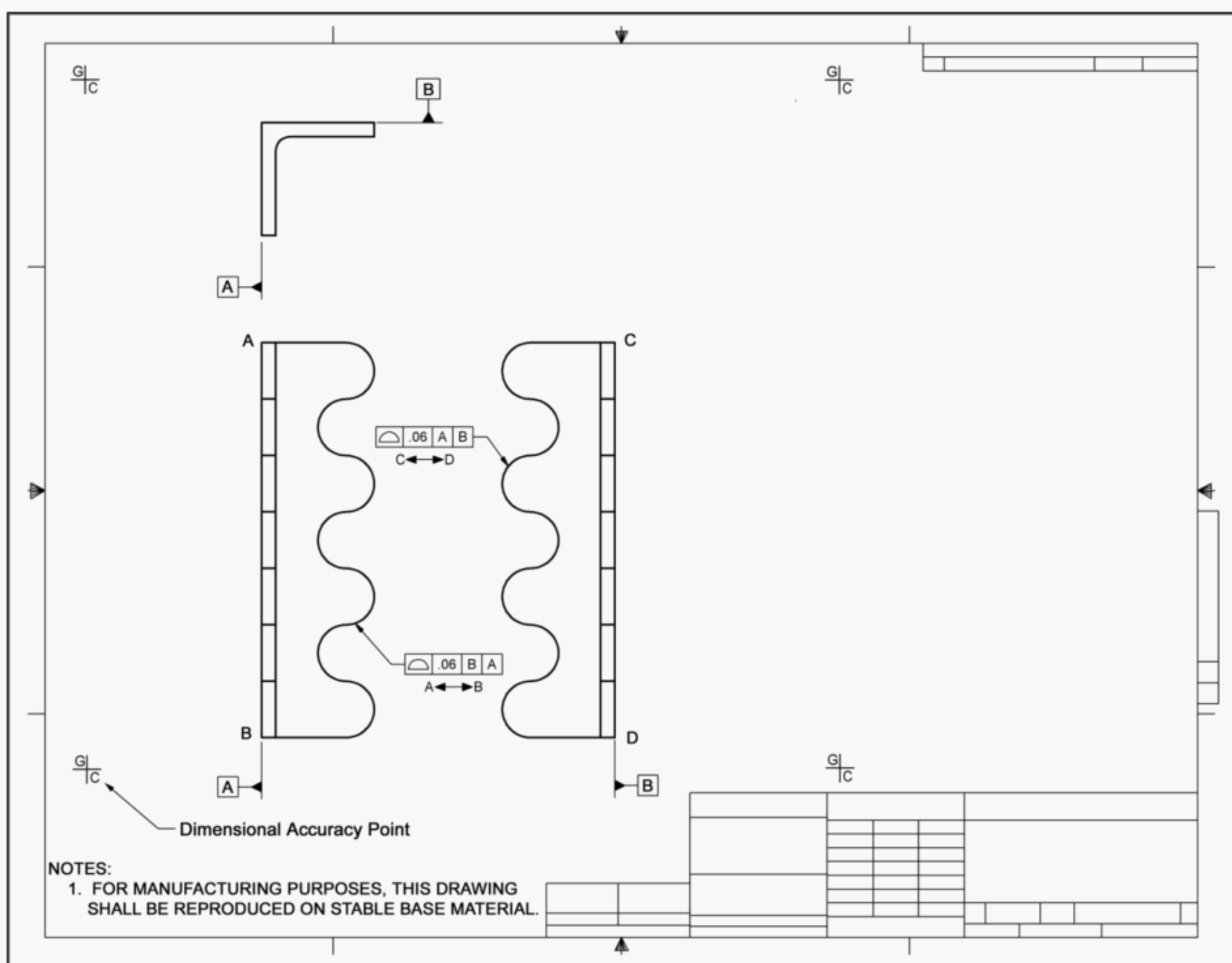
Fig. 7 Wire Harness Drawing Example



**Fig. 8 Template Example**



**Fig. 9 Extrusion Drawing Example**



**Fig. 10 Art Layout Drawing Example**

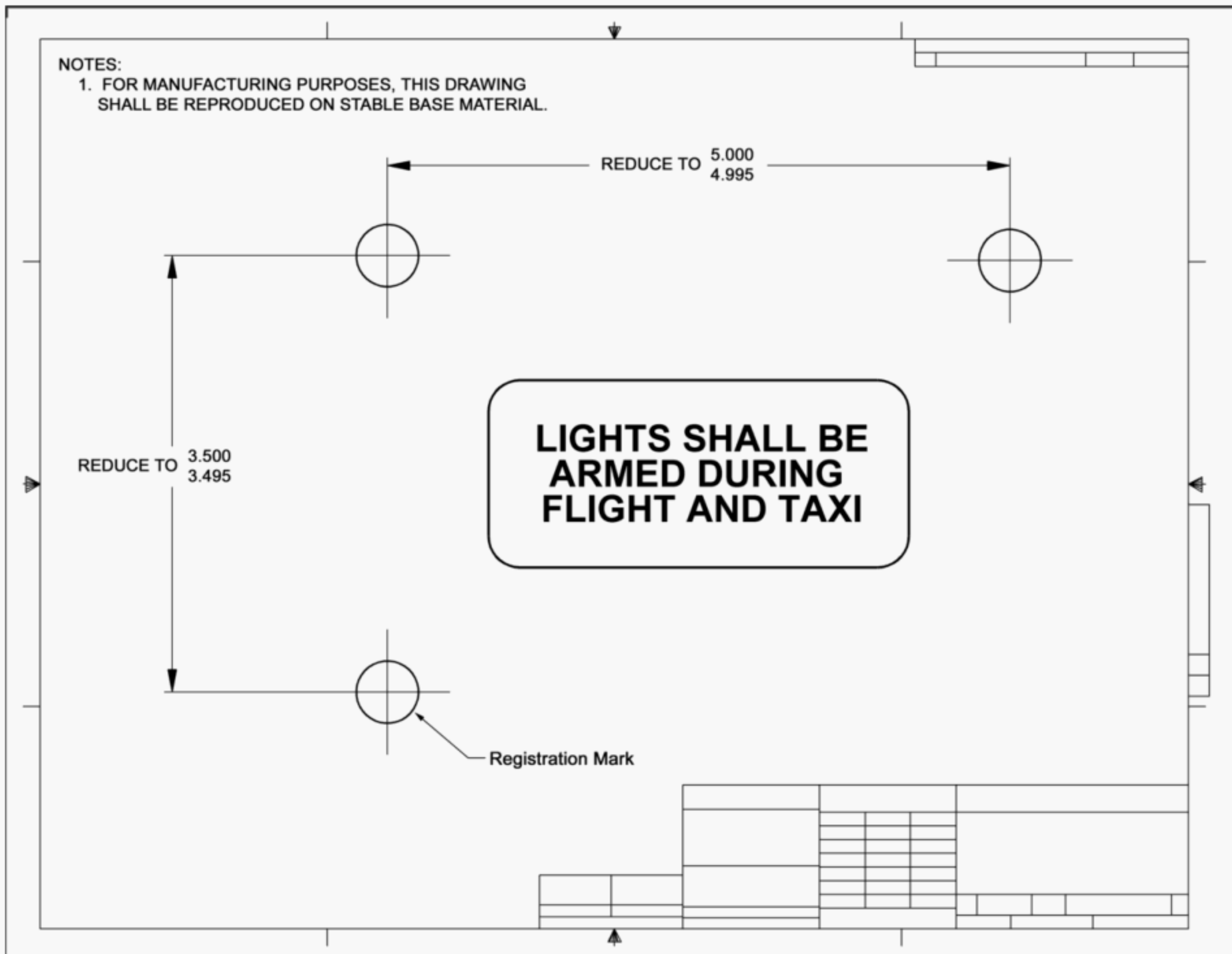


Fig. 11 Assembly Drawing Example

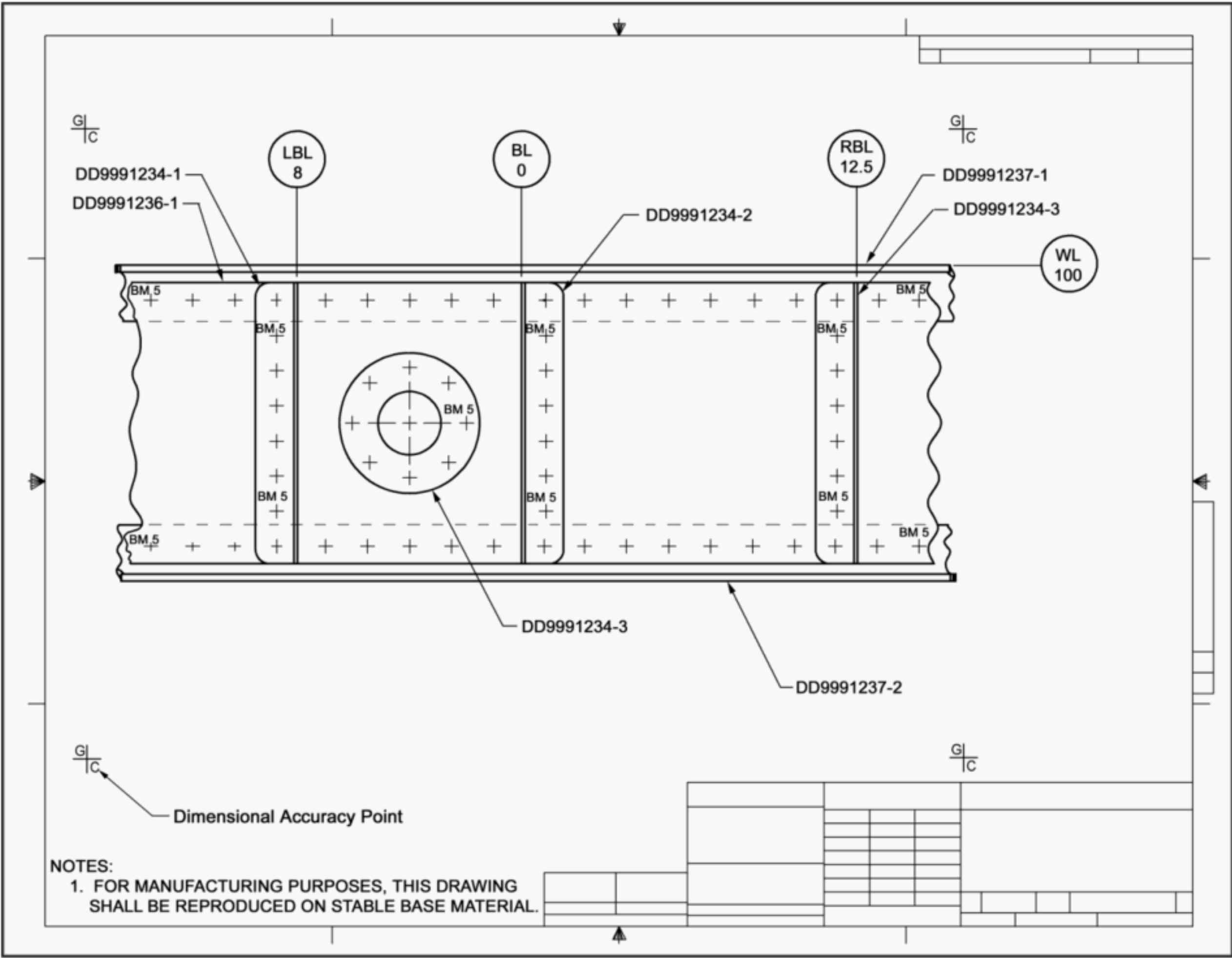


Fig. 12 Paint Configuration Drawing Example

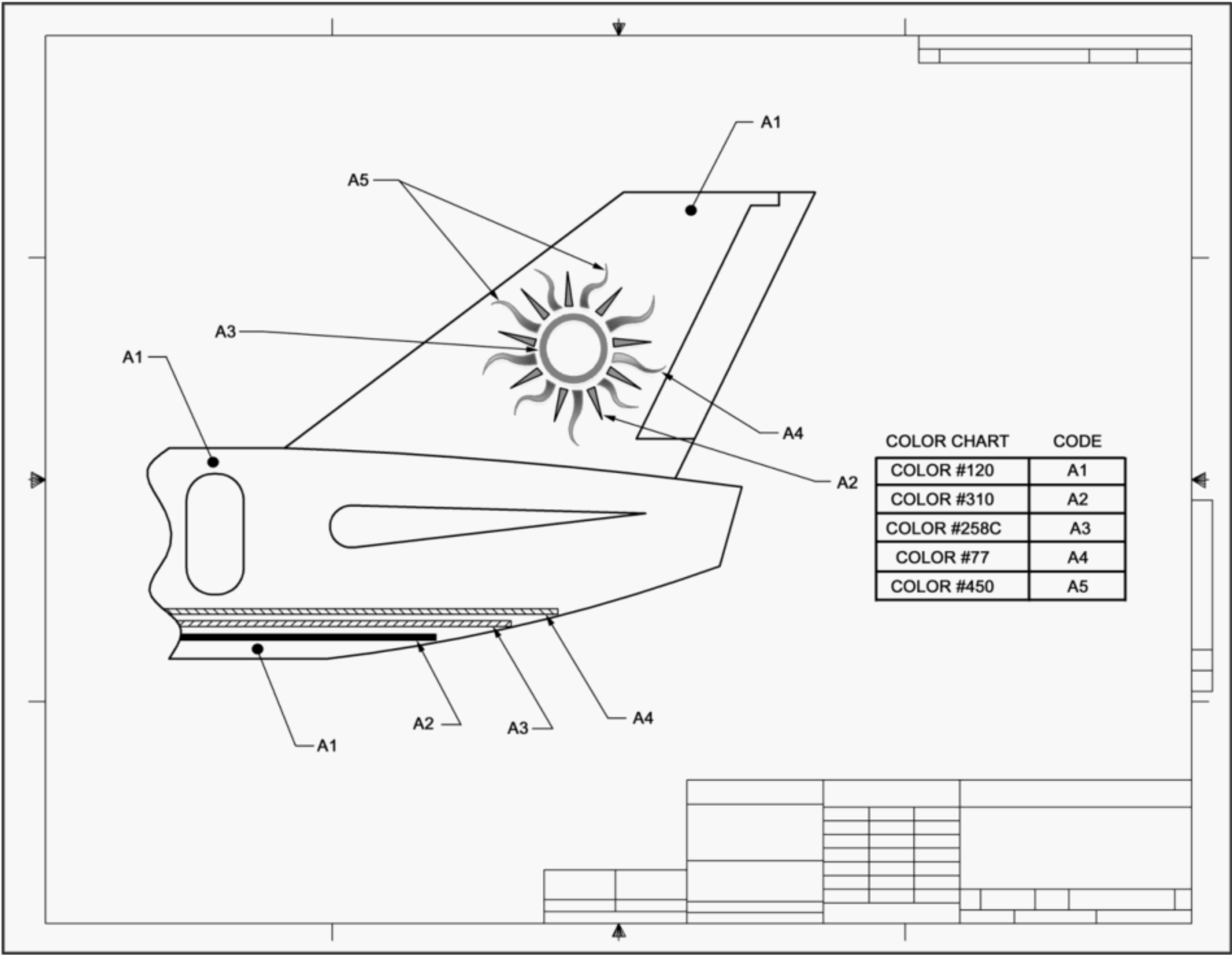
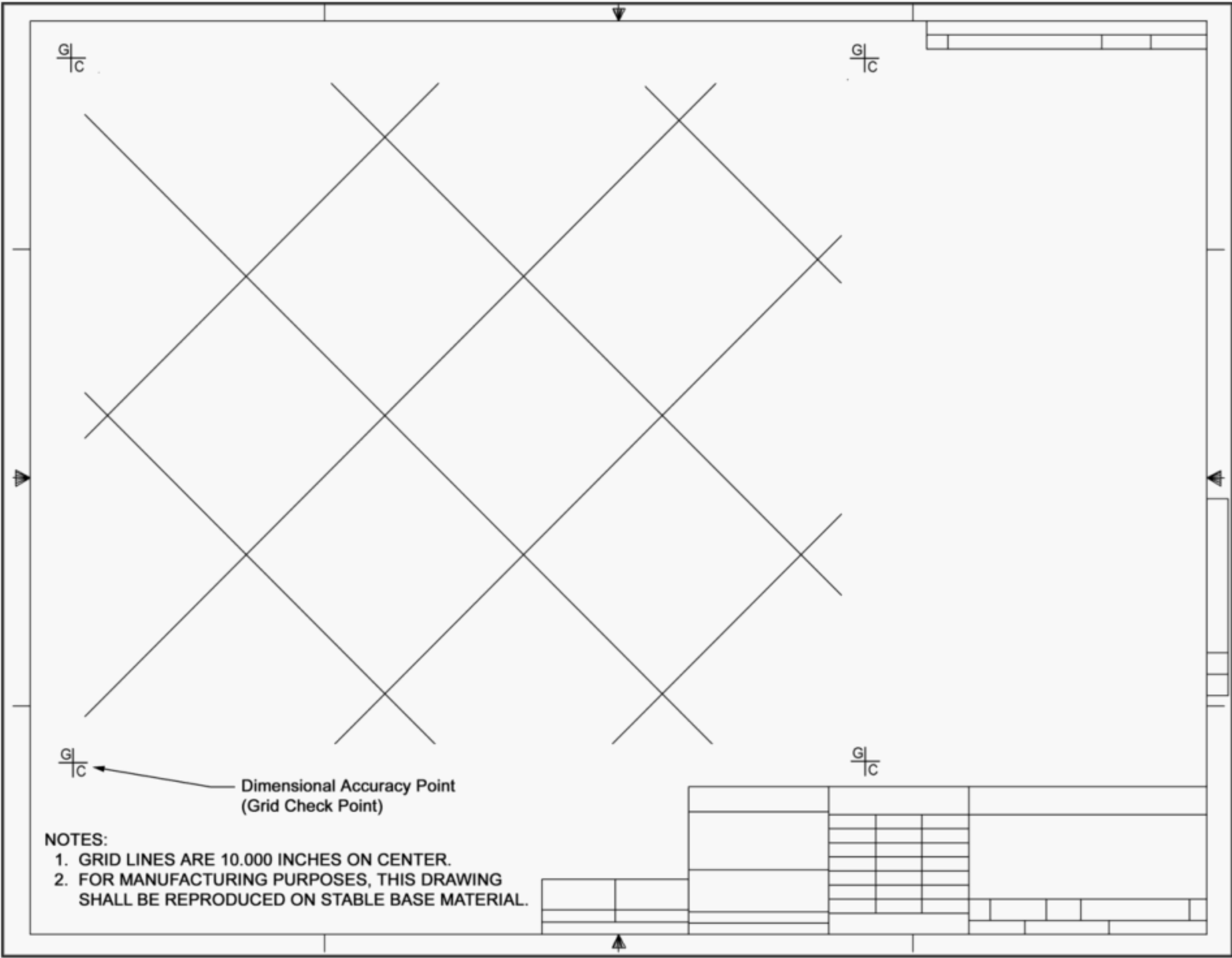




Fig. 13 Rotated Grid Lines



**Fig. 14 Dimensional Accuracy Points**

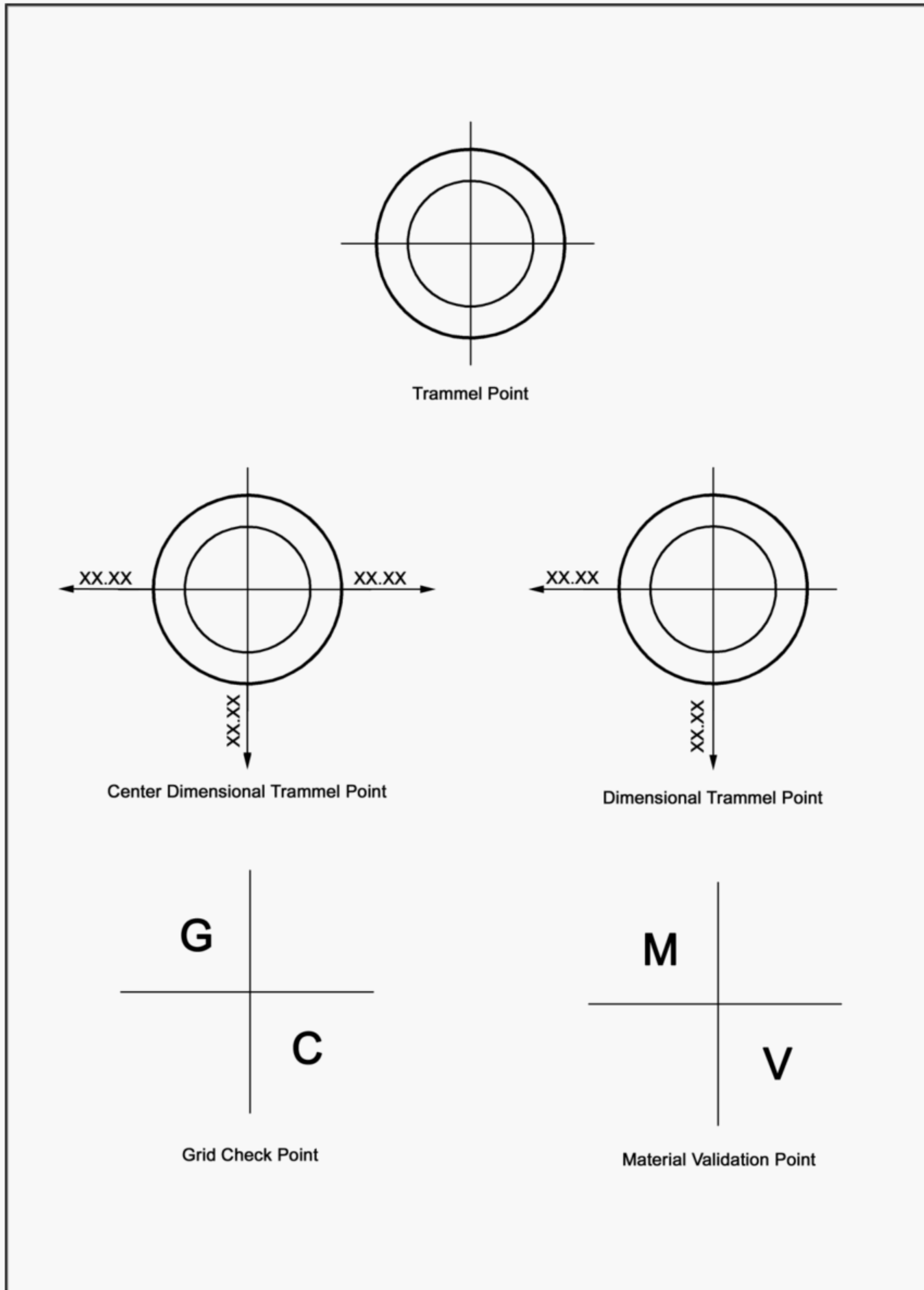
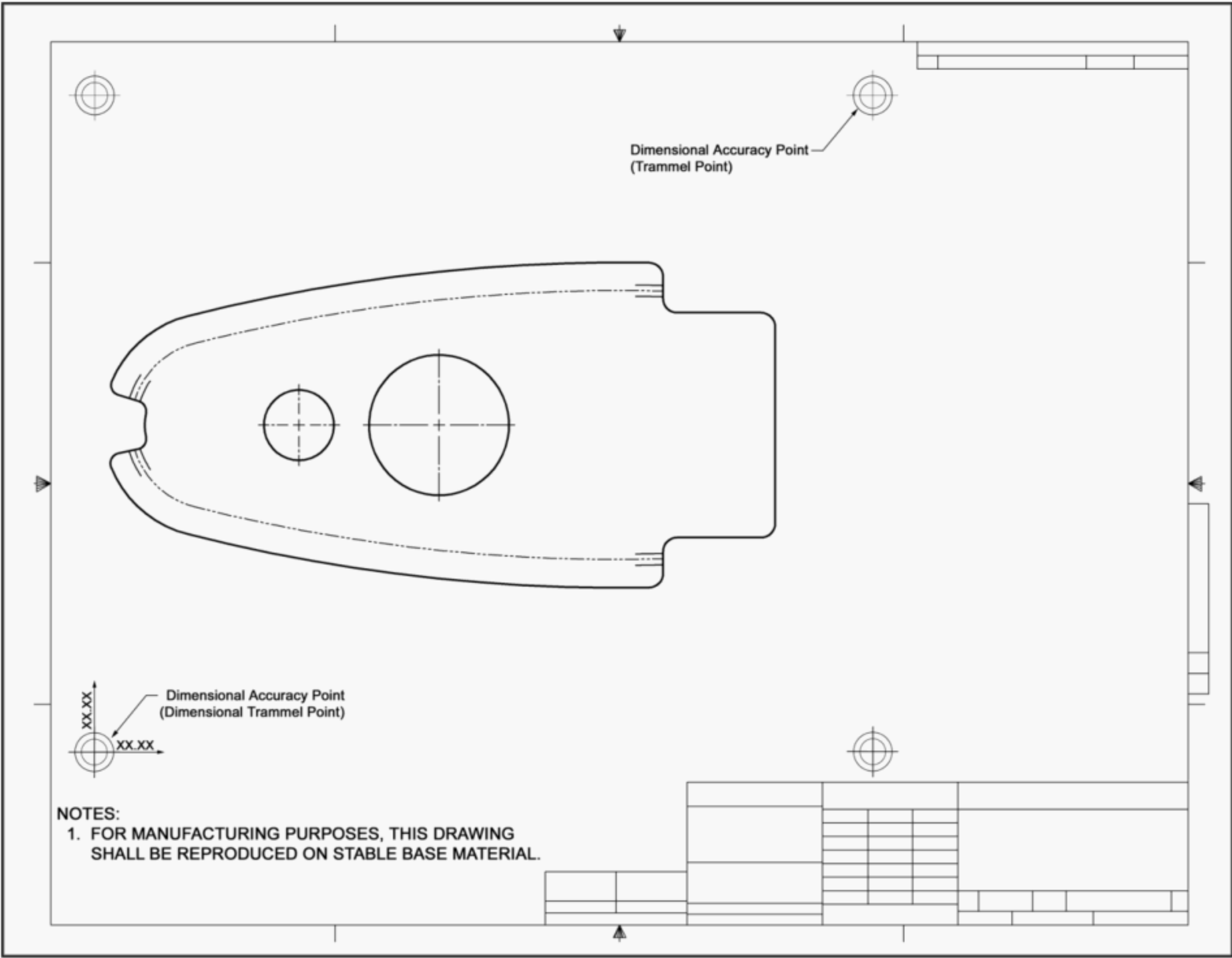


Fig. 15 Dimensional Accuracy Point Examples



**Fig. 16 Dimensional Accuracy Point Example on Roll Drawing Form**

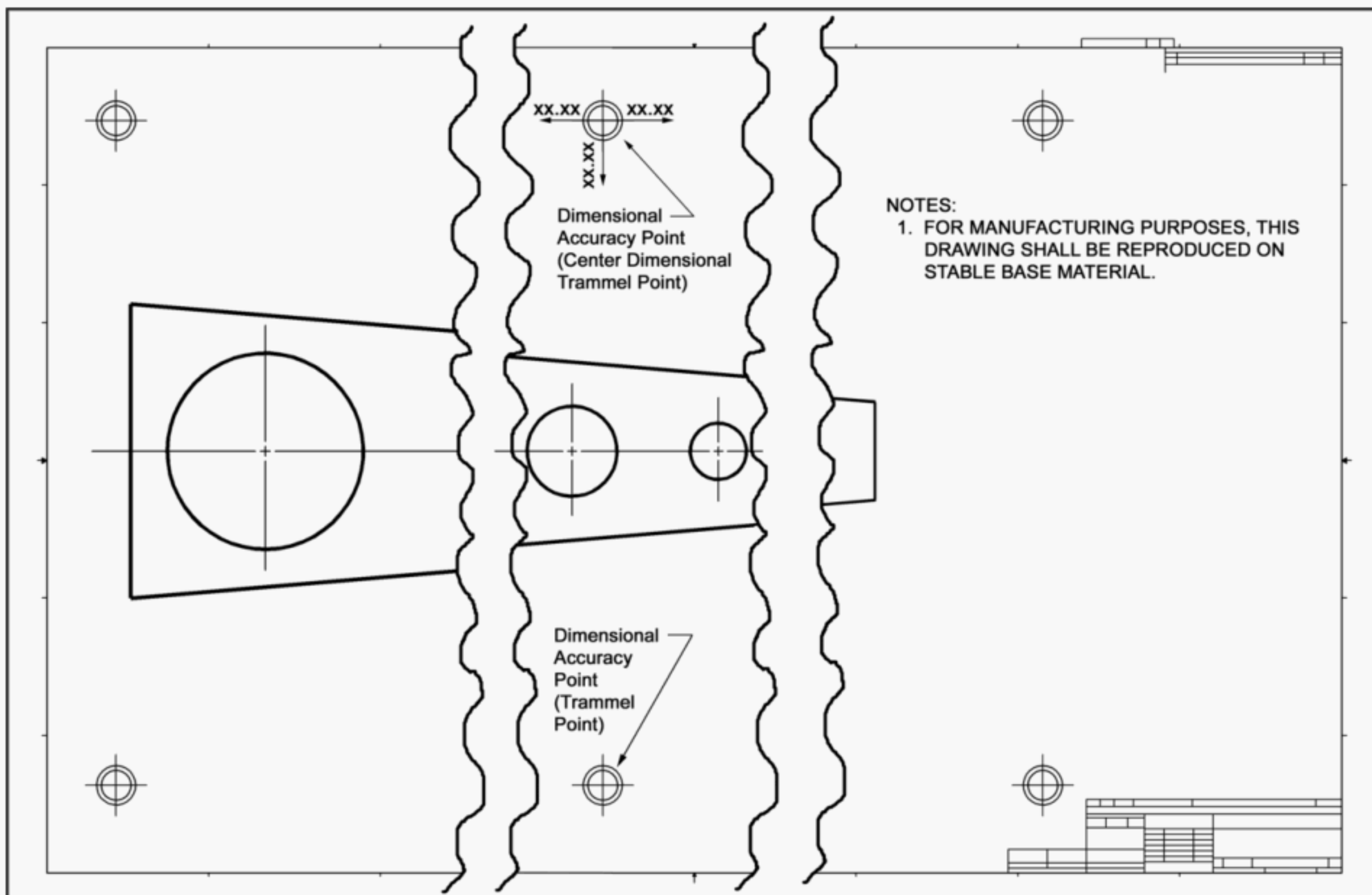
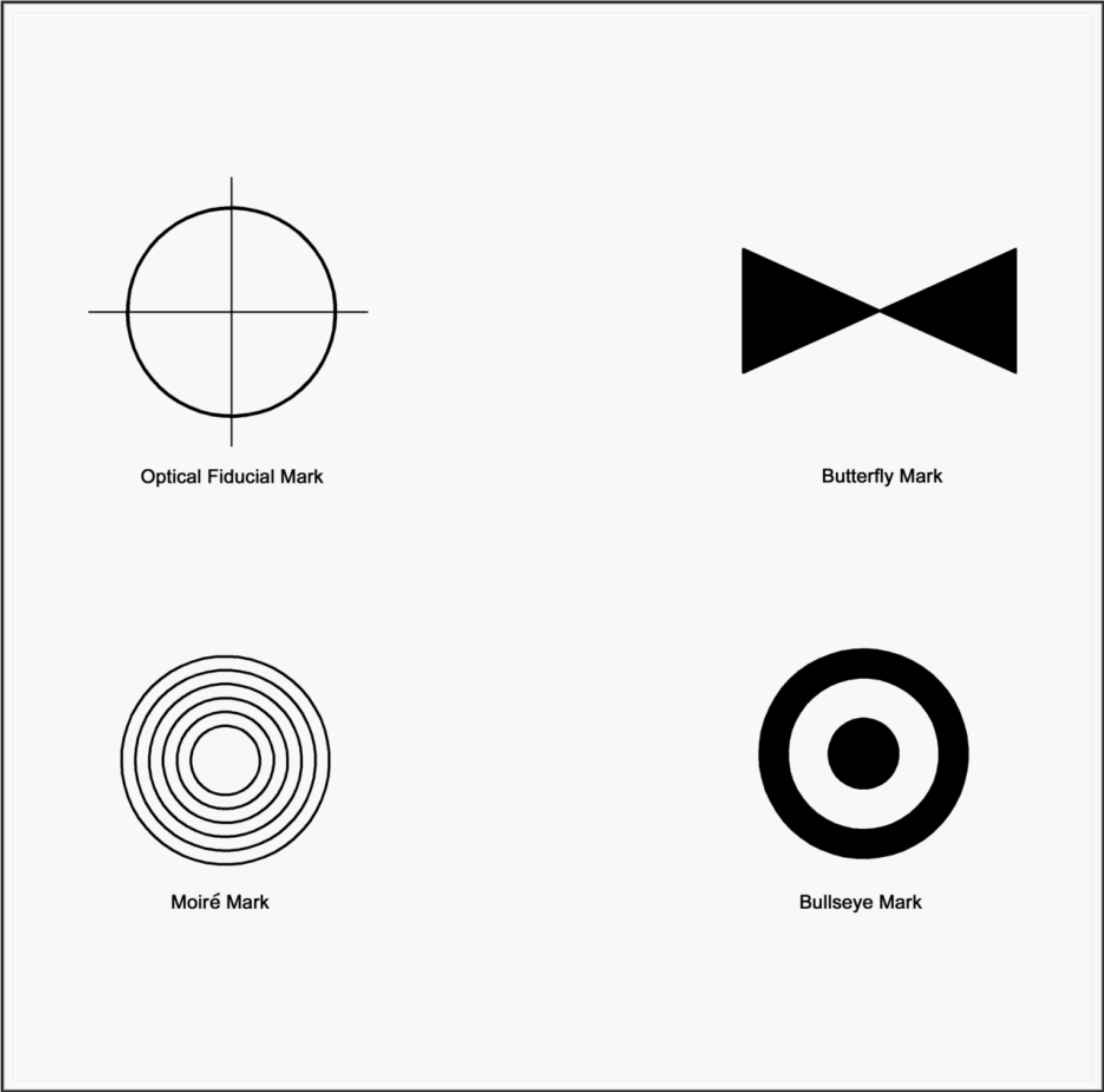


Fig. 17 Registration Mark Examples



**Fig. 18 Common Reference for Split Views on Same Sheet**

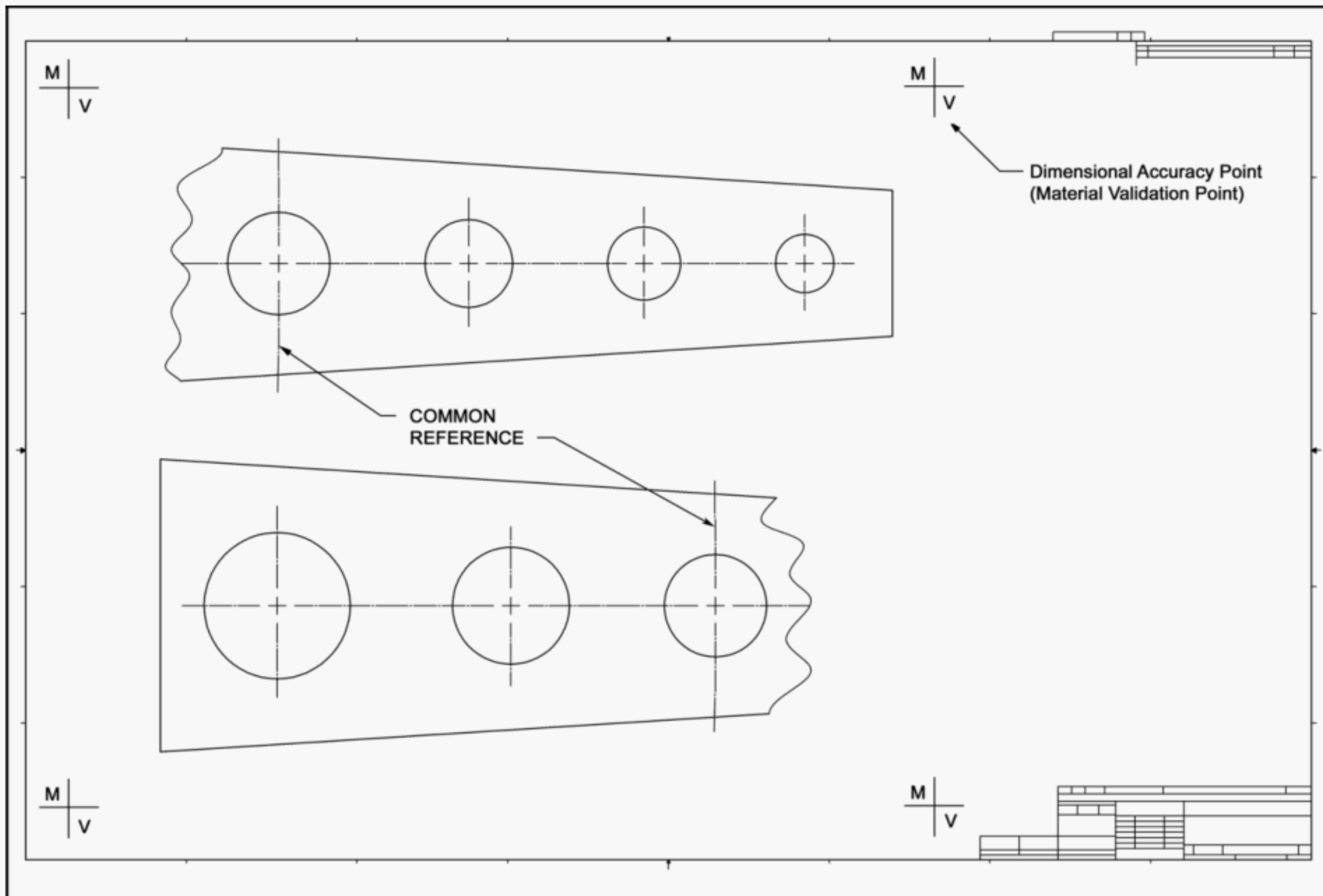
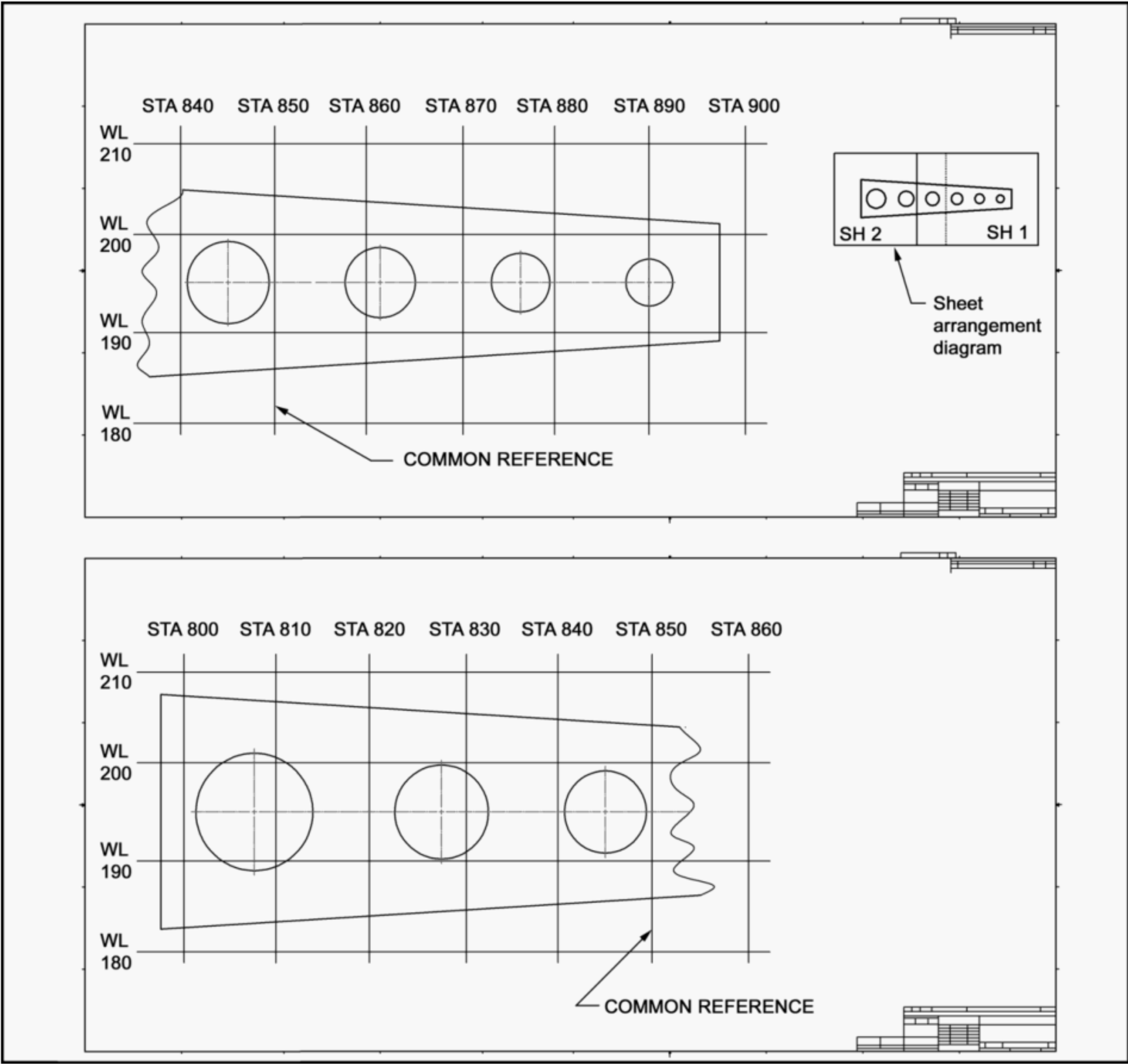




Fig. 19 Common Reference for Split Views on Multiple Sheets



**Fig. 20 Trim After Forming Example**

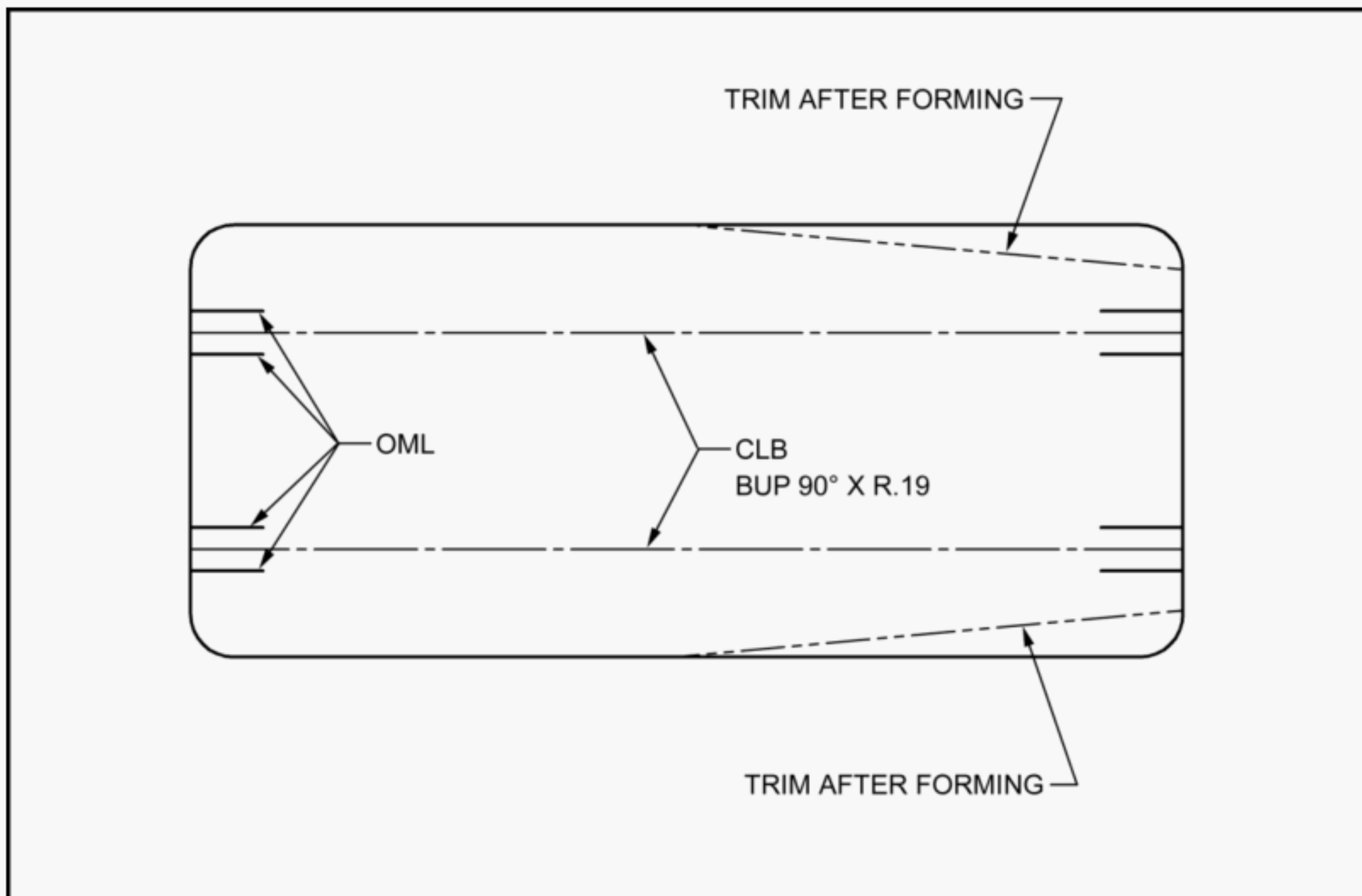
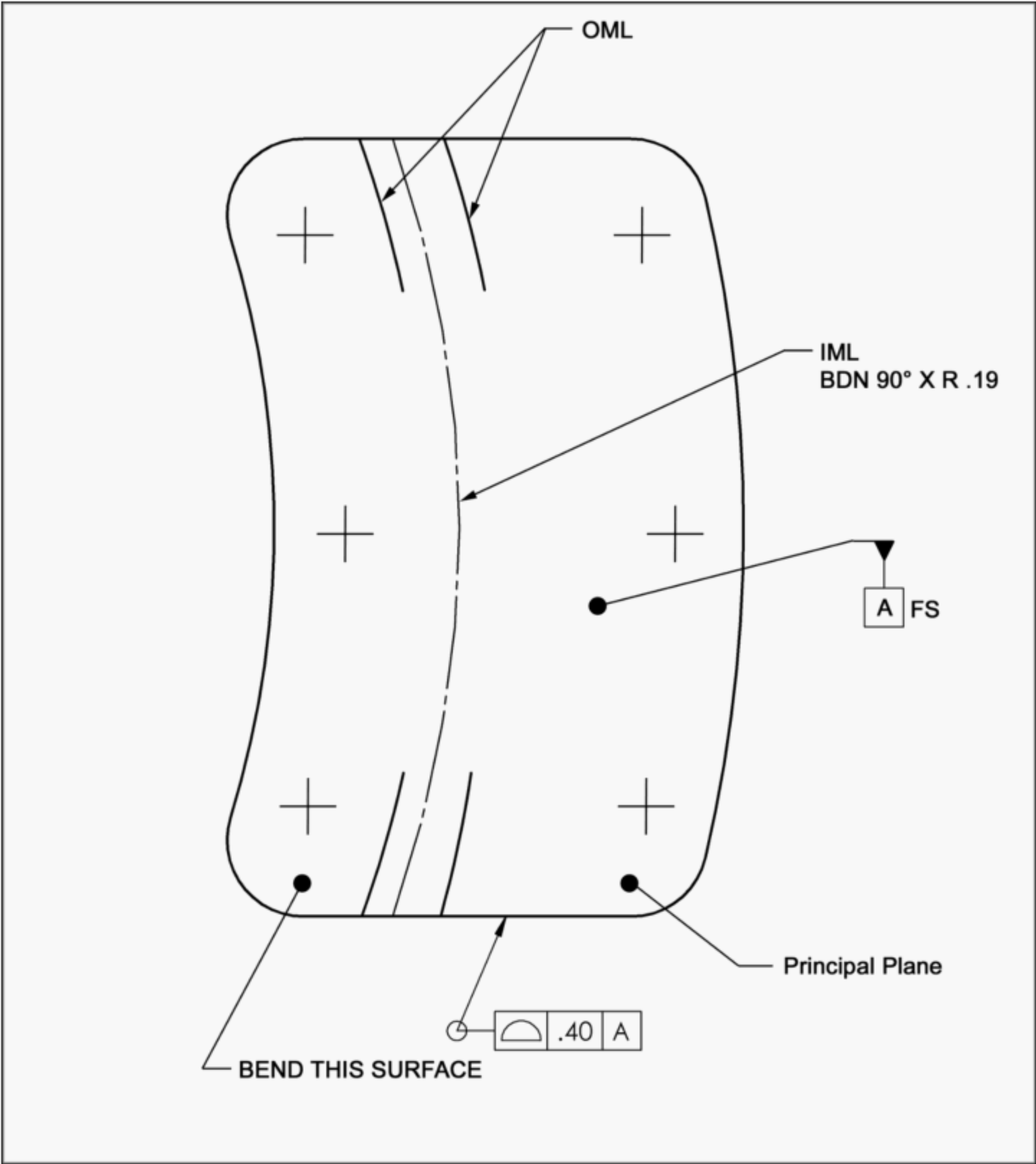


Fig. 21 Bend Instructions Example



**Fig. 22 Flange Angle Examples**

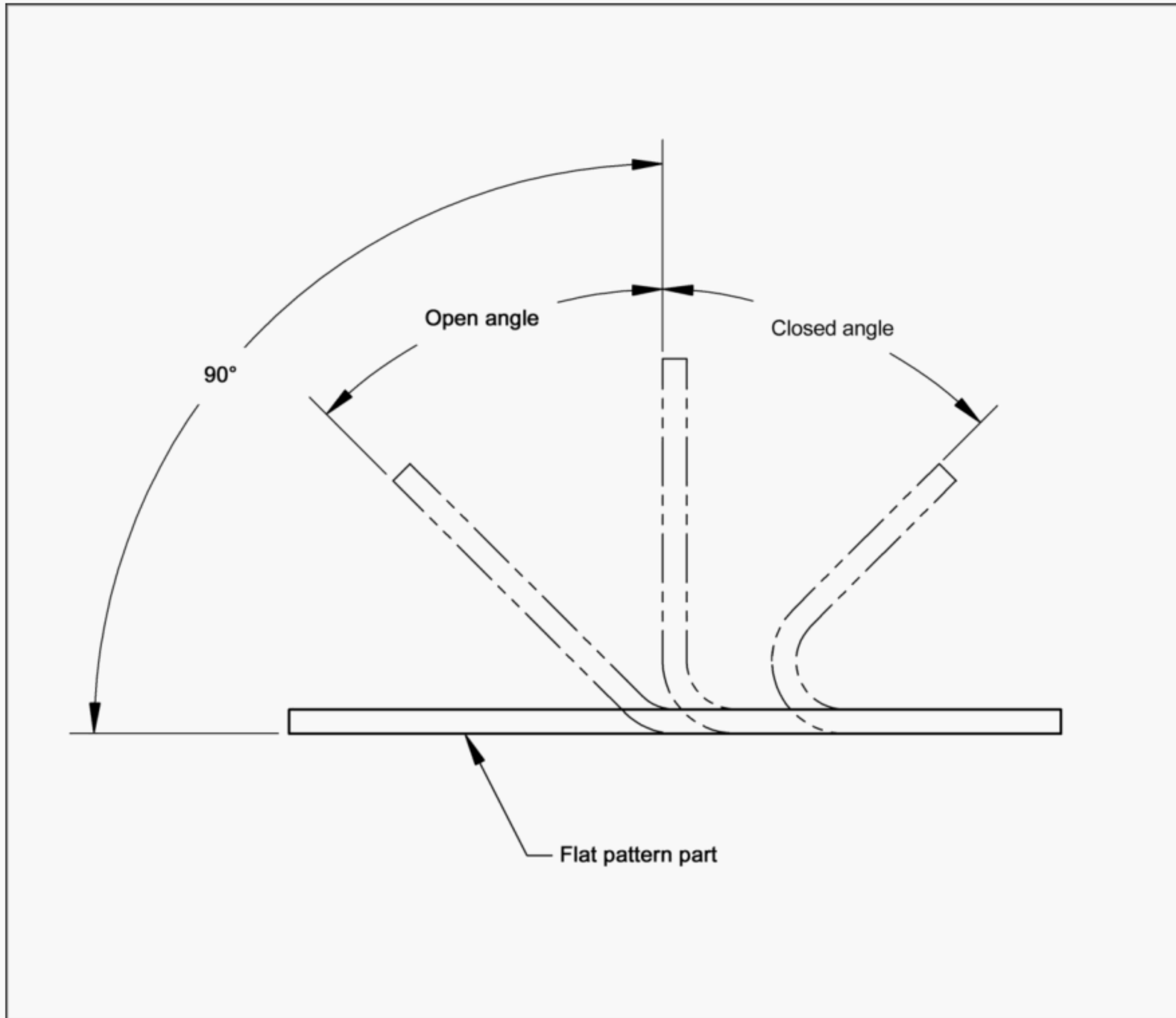
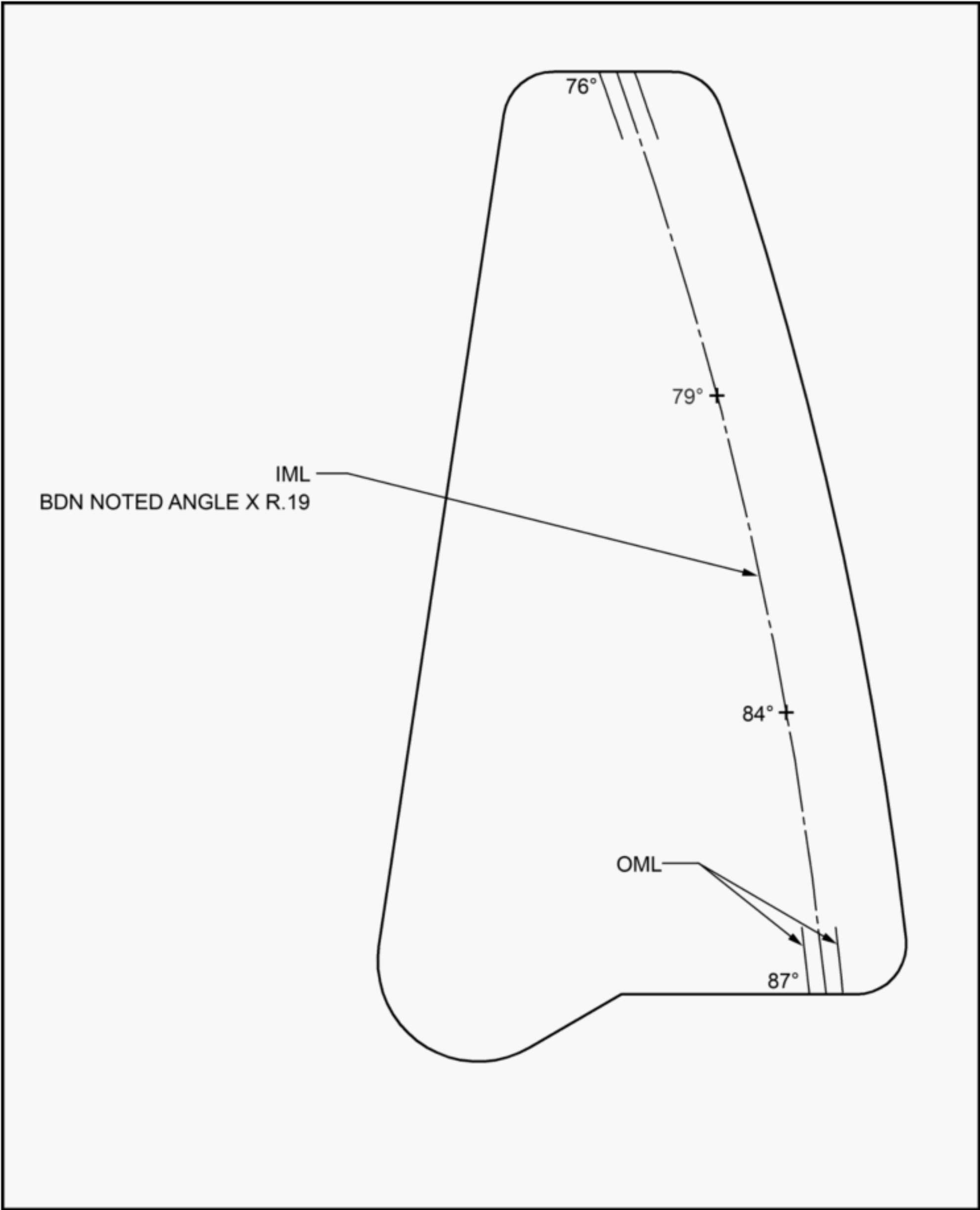


Fig. 23 Variable Bend Angle Example



**Fig. 24 Joggle Material Displacement Example 1**

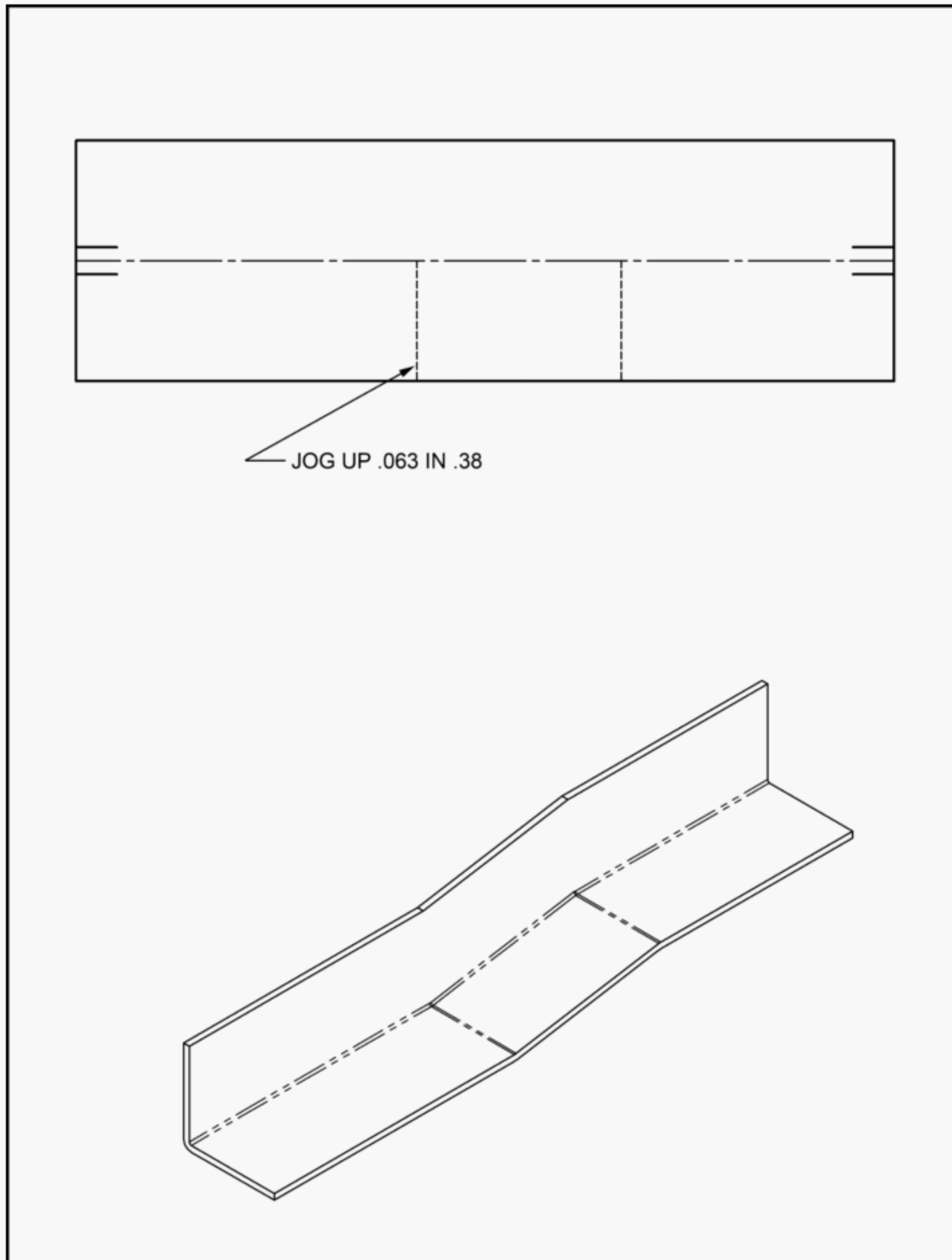
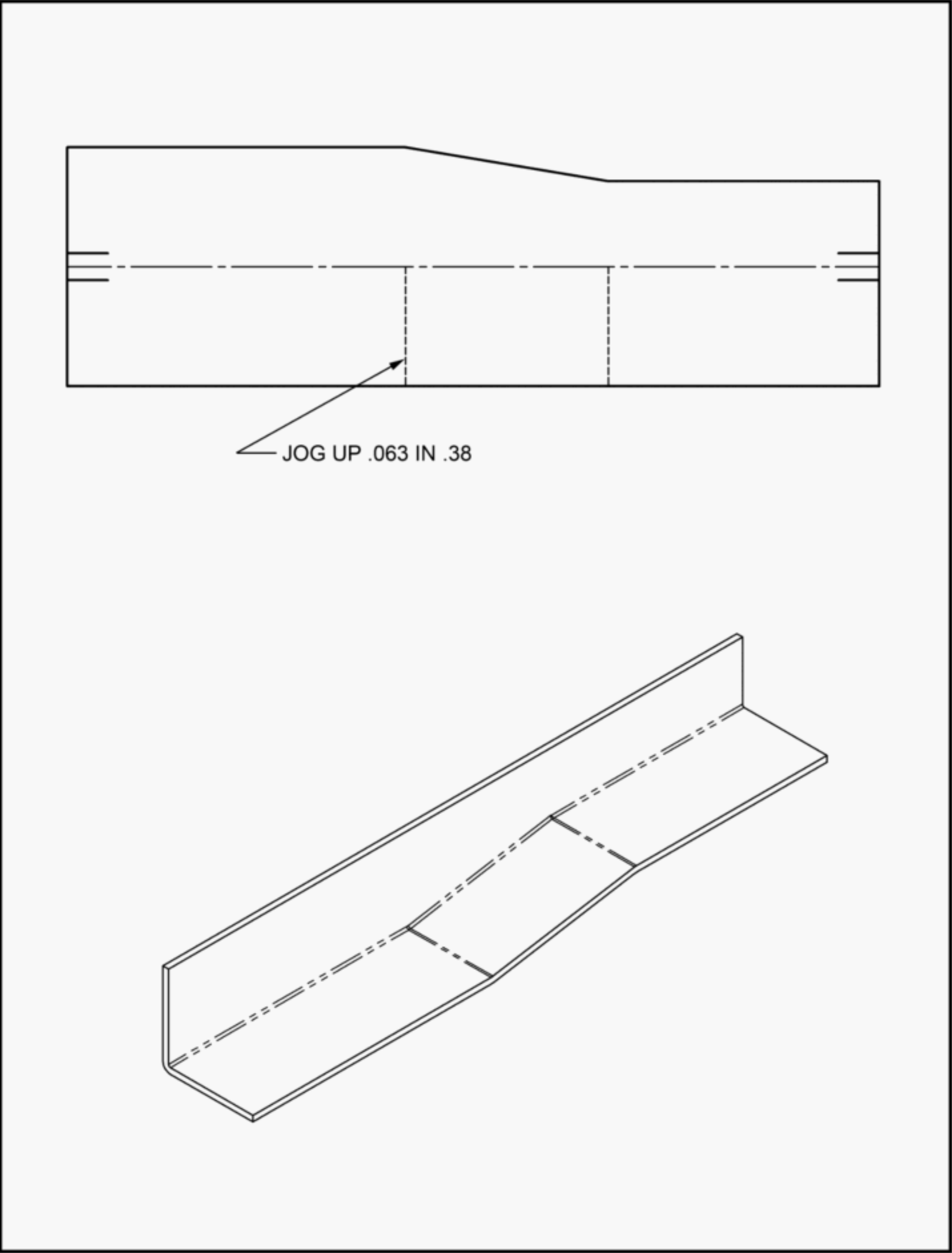


Fig. 25 Joggle Material Displacement Example 2



**Fig. 26 Hydro Joggle Example**

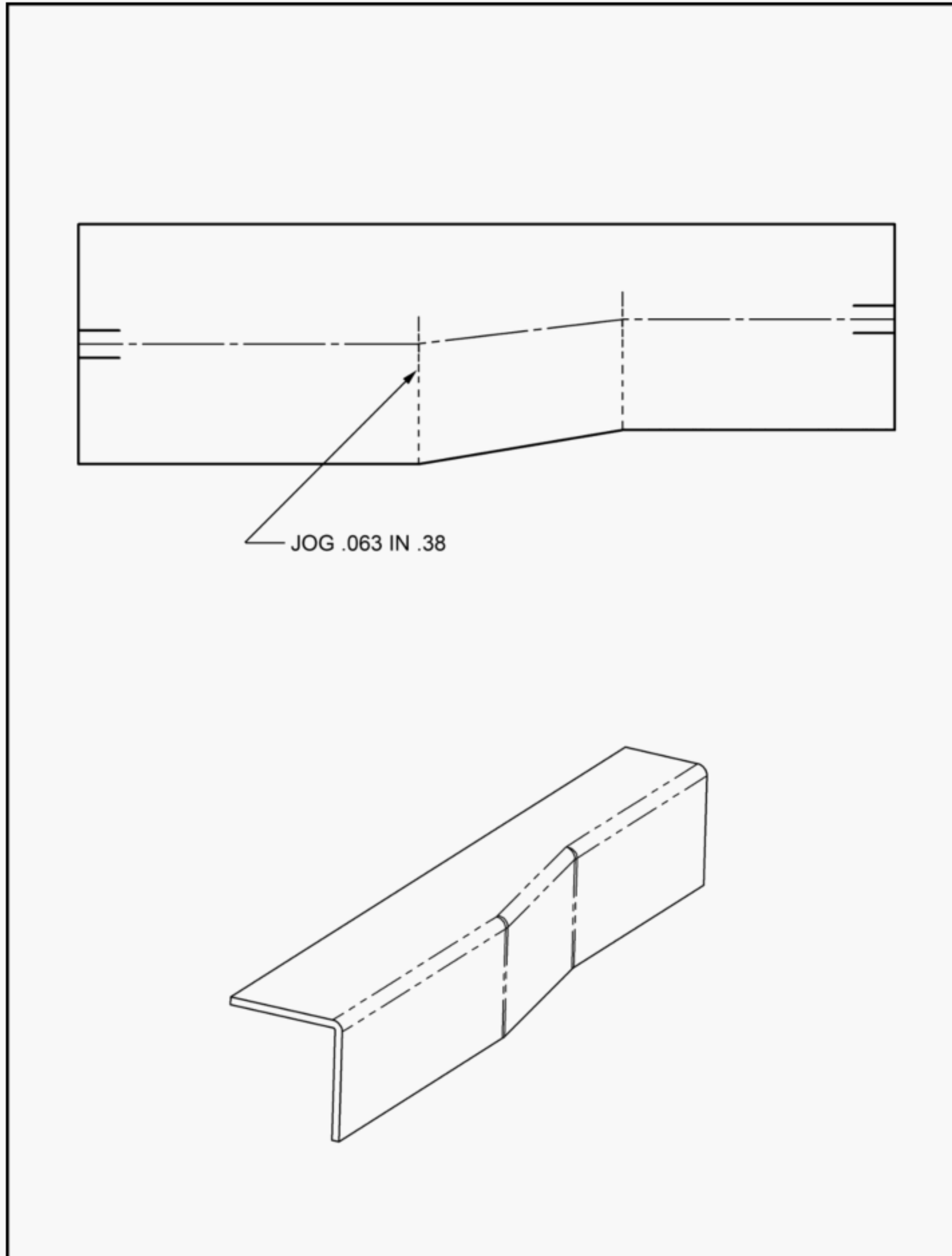
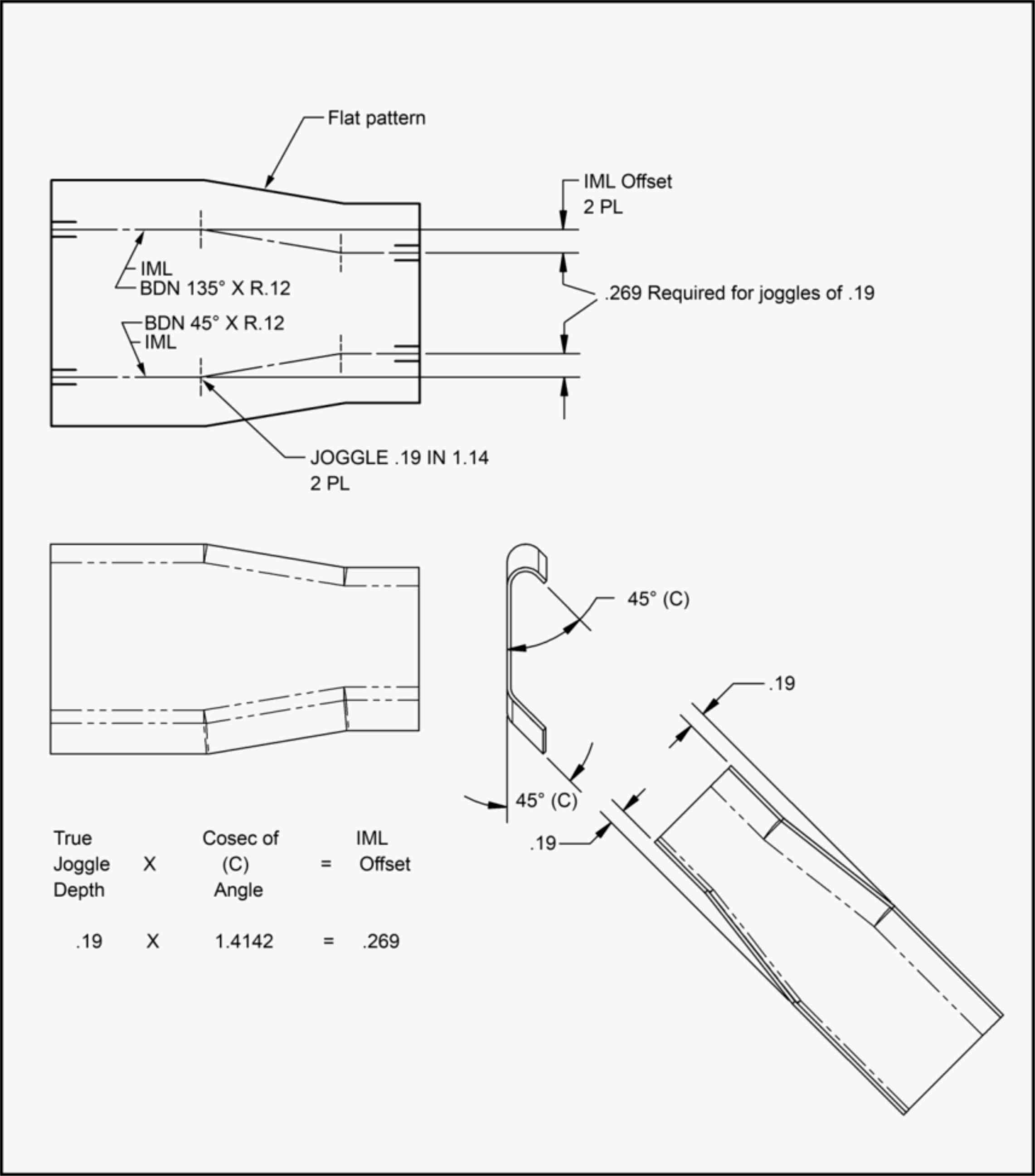




Fig. 27 Hydro Joggle Offset Example



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