

**ISO 6947:2019(E)**

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ISO TC 44/SC 7

Secretariat: BSI

**Welding and allied processes — Welding positions**

*Soudage et techniques connexes — Positions de soudage*

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 7, *Representation and terms*.

This fourth edition cancels and replaces the third edition (ISO 6947:2011), which has been technically revised. The main changes compared to the previous edition are as follows:

- Figure 1 and Figure 2 have been revised;
- the concept of a special test position which is not covered by defined test positions has been introduced;
- editorial corrections/improvements have been made.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html). Official interpretations of TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

## Introduction

This document specifies positions for standard discrete test piece orientation, e.g. PA, PB, H-L045, that have been included in this document since the third edition (ISO 6947:2011).

Since the third edition was published, positions for production welding are also defined. These positions are flat, horizontal, vertical, and overhead. Unlike discrete testing positions, these positions are contiguous.

Welding position are not dependent on the geometrical arrangement of the joint, e.g. butt or fillet joint, or that of the semi-finished product. Welds of all types and in all directions are covered.

The direction of welding (i.e. upwards or downwards) can also contribute to defining welding positions.

The main positions have been given symbols which can easily be used for designation purposes; these symbols were not derived from any particular language.

The concept of a special test position, not covered by the existing and well-defined positions, has been included so that testing can be carried out in positions that do not meet the standard requirements.

The relationship between testing positions and production welding positions is specified elsewhere, e.g. in the ISO 9606 series or ISO 15614 series.



# Welding and allied processes — Welding positions

## 1 Scope

This document defines welding positions for testing and production, for butt and fillet welds, in all product forms.

Annex A gives examples of the limits of the slope of a weld axis and the rotation of the weld face about the weld axis for welding positions in production welds.

Annex B gives a comparison of this document and US designation systems for welding positions.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### welding position

position of a weld defined relative to the slope of the axis and rotation of the face of the weld relative to the horizontal plane

### 3.2

#### main welding position

*welding position* (3.1) designated PA, PB, PC, PD, PE, PF, PG, PH, PJ or PK

Note 1 to entry: See Figure 1 and Figure 2 for welding position designations.

### 3.3

#### special test position

##### SP

any *welding position* (3.1) that is not covered by one of the *main welding positions* (3.2) (see 4.3)

### 3.4

#### slope

##### S

<welding positions> angle of the axis of the weld relative to the *main welding position* (3.2)

### 3.5

#### rotation

##### R

<welding positions> angle of the face of the weld relative to the *main welding position* (3.2)

### 3.6

#### inclined angle

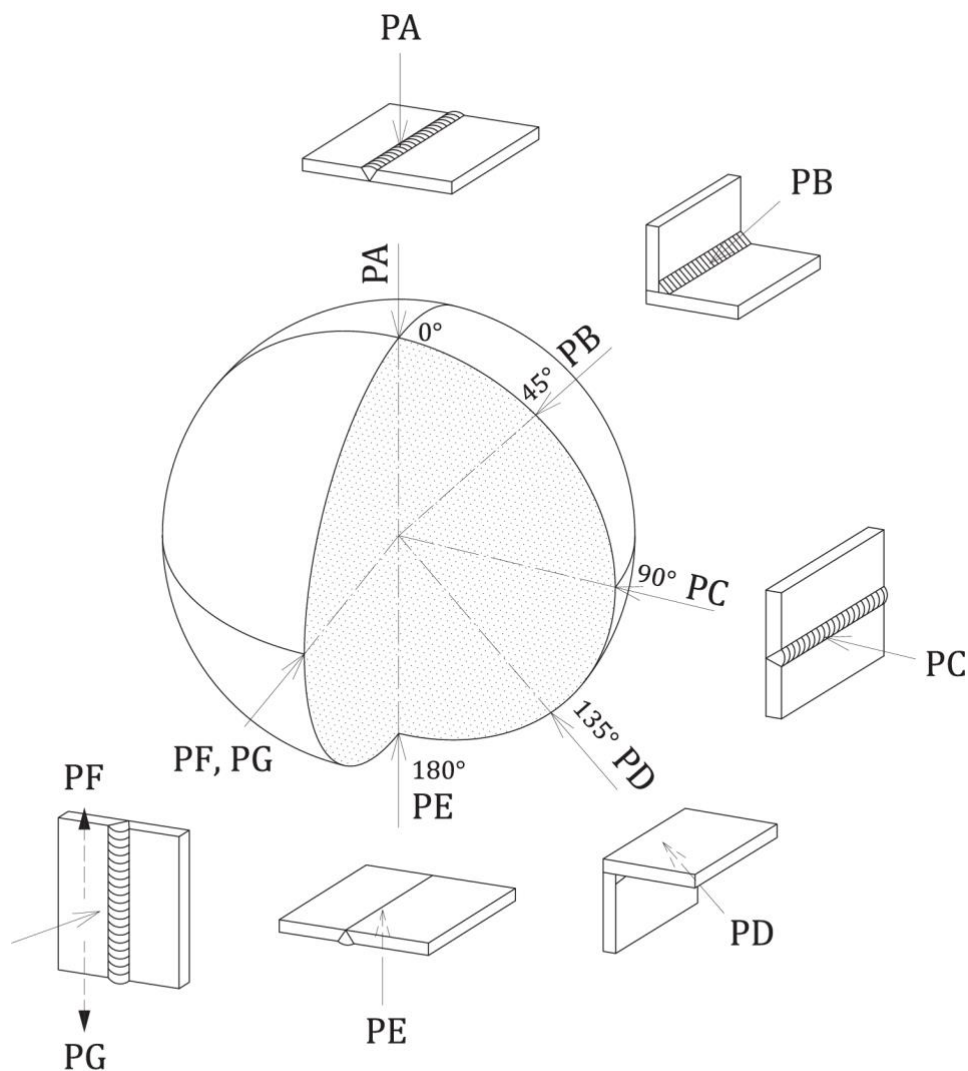
*L*

<welding positions> angle of the axis of the pipe

## 4 Welding positions

### 4.1 Main welding positions

The main welding positions PA to PG are illustrated in Figure 1.



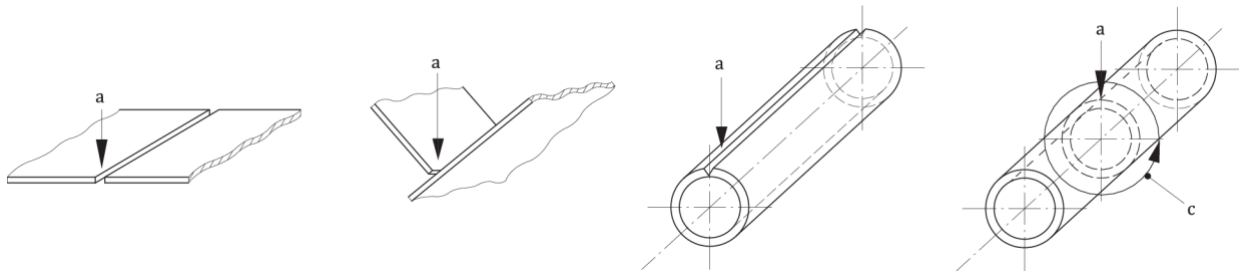
#### Key

- PA flat position
- PB horizontal vertical position
- PC horizontal position
- PD horizontal overhead position
- PE overhead position
- PF vertical position (welding upwards)
- PG vertical position (welding downwards)

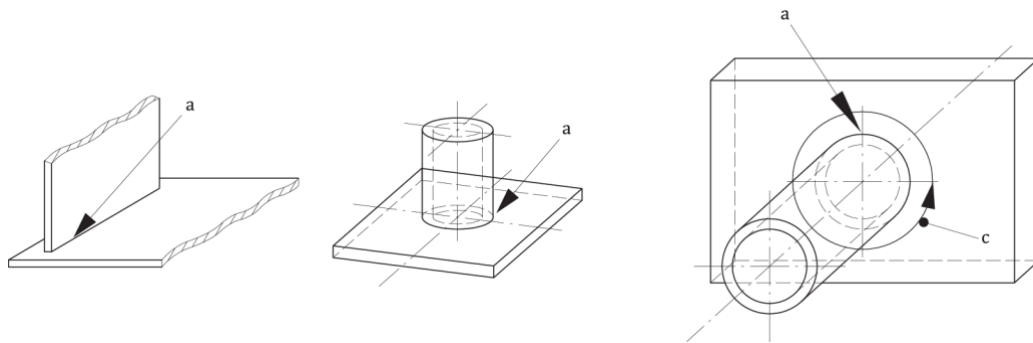
NOTE Solid arrows show the welding position with respect to the face of the weld. Dashed arrows for PF (upwards) and PG (downwards) represent the direction of welding.

**Figure 1 — Main welding positions — PA to PG**

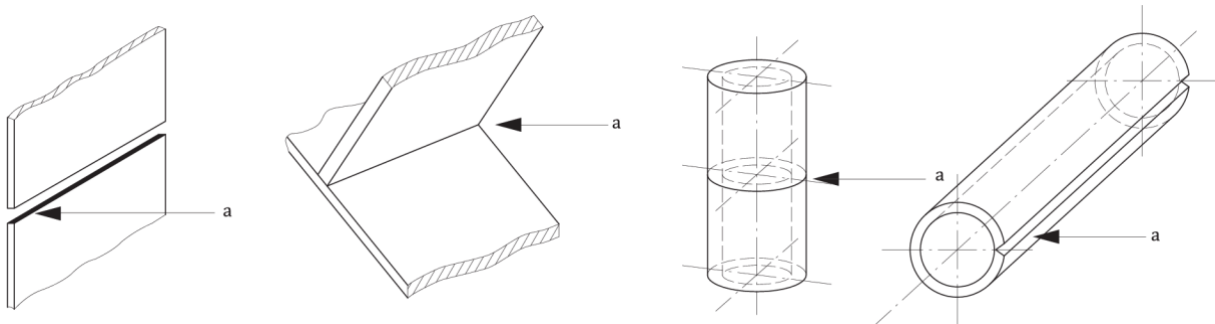
Illustrations of main welding positions for butt and fillet welds are given in Figure 2.



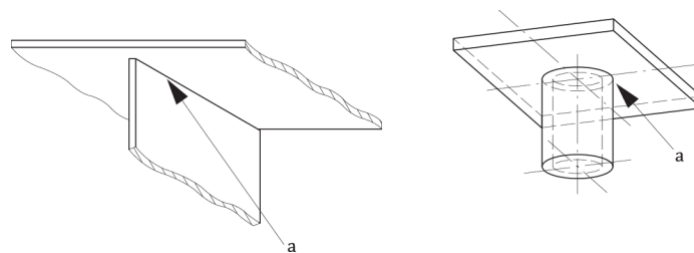
**a) PA: flat position**



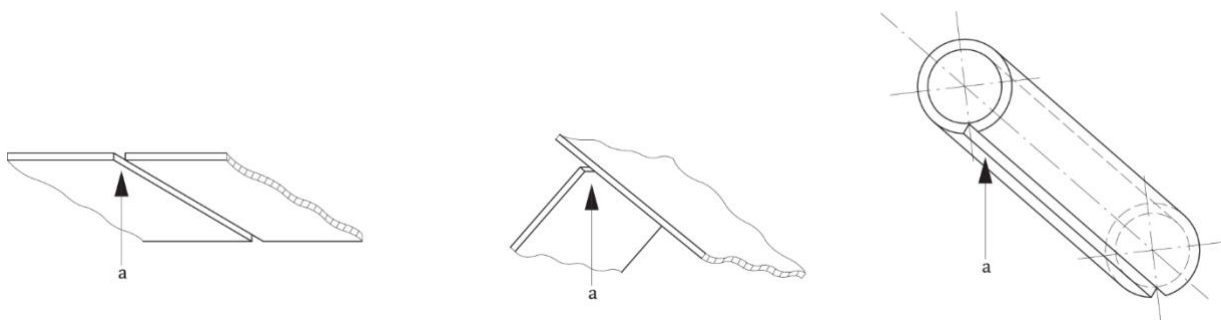
**b) PB: horizontal vertical position**



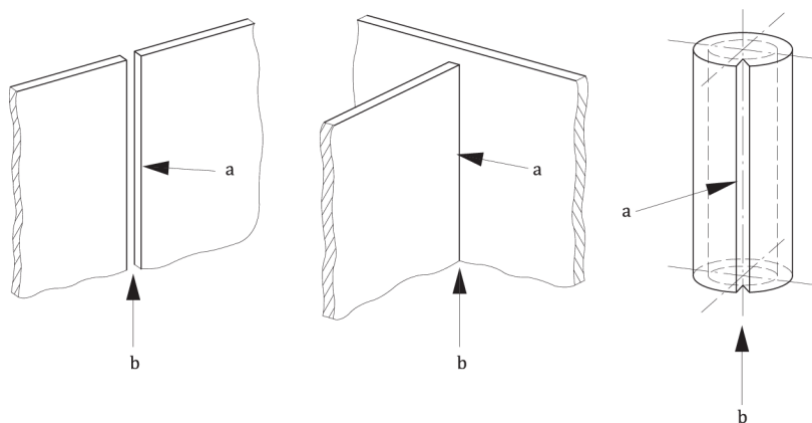
**c) PC: horizontal position**



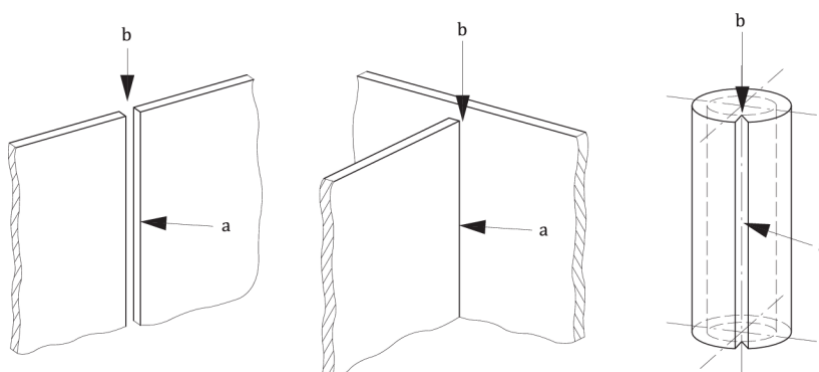
**d) PD: horizontal overhead position**



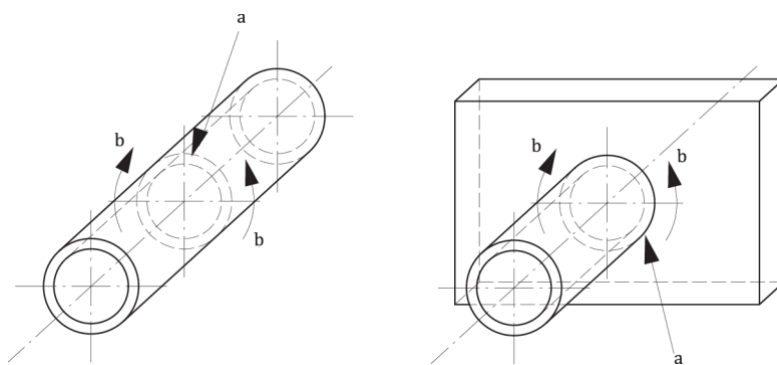
**e) PE: overhead position**



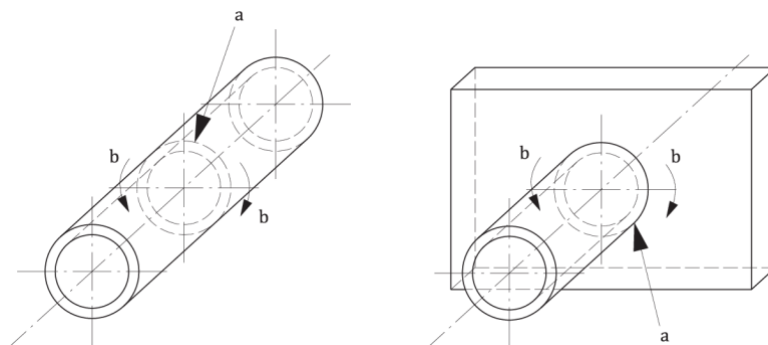
**f) PF: vertical position (welding upwards)**



**g) PG: vertical position (welding downwards)**

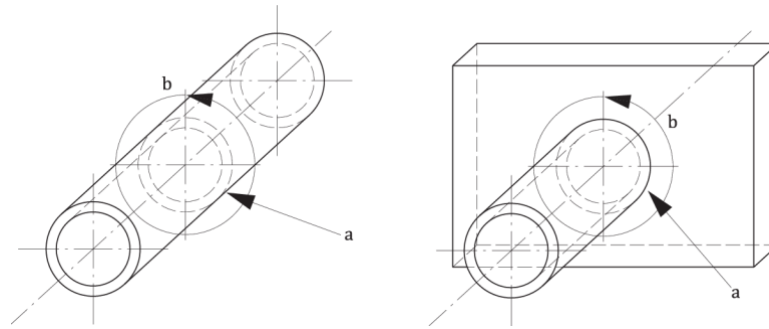


**h) PH: pipe position for welding upwards**



**i) PJ: pipe position for welding downwards**





**j) PK: pipe position for orbital welding**

**Key**

- a The arrow indicates the face of the weld and thus the welding position.
- b The arrow indicates the direction of welding along the joint.
- c The arrow indicates the rotation of the workpieces when welding a pipe in a positioner.

**Figure 2 — Illustrations of main welding positions PA, PB, PC, PD, PE, PF, PG, PH, PJ and PK**

**4.2 Welding positions and allowable deviations for testing**

Welding positions used during welding of a test piece shall not exceed  $\pm 5^\circ$  in slope and  $\pm 10^\circ$  in rotation from the main welding position.

**4.3 Welding positions and ranges in production**

The main welding positions are referenced in other standards, e.g. the ISO 9606 series for qualification of welders, and the ISO 15614 series for qualification of welding procedures.

For production welding, the allowable deviations from the main positions used for qualification of welders and welding procedures are given in Table 1 for butt welds and in Table 2 for fillet welds (see also examples in Annex A). Application standards may extend or restrict the ranges qualified, e.g. an application standard could limit PA to  $15^\circ$  of face rotation rather than  $30^\circ$ .

NOTE For asymmetric tolerances, “plus” means revolving the weld surface towards the main welding position PA and “minus” means revolving the weld surface towards the main welding position PE.

When a test piece is welded using a position outside of the limits (see 3.3) of the main welding positions, the slope and rotation shall be recorded in accordance with Clause 5. The allowable range in production shall be  $\pm 15^\circ$  in slope and in rotation.

**Table 1 — Slope and rotation ranges for welding positions in production butt welds**

Welding position	Main welding position	Slope <i>S</i>	Rotation <i>R</i>
Flat	PA	$\pm 15^\circ$	$\pm 30^\circ$
Horizontal	PC	$\pm 15^\circ$	$+60^\circ$ $-10^\circ$
Overhead	PE	$\pm 80^\circ$	$\pm 80^\circ$
Vertical	PF, PG	$+10^\circ$ to $+75^\circ$	$\pm 100^\circ$
		$\pm 10^\circ$	$\pm 180^\circ$

**Table 2 — Slope and rotation ranges for welding positions in production fillet welds**

Welding position	Main welding position	Slope	Rotation
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		<i>S</i>	<i>R</i>
Flat	PA	±15°	±30°
Horizontal vertical	PB	±15°	+15° -10°
Horizontal	PC	±15°	+35° -10°
Horizontal overhead	PD	±80°	+35° -10°
Overhead	PE	±80°	±35°
Vertical	PF, PG	+10° to +75°	±100°
		±10°	±180°

## 5 Designation

Main welding positions shall be designated by the appropriate symbol in accordance with Figure 1 and Figure 2 (see EXAMPLE 1). The symbol for the main welding position may be supplemented by the values for slope and rotation, given in three digits (see EXAMPLE 2).

When a test piece is welded in a position outside of the limits of the main welding positions, the allowable range in production is ±15° in slope and in rotation. These supplementary values are mandatory when the test piece used for qualification was outside of the slope and rotation limits specified in 4.2.

For circumferential welds in pipes with inclined axes, the indication of slope and rotation shall be simplified in accordance with Figure 2 (see EXAMPLES 3 and 4).

EXAMPLE 1 The main welding position “horizontal vertical” (PB) is:

PB

This is a standard test position and the range qualified is in accordance with Table 2.

EXAMPLE 2 The main welding position “horizontal vertical” (PB), with slope of 15° and rotation of 10°, is:

PB 015-010

This is a special position for which the range qualified is from 0° to 30° of slope and -5° to 25° of face rotation unless specified otherwise in the application standard.

EXAMPLE 3 The welding position on pipes with inclined axes, with welding direction “welding upwards” (PH) and an inclined angle of 45°, is:

PH-L045

This is a special position for which the range qualified is all slopes and to 45° of face rotation with upward progression. The application standard can specify a different range.

EXAMPLE 4 The welding position on pipes with inclined axes, with welding direction “welding downwards” (PJ) and an inclined angle of 45°, is:

PJ-L045

This is a special position for which the range qualified is all slopes and from 30° to 60° of face rotation with downward progression. The application standard may specify a different range.

NOTE In EXAMPLES 3 and 4, the inclined angle given is an example.

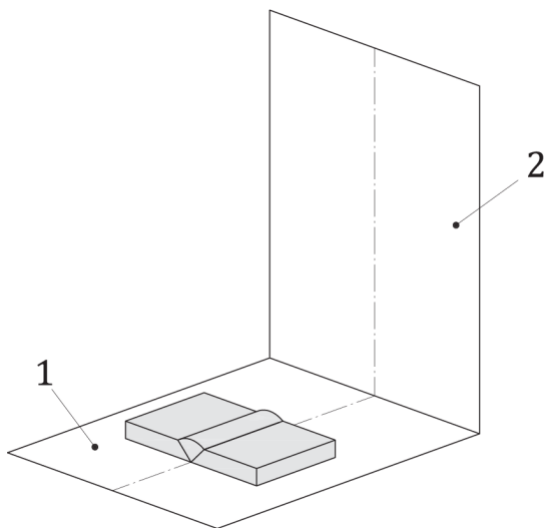
## Annex A (informative)

### Limits of the slope of a weld axis and the rotation of the weld face about the weld axis for welding positions in production welds

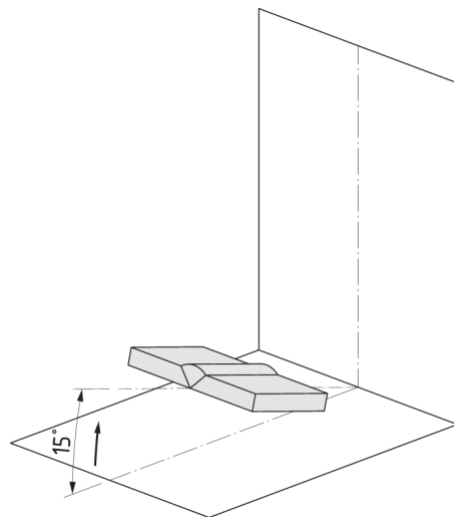
This annex describes, through a series of sketches, the limits of the slope of a weld axis and the rotation of the weld face about the weld axis for welding positions in production welds (see Table 1 and Table 2).

Figures A.1 to A.4 show sketches for butt welds and Figures A.5 and A.6 show sketches for fillet welds.

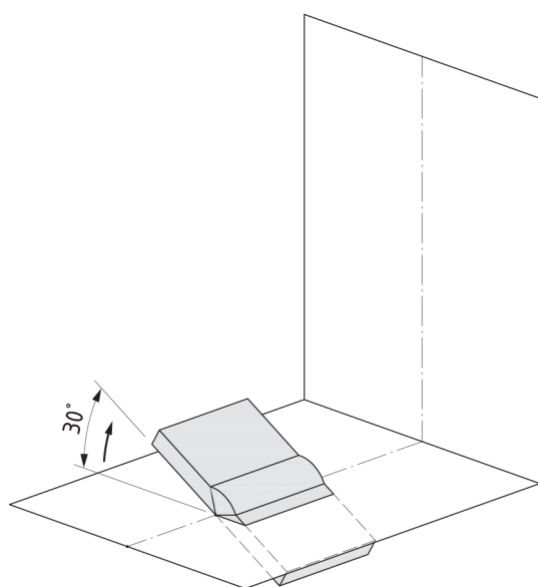
NOTE The convention shown in Figure A.1 a) for horizontal plane and vertical plane applies to all figures in Annex A.



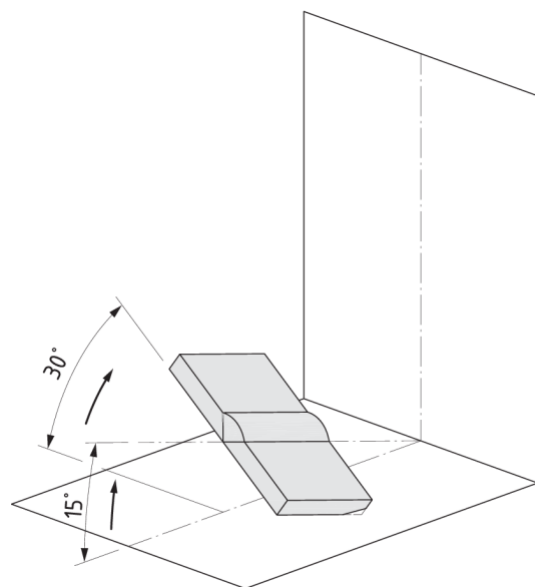
a) Main welding position (PA)



b) Flat position (PA) slope limit



c) Flat position (PA) rotation limit

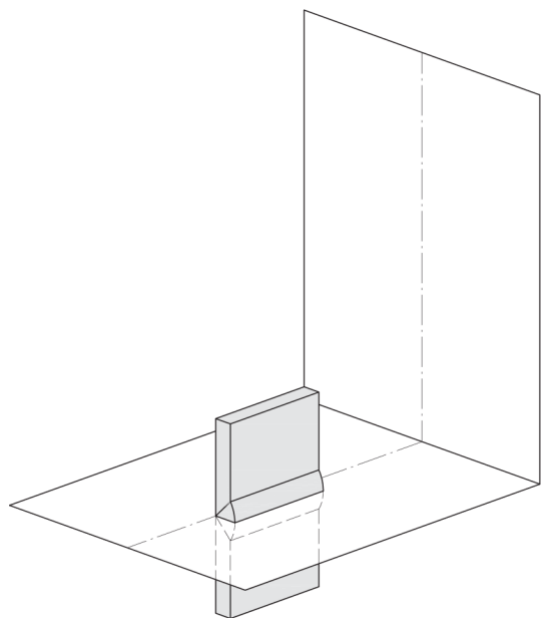


d) Flat position (PA) slope limit and rotation limit

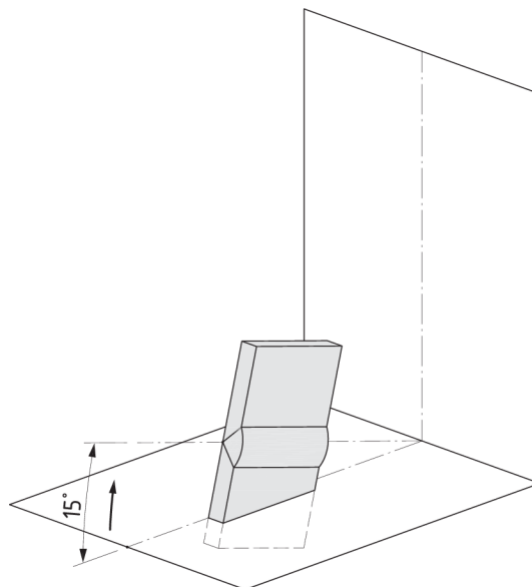
Key

- 1 horizontal plane
- 2 vertical plane

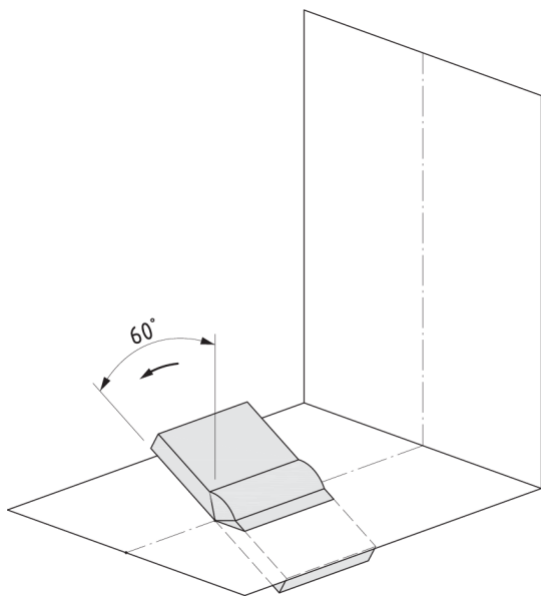
Figure A.1 — Welding position PA slope and rotation limits for butt welds



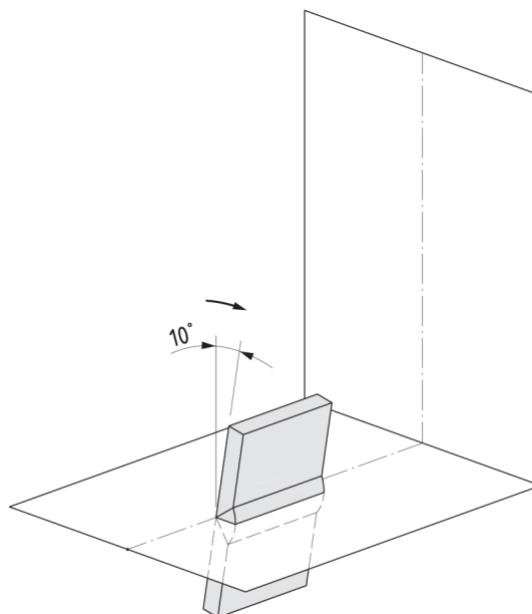
a) Main welding position (PC)



b) Horizontal position (PC) slope limit

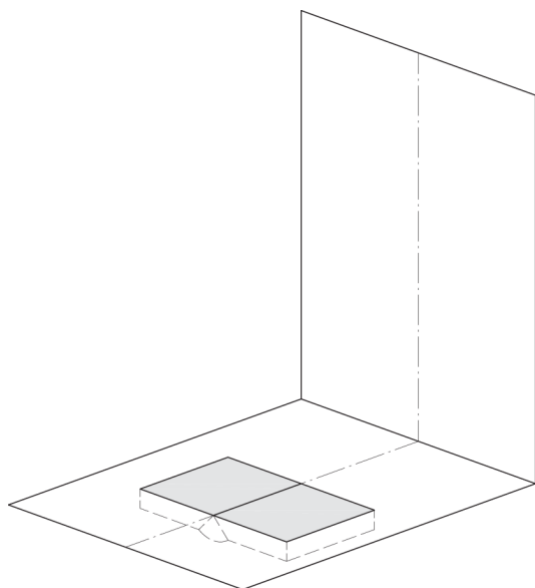


c) Horizontal position (PC)  
rotation limit (+60°)

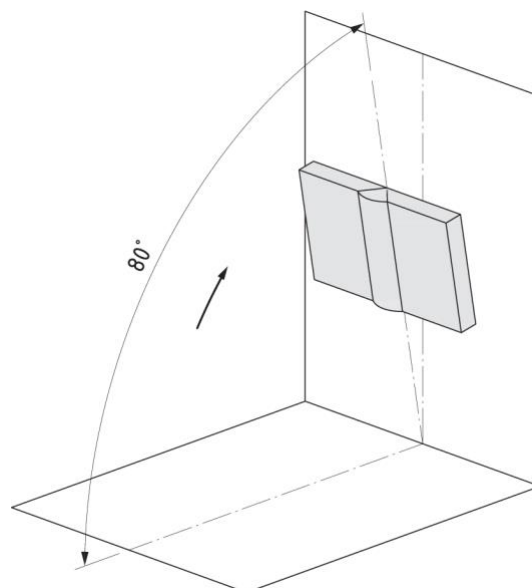


d) Horizontal position (PC)  
rotation limit (-10°)

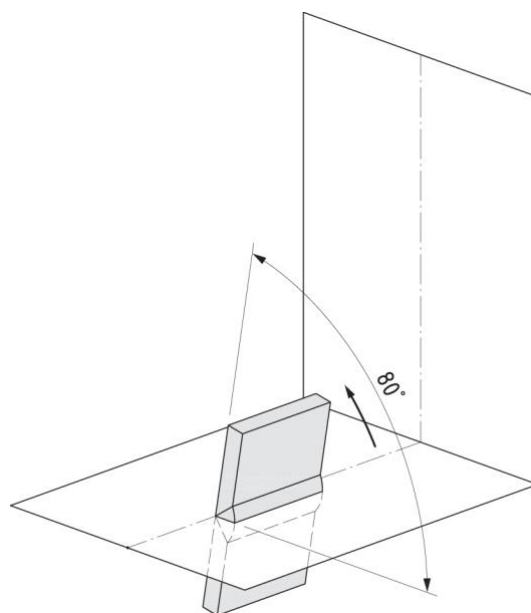
Figure A.2 — Welding position PC slope and rotation limits for butt welds



**a) Main welding position (PE)**

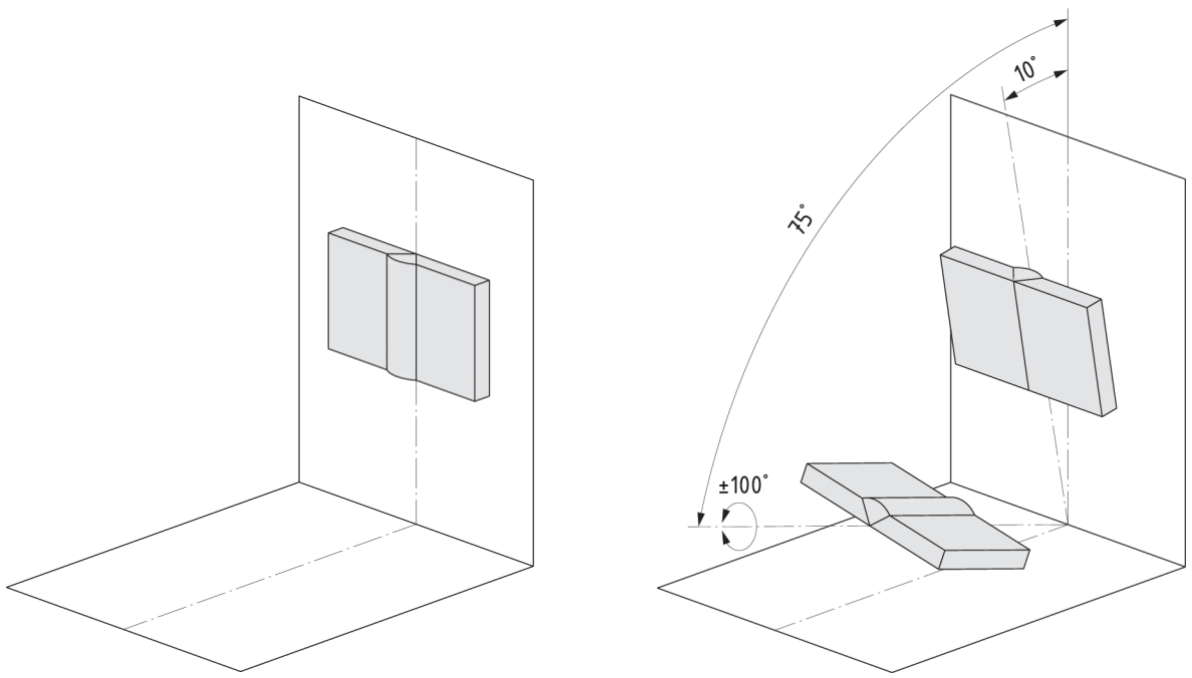


**b) Overhead position (PE) slope limit**



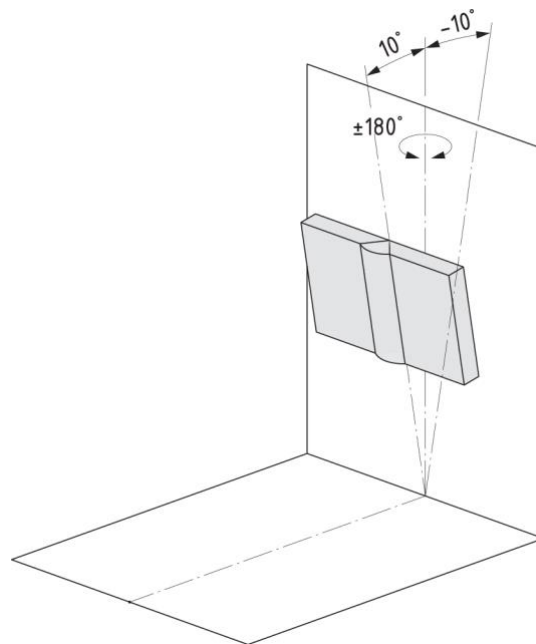
**c) Overhead position (PE)  
rotation limit**

**Figure A.3 — Welding position PE slope and rotation limits for butt welds**



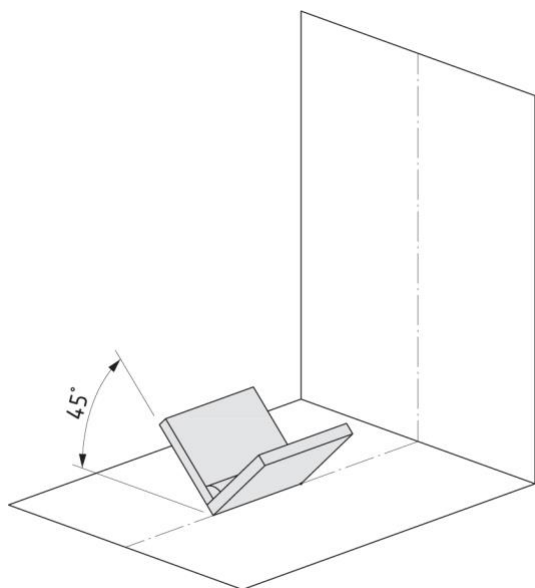
**a) Main welding position (PF, PG)**

**b) Vertical position (PF, PG) slope limit and rotation limit**

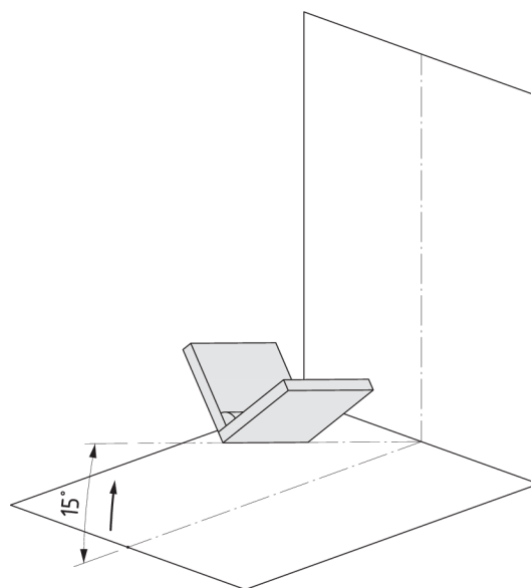


**c) Vertical position (PF, PG) slope limit and rotation limit**

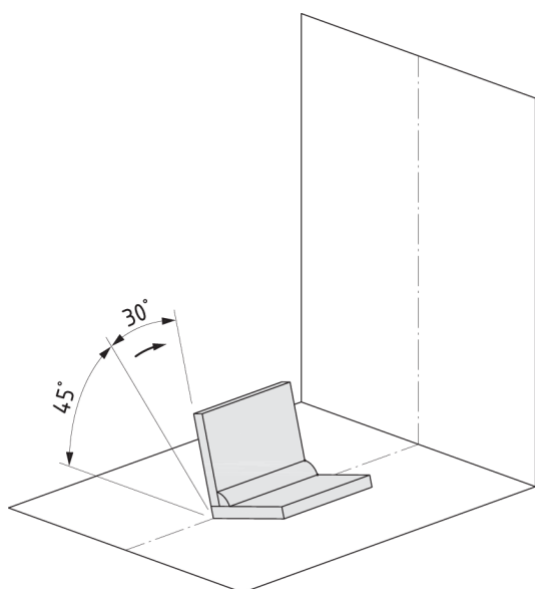
**Figure A.4 — Welding position PF, PG slope and rotation limits for butt welds**



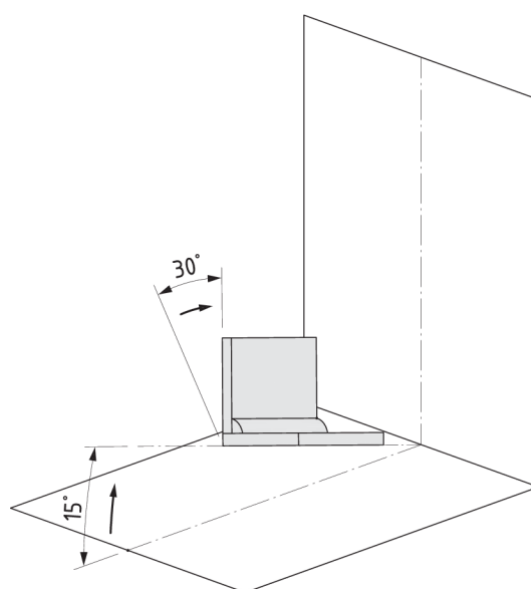
**a) Main welding position (PA)**



**b) Flat position (PA) slope limit**

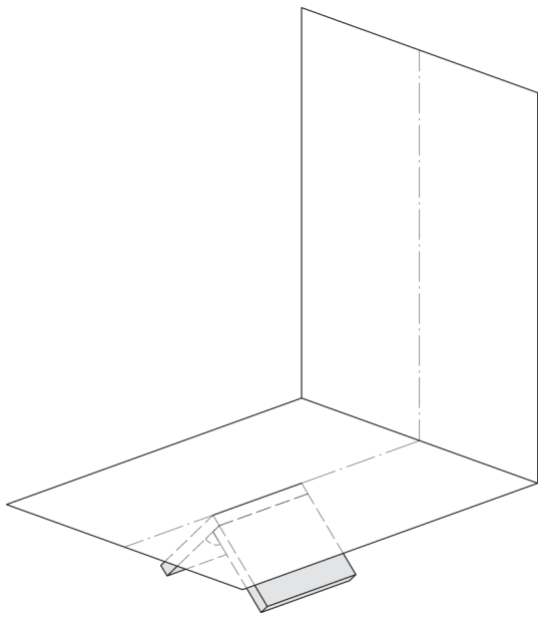


**c) Flat position (PA) rotation limit**

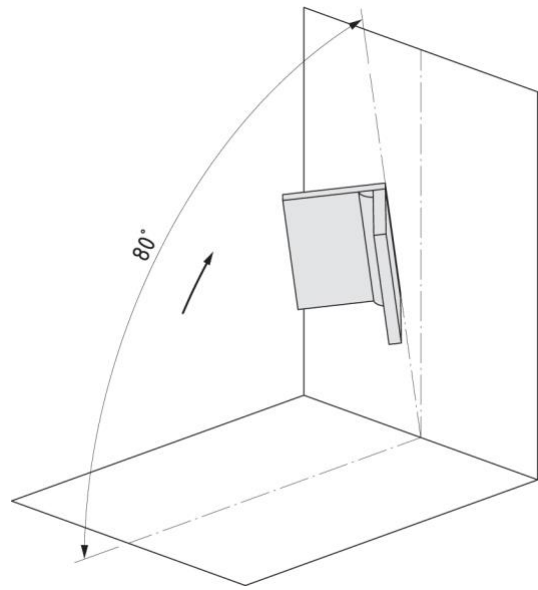


**d) Flat position (PA)  
slope limit and rotation limit**

**Figure A.5 — Welding position PA slope and rotation limits for fillet welds**



**a) Main welding position (PE)**



**b) Overhead welding position (PE) slope limit**

**Figure A.6 — Welding position PE slope and rotation limits for fillet welds**

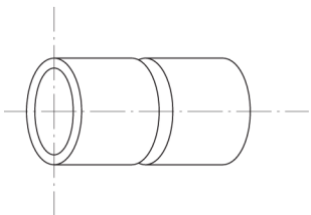
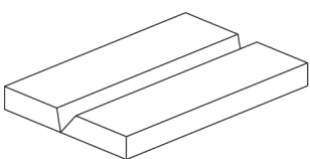
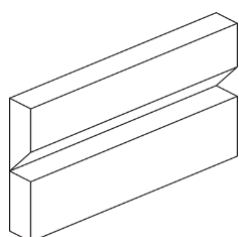
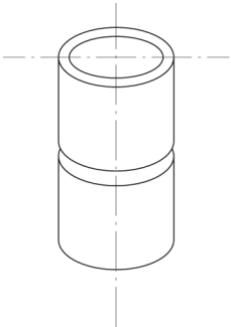
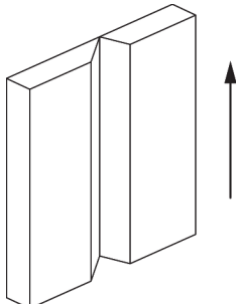


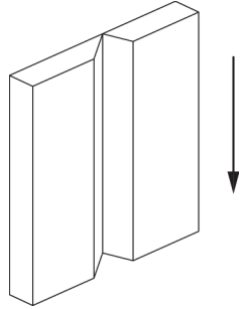
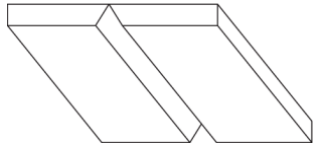
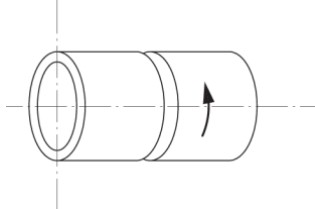
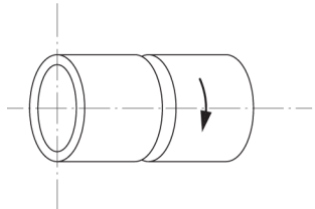
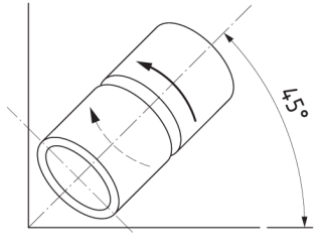
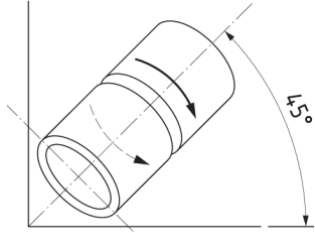
## Annex B (informative)

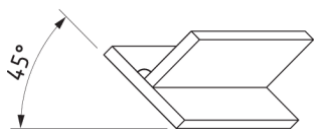
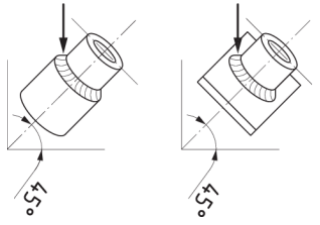
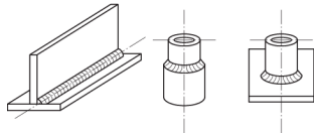
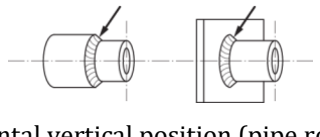
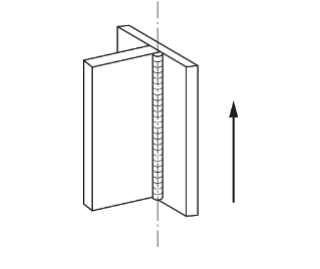
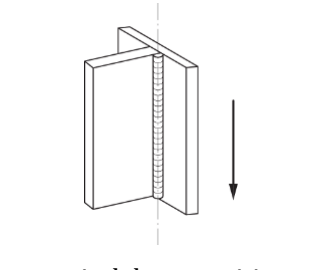
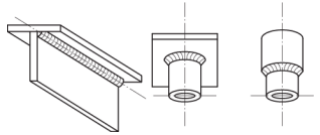
### Comparison of this document and US designation systems for welding positions

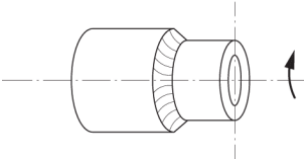
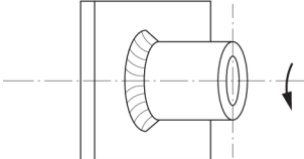
Table B.1 provides a comparison of this document and US designation systems for welding positions<sup>[3][4]</sup>.

**Table B.1 — Comparison of this document and US designation systems for welding positions**

Illustration		Welding position in accordance with AWS A3.0M/A3.0 and ASME Section IX	Welding position in accordance with this document
 flat position (pipe rotating)	 flat position	1G	PA
 horizontal position	 horizontal position	2G	PC
 vertical up position		3G uphill	PF

 <p>vertical down position</p>	<p>3G downhill</p>	<p>PG</p>
 <p>overhead position</p>	<p>4G</p>	<p>PE</p>
 <p>vertical up position (pipe fixed)</p>	<p>5G uphill</p>	<p>PH</p>
 <p>vertical down position (pipe fixed)</p>	<p>5G downhill</p>	<p>PJ</p>
 <p>inclined position (pipe fixed) welding upwards</p>	<p>6G uphill</p>	<p>PH-L045<sup>a</sup></p>
 <p>inclined position (pipe fixed) welding downwards</p>	<p>6G downhill</p>	<p>PJ-L045<sup>a</sup></p>

 <p>45°</p> <p>flat position</p>	<p>1F</p>	<p>PA</p>
 <p>45°</p> <p>45°</p> <p>flat position (pipe rotating)</p>	<p>1FR</p>	<p>PA</p>
 <p>horizontal vertical position</p>	<p>2F</p>	<p>PB</p>
 <p>horizontal vertical position (pipe rotated)</p>	<p>2FR</p>	<p>PB</p>
 <p>vertical up position</p>	<p>3F uphill</p>	<p>PF</p>
 <p>vertical down position</p>	<p>3F downhill</p>	<p>PG</p>
 <p>horizontal overhead position</p>	<p>4F</p>	<p>PD</p>

 <p data-bbox="384 416 746 450">vertical up position (pipe fixed)</p>	<p data-bbox="1058 320 1161 353">5F uphill</p>	<p data-bbox="1321 320 1362 353">PH</p>
 <p data-bbox="368 663 762 696">vertical down position (pipe fixed)</p>	<p data-bbox="1042 566 1177 600">5F downhill</p>	<p data-bbox="1329 566 1362 600">PJ</p>
<p data-bbox="150 719 564 752"><sup>a</sup> The inclined angle is an example only.</p>		

## Bibliography

- [1] ISO 9606 (all parts), *Qualification testing of welders — Fusion welding*
- [2] ISO 15614 (all parts), *Specification and qualification of welding procedures for metallic materials — Welding procedure test*
- [3] ASME Section IX, ASME boiler and pressure vessel code — Section IX: Welding and brazing qualifications
- [4] AWS A3.0M/A3.0, *Standard welding terms and definitions including terms for adhesive bonding, brazing, soldering, thermal cutting, and thermal spraying*