

Definition of the protected field of the camera-based protection system PSEnvip



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March 2013

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Abbreviations

Muting	Timely limited automatic suspension of safety functions
AP	A pplication P rogram
OD	O verrun D istance

1. Useful documentation

Reading the documentation listed below is necessary for understanding this application note. The availability of the indicated tools and safe handling are also presupposed with the user.

1.1. Documentation from Pilz GmbH & Co. KG

No.	Description	Item No.
1	Pilz international homepage, download section	www.pilz.com
2	Operating Manual PSEnvip	1001 276-EN-xx
3		
4		
5		
6		

1.2. Documentation from other sources of information

No.	Description	Item No.
1		
2		

2. Application Task

This Application Note describes how the protected field of the camera-based protection system PSEnvip is defined, based on tool shape, tool position and configured overrun distance.

The protected field is defined once the tool change adjustment has been completed by the PSEnvip. The operator has only limited opportunity to influence this, e.g. by changing the tool position.

However, knowing how the protected field is defined can help the operator understand the system behaviour.

2.1. Precision and tolerances

All dimensions stated in this document are nominal dimensions. They refer to the tool shape and position detected by the system.

When detecting the tool shape and position and consequently when defining the geometry of the protected field, there are system-based tolerances as well as other influences outside the system, which can influence the geometry of the protected field.

System-based tolerances are:

- ▶ +/- 0.8mm for x and y position of the tool centre point and for the position of the bending lines

Influences outside the system are:

- ▶ An angular misalignment of the receiver in a vertical direction will falsify the y position of the tool and thereby the protected field. This effect is increased with distance from the receiver. As a result, it is strongest on large presses close to the transmitter. For this reason it's important that the initial adjustment using the templates is very precise.
- ▶ In combination with the safety control system, the PSEnvip signals (OSSD, Mute) may need to be calibrated with the application program (AP). Additional run times and cycle times for the safety control system must be considered in this calibration, as well as the current speed of the press.

2.2. Pointed tools of tool class 1

These tools can be safeguarded in compliance with the standards. These tools include the following:

- ▶ Pointed tools with an angle up to 90° . The radius of the tool centre point may be a maximum of 2mm.
- ▶ If the tool is not symmetrical to the bending line, the angle of the front surface of the tool to the vertical may be a maximum of 45° . The key factor here is the straight line between the lowest point and the front surface at 6mm height.
- ▶ Stamping tools with a width $<4\text{mm}$ are also regarded as pointed tools.

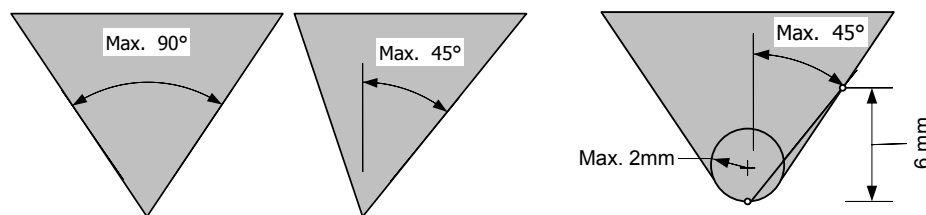


Fig. 1: Standard tool shapes

The tool X position should generally be on the rear adjustment auxiliary line. For a standard tool, it may be a maximum of 15mm in front of or 4mm behind this rear adjustment auxiliary line.

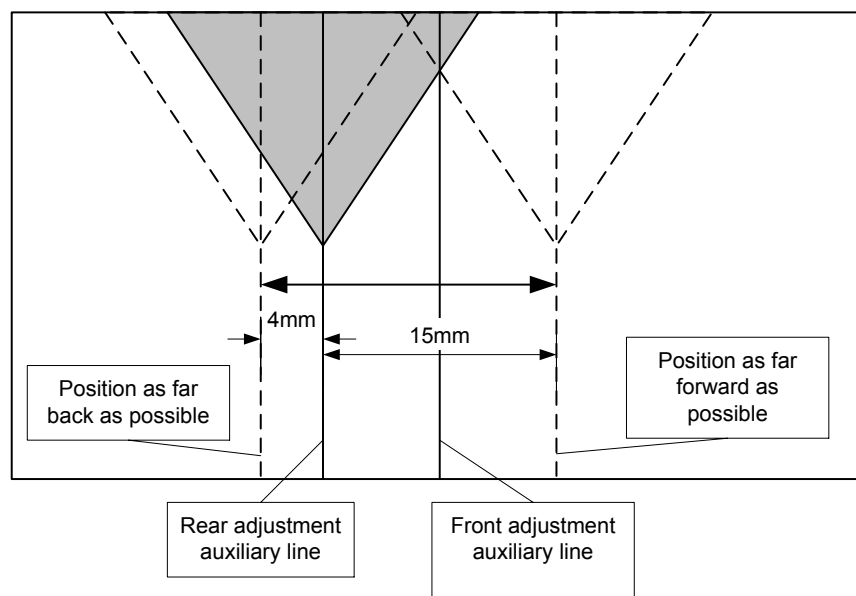


Fig. 2: Standard tool position

A large number of monitoring beams span the protected field for standard tools. These are distributed within the PSEnvip's detection zone, based on the tool X position and the tool shape. The protected field consists of three areas (see Fig. 3). These areas can be partly blanked via the reduced protected field modes.

- ▶ The central protected field is 1.2mm behind the bending line and has a width of 1.6 / 4mm. It safeguards the immediate danger zone and is always active in the reduced protected field modes.
 - The width in the basic version is always 1.6 mm; the width in the productive version is 1.6mm during most muting steps.
 - In the last muting step with a minimum protected field, the width is 4mm.
 - So, adding on the system tolerances, the central protected field starts between 0.4 and 2mm behind the bending line and ends between 2 and 6mm behind the bending line.
- ▶ The upstream protected field is used for premature shutdown in the event of a side intervention. It can be muted in box mode, to prevent a protected field being violated by a box that has already been bent. The front protected field always ends in front, irrespective of the tool position, 30mm ahead of the rear adjustment auxiliary line. So the actual width of the front protected field varies if the tool centre point does not lie exactly on the rear adjustment auxiliary line.
- ▶ The downstream protected field is used for protection against reaching behind the system. It can be muted in back gauge mode, to prevent a protected field being violated by the back gauge. The rear protected field ends 12mm behind the tool bending line.
- ▶ The front and rear protected field can also be muted simultaneously in box/back gauge mode. The fact that an area has been muted must be acknowledged by the operator with each press stroke.

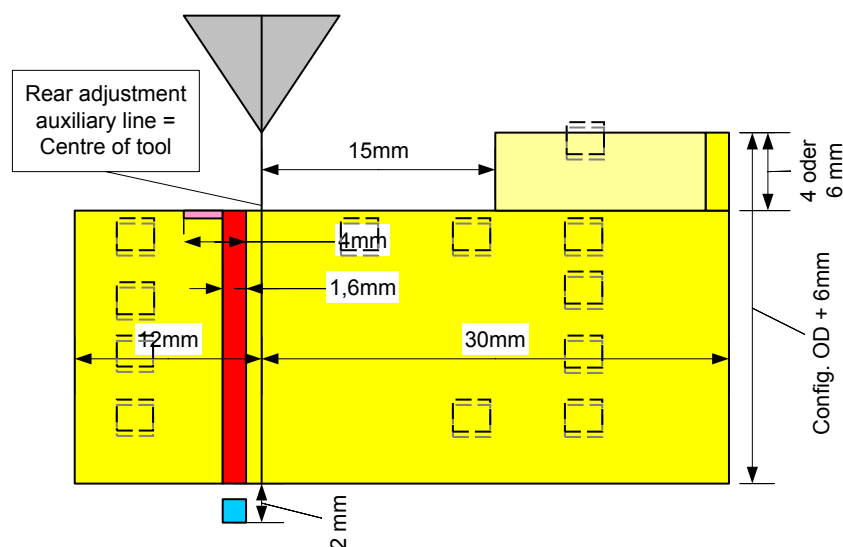


Fig. 3: Standard protected field

The protected field starts 4 or 6mm below the tool, depending on the overrun distance. The value depends on the configured overrun distance and the current muting step (on the productive version). These are the overrun reserve and simultaneously the swarf tolerance in the event of contamination on the tool.

It ends 6mm plus the configured overrun distance (between 2 and 14mm) below the tool.

In the front area, the front protected field extends to the height of the tool. This serves as additional protection for intervention diagonally from above.

The width of this elevated area is variable.

- ▶ In the basic version and in the non-muted protected field in the productive version it is just 1.6mm wide.
- ▶ However, it extends to up to 15mm towards the bending line in the course of dynamic muting.

In the productive version, at the end of the working movement the protected field is held at the pinch point 2mm below the central protected field by an advance measuring field and is gradually reduced in height from the top.

2.3. Wide and horizontal tools of tool class 1

These tools can be safeguarded in compliance with the standards. These tools include the following:

- ▶ Stamping tool (width from 4-32mm), see Fig. 4
- ▶ Semi-circular tools (radius between 2 and 25mm), see Fig. 5.
- ▶ Special forms (e.g. Z-bending tools up to a width of 32mm), see Fig. 6.

These tools have 2 bending lines:

- ▶ On vertical tools (front surface max. 45° to vertical), the front bending line is on the tool centre point, (see Fig. 6).
- ▶ On flat tools (front surface > 45°), the front bending line is at the front of the tool, at a height of 6mm (see Fig. 5).
- ▶ The rear bending line is at the rear of the tool, at a height of 2mm.

On these tools too, the centre of the tool should be on the rear adjustment auxiliary line. For tool class 1, the front bending line may be a maximum of 16mm ahead of the rear adjustment auxiliary line; the rear bending line may be a maximum of 16mm behind it.

The protected field for these tools looks as follows¹:

- ▶ The central protected field is 1.2mm behind the front bending line and has a width of 1.6 / 4mm. It safeguards the immediate danger zone and is always active in the reduced protected field modes.
 - So, adding on the system tolerances, the central protected field starts between 0.4 and 2mm behind the bending line and ends between 2 and 6mm behind the bending line.
- ▶ The upstream protected field is used for premature shutdown in the event of a side intervention. It can be muted in box mode, to prevent a protected field being violated by a box that has already been bent. The front protected field always ends at the front, 30mm ahead of the rear adjustment auxiliary line.
- ▶ The rear protected field ends at the back with the rear bending line. With these tools it isn't used for protection against reaching behind the system, but it does also safeguard the immediate danger zone below the tool. As such it is always active in the reduced protected field modes. Back gauge mode is not possible on these tools. This can be seen on the display; the camera symbol for the rear protected field remains active (see Fig. 7). However, back gauge mode is not actually required on these tools, as the protected field ends at the back with the tool.

¹ The illustrations below show the areas of the protected fields as closed surfaces for reasons of clarity. Actually, separate monitoring beams distributed within the PSEnvip's detection zone span the areas of the protected field.

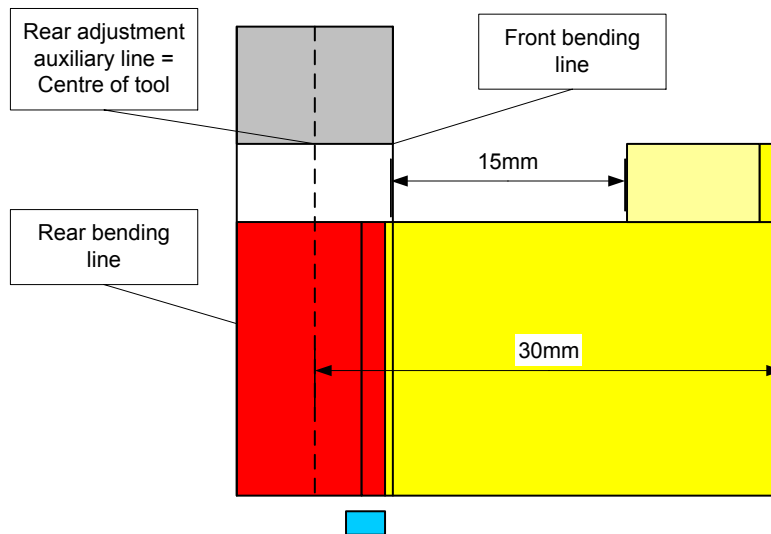


Fig. 4: Protected field² for stamping tool of tool class 1 (max. 32mm width)

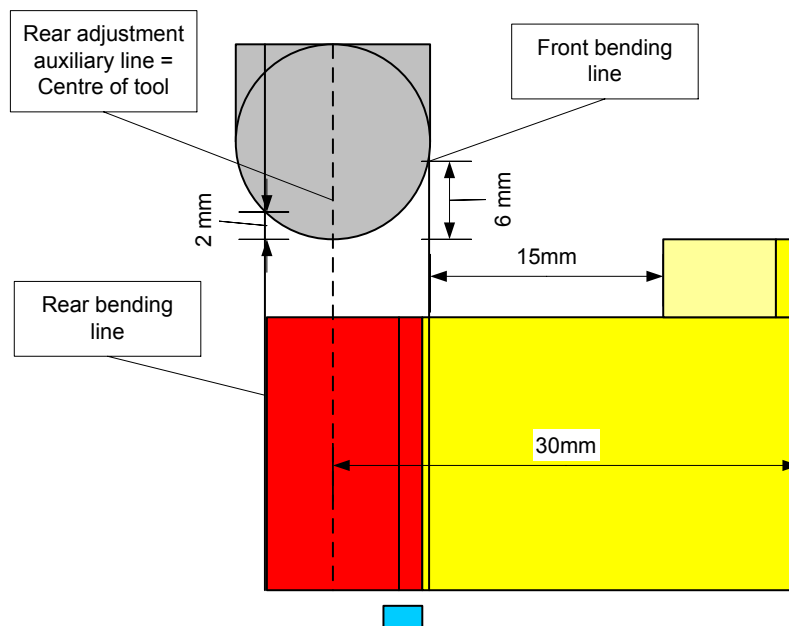


Fig. 5: Protected field³ for radii of tool class 1 (max. 25mm radius)

^{2,3} See note about protected field on page 10

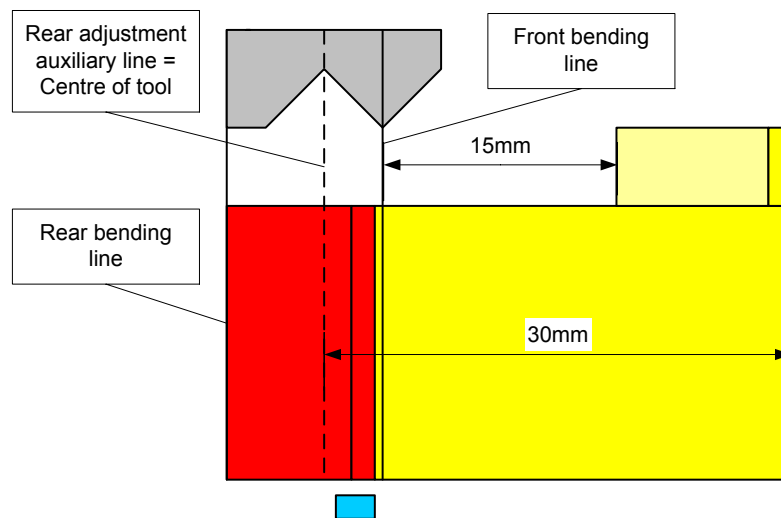


Fig. 6: Protected field⁴ for vertical special tools of tool class 1 (max. 32mm width)

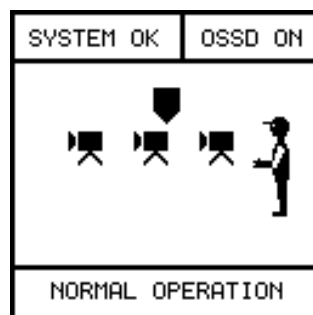


Fig. 7: Display in back gauge mode on horizontal tools of tool class 1

⁴ See note about protected field on page 10

2.4. Tools of tool class 2

These tools cannot be safeguarded in compliance with the standards. Communication to the safety control system is required and the switchover point must be raised. However, the tool can still be detected by the PSEnvip across its whole width.

These tools include the following:

- ▶ Stamping tool (from 32 to 42mm), see Fig. 8.
- ▶ Semi-circular tools (radius between 25 and 50 mm), see Fig. 9.
- ▶ Wide special forms

The bending lines and the protected fields⁵ are determined in exactly the same way as the wide tools in class 1.

As the upstream protected field is narrower than 15mm, protection against side intervention is reduced and the switchover point must be raised.

Even the raised front protected field from 15mm before the tool (protection for intervention diagonally from above) is omitted on these tools.

On stamping tools of this class, the centre of the tool should be on the front adjustment auxiliary line in the centre of the image; on semi-circular tools it should be on the rear adjustment auxiliary line.

With this adjustment it is possible to safeguard tools of maximum width with tool class 2.

Also with these tools, the front protected field can be muted in box mode; the rear protected field cannot be muted.

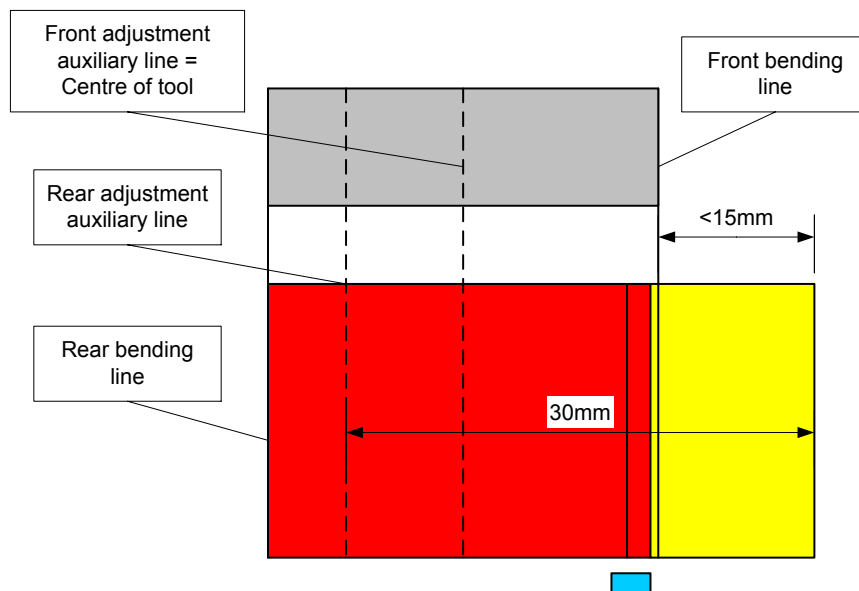


Fig. 8: Protected field⁶ for stamping tools of tool class 2

^{5,6} See note about protected field on page 10

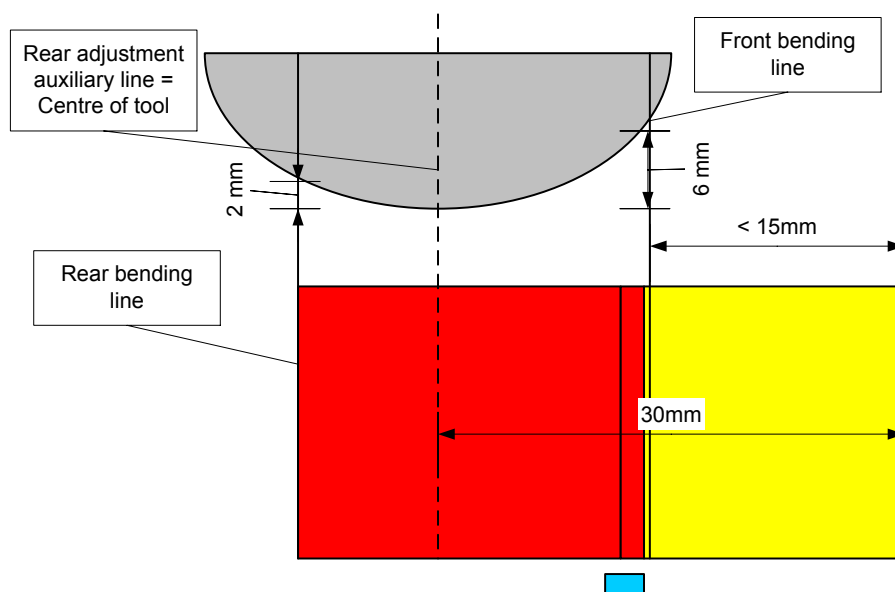


Fig. 9: Protected field⁷ for radii of tool class 2

⁷ See note about protected field on page 10

2.5. Tools of tool class 3

These tools can no longer be detected across their whole width by the PSEnvip. Neither can they be safeguarded in compliance with the standards. Communication to the safety control system is required, the switchover point must be raised still further and each press stroke must be acknowledged.

These tools include the following:

- ▶ Stamping tools from 42mm
- ▶ Semi-circular tools with a radius over 50mm
- ▶ Excessively wide special forms

Normally with these tools there is neither a front nor a rear bending line to determine. As a result, the maximum detection zone is safeguarded constantly. The central protected field goes over into the front field and lies as far forward as possible (see Fig. 10).

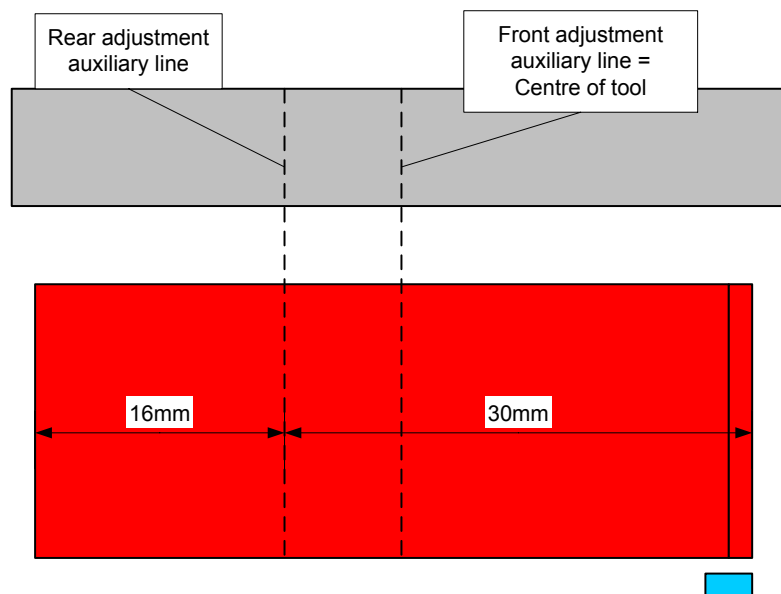


Fig. 10: Protected field⁸ of tool class 3, no bending line detected

⁸ See note about protected field on page 10

On these tools, neither the front nor the rear protected field can be muted; the maximum protected field is also active in reduced protected field modes. This can be seen on the display; the camera symbols for all protected fields are constantly active (see Fig. 11).

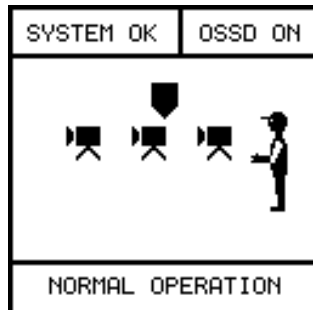


Fig. 11: Display in box/back gauge mode with tool class 3, no front bending line detected

If the front bending line is to be detected and only the rear line is not, the central protected field will again be 1mm behind this bending line. There will then be an additional upstream protected field, which can again be muted in box mode (see Fig. 12).

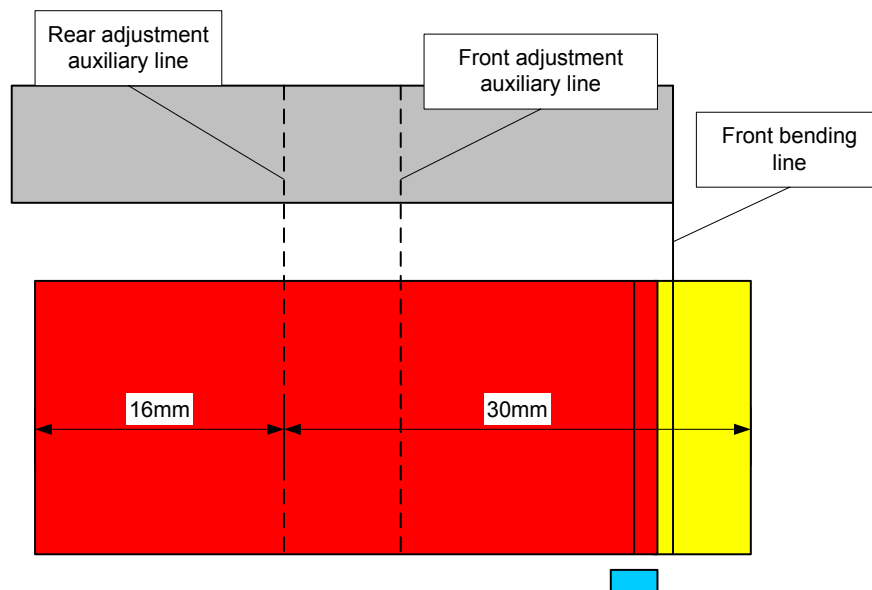


Fig. 12: Protected field⁹ of tool class 3, front bending line detected

If the rear bending line is to be detected and only the front line is not, the protected field will end at the back with the rear bending line. However, there will be neither an upstream nor a downstream protected field that can be muted (see Fig. 13).

⁹ See note about protected field on page 10

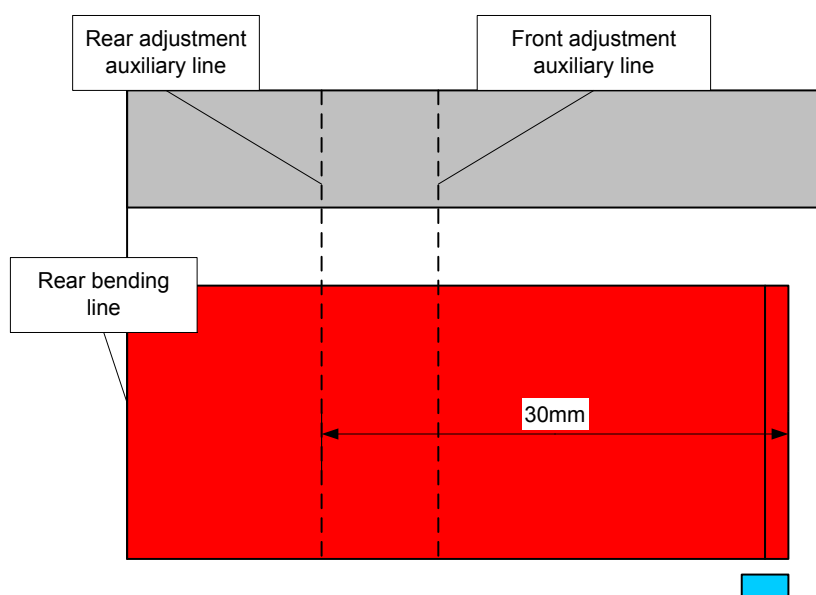


Fig. 13: Protected field¹⁰ of tool class 3, rear bending line detected

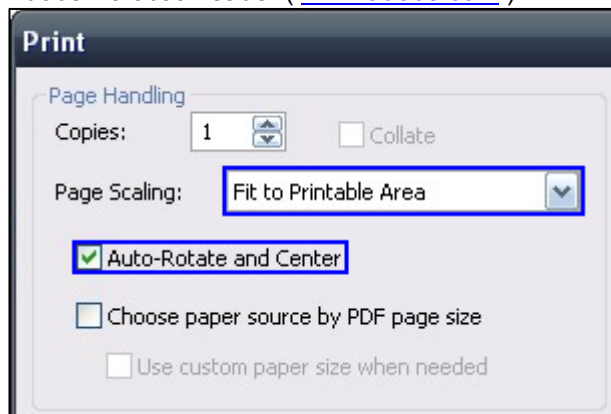
¹⁰ See note about protected field on page 10

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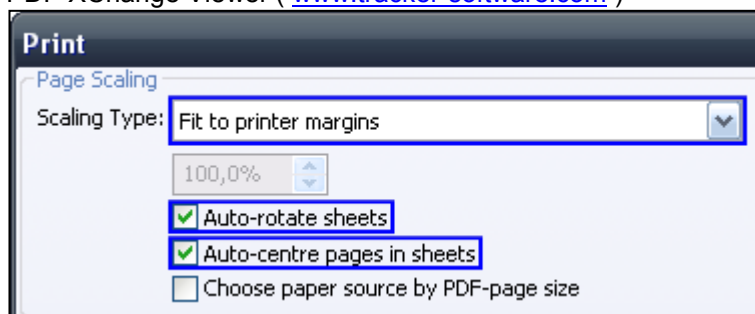
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