

Guideline BFS-RL 02-101

Presentation of Steel Structures in Workshop Drawings

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Presentation of Steel Structures in Workshop Drawings

Recommendations of the Fabrication Working Group

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Foreword

This guideline contains regulations for presenting steel structures on workshop drawings for steel construction, steel bridge construction and pressure vessel construction. The guideline is subdivided accordingly in three chapters: Chapters 3-5.

The guideline serves to simplify and standardise workshop drawings in the fields of steel construction in general, bridge construction and construction of pressure vessels. Compliance with the guideline ensures a high degree of clarity when producing drawings and leads to a sound understanding in the workshop of the facts presented.

1 | Scope

This guideline is intended primarily for design engineers and technical system planners who are responsible for the design of steel structural elements and their presentation in drawings.

The guideline is also intended for system houses that create and offer CAD systems for steel construction.

2 | Normative references

2.0 | General

Consideration should be given to the following documents when using this guideline. The numbering 2.1-2.3 assigns the documents to the three chapters.

2.1 | Steel construction in general

DAST 022	Hot dip galvanising of load-bearing steel structural elements
DIN 406-10	Engineering drawing practice; dimensioning; concepts and general principles
DIN 406-11	Engineering drawing practice; dimensioning; principles of application
DIN EN 1090-2	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures
DIN ISO 128-22	Technical drawings - General principles of presentation - Part 22: Basic conventions and applications for leader lines and reference lines
DIN ISO 128-23	Technical drawings - General principles of presentation - Part 23: Lines on construction drawings
DIN ISO 128-30	Technical drawings - General principles of presentation - Part 30: Basic conventions for views
DIN ISO 128-40	Technical drawings - General principles of presentation - Part 40: Basic conventions for cuts and sections
DIN ISO 128-44	Technical drawings - General principles of presentation - Part 44: Sections on mechanical engineering drawings
DIN ISO 128-50	Technical drawings - General principles of presentation - Part 50: Basic conventions for representing areas on cuts and sections
DIN ISO 5261	Technical drawings - Simplified representation of bars and profile sections
DIN ISO 5455	Technical drawings; scales

DIN ISO 6284	Construction drawings - Indication of limit deviations
DIN ISO 6410-1	Technical drawings; screw threads and threaded parts; general conventions
DIN EN ISO 128-20	Technical drawings - General principles of presentation - Part 20: Basic conventions for lines
DIN EN ISO 216	Writing paper and certain classes of printed matter - Trimmed sizes - A and B series, and indication of machine direction
DIN EN ISO 2553	Welding and allied processes - Symbolic representation on drawings - Welded joints
DIN EN ISO 6433	Technical product documentation - Part references
DIN EN ISO 12944	Paints and varnishes - Corrosion protection of steel structures by protective coating systems
ISO 128-34	Technical drawings - General principles of presentation - Part 34: Views on mechanical engineering drawings
ISO 5456-2	Technical drawings - Projection methods - Part 2: Orthographic representations

2.2 | Steel bridge construction

In addition to the documents listed in 2.1, consideration should also be given to:

ZTV-ING	Part 4: Steel construction, composite steel construction
TL/TP-ING	Part 4: Steel construction, composite steel construction
DB-Richtlinie 804	Planning, constructing and maintaining railway bridges (and other civil engineering works), all parts.

2.3 | Pressure vessel construction

In addition to the documents listed in 2.1, consideration should also be given to:

AD 2000	Manufacture and Testing of Pressure Vessels
DGRL	Pressure Equipment Directive
ZTV-ING	Part 4: Steel construction, composite steel construction
TL/TP-ING	Part 4: Steel construction, composite steel construction

2.4 | Terms

When using this document, the terms given in DIN 406-10 apply for dimensioning, terms and general principles.

3 | Steel construction in general

3.0 | General

This chapter regulates the requirements of steel structural engineering.

3.0 | Scales

The major scale of the drawing has to be given in the title block. A scale of 1:10 in combination with the Line Group 0,5 is recommended for presenting smaller steel components with nominal section sizes ≤ 500 mm.

As an alternative, a major scale of 1:15 combined with the Line Group 0,35 can be chosen; this is particularly suitable for presenting larger steel components.

Secondary scales that deviate from the major scale can be used for emphasis in views, sections and details. If such secondary scales are used, these must always be clearly marked on projections, or sectional or detail drawings. Possible secondary dimensions are 1:5, 1:2, 1:1.

Smaller scales (e.g. 1:25, 1:50 or 1:100) are not suitable for workshop drawings. However, they can be used in special cases (e.g. for welding seam test schedule or corrosion protection schedule).

Further regulations regarding scales are given in DIN ISO 5455.

3.2 | Lines / line groups

The line widths and line types of the line groups for the specified purpose are shown in Table 1 below.

Lines / Line Groups	Line Widths	Line Types	Purpose
0,5	0,5 thick line	continuous line	visible edges
		dashed line	-
		long dashed and dotted line	-
	0,25 thin line	continuous line	dimension lines, auxiliary dimension lines, reference arrows, reference lines, leader lines, zigzag lines, condensed lines, etc.
		dashed line	hidden edges (outlines)
		long dashed and dotted line	section planes, system lines, centre lines, lines of symmetry
	0,35 graphic symbols	continuous line	sizes, weld seam symbols and other symbols
		dashed line	-
		long dashed and dotted line	-
	1,0 very thick line	continuous line	headings, projections, sections or details, arrows to label sections and views, reinforcing steels, lines of special significance
		dashed line	-
		long dashed and dotted line	section line, boundaries for contracts, stages and fields
		long dashed double-dotted line	cables
	0,35	0,35 thick line	continuous line
dashed line			-
long dashed and dotted line			-
0,18 thin line		continuous line	dimension lines, auxiliary dimension lines, reference arrows, reference lines, leader lines, zigzag lines, condensed lines, etc.
		dashed line	hidden edges (outlines)
		long dashed and dotted line	section planes, system lines, centre lines, lines of symmetry
0,25 graphic symbols		continuous line	sizes, weld seam symbols and other symbols
		dashed line	-
		long dashed and dotted line	-
0,7 very thick line		continuous line	headings, projections, sections or details, arrows to label sections and views, reinforcing steels, lines of special significance
		dashed line	-
		long dashed and dotted line	section line, boundaries for contracts, stages and fields
		long dashed double-dotted line	cables

Table 1

Further information can be found in DIN EN ISO 128-20, DIN ISO 128-22 and DIN ISO 128-23.

3.3 | Drawing-sheet formats

Unless there are special reasons to the contrary, DIN A0 is used as the standard format for workshop drawings. If smaller format sheets are adequate for a clear presentation of the components, other DIN formats given in DIN EN ISO 216 A-series can be used.

For the presentation of longer components, the DIN A0 format can be used up to twice its length in the longitudinal direction in special cases, such as when a shortened presentation of the component is not appropriate.

3.4 | Presentation of main components

Each main component has to be presented with its main view (mostly the side elevation). Possible cutting guides have to be inserted in this main view.

If further views of the component are needed, such as a plan view or bottom view, these have to be created using the third angle projection method (see DIN ISO 128-30, Annex A, and ISO 5456-2).

The plan view then appears above the side elevation on the drawing sheet; the view of the end of a rod then appears folded out directly next to the end of the rod. If necessary, bottom and rear views are presented below the main view. Views produced in this way must not be rotated through 180° to each other under any circumstances. In order to avoid this problem, bottom and/or rear views have to be presented as longitudinal sections (e.g. through the web) and labelled with the section identifier. The graphic symbol for the projection method has to be shown in the title block.

All main components in the main view have to be labelled and positioned with the parts list text. The main item number has to be clearly highlighted and preferably encircled.

Type size and line width of the text of the main position have to be chosen in such a way that they clearly differentiate the main position from the other positions.

In many cases it is necessary to mark the system axes, e.g. when components are presented rotated compared to their installed position.

The extent to which the environment of the component, neighbouring components, brickwork, concrete, sealing joints, façade parts, heights above datum, stock requirements, erection aids, etc. should also be included in the presentation of the main components, has to be clarified from case to case.

If the main components are presented on different drawings (e.g. fabrication drawing, measuring plan, corrosion protection schedule, etc.), the main orientation of the components has to be in the same direction in all of these drawings.

3.5 | Presentation of add-on parts

The add-on parts have to be presented in the views of the main components and in the sections and have to be positioned there with reference arrows (see also Section 3.10).

All add-on parts also have to be presented additionally on the drawing as individual components with ascending item number. Rotating the presentation of the individual component compared with the presentation in the assembly view should be avoided.

The exploded view contains all dimensions necessary for fabrication and inspection and all information needed for processing, such as chamfers, counterbores, machining, etc. Differing scales should be avoided.

3.6 | Shortened presentations of components - condensed lengths

Longer, straight component areas without information content can be presented in a shortened form. Necessary information must not become lost in the process. The gap between the condensed lines -area that is not presented - must be at least 5 mm on the drawing sheet and has to be clearly marked, e.g. with a thin zigzag line (see also DIN ISO 128-34).

3.7 | Views, sections and details

The position of the views and the cutting guide have to be clearly defined, usually in the main view. The number of views and sections should be limited to the quantity necessary for clear and complete determination of the component. Unnecessary repetition of a detail should be avoided (see also DIN ISO 128-30).

Views and sections should be given an explanatory heading. If a secondary dimension is used for a section, this has to be positioned clearly directly below or behind the heading.

It is preferable to carry out sections on a single level and without offsetting.

Views and sections have to have a clear structure on the drawing sheet so that they are easy to find. Sections should be labelled with capital letters and presented in ascending alphabetical order (see also DIN ISO 128-40).

Views and sections are necessary for clarification of the assembled situation. The depth of the cutting guide should be chosen so that small, confusing, invisible edges can be shown in the sectional representation. If, as an exception, drilled holes in hidden components have to be shown in the sectional representation, it is essential to ensure that these drilled holes are presented as hidden with dashed lines.

Cut surfaces of components (sections, sheet, etc.) have to be shaded (see also DIN ISO 128-50).

Details are necessary to make the assembly clear if this is not unequivocally evident with the major scale of the drawing chosen. For this, a detail is encircled in the main drawing and usually labelled with a number. Details are always prepared using a larger secondary scale.

Details have to be given a descriptive heading. The secondary scale chosen has to be clearly given directly below or above the heading.

Details have to be included on the drawing sheet in a clearly structured manner so that one can ensure that the detailed view is easy to find. Details are usually sorted in ascending order on the drawing sheet.

3.8 | Dimensioning

Dimensions are to be given in millimetres [mm].

The intersections of dimension lines and extension lines are usually marked with a diagonal line (see also DIN 406-10).

The ends of the extension lines should be positioned in such a way that the reference point to which the dimension line corresponds is clearly identifiable.

Intersections of extension lines should be avoided if possible. If this is not always possible, one of the extension lines should be interrupted at the point of intersection.

No dimension lines or extension lines should be inserted in shaded areas.

Dimensions should usually be marked as chain dimensions. Generally, one must ensure that the reference point for the dimension is apparent. For example, the reference for holes drilled in flanges is usually the system line and for connecting bores of deck beams it is the upper edge of the supporting beam. This reference dimension is usually made evident by not marking any unnecessary complementary dimensions.

In cases in which errors of summation of many individual dimensions can occur, e.g. long girders with many add-on parts or shear connectors, one should choose dimensioning that continuously increases from the original point.

Complete dimensioning of a steel construction includes:

- system dimensions, minus dimensions, dimensions between axes, axial relationships, interrupted dimension chains for flanges and webs, dimensioning of the connecting bores, system triangles with diagonal connections and dimensions of angled cuts in degrees and in millimetres [mm].

Mounting dimensions of add-on parts must refer to the connecting bores of the add-on parts and not on their component edges.

Special control dimensions have to be included. Here the permissible tolerances given in the drawing stamp apply provided the control dimension given does not make more stringent demands (see also DIN 406, Part 10 and DIN 406, Part 11).

Diameters of drilled holes have to be marked with \emptyset symbols in front of the dimension. Root dimensions, perpendicular to the drawing sheet plane, can be included simply using the prefix 'w = ...'.

With elongated holes, the dimensions always refer to the diameter and spacing between the centres of the circles. The letters LL are used as a prefix for these dimensions (e.g. LL 20x30).

Radii have to be labelled with an arrow and the letter 'R' before the size.

The graphical triangle symbol is used to indicate a slope triangle or to specify a slope. For fabrication reasons, the corresponding angle is given additional as an auxiliary measurement (see also DIN 406, Part 11).

3.9 | Marking of add-on parts on main components

To facilitate measuring and marking in the assembly, the main components have centre marks or marking lines at those positions where the add-on parts are to be connected. Where possible, detailed regulations covering this should be agreed with the fabrication plant.

3.10 | Item numbers / labelling of parts

The item numbers of the main components should be clearly marked.

When presenting single components, add-on parts should be labelled with their item number and their position text. In views of the main components, add-on parts should be shown with a reference arrow with the attached and encircled item number. If add-on parts are non-visible in a view, they are usually also not labelled or marked with an arrow.

With complex components (e.g. lattice girders, welded constructions, etc.) it can be useful to use an assembly position. The respective shipping dimension can be added to the assembly position if required. The assembly item number has to be clearly marked like the main item number.

Only digits should be used for the item numbers. Prefixes and suffixes should be avoided. Item numbers should be five digits at the most (DSTV interface for parts lists). The

allotment of number ranges (e.g. main components from 1-999 and add-on parts from 1001 to 9999) should be agreed if possible with the fabrication plant.

In addition to the item number, profile description, dimensions, number of pieces and alloy designation, special requirements for material testing (e.g. Z value, bead bend test, ultrasonic testing) should be specified.

For a defined drawings group (e.g. building phase, partial system or complete order) one should strive to ensure that identical components keep the same item number for all drawings.

The parts list results from the drawings of all positions presented; consideration is given to the respective number of parts that belong to each drawing.

3.11 | Information on weld seams and presentation of weld seams

Indicating weld seams on workshop drawings is carried out using the general rules for technical drawings. The symbols contained in DIN EN ISO 2553 should be used. Accordingly, field welded seams have to be marked with a flag.

If the symbols in DIN EN ISO 2553 are inadequate for ensuring unambiguous weld pretreatment and professional execution of the welded joint, the seam details have to be presented on the drawing in the form of special welding details or on a separate welding detail plan.

If a special welding detail is used, the number of the welding detail is given on the reference arrow instead of the weld seam symbol from DIN EN ISO 2553. For workshop welds the letters 'WS...' are placed in front of the number; for field welds, the letters 'MS...' are used.

When presenting weld seams, the arrow usually points to the point at which the weld seam is to be carried out. Placing the arrow head on the opposite side (as is basically possible according to DIN EN ISO 2553) should not be used in steel construction.

The labelling of the weld seams is usually carried out on the views of the main components and in the associated sections. Double labelling should be avoided if possible.

To avoid errors, all seams to be carried out should be marked explicitly with their width on the drawing. A blanket statement like 'all non-labelled weld seams FW a=3' is only permitted for components of secondary importance (e.g. balustrades, cat ladders).

The symbol for 'weld-all-around fillet joint' should only be used when this necessitates an 'a' dimension on the front faces of the component and at the same time an adequate 'z' dimension is ensured. If either of these two conditions is not fulfilled, clear and complete weld symbols have to be used, e.g. double fillet weld.

All weld seams for complementary NDT (MT/PT, UT or RT) that is necessary from a technical or contractual point of view and goes beyond the requirements of DIN EN 1090, have to be marked specially and clearly on the drawing. As an alternative it is recommended in complex cases to prepare a special welding seam test schedule.

A suitable imprint above the title block has to include quality requirements for the weld seams, decisive assessment groups and test standards, and a signature field for the examination of the drawing from a welding point of view.

3.12 | Fasteners / presentation of screw fasteners

Fasteners together with product standard and designation, length and quality have to be assigned to the component to be connected and indicated in the drawing as parts-list relevant 'texts'. A suitable measure should be adopted to differentiate between screw fasteners for the workshop and for the erection. Screw fasteners are not normally given an item number because they are included in the parts list with their standard designation.

Hole spacings, bore diameters and number of holes have to be presented on the drawing (see also Section 3.8).

Additional details and dimensions are necessary on the drawing for countersunk holes, threaded holes and blind holes.

Special fabrication instructions (e.g. close-fitting connection) have to be shown clearly on the drawing.

Information on the method of preloading, preloading forces (planned, non-planned or structural) and fastener torques for the different screw fastener diameters have to be included, e.g. in the form of a table above the title block

3.13 | Information on corrosion protection

Information on the pretreatment of the substrate (e.g. SA2½ and P2) and the application of the corrosion protection system should be given in the form of a suitable table above the title block. Special instructions, such as corrosion protection at HV or GV joints, under rail clamps and rail supports, have to be clearly indicated on the drawing. If there is a special corrosion protection schedule, reference should be made to it under the respective plan number. In the case of a galvanised construction, consideration has to be given to DIN EN ISO 12944, a degree of pretreatment according to DIN EN ISO 8501-3 and DASt Guideline 022.

3.14 | Information on tolerances

Information on general tolerances has to be arranged in the form of a suitable imprint above the title block.

Special limited tolerances that go beyond this have to be defined by framed component dimensioning (see also Section 3.8) with detailed tolerance requirement. Amongst other things, consideration also has to be given to DIN EN ISO 13920 and DIN EN 1090-2.

3.15 | Information on execution classes and corresponding fabrication documents

The execution classes in accordance with DIN EN 1993-1-1 NA/A1 and DIN EN 1090-2 must be given in the form of a suitable imprint above the title block.

There must be reference to the appropriate drawings if complex components are presented on several drawings.

3.16 | Revising and updating drawings

A history of revisions has to be maintained in a suitable form immediately above the title block. Every revision to the drawing is indexed and provided with a written description of the change, a revision date and a name. Small letters in ascending alphabetical order should preferably be used for the drawing indices.

For the written description a suitable short reference should be given so that the user of the drawing is able to quickly recognise the change on the drawing.

Besides the written description, revisions should usually be clearly marked using a revision cloud of the affected drawing contents (e.g. with an index framed in a triangle).

4 | Steel bridge construction

4.0 | General

Summary of all sections that are unchanged with respect to Chapter 3: the following sub-items from Chapter 3 'Steel construction in general' apply unchanged for steel bridge construction and will therefore not be explicitly described below:

Section	Topic
3.2	Lines / line groups
3.3	Drawing-sheet formats
3.5	Presentation of add-on parts
3.7	Views, sections und details
3.8	Dimensioning
3.9	Marking of add-on parts on main components
3.10	Item numbers / labelling of parts
3.12	Fasteners / presentation of screw fasteners
3.15	Information on execution classes and corresponding fabrication documents
3.16	Revising and updating drawings

4.1 | Scales

In view of the very different components and component sizes in bridge construction, no fixed requirement can be given for the major scale of a drawing in bridge construction.

However, the scale 1:10 in combination with the Line Group 0,5 or the scales 1:15 o. 1:20 in combination with the Line Group 0,35 are preferably used.

In addition, the regulations in Section 3.1 apply.

4.4 | Presentation of main components

The main components should be presented in the service position and in the 'tension-free workshop form'. Dimensions of cambers and drilled holes should be given at convenient positions (usually on all cross-beam axes).

It is always necessary to mark the system axes (longitudinal axes, pillars, cross-beams, cables, etc.).

Due to the component dimensions and the regularity of a bridge superstructure it can be useful to detail and assign item numbers on longitudinal and transverse systems on separate drawing sheets, or to present the details marked on separate drawing sheets.

For the respective components, cross references to the reference drawings of ZTV-ING or other special standards (e.g. RIL 804, etc.) that have to be observed must be clearly marked.

Otherwise the regulations given in Section 3.4 apply.

4.6 | Shortened presentation of components - condensed lengths

Normally the shortened presentation of components should not be used in bridge construction. If this happens in individual cases, however, the regulations given in 3.6 apply.

4.11 | Information on weld seams and presentation of weld seams

With regards the inspection requirements for weld seams, a detailed welding seam test schedule always has to be prepared.

Otherwise the regulations given in Section 3.11 apply.

4.13 | Information on corrosion protection

Information on the pretreatment of the substrate and the application of the corrosion protection system always has to be given in detail in the form of a corrosion protection schedule.

In addition to the substrate pretreatment, the coating materials and the coating thicknesses, the corrosion protection schedule has to contain information on at least the following points:

- application process, control areas and masking instructions
- special information on areas that come into contact with concrete, storage, cavities, joining, field-welded joints and shear connectors, etc.

Otherwise the regulations given in Section 3.14 apply.

4.14 | Information on tolerances

Besides the regulations given in Section 3.15, ZTV-ING has to be taken into consideration when determining the permitted tolerances.

5 | Pressure vessel construction

5.0 | General

Summary of all sections that are unchanged with respect to Chapter 3: the following sub-items from Chapter 3 'Steel construction in general' apply unchanged for pressure vessel construction and will therefore not be explicitly described below:

Section	Topic
3.2	Lines / line groups
3.3	Drawing-sheet formats
3.5	Presentation of the add-on parts
3.7	Views, sections and details
3.8	Dimensioning
3.9	Marking of add-on parts on main components
3.10	Item numbers / labelling of parts
3.12	Fasteners / presentation of screw fasteners
3.15	Information on execution classes and the corresponding fabrication documents
3.16	Revising and updating drawings

5.1 | Scales

In view of the very different component sizes in pressure vessel construction, no fixed requirement can be given for the major scale of a drawing.

However, the scale 1:10 in combination with the Line Group 0,5 or the scales 1:15 or 1:20 in combination with the Line Group 0,35 are preferably used.

In addition, the regulations in Section 3.1 apply.

5.4 | Presentation of main components

The main components should preferably be presented in their service position. Dimensions of drilled holes should be given at convenient positions (usually on the support axes).

It is always necessary to mark the system axes (longitudinal axes, axes of rotation, etc.).

Due to the component dimensions it can be useful to present the details marked on separate drawing sheets using a larger scale. Otherwise the regulations in Section 3.4 apply.

5.6 | Shortened presentation of components - condensed lengths

Normally the shortened presentation of components should not be used in pressure vessel construction. If this happens in individual cases, however, the regulations given in 3.6 apply.

5.11 | Information on weld seams and presentation of weld seams

With regards the inspection requirements for weld seams, a detailed welding seam test schedule always has to be prepared.

Basically, execution details in accordance with AD 2000 have to be observed. Otherwise the regulations in Section 3.11 apply.

5.14 | Information on corrosion protection

Information on the pretreatment of the substrate and the application of the corrosion protection system should preferably be given in detail in the form of a corrosion protection schedule. In simple cases, a table above the title block suffices.

In addition to the substrate pretreatment, the coating materials and the coating thicknesses, the corrosion protection schedule has to contain information on at least the following points:

- application process, control areas and masking instructions
- special information on areas that come into contact with concrete, storage, cavities, joining, field-welded joints and shear connectors, etc.

Otherwise the regulations given in Section 3.13.

5.15 | Information on tolerances

Besides the regulations given in Section 3.14, ZTV-ING, the AD 2000 Code and the DGRL have to be observed when determining the permitted tolerances.