ASME Y14.31-2014
(Revision of 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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The American Society of Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: June 18, 2014

This Standard will be revised when the Society approves the issuance of a new edition.

Periodically certain actions of the ASME Y14 Committee may be published as Cases. Cases are published on the ASME Web site under the Y14 Committee Page at go.asme.org/Y14committee as they are issued.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The Y14 Committee Page can be found at go.asme.org/Y14committee. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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FOREWORD

Undimensioned Drawings is the type designation applied to engineering drawings prepared on environmentally stable material 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, 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.

The following is a summary of the significant changes incorporated in this revision:

- Paragraph 1.3 was added.
- References were relocated to section 2.
- Definitions were relocated to section 3 and the definition of *original* was added.
- SI units were converted to U.S. Customary units.
- Paragraph 6 was revised to clarify that the requirement for meeting L-P-519 is for originals stored in a nonelectronic format.
- In para. 7.4, crop marks were added as an alternative practice.
- Figure 5-6 was revised to show an example of crop marks.

When this Standard is specified as a requirement, its defined requirements are assumed to be consistent with the needs of the user. Therefore, each user provides appropriate application consistent with the environment in which it is applied. Those who use this Standard as a requirement for contractual purposes should keep the following facts in mind:

(a) This Standard should be tailored to meet any specific needs. All users shall take careful note of the necessity of tailoring this Standard and the contents. The extent of tailoring will in large part be governed by drawing ownership and the logistics intent.

(b) It is not the intent of this Standard to prevent individual organizations from designing specific drawing practices that meet their individual needs, but rather to provide common engineering delineation standards to aid the increasing interchange of drawings between industry, government, and other users.

It is well recognized that individual companies have many detailed requirements for their specific method of operation. Consequently, the minimum requirements set forth in this Standard will provide them flexibility in implementation.

The successful creation and release of this Standard is attributed to the subcommittee members and their respective companies.

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

This Standard was approved as an American National Standard on April 16, 2014.

ASME Y14 COMMITTEE
Engineering Drawing and Related Documentation Practices

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, Y14 Standards Committee
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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

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.

Proposing a Case. Cases may be issued for the purpose of providing alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Attending Committee Meetings. The Y14 Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the Y14 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at go.asme.org/Y14committee.

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. 1-1, 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. 1-1, 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 ASME Y14 Series Conventions

The conventions in paras. 1.3.1 through 1.3.10 are used in this and other ASME Y14 standards.

1.3.1 Mandatory, Recommended, Guidance, and Optional Words

(a) The words "shall" and "will" establish a mandatory requirement.
(b) The word "should" establishes a recommended practice.
(c) The word "may" establishes an optional practice.
(d) The words "typical," "example," "for reference," and the Latin abbreviation "e.g." indicate suggestions given for guidance only.
(e) The word "or," used in conjunction with a mandatory requirement or a recommended practice, indicates that there are two or more options for complying with the stated requirement or practice.

1.3.2 Cross-Reference of Standards. Cross-reference of standards in text, with or without a date following the standard designator, shall be interpreted as follows:
(a) Reference to other ASME Y14 standards in the text without a date following the standard designator indicates that the issue of the standard identified in the References section (section 2) shall be used to meet the requirement.
(b) Reference to other ASME Y14 standards in the text with a date following the standard designator indicates that only that issue of the standard shall be used to meet the requirement.

1.3.3 Invocation of Referenced Standards. The following examples define the invocation of a standard when specified in the References section (section 2) and referenced in the text of this Standard:
(a) When a referenced standard is cited in the text with no limitations to a specific subject or paragraph(s) of the standard, the entire standard is invoked. For example, "Dimensioning and tolerancing shall be in accordance with ASME Y14.5" is invoking the complete standard because the subject of the standard is dimensioning and tolerancing and no specific subject or paragraph(s) within the standard is invoked.
(b) When a referenced standard is cited in the text with limitations to a specific subject or paragraph(s) of the standard, only the paragraph(s) on that subject is invoked. For example, "Assign part or identifying numbers in accordance with ASME Y14.100" is invoking only the paragraph(s) on part or identifying numbers, because the subject of the standard is engineering drawing practices and part or identifying numbers is a specific subject within the standard.
(c) When a referenced standard is cited in the text without an invoking statement such as "in accordance with," the standard is for guidance only. For example, "For gaging principles, see ASME Y14.43" is only for guidance and no portion of the standard is invoked.

1.3.4 Parentheses Following a Definition. When a definition is followed by a standard referenced in parentheses, the standard referenced in parentheses is the source for the definition.

1.3.5 Notes. Notes depicted in this Standard in ALL UPPERCASE letters are intended to reflect actual drawing entries. Notes depicted in initial uppercase or lowercase letters are to be considered supporting data to the contents of this Standard and are not intended for literal entry on drawings. A statement requiring the addition of a note with the qualifier "such as" is a requirement to add a note, and the content of the note is allowed to vary to suit the application.

1.3.6 Acronyms and Abbreviations. Acronyms and abbreviations are spelled out the first time they are used in this Standard, followed by the acronym or abbreviation in parentheses. The acronym is used thereafter throughout the text.

1.3.7 Units. U.S. Customary units are featured in this Standard. It should be understood that the International System of Units (SI) could equally have been used without prejudice to the principles established.

1.3.8 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 are incomplete by intent so as to illustrate a concept or facet thereof. The absence of a figure(s) has no bearing on the applicability of the stated requirements or practice. To comply with the requirements of this Standard, actual data sets shall meet the content requirements set forth in the text. To assist the user of this Standard, a listing of the paragraph(s) that refers to an illustration appears in the lower right-hand corner of each figure. This listing may not be all-inclusive. The absence of a listing is not a reason to assume inapplicability. Some figures are illustrations of models in a three-dimensional environment. Figures illustrating drawings in digital format have a border included. When the letter "h" is used in figures for letter heights or for symbol proportions, select the applicable letter height in accordance with ASME Y14.2.

1.3.9 Precedence of Standards. The following are ASME Y14 standards that are basic engineering drawing standards:

ASME Y14.1	Decimal Inch Drawing Sheet Size and Format
ASME Y14.1M	Metric Drawing Sheet Size and Format
ASME Y14.2	Line Conventions and Lettering
ASME Y14.3	Orthographic and Pictorial Views
ASME Y14.5	Dimensioning and Tolerancing
ASME Y14.24	Types and Applications of Engineering Drawings
ASME Y14.34	Associated Lists
ASME Y14.35	Revision of Engineering Drawings and Associated Documents
ASME Y14.36M	Surface Texture Symbols
ASME Y14.38	Abbreviations and Acronyms for Use on Drawings and Related Documents
ASME Y14.41	Digital Product Definition Data Practices
ASME Y14.100	Engineering Drawing Practices

All other ASME Y14 standards are considered specialty types of standards and contain additional requirements or make exceptions to the basic standards as required to support a process or type of drawing.

1.3.10 Unless Otherwise Specified (UOS). The phrase "unless otherwise specified" or UOS is used to indicate a default requirement. The phrase is used when the default is a generally applied requirement and an exception may be provided by another document or requirement.

2 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 Y14.3-2012, Orthographic and Pictorial Views
ASME Y14.5-2009, Dimensioning and Tolerancing
ASME Y14.35-2014, Revision of Engineering Drawings and Associated Documents
ASME Y14.43-2011, Dimensioning and Tolerancing Principles for Gages and Fixtures
ASME Y14.100-2013, Engineering Drawing Practices

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

IPC-T-50K, Terms and Definitions for Interconnecting and Packaging Electronic Circuits
IPC-2221B, Generic Standard on Printed Board Design

Publisher: IPC — Association Connecting Electronics Industries (IPC), 3000 Lakeside Drive, 309 S, Bannockburn, IL 60015 (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, DLA Document Services, 700 Robbins Avenue, Building 4/D, Philadelphia, PA 19111-5094 (http://quicksearch.dla.mil)

3 DEFINITIONS

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

3.1 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.

3.2 Bend Radius

bend radius: the inside radius of a formed part.

3.3 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. 3-1.

3.4 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.

3.5 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. 3-2.

3.6 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.

3.7 Comparator Drawing

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

3.8 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.

3.9 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.

3.10 Flange

flange: the portion of the item being bent.

3.11 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. 3-3.

3.12 Grid Lines

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

3.13 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.

3.14 Inside Mold Line (IML)

inside mold line (IML): the line representing the intersection of the projected inside surfaces of a formed item. See Fig. 3-1.

3.15 Joggle

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

3.16 Original

original: the current design activity's reproducible drawing or data set, on which is kept the revision record recognized as official (ASME Y14.100).

3.17 Outside Mold Line (OML)

outside mold line (OML): the line representing the projected outside surfaces of a formed item. See Fig. 3-1.

3.18 Principal Plane

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

3.19 Printed Circuit Drawing

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

3.20 Registration Mark

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

3.21 Reproduction

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

3.22 Template

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

3.23 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).

3.24 True Geometry Views

true geometry views: views that show the actual shape description, and when they are section views they show the actual shape cut by the cutting plane (ASME Y14.3).

3.25 Undimensioned Drawing

undimensioned drawing: a drawing graphic sheet that defines an item graphically, predominantly without the use of dimensions.

3.26 Validation

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

3.27 Verification

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

3.28 Wire Harness Drawing

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

4 UNDIMENSIONED DRAWING

An undimensioned drawing graphically defines the item in true geometry view(s). Dimensions may be included to establish a defined 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 that 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.

5 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. 5-1.

(b) parts requiring art layout for fabrication, e.g., printed circuit boards. See Fig. 5-2.

NOTE: Requirements for the preparation of printed circuit boards are provided in IPC-2221.

(c) wire harnesses. See Fig. 5-3.

(d) items that are developed as flat patterns, with or without forming. See Fig. 5-4.

(e) ply detail items for composite laminates.

(f) extrusions and formed sheet metal sections that require profiling operations. See Fig. 5-5.

(g) items requiring art layout for fabrication, e.g., identification and instruction plates. See Fig. 5-6.

(h) items that lie in a flat plane and have a profusion of fastener attachments. See Fig. 5-7.

(i) paint configurations. See Fig. 5-8.

6 MEDIA

The design tolerance requirements and the method of manufacture will generally be determining factors when selecting presentation media. Originals that are stored in an nonelectronic format and 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.

6.1 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 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.

6.2 Storage

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

6.3 Reproductions

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

7 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.

7.1 Validation Criteria

Tolerances between dimensional references are as follows:

(a) Grid Lines

(1) Grid Unit. Tolerance ±.005 in., noncumulative; diagonal ±.007 in.

(2) Total Grid. Tolerance ±.010 in.; diagonal ±.014 in.

(b) Dimensional Accuracy Points. Tolerance ±.010 in., noncumulative; diagonal ±.014 in.

(c) Registration Marks. Tolerance ±.005 in., noncumulative; diagonal ±.007 in.

Diagonal dimensional references need not be specified on the drawing.

7.2 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. or 10.000 in. 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. 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. 5-1 and 7-1. 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. diameter at the grid intersection points shall be retained.

7.3 Dimensional Accuracy Points

Dimensional accuracy points may be constructed as shown in Fig. 7-2. 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. 7-3. 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. 7-4. The center dimensional accuracy point shall be constructed as shown in Fig. 7-2. The dimensional accuracy points shall be equally spaced horizontally and equally spaced vertically.

7.4 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. 5-2 and 7-5.

NOTE: As an alternative practice, crop marks may be used, indicating the corners of the base material. The dimensions of the base material shall be defined directly or by reference. See Fig. 5-6.

8 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 reference 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. 8-1 and 8-2.

8.1 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. from the designated common reference. See Fig. 8-1.

8.2 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. 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. 8-2.

9 TOLERANCES

9.1 Graphical Tolerances

All features of the item shown in the graphical representation shall be drawn to a tolerance of ±.010 in. of the actual size and location.

9.2 Item Tolerances

9.2.1 Contour Definition Drawings, Templates, and Comparator Drawings. 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.

9.2.2 Wire Harness Drawings. For wire harness drawings, the lines defining the centerline 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.

9.2.3 Printed Circuit Boards. 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.

9.3 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.

10 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, the following:

(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.

11 REVISIONS

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

12 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 that are method specific.

12.1 General Requirements

Basic presentation of a flat pattern is shown in Fig. 5-4. 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.

12.1.1 Brake Process Requirements. When items with straight bend lines are formed using a brake process, the bend line is indicated as a CLB. See Fig. 3-2. Items that are formed using a brake process shall have the majority of the flange bend instructions indicating bend up.

12.1.2 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 IML or FBL. See Fig. 3-3. 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.

12.2 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. 12-1. 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 centerlines indicating the location for the forming tool. The IML, FBL, and CLB lines for flanges shall be shown as centerlines. The OML shall be a solid line, .50 in. in length, at each end of the part. See Fig. 12-1. Joggle lines shall be hidden lines.

12.3 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. 12-2.

(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.

12.4 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. 12-3.

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°.

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

12.4.2 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. 12-4.

12.5 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 12-5 and 12-6 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. 12-7. 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. 12-8.

12.6 Design Information

Design information, e.g., bend formulas and reliefs, used to calculate the material displacement due to the use of specific forming processes, is defined in references available in standard design handbooks.

Fig. 1-1 Undimensioned Drawing Contributors

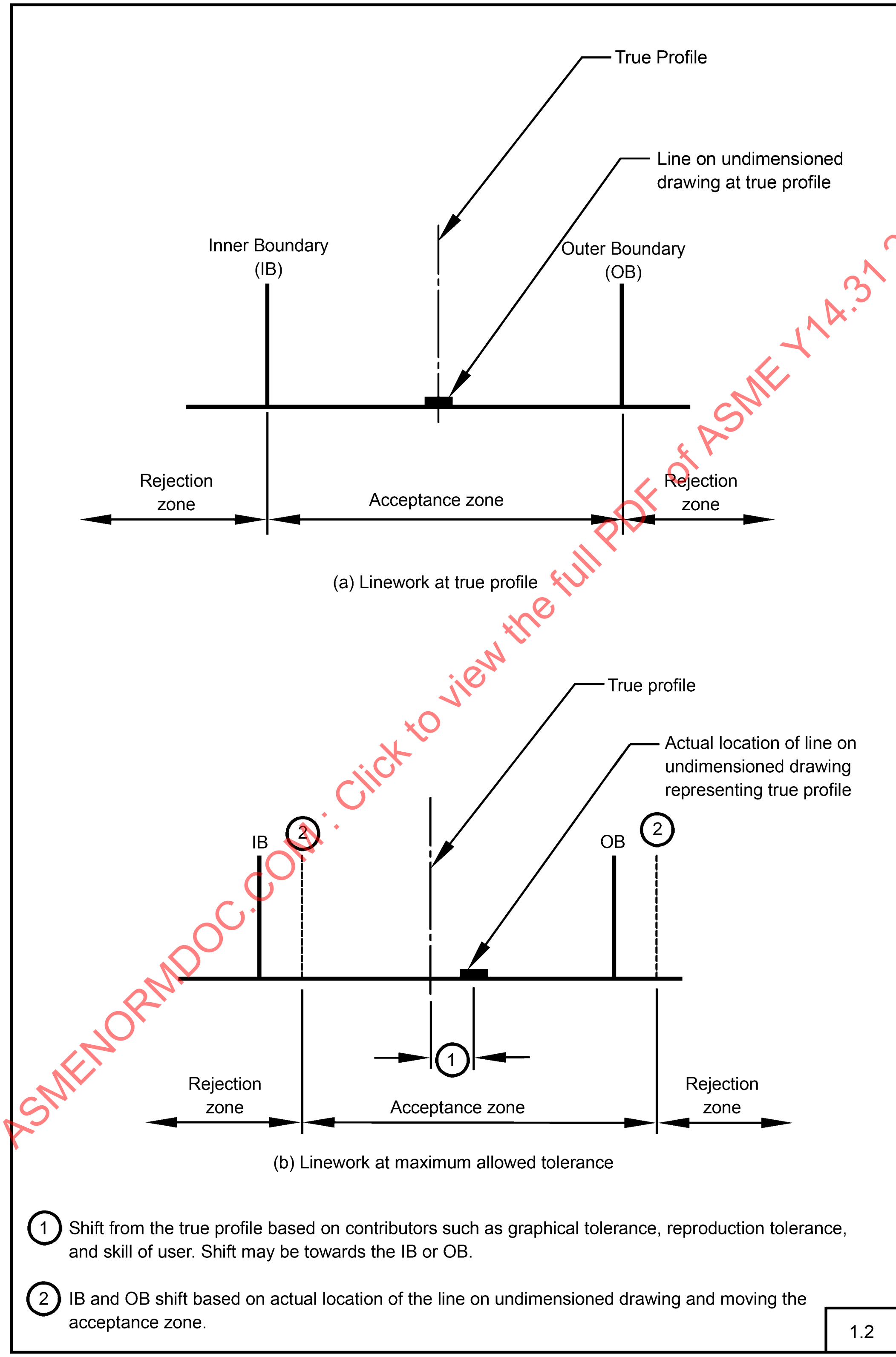

Fig. 3-1 Forming and Bending Line Examples

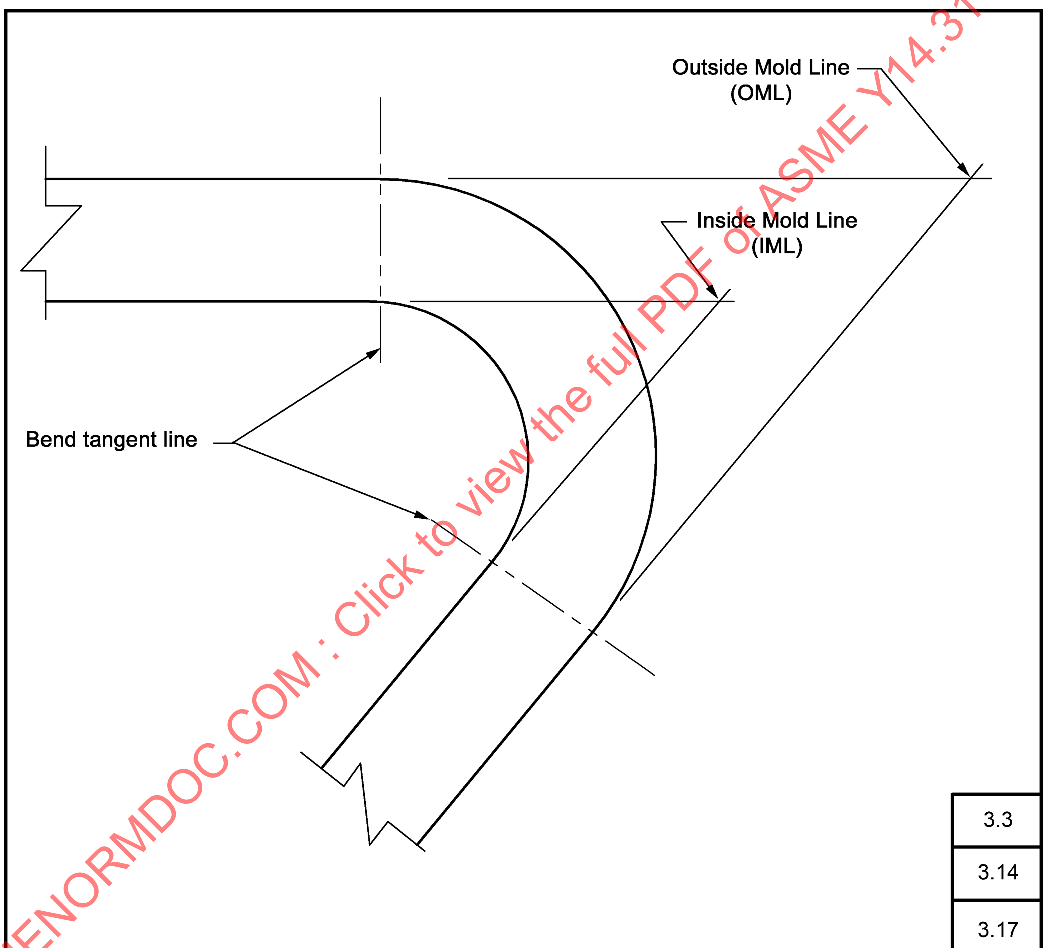

Fig. 3-2 Brake Process Example

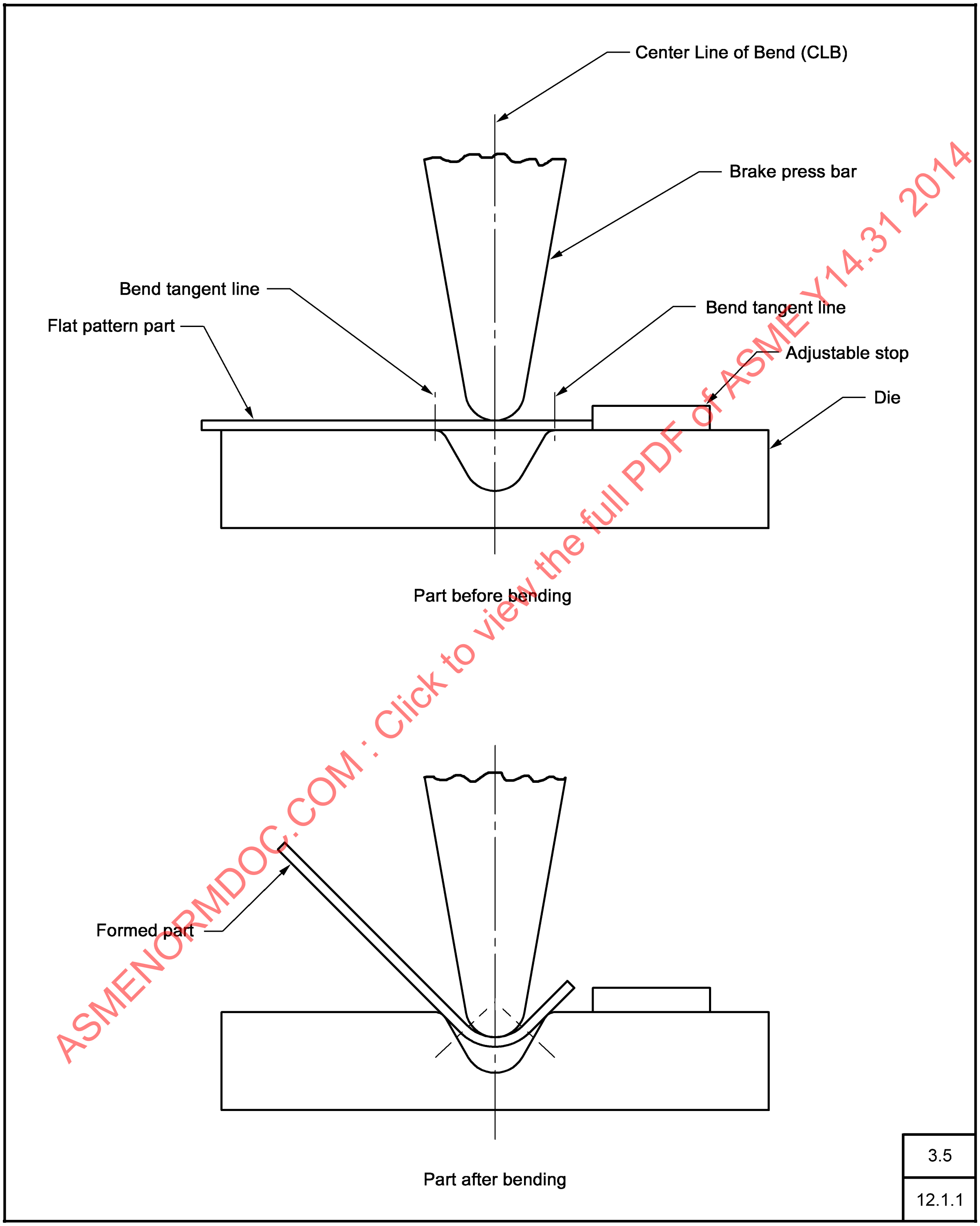

Fig. 3-3 Hydro Process Example

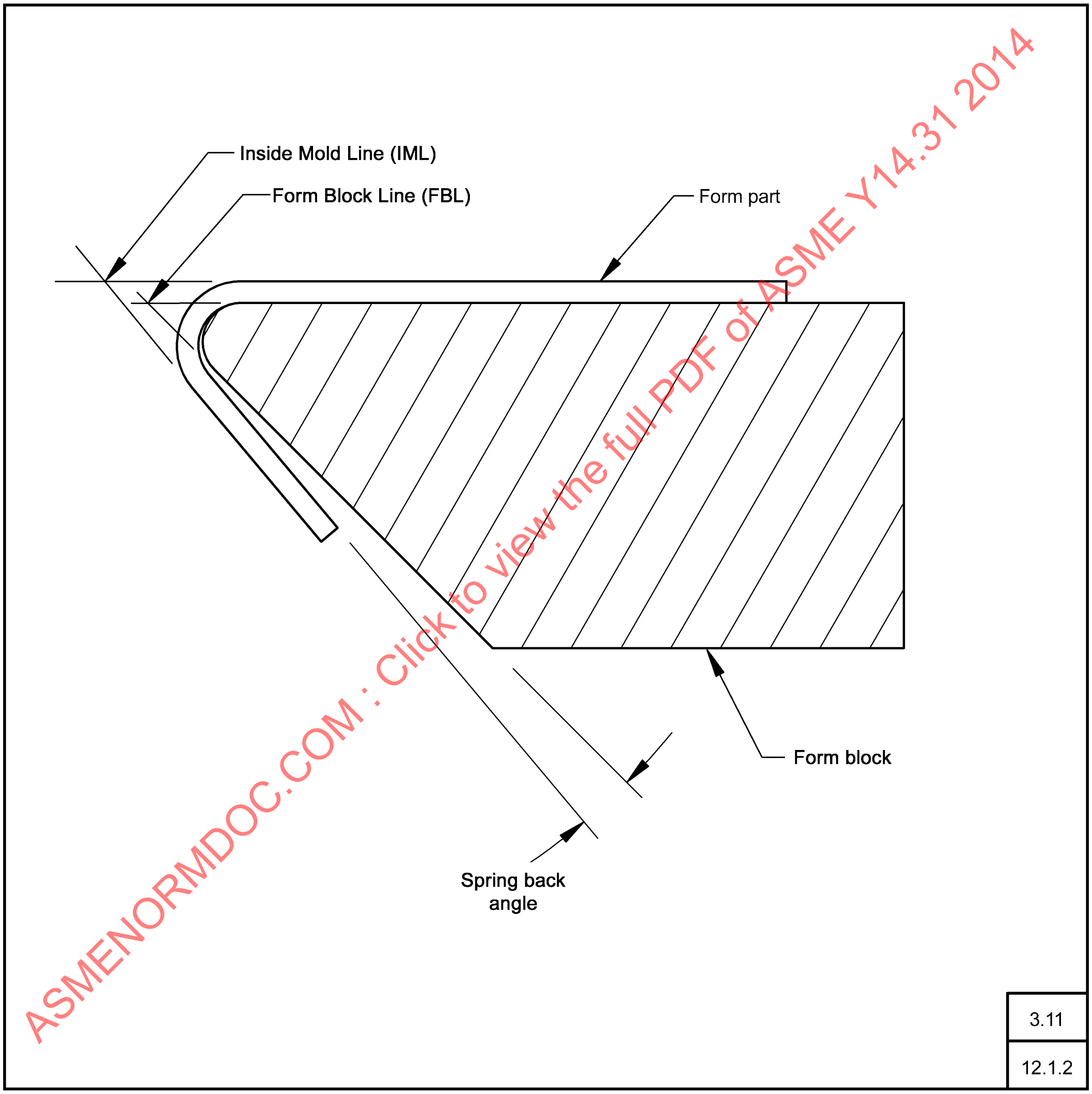

Fig. 5-1 Contour Definition Drawing Example

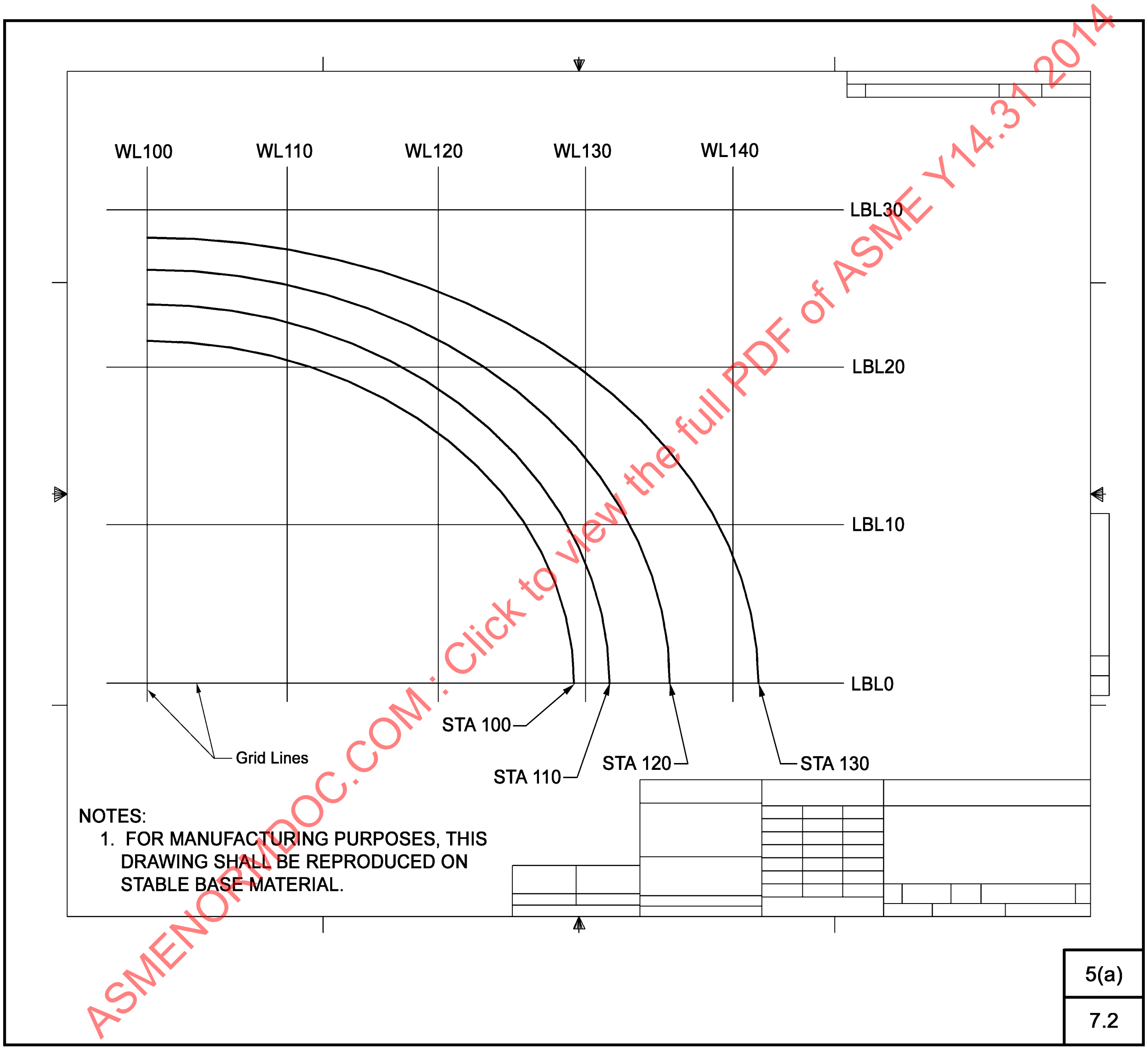

Fig. 5-2 Printed Circuit Drawing Example

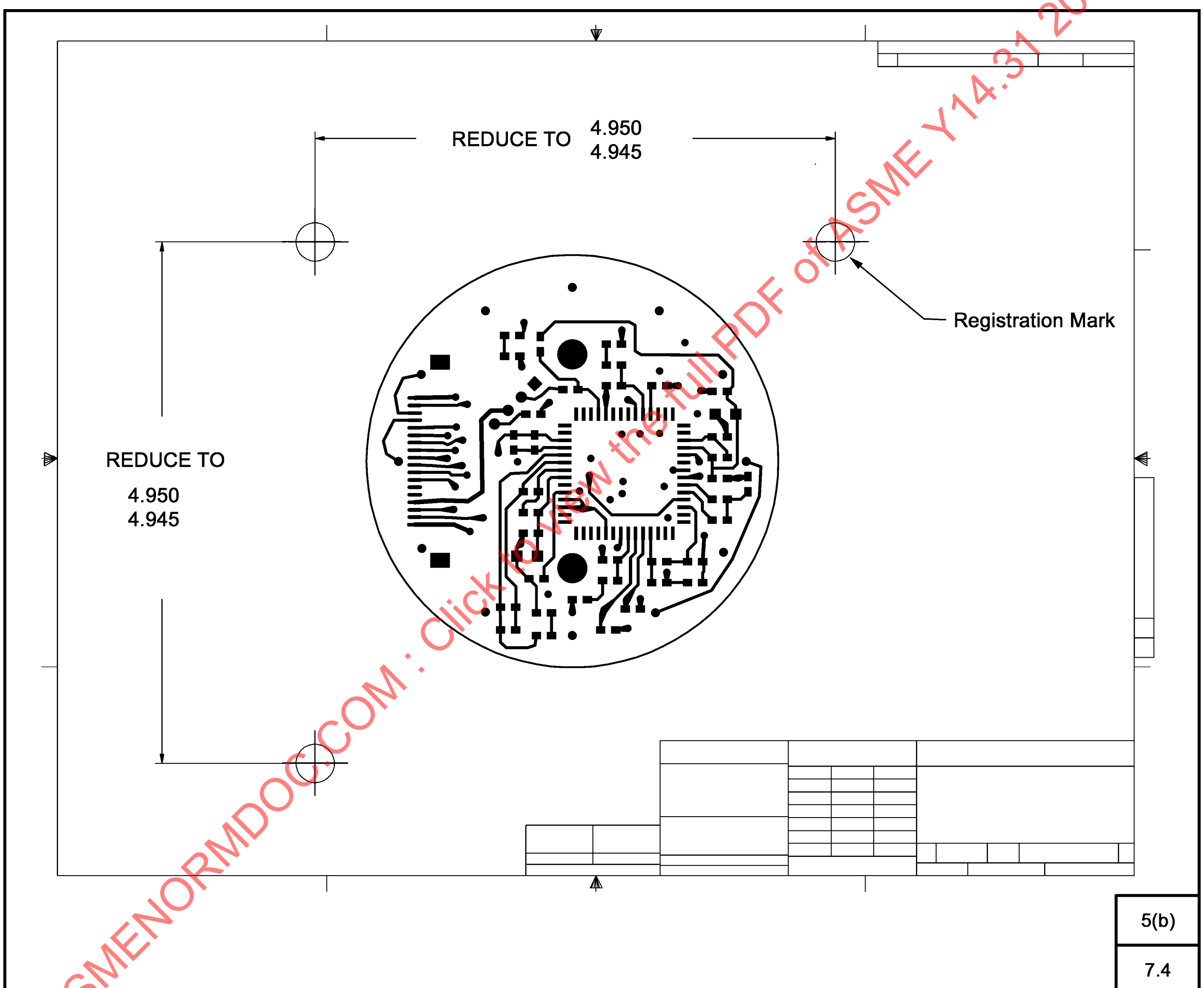

Fig. 5-3 Wire Harness Drawing Example

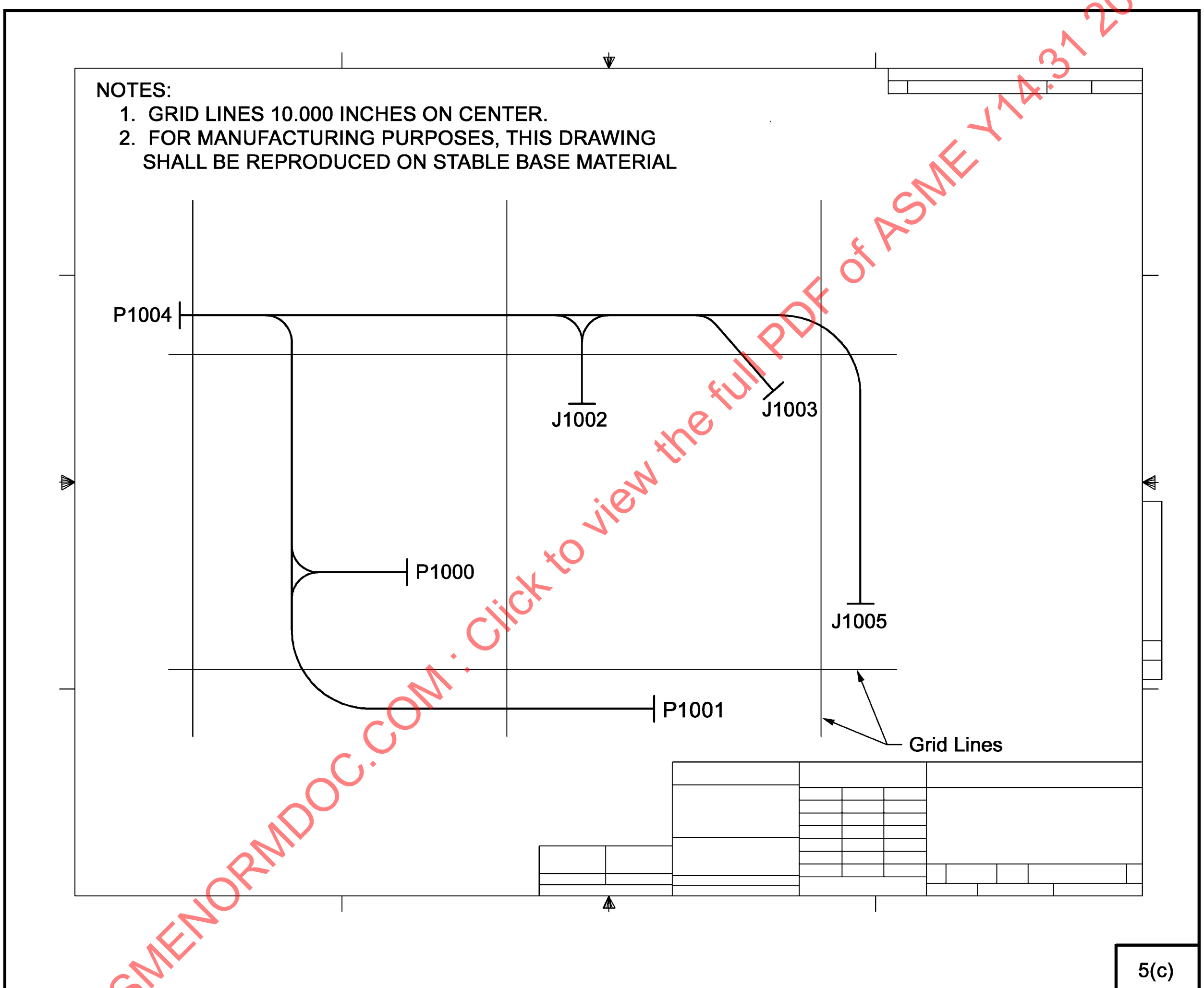

Fig. 5-4 Template Example

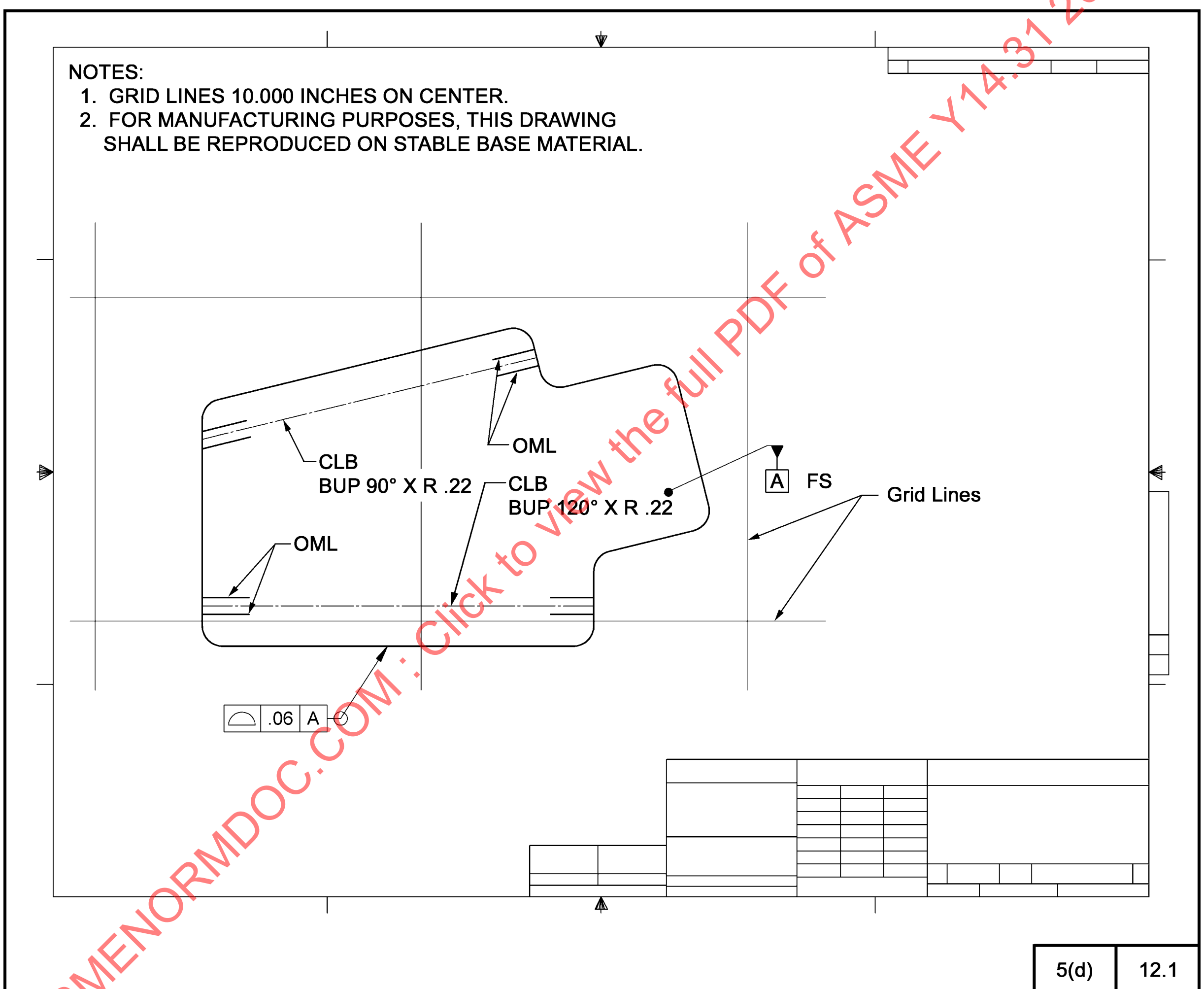

Fig. 5-5 Extrusion Drawing Example

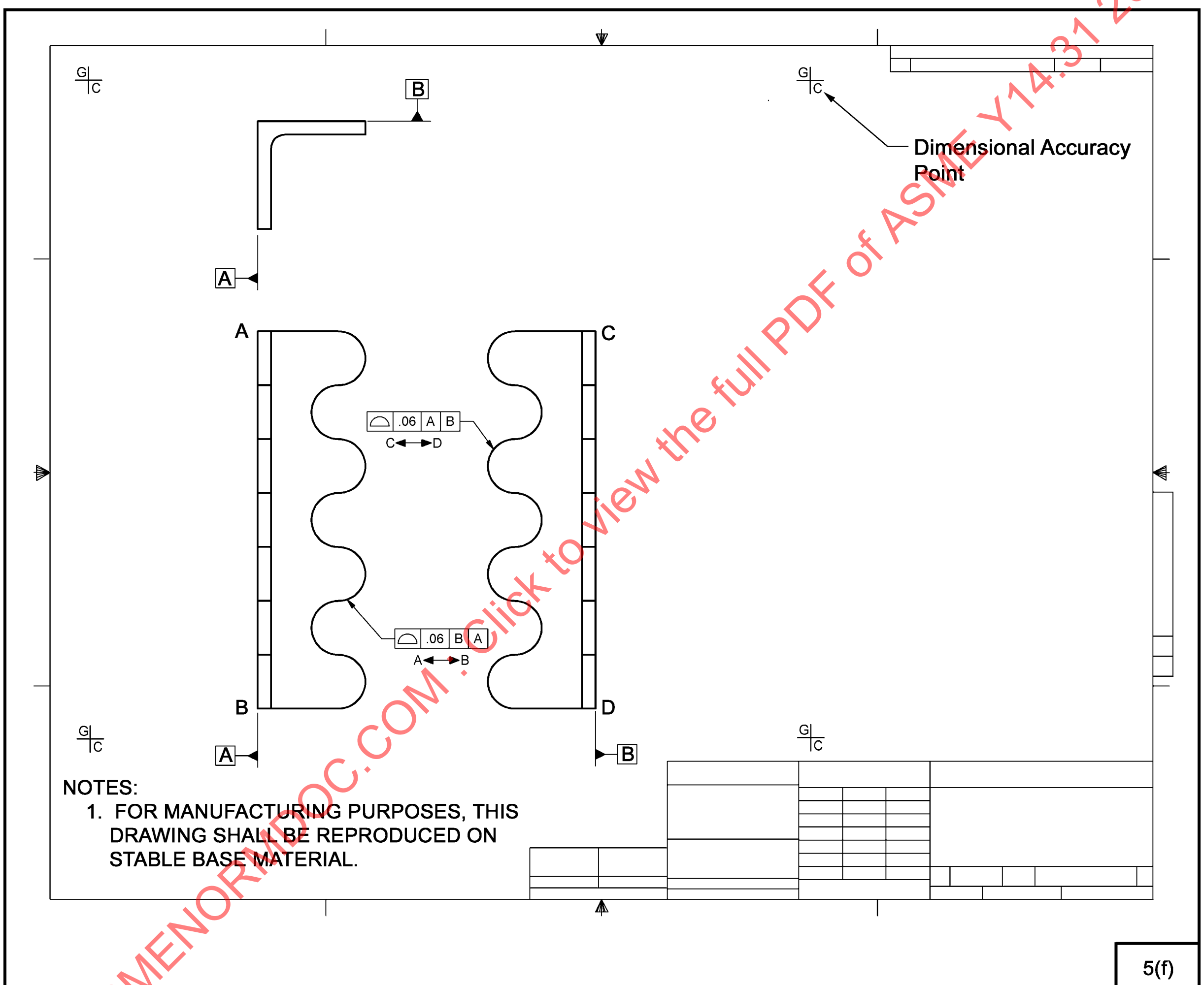

Fig. 5-6 Art Layout Drawing Example

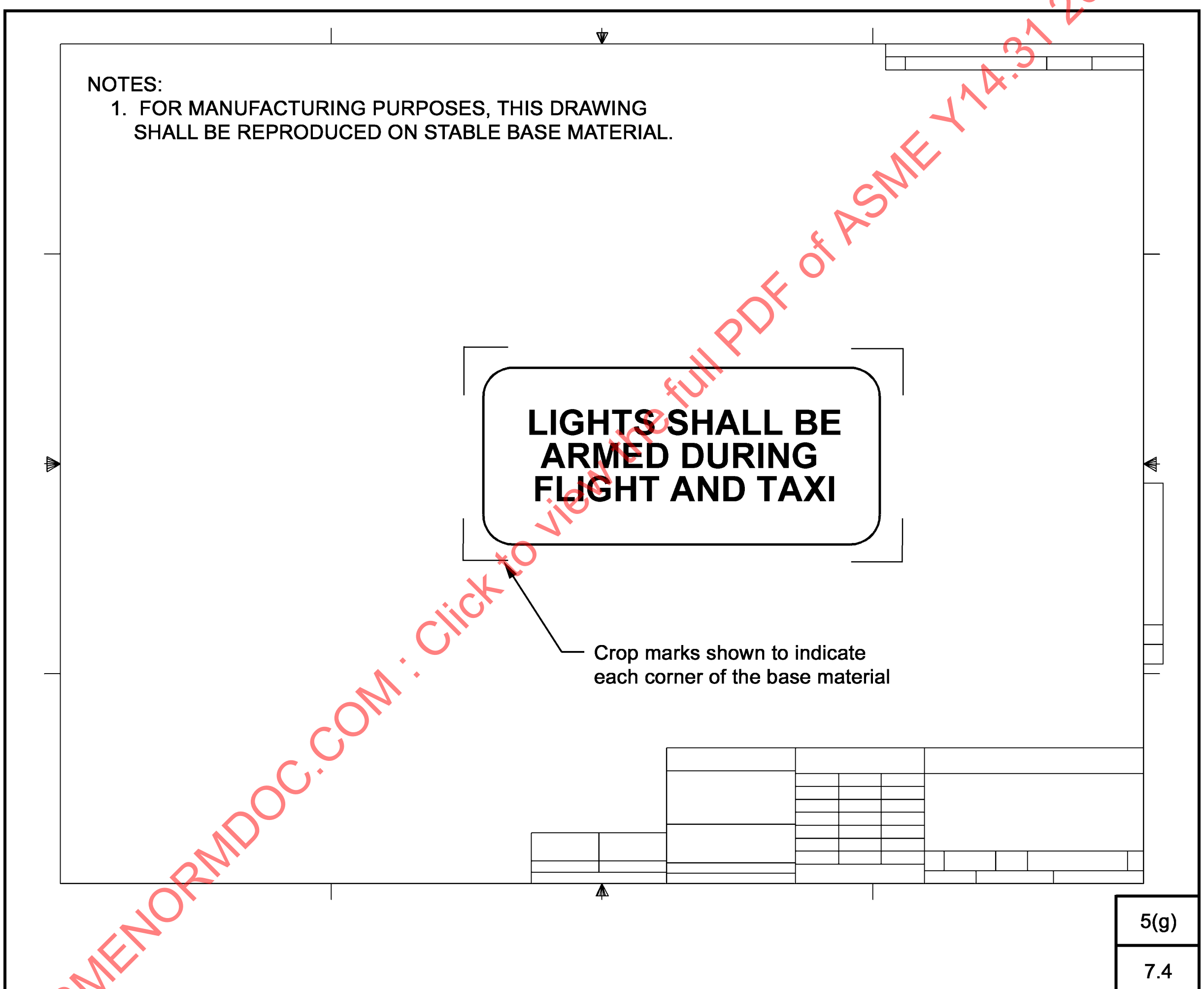

Fig. 5-7 Assembly Drawing Example

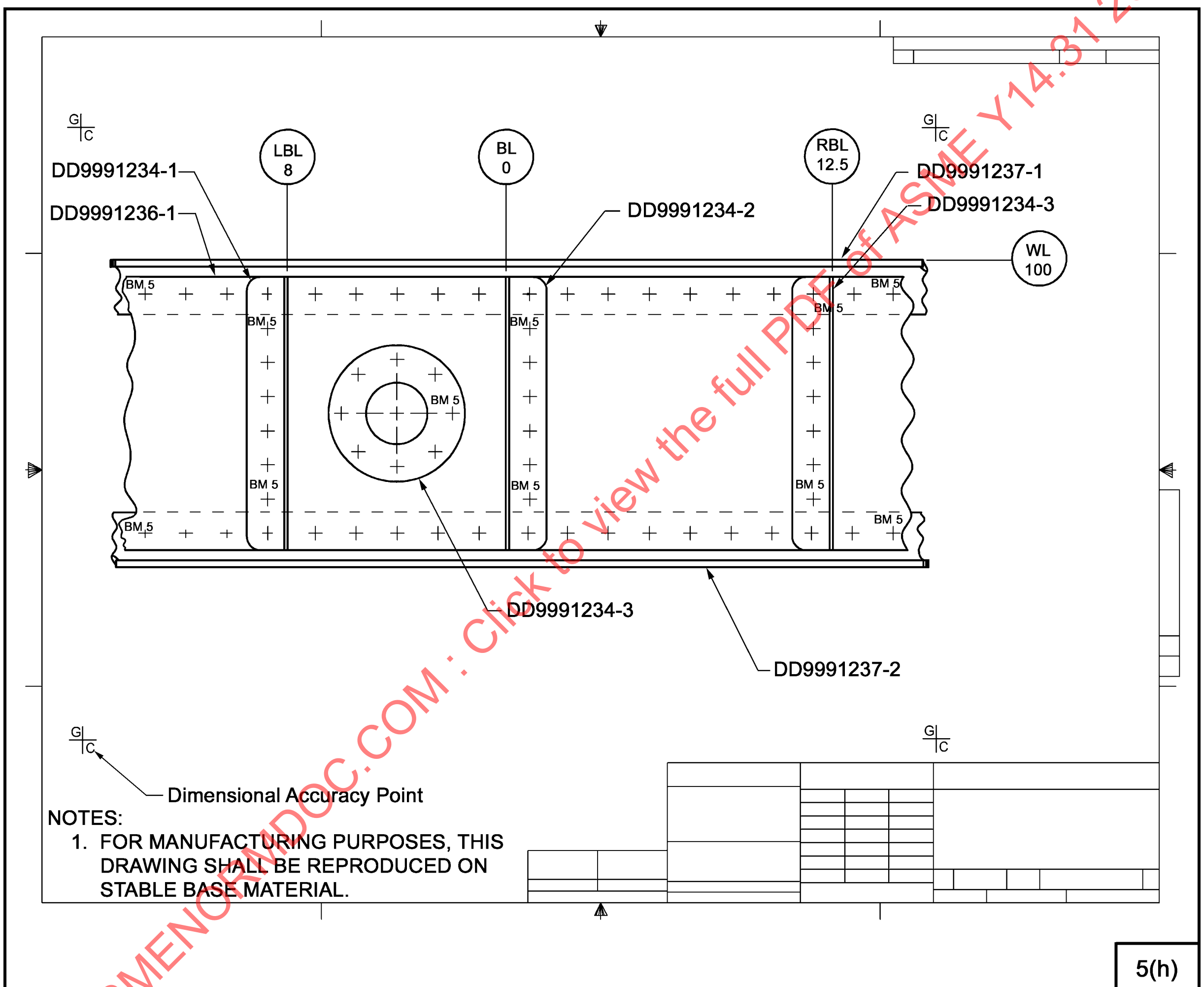

Fig. 5-8 Paint Configuration Drawing Example

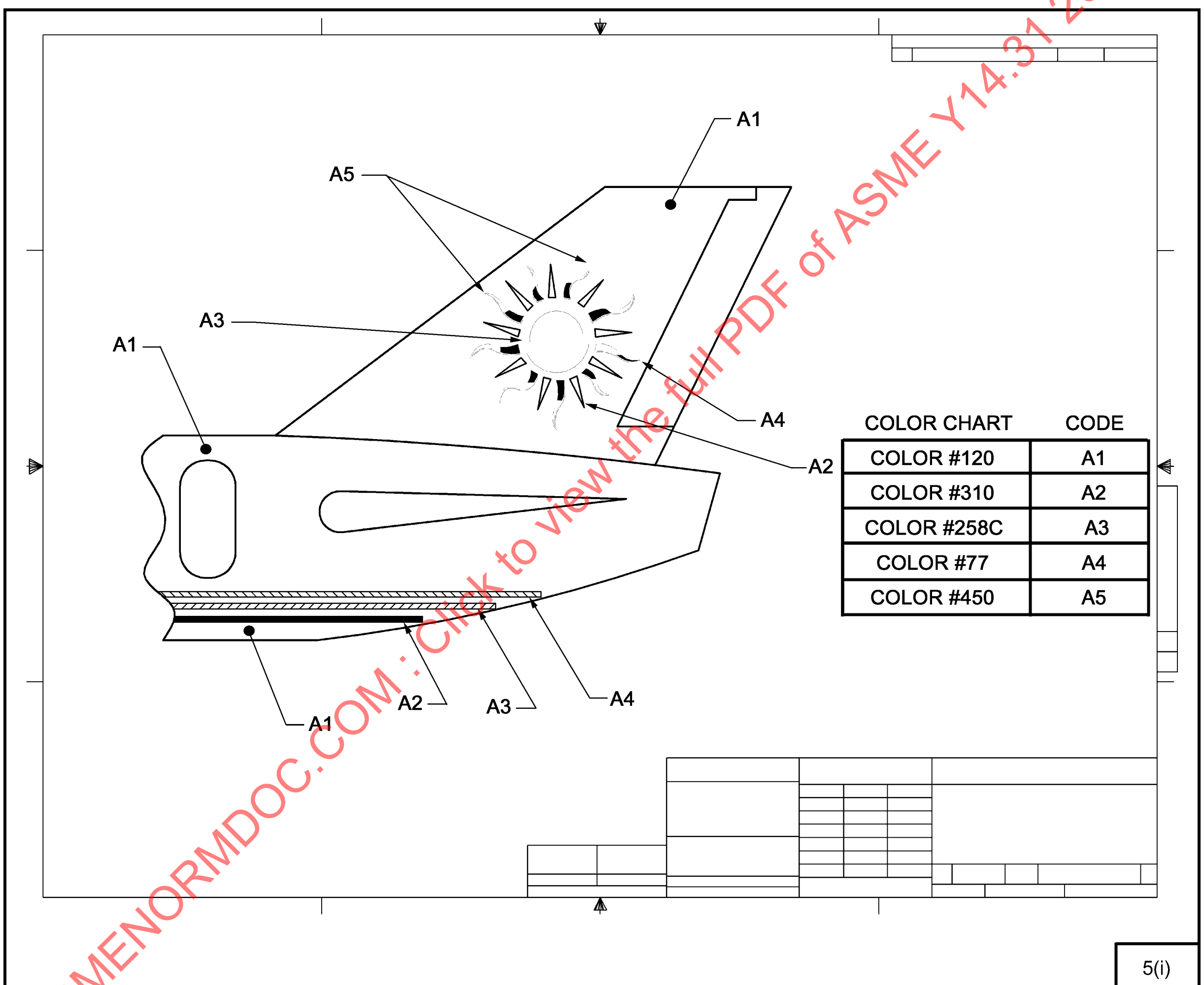

Fig. 7-1 Rotated Grid Lines

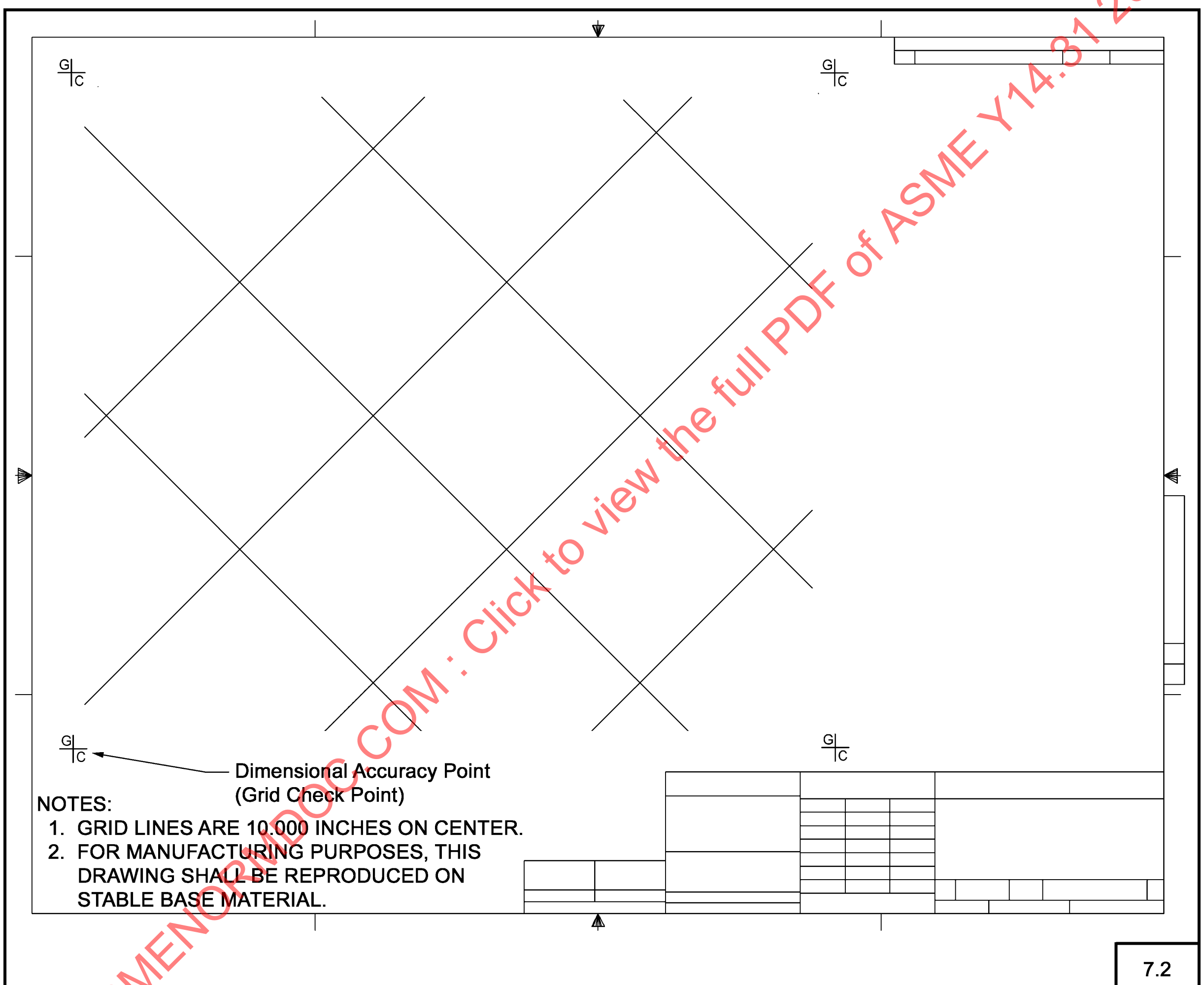

Fig. 7-2 Dimensional Accuracy Points

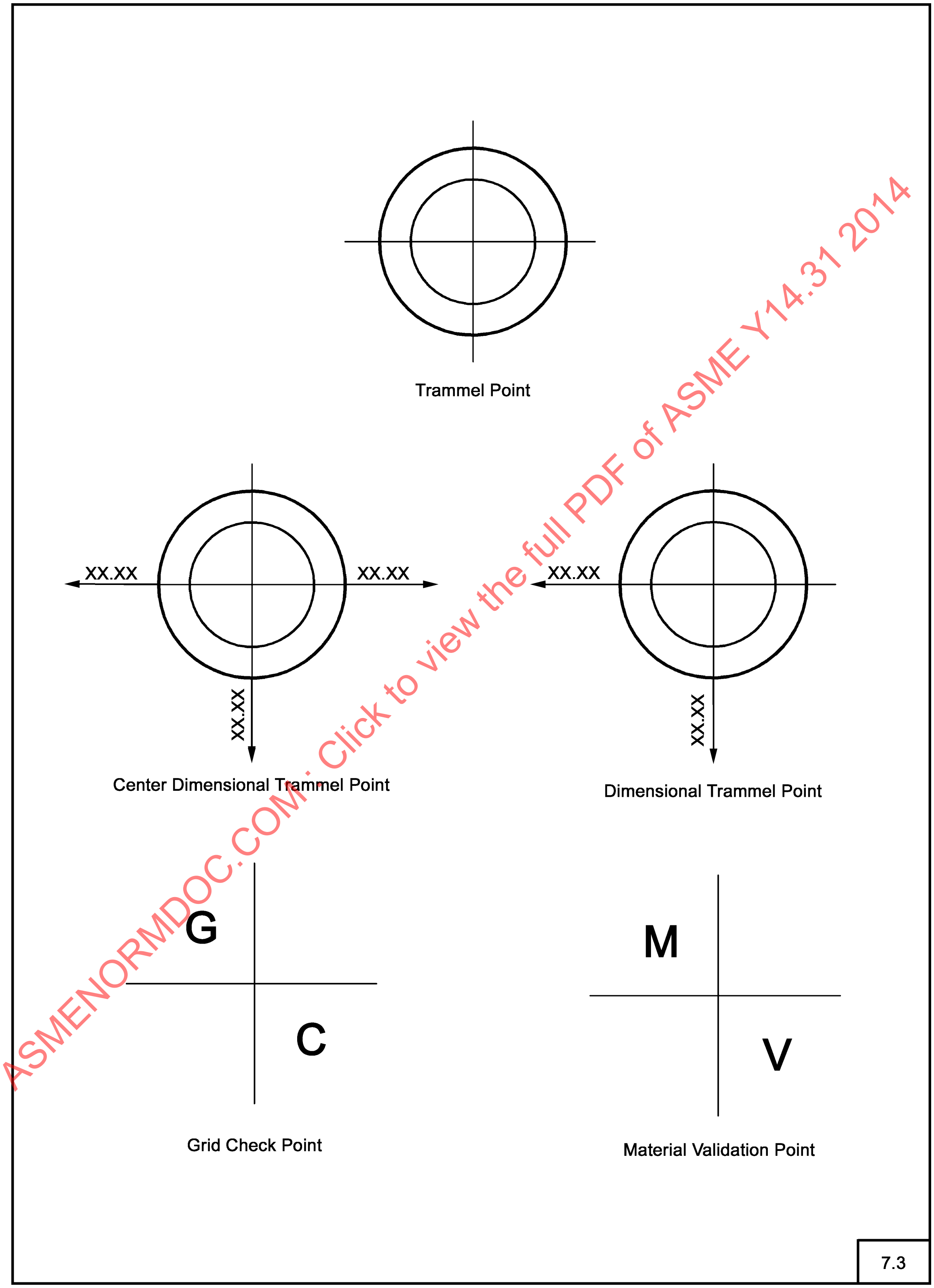

Fig. 7-3 Dimensional Accuracy Point Examples

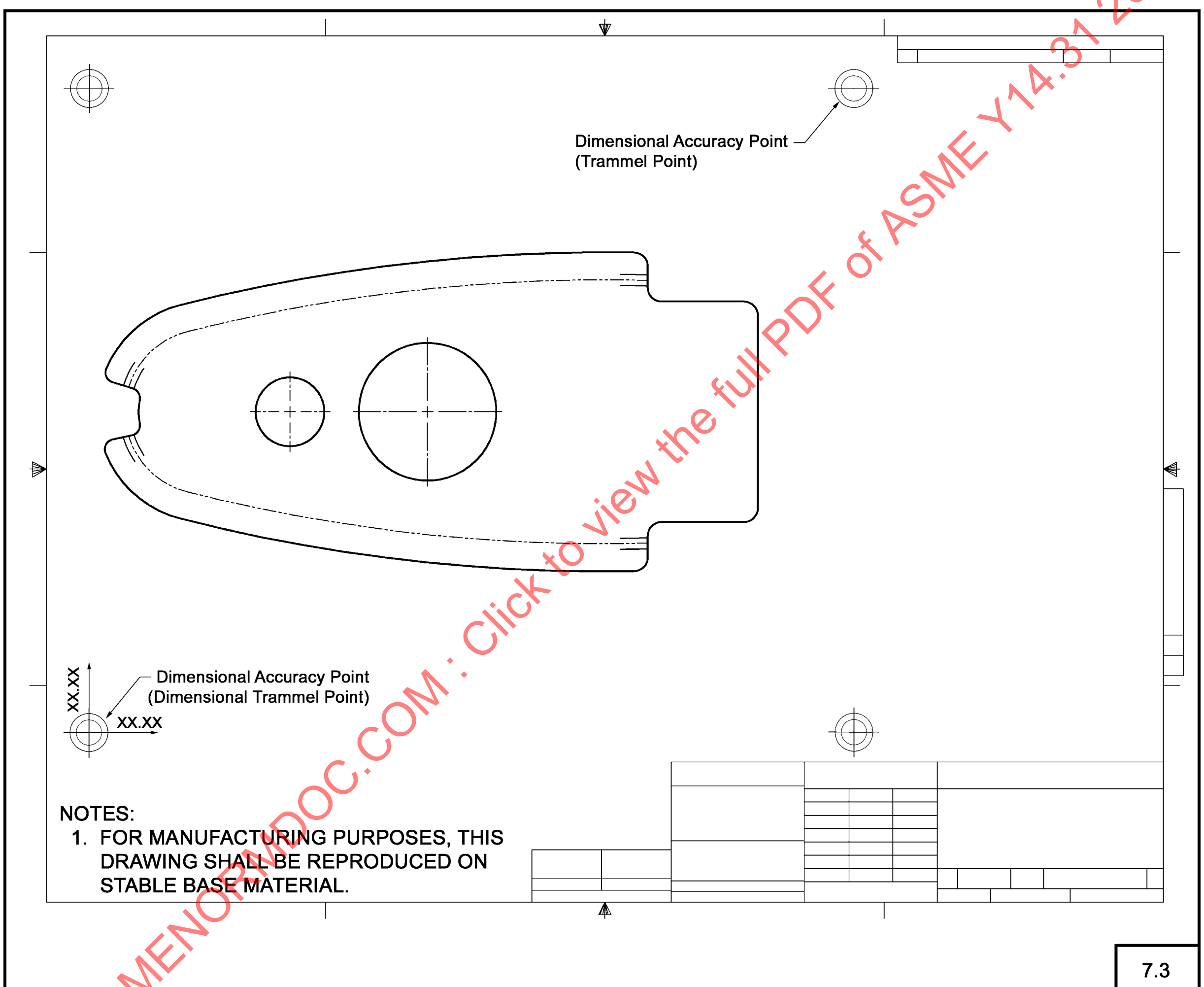

Fig. 7-4 Dimensional Accuracy Point Example on Roll Drawing Form

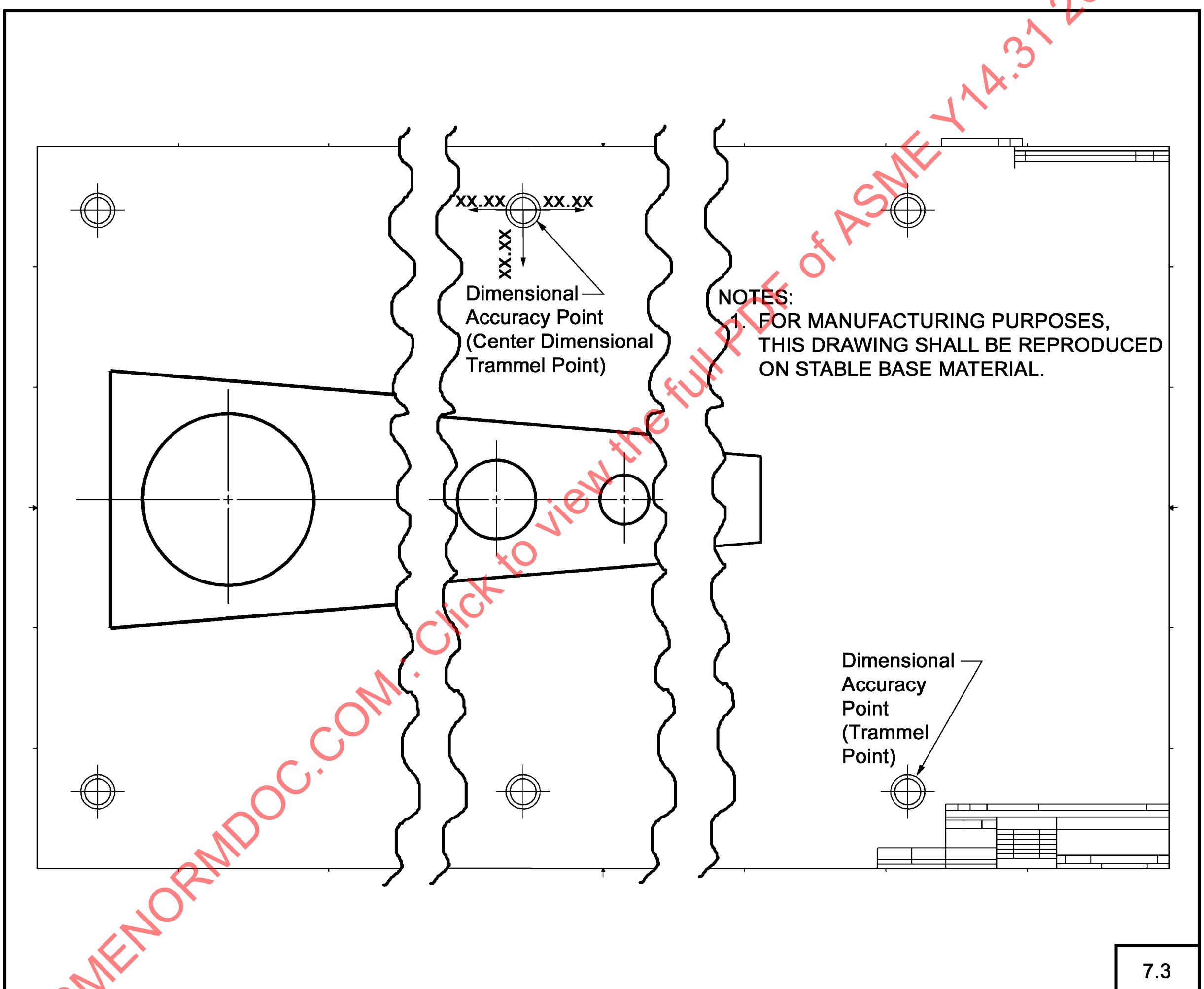

Fig. 7-5 Registration Mark Examples

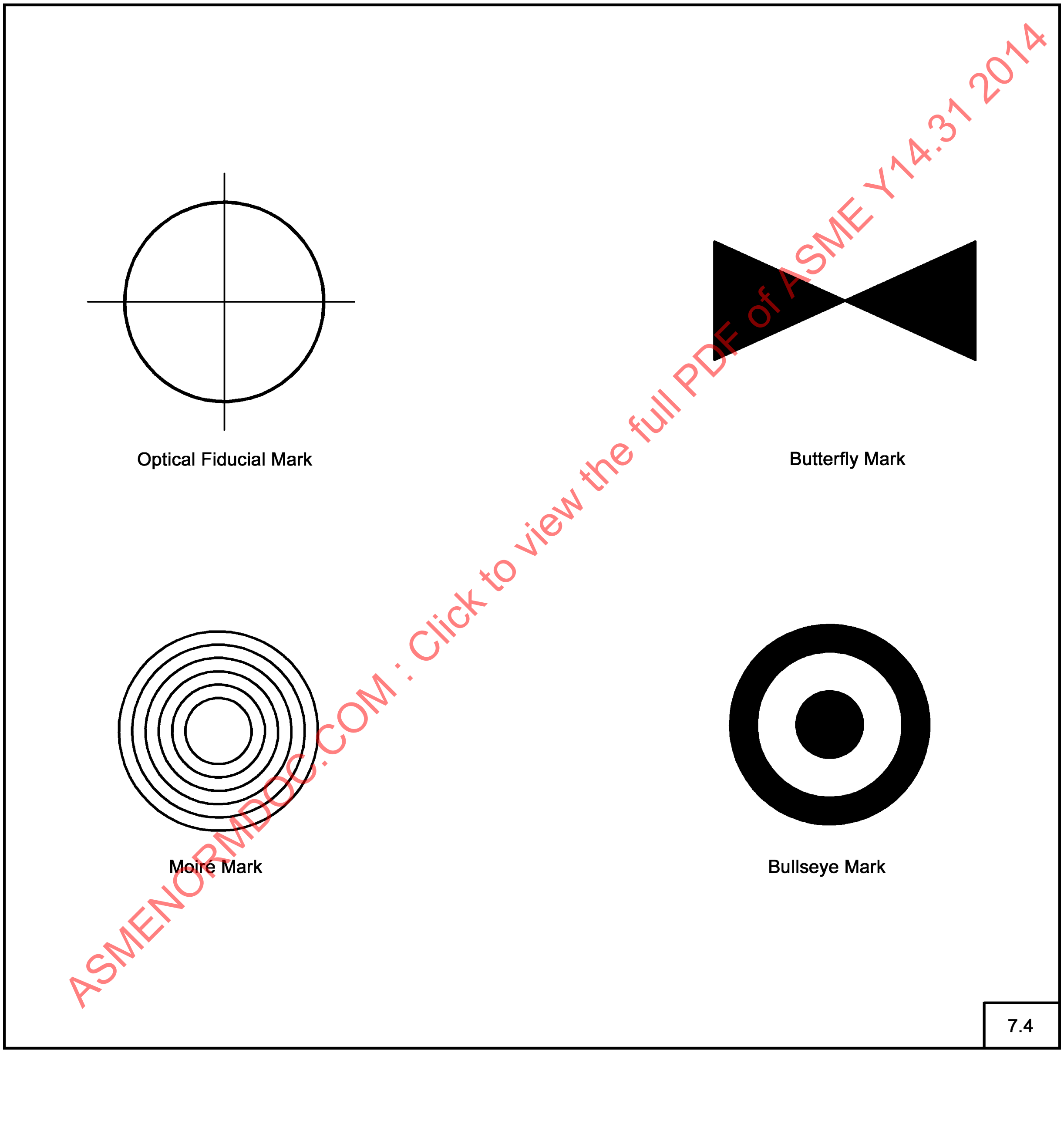

Fig. 8-1 Common Reference for Split Views on Same Sheet

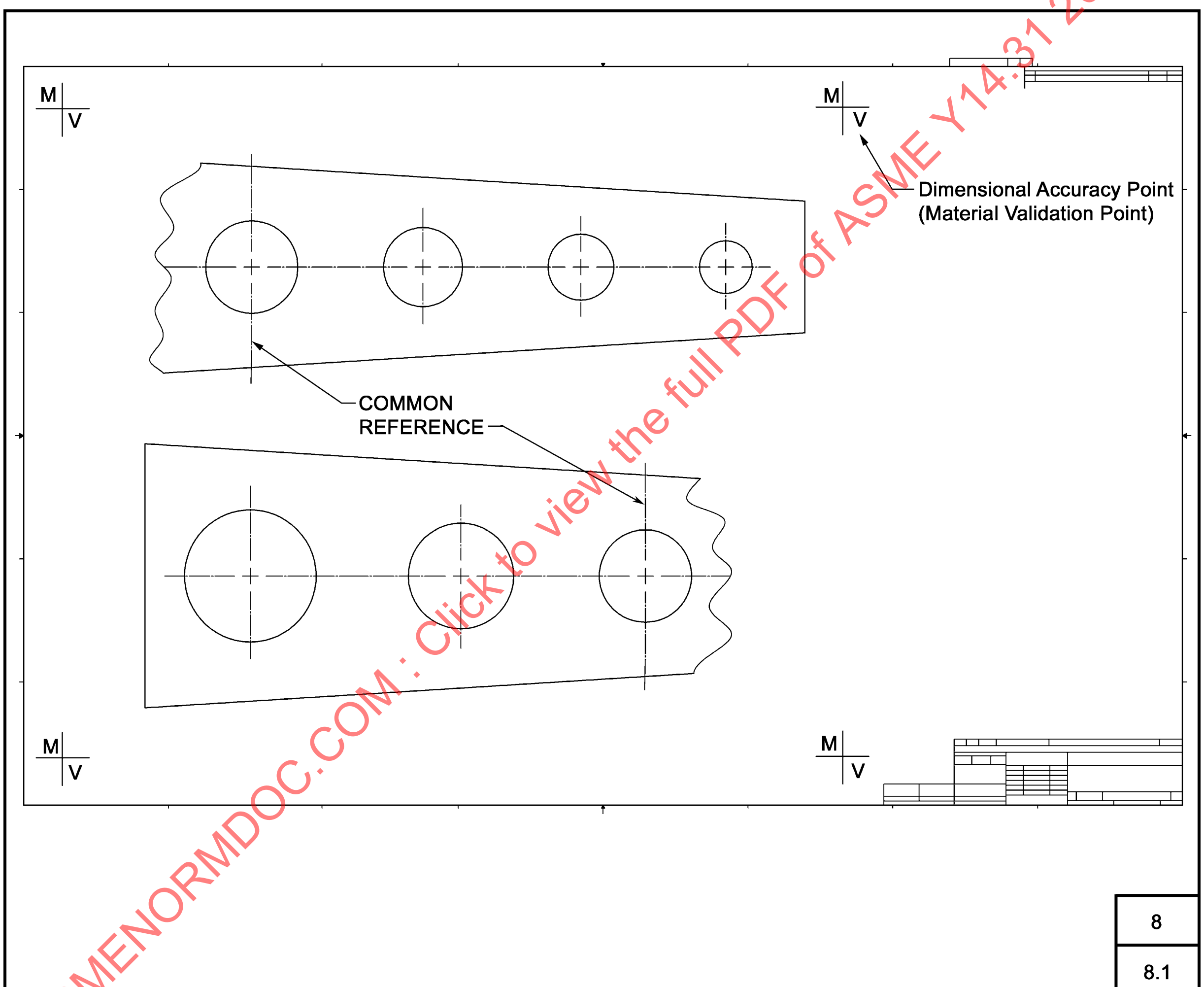

Fig. 8-2 Common Reference for Split Views on Multiple Sheets

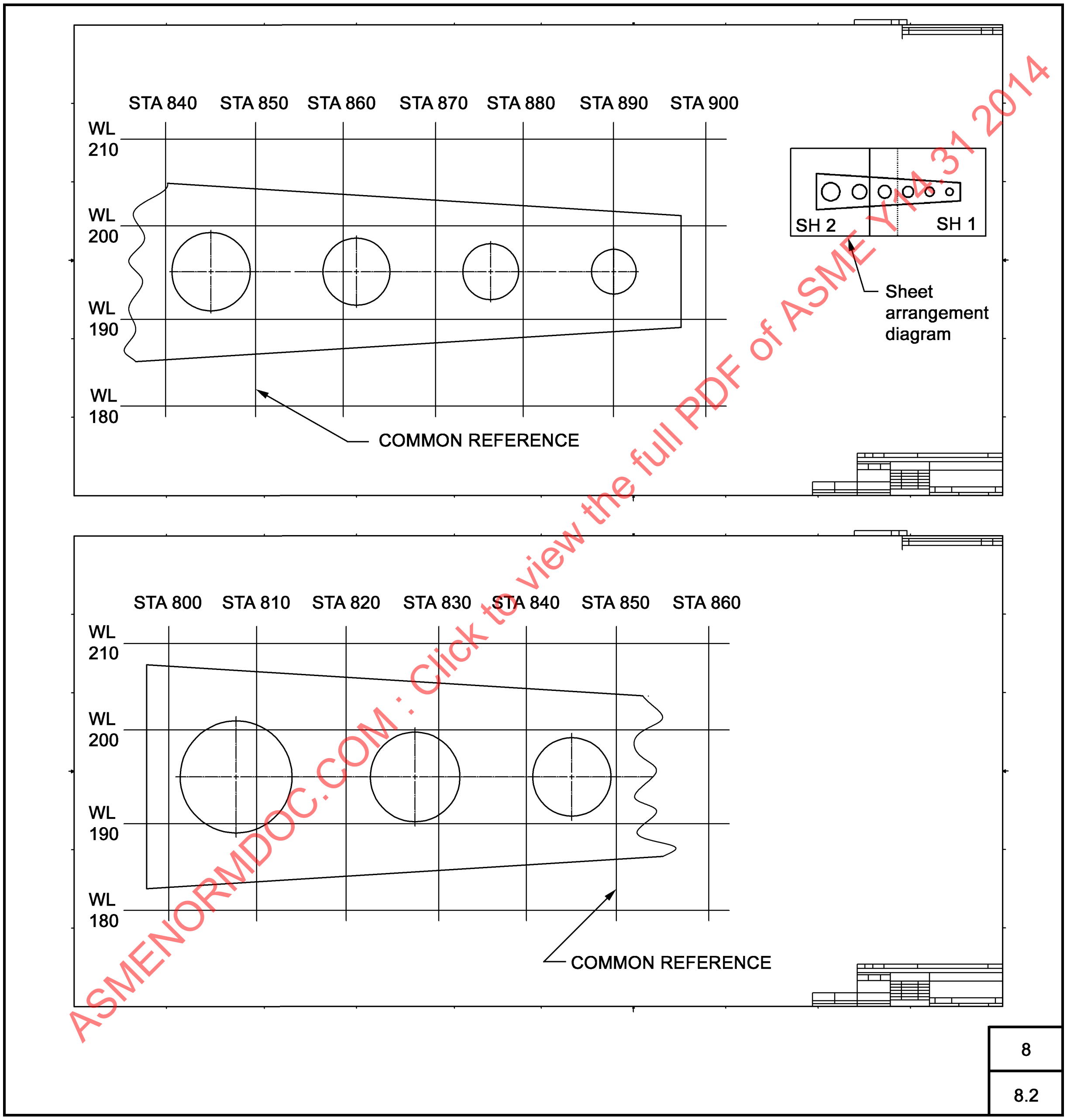

Fig. 12-1 Trim After Forming Example

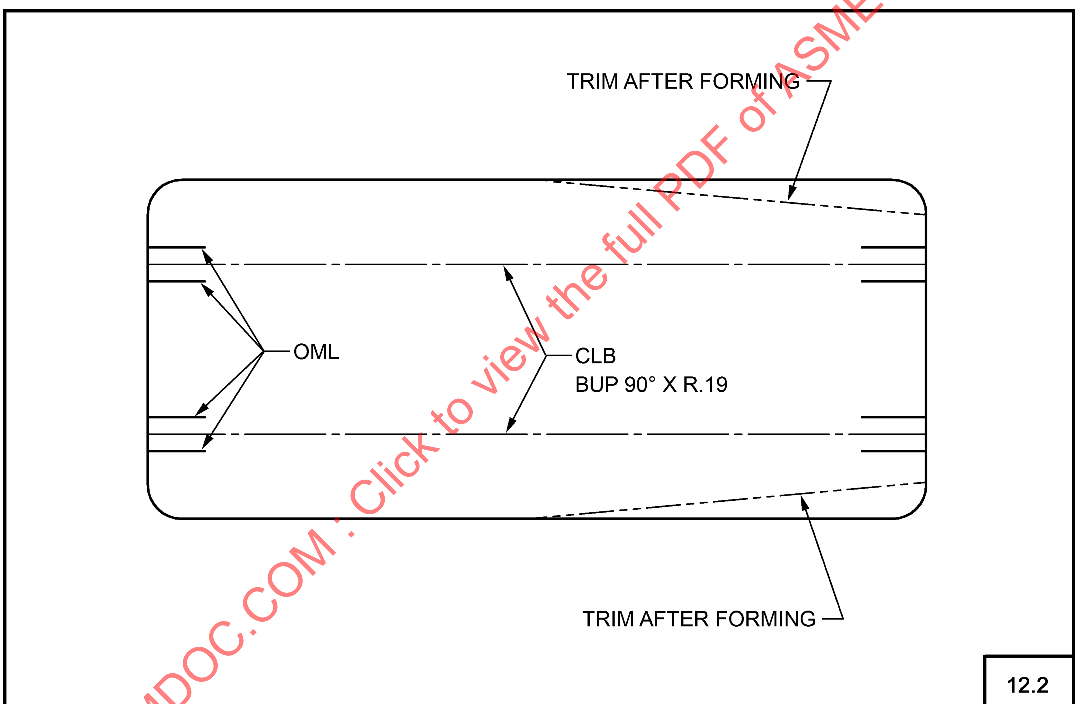

Fig. 12-2 Bend Instructions Example