
**Steel sheet, metallic-coated by the
continuous hot-dip process for
corrugated steel pipe**

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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).

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).

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.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This third edition cancels and replaces the second edition (ISO 16172:2011), which has been technically revised. Tables and text have been updated for clarity.

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.

Steel sheet, metallic-coated by the continuous hot-dip process for corrugated steel pipe

1 Scope

This document is applicable to the minimum requirements for steel sheet used in the manufacture of corrugated steel pipe, in coils, flat cut lengths and corrugated cut lengths metallic-coated by the continuous hot-dip process.

This product is intended for storm sewers, culverts, drains and similar uses.

Several metallic-coated materials are covered, which relies on users to determine which product best serves their needs. Four different metallic coatings are included:

- zinc coated;
- zinc-5 % aluminium-mischmetal alloy coated;
- 55 % aluminium-zinc alloy coated;
- aluminium-silicon alloy coated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1460, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 16163, *Continuously hot-dipped coated steel sheet products — Dimensional and shape tolerances*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms 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 Terms and definitions

3.1.1

fabricator

<corrugated metal pipe> organization that produces the finished pipe

3.1.2

manufacturer

<corrugated metal pipe> organization that produces the metal sheet from which the pipe is made

3.1.3

purchaser

<corrugated metal pipe> person or agency that purchases the finished pipe

Note 1 to entry: For the purposes of this document, the *fabricator* (3.1.1) may also be considered as the purchaser of the sheet, where that term is used in this document. Such an interpretation does not restrict the purchaser of finished pipe from enforcing any provisions of this specification.

3.1.4

lot

up to a specified quantity of steel sheet of the same thickness and coating condition

3.2 Abbreviated terms

Zn	zinc
Zn-5Al-MM	zinc-5 % aluminium-mischmetal alloy
55Al-Zn	55 % aluminium-zinc alloy
Al-Si	aluminium-silicon alloy

4 Condition of manufacture

4.1 Chemical composition

The chemical composition (heat analysis and product analysis) of the base metal shall conform to the requirements of Table 1.

Table 1 — Chemical composition

Mass fractions in per cent

Element	Heat analysis	Product analysis
Sulfur, max., %	0,05	0,06
Sum of carbon, manganese, phosphorus, sulfur and silicon, max., %	0,70	0,74

4.2 Mechanical properties

The mechanical properties of the base metal shall conform to the requirements of Table 2.

Table 2 — Mechanical properties of flat sheet prior to fabrication^a

Tensile requirements	Limits
Tensile strength ^b , min., MPa	310
Yield strength ^b , min. MPa	230
Elongation, in 50 mm ^c , min., %	20

^a To determine conformity with this specification, round each value for tensile strength and yield strength to the nearest 1 MPa and each value for elongation to the nearest 1 %.

^b Yield strength and tensile strength are based on the thickness of the base metal. If tests are made after coating, determine the base metal thickness after stripping the coating from the ends of the specimen contacting the grips of the tension-testing machine prior to tensile testing.

^c The elongation requirement does not apply to material tested after corrugating.

4.3 Coating

4.3.1 Coating mass

The coating mass shall conform with the requirements listed in [Table 3](#). The coating mass is the total amount of coating on both sides of the sheet, expressed in grams per square metre.

4.3.2 Coating adherence

The adhesion of the coating shall be such that no peeling or flaking occurs while the coated sheet is being corrugated and formed into pipe.

4.4 Surface treatment

A chemical treatment is normally applied to the metallic-coated steel sheet to minimize the hazard of wet-storage stains during shipment and storage. However, the inhibiting characteristics of the treatment are limited and if a shipment is received wet, the material shall be used immediately or dried.

Table 3 — Coating mass (total both sides)

Type	Coating mass		Equivalent coating thickness ^a	
	Triple spot, average, min. g/m ²	Single spot, min. g/m ²	Triple spot, average, min. µm	Single spot, min. µm
Zn	610	550	86	78
Zn-5Al-MM	640	550	93	80
55Al-Zn	210	180	56	48
Al-Si	305	275	95	86

^a Coating thicknesses are approximate, for information only. Conversions are based on the following relationships: Zn coating: 1 g/m² = 0,141 5 µm; Zn-5Al-MM: 1 g/m² = 0,146 0 µm; 55Al-Zn coating: 1 g/m² = 0,266 36 µm; Al-Si coating: 1 g/m² = 0,331 28 µm.

5 Dimension and shape tolerances

5.1 Thickness

Sheet thickness shall conform to the dimensions specified in [Table 4](#). The thickness of the sheet includes both the base metal and the coating.

Table 4 — Coated-steel-sheet thickness requirements

Specified thickness mm	Minimum thickness mm
1,0	0,9
1,3	1,2
1,6	1,5
2,0	1,8
2,8	2,6
3,5	3,3
4,3	4,0

NOTE Thickness is measured not less than 10 mm from an edge. On corrugated sheet, thickness is measured on the tangents of corrugations.

^a Aluminium-silicon alloy coated sheet is not available in these thicknesses.

5.2 Length

Permissible variations in the length of cut-length sheets, both flat and corrugated, shall be in accordance with ISO 16163.

5.3 Flatness

Permissible variations in the width and camber of flat sheet material shall be in accordance with ISO 16163. The flatness tolerances are given in [Table 5](#).

Table 5 — Flatness tolerances (cut lengths only)

Specified thickness mm	Specified width mm	Flatness tolerance (maximum deviation from a horizontal flat surface) mm
1,3 and thinner	up to 1 900, inclusive	13
	over 900 to 1 500, inclusive	19
1,6 and thicker	Up to 1 500, inclusive	13
NOTE This table also applies to sheets cut to length from coils by the fabricator when adequate flattening measures are performed.		

5.4 Other dimensions

5.4.1 Corrugated configurations

Corrugations shall form smooth continuous curves and tangents. The dimensions of the corrugated sheet shall be in accordance with [Table 6](#).

Table 6 — Dimension of corrugated sheet

Nominal size mm	Maximum pitch ^a mm	Minimum depth ^b mm	Radius of curvature mm	
			nominal	minimum
68 by 13	73	12	17	13
75 by 25	83	24	14	13
125 by 25	135	24	40	36
^a Pitch is measured from the crest of corrugations, at 90° to the direction of the corrugations.				
^b Depth is measured as the vertical distance from a straight edge resting on the corrugation crests to the bottom of the intervening valley.				

5.4.2 Corrugated sheet width

The covering width of corrugated sheet shall be in accordance with [Table 7](#). The covering width is the distance between the crests of the extreme corrugations. The lip dimension of corrugated sheet shall be in accordance with [Table 8](#) and is measured along the radial curvature from the crest of the corrugation to the edge of the sheet. There is no established tolerance for overall width, since the covering width and lip dimensions are the governing factors for the formed product.

Table 7 — Covering width tolerance of corrugated sheet

Covering width mm	Tolerance over and under mm
up to 600	6
over 600 to 900	10
over 900 to 1 200	13

Table 8 — Lip dimensions of corrugated sheet

Nominal corrugation-size pipe	Lip dimension	
	For riveted pipe construction	For spot welded construction
68 by 13	19	11
75 by 25	22	13
125 by 25	22	13

5.5 Chemical composition

An analysis of each heat shall be made by the manufacturer to determine conformity with the requirements of [Table 1](#).

5.6 Mechanical properties

One representative sample from each lot of 50 tons or less shall be used for the tensile test to determine conformity with the requirements of [Table 2](#). Mechanical property tests shall be conducted on the sheet prior to corrugating or other fabrication, whenever possible. If the tests are made after corrugating, the specimens shall be taken on the tangents of corrugations and used for the determination of tensile and yield strength only.

5.7 Coating tests

5.7.1 Coating mass

Test specimens shall be taken from each lot from a sample piece approximately 300 mm in length by the as-coated width. Three specimens are cut from the sample, one from the mid-width position and one from each side, not closer than 25 mm from the side edge. The minimum specimen area shall be 1 200 mm².

5.7.2 Triple-spot test

The triple-spot test result shall be the average coating mass found on the three specimens taken according to [5.7.1](#).

5.7.3 Single-spot test

The single-spot test result shall be the minimum coating mass found on any one of the three specimens used for the triple-spot test (see [5.7.2](#)).

6 Test methods

6.1 Tensile tests

The tests shall be conducted in accordance with the methods specified in ISO 6892-1.

6.2 Coating mass

The manufacturer shall conduct tests using methods deemed necessary to ensure that the material conforms with the requirements as given in [Table 3](#). Commonly used methods include those given in ISO 1460, ISO 3497 or ISO 2178. Coating mass is determined by converting coating thickness measurements made with magnetic gauges (ISO 2178) or by X-ray spectrometry (ISO 3497) using the relationship given in [Table 3](#). The test methods in ISO 2178 and ISO 3497 may be used as a basis for acceptance but not for rejection. In cases of dispute, ISO 1460 shall be used as the referee method.

7 Resubmission

7.1 The manufacturer may resubmit, for acceptance, the products that have been rejected during earlier inspection because of unsatisfactory properties, after s/he has subjected them to a suitable treatment (e.g. selection, heat treatment), which, on request, will be indicated to the purchaser. In this case, the tests shall be carried out as if they applied to a new lot.

7.2 The manufacturer has the right to present the rejected products to a new examination for conformity with the requirements of another quality.

8 Workmanship

8.1 The surface condition shall be that normally obtained for a metallic-coated steel sheet product.

8.2 The steel sheet in cut lengths shall be free from quantities of laminations, surface flaws and other imperfections that are detrimental to the final product or to subsequent appropriate processing.

8.3 Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove nonconforming portions, as can be carried out on the cut length product. However, it is the responsibility of the manufacturer to provide a product that meets the requirement for surface condition that is normally obtained on metallic-coated steel sheet products.

9 Inspection and acceptance

9.1 While not usually required for products covered by this document, the purchaser may specify that inspection and tests for acceptance be observed prior to shipment from the manufacturer's works. In these cases, the manufacturer shall afford the purchaser's inspector all reasonable facilities to determine that the steel is being furnished in accordance with this document. However, this does not relieve the manufacturer of the responsibility to provide a product that meets the requirements for surface condition normally obtained in metallic-coated corrugated steel product.

9.2 Steel that is reported to be defective after arrival at the user's works shall be set aside, properly and correctly identified, and adequately protected.

10 Coil size

When steel sheet in accordance with this document is ordered in coils, a minimum or range of acceptable inside diameter(s) (ID) shall be specified. In addition, the maximum outside diameter (OD) and the maximum acceptable coil mass shall be specified.

11 Certification

11.1 A manufacturer's certification shall be furnished to the purchaser when specified in the purchase order or contract. The certification shall be in accordance with, and make reference to, the provisions of this document.

11.2 The test results, including chemical composition, mechanical properties, coating type, and coating mass for each heat and coating lot shall be maintained by the manufacturer for seven years without regard to whether a certification was furnished. The test results shall be made available to the fabricator and purchaser upon request.

12 Marking

12.1 Each 0,5 to 1,5 m of sheet in coils or cut lengths shall be identified by showing the following:

- a) name of manufacturer;
- b) brand name (if appropriate);
- c) specified thickness;
- d) coating type (Zn, Zn-5Al-MM, 55Al-Zn, Al-Si);
- e) specified coating mass;
- f) identifying symbols relating to a specific heat number and coating lot number;
- g) applicable ISO designation number, i.e. ISO 16172:2018.

12.2 In the event the above marking is removed or obliterated, or the sheet identified as "non-specification" on each 0,5 to 1,5 m of sheet in a coating lot or heat for which control tests, as prescribed herein, show nonconformity to this document.

13 Information to be supplied by the purchaser

13.1 All sheet, both flat and formed, covered by this document shall be ordered only according to the specified thicknesses in [Table 4](#) on coated-steel-sheet thickness requirements.

13.2 All material furnished in accordance with this document shall be surface treated, unless otherwise specified in the purchaser order.

13.3 To specify requirements adequately using this document, enquiries and orders shall include the following information:

- a) a reference to this document, i.e. ISO 16172:2018;
- b) name of material used;
- c) coating type and, where appropriate, class;
- d) dimensions: for cut lengths, thickness; width; either flat or overall corrugated; length; pitch; and depth of corrugations, if corrugated; for coils, thickness; width; coil requirements (maximum outside diameter, acceptable inside diameter);
- e) certification, if required.

NOTE Abbreviations can be used to describe the coating type.