INTERNATIONAL STANDARD

ISO 10799-1

First edition
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Cold-formed welded structural hollow sections of non-alloy and fine grain steels —

Part 1: Technical delivery conditions

Profils creux de construction formés à froid, soudés, en acier non allié ou à grains fins —

Partie 1: Conditions techniques de livraison

Reference number
ISO 10799-1:2011(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 10799-1 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 1, *Steel tubes*.

This first edition of ISO 10799-1 cancels and replaces ISO 10799:2001, of which it constitutes a minor revision. In particular, better grouping of several documents by subject area and minor editorial improvements have been carried out.

ISO 10799 consists of the following parts, under the general title *Cold-formed welded structural hollow sections of non-alloy and fine grain steels*:

— *Part 1: Technical delivery conditions*

— *Part 2: Dimensions and sectional properties*

Cold-formed welded structural hollow sections of non-alloy and fine grain steels —

Part 1:
Technical delivery conditions

1 Scope

This part of ISO 10799 specifies the technical delivery requirements for cold-formed welded structural hollow sections of circular, square or rectangular form. It is applicable to structural hollow sections formed cold without subsequent heat treatment.

The grades, chemical composition and mechanical properties for non-alloy steels and fine grain steels are given in Annexes A and B, respectively.

NOTE 1 For the requirements for tolerances, dimensions and sectional properties, see ISO 10799-2.

NOTE 2 For hot finished structural hollow sections, see ISO 12633-1.

2 Normative references

The following referenced documents are indispensable for the application 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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404, *Steel and steel products — General technical delivery requirements*

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels*

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

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 10474:1991, *Steel and steel products — Inspection documents*

ISO 10799-2, *Cold-formed welded structural hollow sections of non-alloy and fine grain steels — Part 2: Dimensions and sectional properties*

ISO 10893-2, *Non-destructive testing of steel tubes — Part 2: Automated eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections*

ISO 10893-3, *Non-destructive testing of steel tubes — Part 3: Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 10893-6, *Non-destructive testing of steel tubes — Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections*

ISO 10893-11, *Non-destructive testing of steel tubes — Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

3 Terms and definitions

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

3.1
tube
hollow long product open at both ends of any cross-sectional shape

3.2
structural hollow section
tube intended to be used for structural purposes

3.3
normalizing rolling
rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing

3.4
cold forming
process in which the main forming is carried out at ambient temperature

3.5
thermomechanical rolling
rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties which cannot be achieved or repeated by heat treatment alone

NOTE 1 Subsequent heating above 580 °C may lower the strength values.

NOTE 2 Thermomechanical rolling leading to the delivery condition M can include processes with an increasing cooling rate with or without tempering including self-tempering, but excluding direct quenching and quenching and tempering.

4 Classification and designation

4.1 Classification

4.1.1 Within the steel grades of the non-alloy steels given in Annex A, three qualities JR, J0 and J2 are specified. These qualities differ in respect of specified impact requirements, and limits on values of various elements, with particular reference to sulfur and phosphorus, and inspection and testing requirements.

4.1.2 Within the steel grades of the fine grain steels given in Annex B, four qualities, N, NL, M and ML, are specified. These differ in respect of the carbon, sulfur and phosphorus content and low-temperature impact properties.

4.2 Designation

4.2.1 For non-alloy steel structural hollow sections, the steel designation consists of:

— a reference to this part of ISO 10799, i.e. ISO 10799-1:2011;

— the capital letter S for structural steel;

— the indication of the minimum specified yield strength for thicknesses ≤ 16 mm, expressed in newtons per square millimetre (N/mm^2);

— the capital letters JR for the qualities with specified impact properties at room temperature;

— the capital letter J and a number 0 or 2 for the qualities with specified impact properties at 0 °C and −20 °C respectively;

— the capital letter H to indicate hollow sections.

4.2.2 For fine grain steel structural hollow sections, the steel designation consists of:

— a reference to this part of ISO 10799, i.e. ISO 10799-1:2011;

— the capital letter S for structural steel;

— the indication of the minimum specified yield strength for thicknesses ≤ 16 mm, expressed in newtons per square millimetre (N/mm^2);

— the capital letter N to indicate normalized or normalized rolled feedstock material (see 6.3);

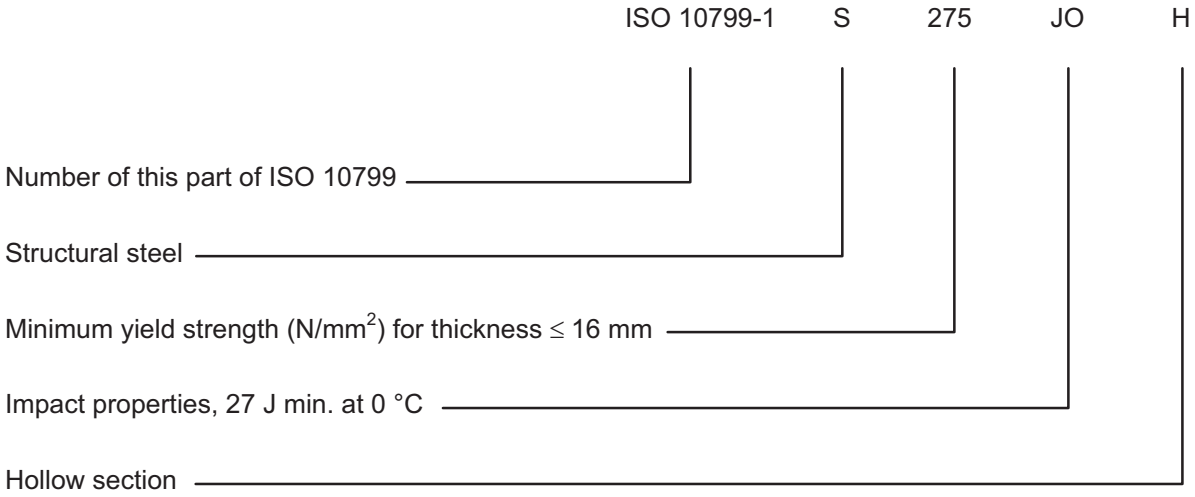
— the capital letter M to indicate thermomechanically rolled feedstock material (see 6.3);

— the capital letter L for the qualities with specified minimum values of impact energy at a temperature of −50 °C;

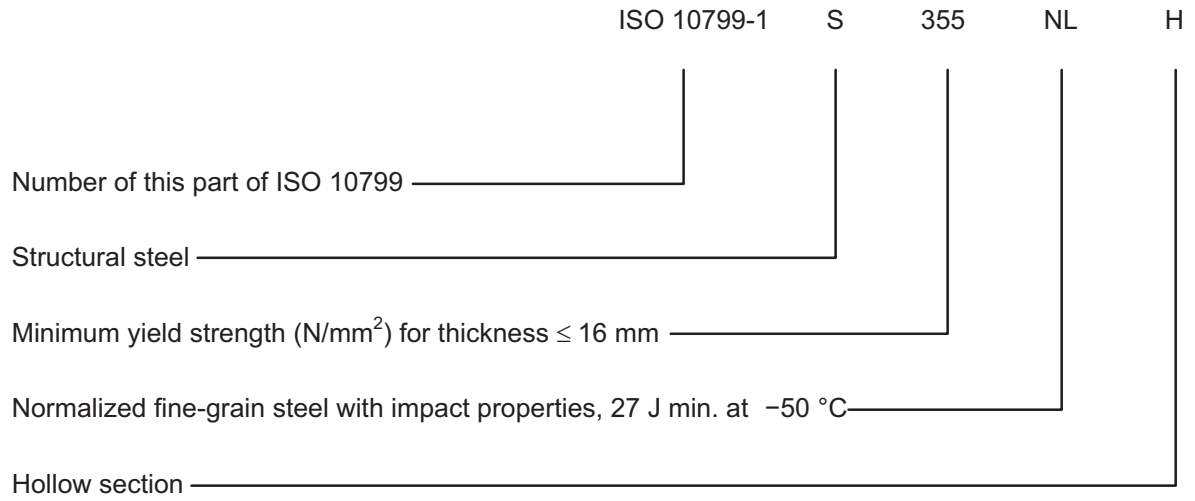
— the capital letter H to indicate hollow sections.

4.2.3 The product shall be designated as illustrated by the following examples:

EXAMPLE 1



EXAMPLE 2



5 Information to be supplied by the purchaser

5.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) the quantity (mass or total length or number);

b) the type of length and length range or length (see ISO 10799-2);

c) details of the product form:

CFCHS = cold-formed welded circular hollow section;

CFRHS = cold-formed welded square or rectangular hollow section;

d) the steel designation (see 4.2);

e) the dimensions (see ISO 10799-2);

f) the options required (see 5.2);

g) the type of inspection document required (see 7.2 and Tables 2 and 3).

5.2 Options

A number of options are specified in this part of ISO 10799; they are listed in this subclause with the appropriate subclause references. In the event that the purchaser does not indicate his/her wish to implement any of these options at the time of enquiry and order, the products shall be supplied in accordance with the basic specification (see 5.1).

a) Option 1: product analysis shall be carried out (see 6.6.1).

b) Option 2: a maximum carbon equivalent value (CEV) in accordance with Table A.2 shall be provided for non-alloy grades (see 6.6.2).

c) Option 3: the Cr, Cu, Mo, Ni, Ti and V cast analysis contents shall be reported in the inspection certificate or inspection report for non-alloy grades (see 6.6.2).

d) Option 4: a maximum CEV in accordance with Table B.3 shall be provided for fine grain steels S275, S355 and S420 (see 6.6.3).

e) Option 5: the cast analysis limits for grade S460 (see 6.6.3) shall be

   1) $V + Nb + Ti \leq 0{,}22$ %, and

   2) $Mo + Cr \leq 0{,}30$ %.

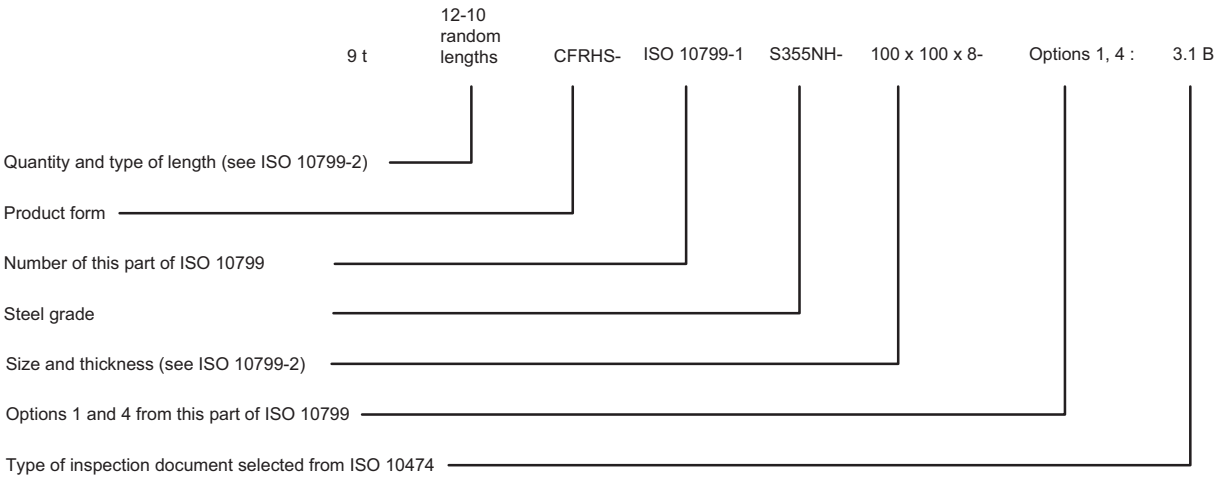
f) Option 6: impact properties of quality J0 and JR shall be verified. This option applies only when products are ordered with specific inspection and testing (see 6.7.4).

g) Option 7: the material shall be suitable for hot dip galvanized coating (see 6.8.2).

h) Option 8: weld repairs to the body of non-alloy structural steel hollow sections shall not be permitted (see 6.9.4).

i) Option 9: specific inspection and testing for non-alloy grades of qualities JR and J0 shall be applied (see 7.1.1).

5.3 Example



6 Requirements

6.1 General

Structural hollow sections of non-alloy steels shall comply with the requirements of Annex A; structural hollow sections of fine grain steels shall comply with the requirements of Annex B.

6.2 Steel manufacturing process

6.2.1 The steel manufacturing process shall be at the discretion of the steel producer.

6.2.2 For the non-alloy structural steels given in Annex A, the method of deoxidation shall be as given in Table A.1.

6.2.3 For the fine grain steels given in Annex B, the method of deoxidation shall be as given in Table B.1 or Table B.2.

6.2.4 The fine grain steels given in Annex B shall have a ferritic grain size equal to or finer than 6 when measured in accordance with ISO 643 (see 6.7.3).

6.3 Condition of feedstock material

According to the designation given in the order, the following delivery conditions apply for the feedstock material used for the manufacture of cold-formed hollow sections:

— as rolled or normalized/normalized rolled (N) for steels of qualities JR, J0 and J2 according to Annex A;

— normalized/normalized rolled (N) for steels of qualities N and NL according to Annex B;

— thermomechanically rolled (M) for steels of quality M and ML according to Annex B.

6.4 Structural hollow section manufacturing process

6.4.1 Structural hollow sections shall be manufactured by electric welding or submerged arc welding without subsequent heat treatment (see 6.5.1). Hollow sections manufactured by a continuous process shall not include welds used for joining lengths of the flat-rolled strip prior to forming the hollow section, except that for helically welded submerged arc-welded hollow sections such welds shall be permitted when tested in accordance with 9.4.3.

6.4.2 Electric welded hollow sections are normally supplied without trimming the internal weld bead.

6.4.3 For quality assurance requirements, see ISO 404. If the purchaser specifies quality assurance, an appropriate International Standard, such as ISO 9001, can be used.

6.5 Delivery conditions

6.5.1 The hollow sections shall be delivered cold formed without subsequent heat treatment except that the weld seam may be in the as welded or heat treated condition.

NOTE For submerged arc welded hollow sections above 508 mm outside diameter, it can be necessary to perform a warm shaping operation, which does not affect the mechanical properties, in order to meet the out-of-roundness tolerance requirements.

6.6 Chemical composition

6.6.1 The cast analysis reported by the steel producer shall apply and shall comply with the requirements of Table A.1 or Table B.1 or B.2.

Option 1 (see 5.2): a product analysis shall be carried out for hollow sections supplied with specific inspection and testing.

The permissible deviations of the product analysis from the specified limits cast analysis are given in Table 1.

When a CEV is required, it shall be determined from the cast analysis using the formula:

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

6.6.2 For non-alloy steel products, the following additional requirements may be requested at the time of enquiry and order for products supplied with specific inspection and testing (see 7.1).

Option 2 (see 5.2): the CEV in accordance with Table A.2.

Option 3 (see 5.2): the recording on the inspection certificate or inspection report of the Cr, Cu, Mo, Ni, Ti and V content (cast analysis).

Table 1 — Permissible deviations of the product analysis from the specified limits of the cast analysis given in Tables A.1, B.1 and B.2

Element	Permissible limiting content in the cast analysis mass fraction %		Permissible deviation of the product analysis from specified limits for the cast analysis mass fraction %
C[a]		≤ 0,20	+0,02
		> 0,20	+0,03
Si		≤ 0,60	+0,05
Mn	non-alloy	≤ 1,60	+0,10
	fine grain	≤ 1,70	−0,05 +0,10
P	non-alloy	≤ 0,045	+0,010
	fine grain	≤ 0,035	+0,005
S	non-alloy	≤ 0,045	+0,010
	fine grain	≤ 0,030	+0,005
Nb		≤ 0,050	+0,010
V		≤ 0,20	+0,02
Ti		≤ 0,05	+0,01
Cr		≤ 0,30	+0,05
Ni		≤ 0,80	+0,05
Mo		≤ 0,20	+0,03
Cu		≤ 0,35	+0,04
		0,35 < Cu ≤ 0,70	+0,07
N		≤ 0,025	+0,002
Al_{Total}		≤ 0,020	−0,005

[a] For S235JRH for thicknesses less than or equal to 16 mm, the permissible deviation is +0,04 % C, and for thicknesses greater than 16 mm and less than or equal to 40 mm, the permissible deviation is +0,05 % C.

6.6.3 For fine grain steel hollow sections, the following additional requirements may be requested at the time of enquiry and order.

Option 4 (see 5.2): the CEV for steel grades S275, S355 and S420 in accordance with Table B.3.

Option 5 (see 5.2): for steel grade S460, the following limits for the cast analysis:

$V + Nb + Ti \leq 0{,}22$ % and $Mo + Cr \leq 0{,}30$ %.

A maximum CEV may be agreed between the purchaser and manufacturer as an alternative to option 5.

6.7 Mechanical properties

6.7.1 Under the inspection and testing conditions as specified in Clause 7 and in the delivery condition as specified in 6.5, the mechanical properties shall comply with the relevant requirements of Tables A.3, B.4 and B.5.

Stress relief annealing at more than 580 °C or for over 1 h can lead to deterioration of the mechanical properties. If the purchaser intends to stress relief anneal the products at higher temperatures or for longer times, the minimum values of the mechanical properties after such a treatment should be agreed at the time of the enquiry and order.

6.7.2 For impact tests, standard V-notch test pieces (see ISO 148-1) shall be used. If the nominal product thickness is not sufficient for the preparation of standard test pieces, the test shall be carried out using test pieces of width less than 10 mm, but not less than 5 mm. The minimum average values given in Tables A.3, B.4 and B.5 shall be reduced in direct proportion of the actual width of the test piece to that of the standard test piece.

Impact tests are not required for nominal thickness less than 6 mm.

6.7.3 For fine grain steel hollow sections in thicknesses that do not permit test pieces of width greater than or equal to 5 mm to be taken, the ferritic grain size (see 6.2.4) shall be verified by the method specified in ISO 643.

When aluminium is used as the grain refining element, the grain size requirement shall be deemed to be fulfilled if the cast analysis shows the aluminium content to be not less than 0,020 % total aluminium or alternatively 0,015 % soluble aluminium. In these cases, verification of the grain size is not required.

6.7.4 Subject to the limitations of 6.7.2:

a) the impact properties of structural hollow sections of steel qualities J2, M, N, ML and NL shall be verified;

b) the impact properties of structural hollow sections of steel qualities JR and J0 are not verified.

Option 6 (see 5.2): the purchaser may request at the time of enquiry and order, for products supplied with specific inspection and testing (see option 9), that the impact properties of steel qualities JR and J0 be verified.

6.8 Technological properties

6.8.1 Weldability

The steels specified in this part of ISO 10799 shall be suitable for welding by all appropriate welding processes.

NOTE 1 With increasing product thickness, increasing strength level and increasing carbon equivalent level, the occurrence of cold cracking in the welded zone forms the main risk. Cold cracking is caused by the following factors in combination:

— the amount of diffusible hydrogen in the weld metal;

— a brittle structure of the heat-affected zone;

— significant tensile stress concentrations in the welded joint.

NOTE 2 When following recommendations laid down in any relevant standard, the welding conditions and various welding ranges of the steel grades can be determined according to the product thickness, applied welding energy, the design requirements, electrode efficiency, welding process and weld metal properties.

6.8.2 Hot dip galvanized coating

Option 7 (see 5.2): at the time of enquiry and order, the purchaser may request that the products be suitable for hot dip galvanized coating.

6.9 Surface condition

6.9.1 The hollow sections shall have a smooth surface corresponding to the manufacturing method used; however, bumps, cavities or shallow longitudinal grooves resulting from the manufacturing process are permissible, provided the remaining thickness is within tolerance.

Surface defects may be removed by the manufacturer by grinding, provided the thickness of the hollow section after the repair is not less than the minimum permissible thickness. (See ISO 10799-2 for thickness tolerance.)

6.9.2 The ends of the hollow section shall be cut nominally square with the axis of the product.

6.9.3 For both non-alloy and fine-grain steel structural hollow sections, repair of the weld shall require authorization.

6.9.4 For non-alloy structural hollow sections, repair of the body by welding shall be permitted unless otherwise specified. The conditions under which, and the extent to which, welding repair to the body may be carried out shall be agreed between the manufacturer and the purchaser.

Option 8 (see 5.2): the purchaser may specify at the time of enquiry and order that repair of the body by welding not be carried out.

For fine grain structural steel hollow sections, repair of the body by welding shall not be permitted unless otherwise agreed.

6.9.5 Welding repair shall be carried out by operators qualified in accordance with ISO 9606-1. Welding repair procedures shall be in accordance with ISO 15607, ISO 15609-1 and ISO 15614-1. The repair welding procedures shall be covered by the manufacturer's quality assurance system.

6.9.6 The repaired hollow section shall comply with all the requirements of this part of ISO 10799.

6.10 Non-destructive testing of welds

The seam weld of all hollow sections supplied with specific inspection and testing shall be subjected to a non-destructive test (NDT) (see 9.4).

6.11 Tolerances and mass

6.11.1 Tolerances

Tolerances for cold-formed structural hollow sections shall be as specified in ISO 10799-2.

6.11.2 Mass

Mass shall be determined using a density of 7,85 kg/dm^3.

Dimensions, sectional properties and mass per unit length for a range of standard sizes of cold-formed structural hollow sections are given in ISO 10799-2. It is preferable that the purchaser select the dimensions of the hollow sections from this range of standard sizes.

7 Inspection

7.1 Types of inspection and testing

7.1.1 Hollow sections of non-alloy steels in qualities JR and J0 (see Annex A) shall be subjected to non-specific inspection and testing in accordance with ISO 404 unless otherwise specified by the purchaser at the time of enquiry and order.

Option 9 (see 5.2): the purchaser may request specific inspection and testing at the time of enquiry and order.

7.1.2 Hollow sections of non-alloy steel quality J2 (see Annex A) and fine grain steels of qualities M, N, ML and NL (see Annex B) shall be subjected to specific inspection and testing in accordance with ISO 404.

7.2 Types of inspection documentation

7.2.1 For products supplied with non-specific inspection and testing, a test report (see ISO 10474:1991, 2.2) in accordance with ISO 10474 shall be provided.

The test report shall contain the following information:

a) commercial transactions and parties involved;

b) description of products to which the test report applies;

c) information on tests as follows:

   1) tensile test reports;

   2) chemical composition: a cast analysis;

d) authentication.

7.2.2 For products supplied with specific inspection and testing, an inspection certificate (i.e. type “3.1.A”, “3.1.B” or “3.1.C” as specified in ISO 10474:1991, 3.1) or an inspection report (type “3.2” as specified in ISO 10474:1991, 3.2) in accordance with ISO 10474 shall be provided.

The purchaser shall indicate in the enquiry and order the type of inspection document required [see 5.1 g)].

If an inspection document of type 3.1.A, 3.1.C or 3.2 is specified, the purchaser should notify the manufacturer of the address of the organization or person who is to carry out the inspection and produce the inspection document. In the case of the inspection report 3.2, it shall be agreed which party is to issue the certificate.

The inspection certificate or report shall contain the following information:

a) commercial transactions and parties involved;

b) description of products to which the inspection certificate applies;

c) information on tests as follows:

   1) tensile test: test piece shape and test results;

   2) impact test: test piece type and test results;

   3) the cast analysis and, if applicable, the product analysis;

d) authentication.

7.3 Inspection and testing

7.3.1 General

The requirements for inspection and testing are given in Table 2 for hollow sections of non-alloy steels and in Table 3 for hollow sections of fine grain steels.

7.3.2 Non-specific inspection and testing

Where products are supplied with non-specific inspection and testing, the tests shall be carried out by the manufacturer, in accordance with the manufacturer's own procedures, to demonstrate that products made by the same manufacturing process meet the requirements of the order. The products tested may not necessarily be those actually supplied.

7.3.3 Specific inspection and testing

When products are supplied with specific inspection and testing, the tests shall be carried out on the products to be supplied or on test units of which the product to be supplied is a part, or (when applicable) on all hollow sections.

Table 2 — Inspection and testing programme for non-alloy steel hollow sections

Inspection and testing requirements				Scope of inspection and test programme and type of document	
Requirement			Subclause reference(s)	Non-specific inspection and testing	Specific inspection and testing
				Test report[a]	Inspection certificate (type 3.1.A, 3.1.B or 3.1.C)[b] or inspection report (type 3.2)[b]
Mandatory requirements	1	Cast analysis	6.6 9.1	One result per delivery item	One per cast
	2	Tensile test	6.7 9.2	One result per delivery item	One per test unit[d]
	3	Impact test quality J2 only	6.7 9.2	Not applicable	One set per test unit[d]
	4	Surface condition and dimensions	6.9 6.11 9.3	See 9.3	See 9.3
	5	NDT of the weld	6.10 9.4	Not applicable	All products, full length
Optional requirements	6	Product analysis	6.6 9.1	Not applicable	One per test unit[d]
	7	Cast analysis additional elements	6.6 9.1	Not applicable	See option 3
	8	Impact test qualities JR and JO only	6.7 9.2	Not applicable	One set per test unit[c] (only when option 6 is requested)

[a] In accordance with ISO 10474:1991, 2.2.

[b] In accordance with ISO 10474:1991, 3.1.

[c] In accordance with ISO 10474:1991, 3.2.

[d] For test unit, see 8.1.3.

Table 3 — Inspection and testing programme for fine grain steel hollow sections

Inspection and testing requirements				Scope of inspection and test programme and type of document
Requirement			Subclause reference(s)	Specific inspection and testing Inspection certificate (3.1.A, 3.1.B or 3.1.C)[a] or inspection report (3.2)[b]
Mandatory requirements	1	Cast analysis	6.6 9.1	One per cast
	2	Tensile test	6.7 9.2	One per test unit[c]
	3	Impact test	6.7 9.2	One set per test unit[c]
	4	Surface condition and dimensions	6.9 6.11 9.3	See 9.3
	5	NDT of the weld	6.10 9.4	All products, full length
Optional requirement	6	Product analysis	6.6 9.1	One per test unit[c]

[a] In accordance with ISO 10474:1991, 3.1.

[b] In accordance with ISO 10474:1991, 3.2.

[c] For test unit, see 8.1.3.

8 Samples

8.1 Frequency of tests

8.1.1 For products supplied with non-specific inspection and testing, see 7.3.2.

8.1.2 For products supplied with specific inspection and testing, the verification of the mechanical properties and product analysis, if applicable, shall be carried out using a test unit. A test unit is defined as a quantity of hollow sections from one or more cast(s) of the same grade and dimensions manufactured by the same process (i.e. electric welding or submerged arc welding) and, if applicable, in the same heat treatment condition, submitted for acceptance at the same time.

From each test unit, one sample shall be taken sufficient for the preparation of the following test pieces:

— one tensile test piece;

— two sets of three impact test pieces (see 9.2.2);

— one product analysis, where required (see 6.6.1).

8.1.3 The test unit shall consist of the tonnage of sections specified in Table 4.

Table 4 — Test units

Type of section		Test unit
Circular	Square or rectangular	
Outside diameter D mm	External perimeter mm	Mass t
≤ 114,3	≤ 400	≤ 40
> 114,3, ≤ 323,9	> 400, ≤ 800	≤ 50
> 323,9	> 800	≤ 75

8.2 Preparation of samples and test pieces

8.2.1 Selection and preparation of samples for chemical analysis

Samples for product analysis shall be taken from the test pieces or samples for mechanical testing or from the whole thickness of the hollow section at the same location as for the mechanical test samples. The preparation of samples shall be in accordance with ISO 14284.

8.2.2 Location and orientation of samples for mechanical tests

8.2.2.1 Tensile test pieces

The test pieces for tensile testing shall comply with the following.

a) For circular, square or rectangular sections, the test piece may be the full section of the product.

b) For circular sections, not tested in full section, the test pieces shall be taken longitudinally and at a point remote from the weld (see Annex C).

   Alternatively, at the discretion of the manufacturer, transverse test pieces may be taken.

c) For square or rectangular sections, not tested in full section, the test pieces shall be taken longitudinally, midway between the corners, from one of the sides not containing the weld (see Annex C).

   Alternatively, at the discretion of the manufacturer, transverse test pieces may be taken.

8.2.2.2 Impact test pieces

Test pieces for impact testing shall comply with the following.

a) For circular sections, the test pieces shall be taken longitudinally and at a point remote from the weld (see Annex C).

   Alternatively, at the discretion of the manufacturer, transverse test pieces may be taken.

b) For square or rectangular sections, the test pieces shall be taken longitudinally, midway between the corners, from one of the sides not containing the weld (see Annex C).

   Alternatively, at the discretion of the manufacturer, transverse test pieces may be taken.

8.2.3 Preparation of test pieces for mechanical tests

8.2.3.1 General

The requirements of ISO 377 shall apply in conjunction with the test piece location specified in 8.2.2.

8.2.3.2 Tensile test pieces

The requirements of ISO 6892-1 and ISO 6892-2, as appropriate, shall apply.

Test pieces may be non-proportional, but in cases of dispute, proportional test pieces having a gauge length $L_o = 5{,}65\sqrt{S_o}$ shall be used (see 9.2.1). For thicknesses of less than 3 mm, a gauge length of L_o = 80 mm shall be used, provided a test piece width of 20 mm can be achieved. Otherwise, a gauge length of 50 mm shall be used with a test-piece width of 12,5 mm.

8.2.3.3 Impact test pieces

Impact V-notch test pieces shall be machined and prepared in accordance with ISO 148-1. In addition, the following shall apply:

a) for nominal thicknesses $>$ 12 mm, standard test pieces shall be machined in such a way that one side is not further than 2 mm from a rolled surface;

b) for nominal thicknesses $\leq$ 12 mm, where test pieces with reduced sections are used, the width shall be $\geq$ 5 mm.

NOTE Test piece size is dependent on the actual thickness of the sample and, for circular hollow sections, allowance also needs to be made for the curvature of the section.

9 Test methods

9.1 Chemical analysis

The elements to be determined and reported shall be those given in Table A.1, unless option 3 is requested (see 5.2) or Table B.1 or Table B.2.

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the manufacturer.

In case of dispute, the method used shall be agreed, taking into account the relevant International Standards.

9.2 Mechanical tests

9.2.1 Temperature requirements

Tensile tests shall be carried out in the temperature range 10 °C to 35 °C. Impact tests shall be carried out at the temperatures specified in Table A.3 for non-alloy steels, and Tables B.4 and B.5 for fine grain steels. (For retests, see 9.5.)

9.2.2 Tensile tests

The tensile test shall be carried out in accordance with ISO 6892-1 and ISO 6892-2.

For the specified yield strength in Tables A.3, B.4 and B.5, the upper yield stress, R_{eH}, shall be determined.

If a yield phenomenon is not present, the 0,2 % proof strength, $R_{p0,2}$, or the 0,5 % proof stress total elongation, $R_{t0,5}$, shall be determined. In cases of dispute, the 0,2 % proof strength, $R_{p0,2}$, shall apply.

If a non-proportional test piece is used, the percentage elongation value obtained shall be converted to the value for a gauge length $L_o = 5{,}65\sqrt{S_o}$ using the conversion tables given in ISO 2566-1.

For thicknesses less than 3 mm, the percentage elongation may be reported for a gauge length, L_o, of 80 mm or 50 mm (see 8.2.3.1). In this case, the values to be achieved shall be agreed between the purchaser and the manufacturer at the time of enquiry and order.

9.2.3 Impact tests

The impact test shall be carried out in accordance with ISO 148-1 and assessed in accordance with ISO 404 in conformity with the following.

a) The averaged value of a set of three test pieces shall meet the specified requirement. One individual value may be below the specified value, provided it is no less than 70 % of that value.

b) If the conditions of a) are not satisfied, an additional set of three test pieces shall be taken from the same sample and tested. In order for the test unit to be considered in accordance with this part of ISO 10799, after testing the second set, the following conditions shall be satisfied simultaneously:

   1) the average value of six tests shall be equal to or greater than the specified value;

   2) not more than two of six individual values may be lower than the specified value;

   3) not more than one of the six individual values may be lower than 70 % of the specified value.

c) If these conditions are not satisfied the sample product is deemed to be not in accordance with this part of ISO 10799 and retests may be carried out on the remainder of the test unit (see 9.5).

9.3 Visual examination and dimensional inspection

9.3.1 Visual examination

The hollow sections shall be visually examined for compliance with the requirements of 6.9.

9.3.2 Dimensional inspection

The dimensions of the hollow sections shall be inspected for compliance with the requirements of ISO 10799-2.

9.4 Non-destructive testing of welding

9.4.1 General

When the welds of welded structural hollow sections are subjected to NDT, the method shall be in accordance with 9.4.2 or 9.4.3. At the manufacturer's discretion, the NDT may be carried out either on the circular shape prior to final forming, or on the round, square or rectangular hollow sections after final forming.

9.4.2 Electric welded sections

The weld seam shall be tested in accordance with one of the following International Standards:

a) ISO 10893-2 to acceptance level E5, except that the rotating tube/pancake coil technique shall not be permitted;

b) ISO 10893-3 or ISO 10893-11, with the exceptions that the acceptance level shall be based on the use of N 15 internal/external notches and that for the application of ISO 10893-3 a notch width of no greater than twice the depth of the reference notch, with a maximum of 1,0 mm, shall apply.

The International Standard to be applied is at the discretion of the manufacturer.

9.4.3 Submerged arc welded sections

The weld seam shall be tested to level U5 in accordance with ISO 10893-11 or by radiography in accordance with ISO 10893-6 and with an image quality class B.

Butt welds used to join lengths of strip or plate together in the helically submerged arc weld process shall be permitted, provided the butt weld is tested by the same type of procedure and meets the same acceptance level as the main weld seam.

9.5 Retests, sorting and reprocessing

For retests, sorting and reprocessing, ISO 404 shall apply.

10 Marking

10.1 Except as provided for in 10.2 for bundled hollow sections, each hollow section shall be marked by suitable and durable methods, such as painting, stamping, adhesive labels or attached tags with the following:

— the abridged designation, for example, ISO 10799-1 – S275J0;

— the manufacturer's name or trademark;

— in the case of specific inspection and testing, an identification number (e.g. order item number), which permits the correlation of the product or delivery unit to the related inspection document.

EXAMPLE 1 ISO 10799-1 - S235JR + trademark.

EXAMPLE 2 ISO 10799-1 - S275NL + manufacturer's name + order item number.

10.2 Where the products are supplied bundled, the marking required in 10.1 may be on a label, which shall be securely attached to the bundle.

Annex A
(normative)

Structural hollow sections of non-alloy steels — Chemical composition and mechanical properties

Table A.1 — Chemical composition — Cast analysis for product thickness less than or equal to 40 mm[a]

Steel grade	Type of deoxidation[b]	C max. %	Si max. %	Mn max. %	P max. %	S max. %	N[c] max. %
S235JRH	FF	0,17	—	1,40	0,045	0,045	0,009
S275J0H	FF	0,20	—	1,50	0,040	0,040	0,009
S275J2H	FF	0,20	—	1,50	0,035	0,035	—
S355J0H	FF	0,22	0,55	1,60	0,040	0,040	0,009
S355J2H	FF	0,22	0,55	1,60	0,035	0,035	—

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] The deoxidation method is designated as follows:

FF: Fully killed steel containing nitrogen-binding elements in amounts sufficient to bind available nitrogen (e.g. min. 0,020 % total Al, or 0,015 % soluble Al).

[c] The maximum value for nitrogen does not apply if the chemical composition shows a minimum total Al content of 0,020 % with a minimum Al/N ratio of 2:1, or if there is a sufficiency of other nitrogen-binding elements present. The nitrogen-binding elements shall be recorded in the inspection document.

Table A.2 — Maximum carbon equivalent value based on cast analysis

Steel grade	Maximum CEV for nominal thicknesses equal to or less than 40 mm[a]
S235JRH	0,35
S275J0H	0,40
S275J2H	0,40
S355J0H	0,45
S355J2H	0,45

[a] Only circular hollow section available in thicknesses of over 24 mm.

Table A.3 — Mechanical properties of non-alloy steel hollow sections in thicknesses less than or equal to 40 mm[a]

Steel grade	Upper yield strength R_{eH} N/mm^2		Tensile strength R_m N/mm^2		Minimum percentage elongation A_{min} $\left(L_o = 5{,}65\sqrt{S_o}\right)$ [cd]	Impact properties	
	Nominal thickness mm		Nominal thickness mm		Nominal thickness mm	Temperature °C	Minimum average absorbed energy for standard test pieces[e] J
	≤ 16	> 16, ≤ 40	< 3	≥ 3, ≤ 40	≤ 40		
S235JRH[b]	235	225	360 to 510	340 to 470	24	20	27
S275J0H[b]	275	265	430 to 580	410 to 560	20	0	27
S275J2H						−20	27
S355J0H[b]	355	345	510 to 680	490 to 630	20	0	27
S355J2H						−20	27

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] The impact properties are verified only when specified at the time of enquiry and order for products supplied with specific inspection and testing.

[c] For section sizes ≤ 60 mm × 60 mm and equivalent round and rectangular sections, the minimum value for elongation is 17 % for all thicknesses.

[d] For thicknesses less than 3 mm a gauge length, L_o, of 80 mm or 50 mm shall be used (see 8.2.3.2); the values of percentage elongation to be achieved shall be agreed between the purchaser and the manufacturer at the time of enquiry and order (see 9.2.1).

[e] For impact properties for reduced section test pieces, see 6.7.2.

Annex B
(normative)

Structural hollow sections of fine grain steels — Chemical composition and mechanical properties

Table B.1 — Chemical composition — Cast analysis for product thicknesses less than or equal to 40 mm[a] with feedstock material condition N[b]

Steel grade	Type of deoxidation[c]	C max. %	Si max. %	Mn max. %	P max. %	S max. %	Nb max. %	V max. %	Al total min.[d] %	Ti max. %	Cr max. %	Ni max. %	Mo max. %	Cu max. %	N max. %
S275NH	GF	0,20	0,40	0,50 to 1,40	0,035	0,030	0,050	0,05	0,020	0,03	0,30	0,30	0,10	0,35	0,015
S275NLH					0,030	0,025									
S355NH	GF	0,20	0,50	0,90 to 1,65	0,035	0,030	0,050	0,12	0,020	0,03	0,30	0,50	0,10	0,35	0,015
S355NLH		0,18			0,030	0,025									
S460NH	GF	0,20	0,60	1,00 to 1,70	0,035	0,030	0,050	0,20	0,020	0,03	0,30	0,80	0,10	0,70	0,025
S460NLH					0,030	0,025									

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] See 6.3.

[c] The deoxidation method is designated as follows:

GF: Fully killed steel containing nitrogen-binding elements in amounts sufficient to bind the available nitrogen and having a fine grain structure.

[d] If sufficient nitrogen-binding elements are present, the minimum total Al content does not apply.

[e] If the copper content is greater than 0,30 %, the nickel content shall be at least half of the copper content.

Table B.2 — Chemical composition — Cast analysis for product thicknesses less than or equal to 40 mm[a] with feedstock material condition M[b]

Steel grade	Type of deoxidation[c]	C max. %	Si max. %	Mn max. %	P max. %	S max. %	Nb max. %	V max. %	Al total min.[d] %	Ti max. %	Ni max. %	Mo[e] max. %	N max. %
S275MH	GF	0,13	0,50	1,50	0,035	0,030	0,050	0,08	0,020	0,050	0,30	0,20	0,020
S275MLH					0,030	0,025							
S355MH	GF	0,14	0,50	1,50	0,035	0,030	0,050	0,10	0,020	0,050	0,30	0,20	0,020
S355MLH					0,030	0,025							
S420MH	GF	0,16	0,50	1,70	0,035	0,030	0,050	0,12	0,020	0,050	0,30	0,20	0,020
S420MLH					0,030	0,025							
S460MH	GF	0,16	0,60	1,70	0,035	0,030	0,050	0,12	0,020	0,050	0,30	0,20	0,025
S460MLH					0,030	0,025							

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] See 6.3.

[c] The deoxidation method is designated as follows:

GF: Fully killed steel containing nitrogen-binding elements in amounts sufficient to bind the available nitrogen and having a fine grain structure.

[d] If sufficient nitrogen-binding elements are present, the minimum total Al content does not apply.

[e] The total sum of Cr, Cu and Mo shall be not higher than 0,60 %.

Table B.3 — Maximum carbon equivalent value based on cast analysis

Steel grade	Maximum CEV for nominal thicknesses equal to or less than 40 mm[a] %
S275NH S275NLH	0,40
S275MH S275MLH	0,34
S355NH S355NLH	0,43
S355MH S355MLH	0,39
S420MH S420MLH	0,43
S460NH[b] S460NLH[b]	—
S460MH[b] S460MLH[b]	—

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] See 6.6.3, option 5.

Table B.4 — Mechanical properties of hollow sections in thicknesses less than or equal to 40 mm[a] with feedstock material condition N

Steel grade	Minimum yield strength R_{eH} N/mm²		Tensile strength R_m N/mm²	Minimum percentage elongation A_{min} $\left(L_o = 5,65\sqrt{S_o}\right)$ [bc]	Impact properties	
	Nominal thickness mm		Nominal thickness mm	Nominal thickness mm	Temperature °C	Minimum average absorbed energy for standard test pieces[d] J
	≤ 16	> 16, ≤ 40	≤ 40	≤ 40		
S275NH	275	265	370 to 540	24	−20	40
S275NLH					−50	27
S355NH	355	345	470 to 630	22	−20	40
S355NLH					−50	27
S460NH	460	440	550 to 720	17	−20	40
S460NLH					−50	27

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] For section sizes ≤ 60 mm × 60 mm and equivalent round and rectangular section, the minimum value for elongation is 17 % for all thicknesses.

[c] For thicknesses less than 3 mm a gauge length, L_o, of 80 mm or 50 mm shall be used (see 8.2.3.2); the values of percentage elongation to be achieved shall be agreed between the purchaser and the manufacturer at the time of enquiry and order (see 9.2.1).

[d] For impact properties for reduced section test pieces, see 6.7.2.

Table B.5 — Mechanical properties of hollow sections in thicknesses equal to or less than 40 mm[a] with feedstock material condition M

Steel grade	Minimum yield strength R_{eH} N/mm²		Tensile strength R_m N/mm²	Minimum percentage elongation A_{min} $\left(L_o = 5{,}65\sqrt{S_o}\right)$ [bc]	Impact properties	
	Nominal thickness mm		Nominal thickness mm	Nominal thickness mm	Temperature °C	Minimum average absorbed energy for standard test pieces[d] J
	≤ 16	> 16, ≤ 40	≤ 40	≤ 40		
S275MH	275	265	360 to 510	24	−20	40
S275MLH					−50	27
S355MH	355	345	450 to 610	22	−20	40
S355MLH					−50	27
S420MH	420	400	500 to 660	19	−20	40
S420MLH					−50	27
S460MH	460	440	530 to 720	17	−20	40
S460MLH					−50	27

[a] Only circular hollow sections available in thicknesses over 24 mm.

[b] For section sizes ≤ 60 mm and equivalent round and rectangular sections, the minimum value for elongation is 17 % for all thicknesses.

[c] For thicknesses less than 3 mm a gauge length, L_o, of 80 mm or 50 mm shall be used (see 8.2.3.2); the values of percentage elongation to be achieved shall be agreed between the purchaser and the manufacturer at the time of enquiry and order (see 9.2.1).

[d] For impact properties for reduced section test pieces, see 6.7.2.

Annex C
(normative)

Location of samples and test pieces

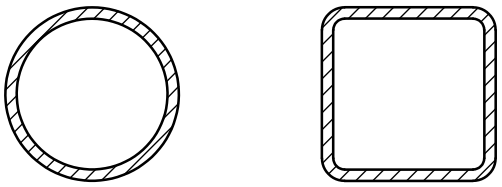
C.1 Location of samples

C.1.1 General

This annex gives information on the location of samples and test pieces for hollow sections (see 8.2.2).

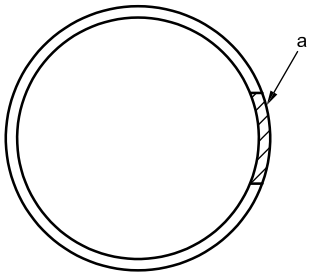
C.1.2 Location of test samples for tensile test

See Figures C.1 to C.3.

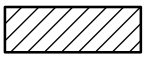


For circular, rectangular or square sections, the test piece may be the full section of the product.

Figure C.1 — Small sections

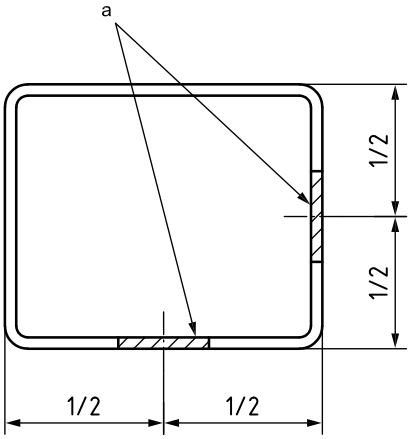


Key

 location of samples

a At any point on circumference remote from the weld.

Figure C.2 — Circular sections



Key

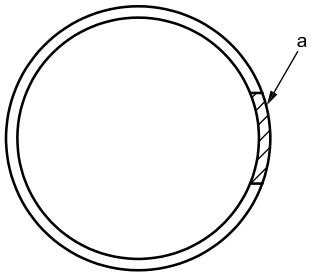
location of samples

a Alternative positions (on any side except a side containing the weld).

Figure C.3 — Square and rectangular sections

C.1.3 Location of test samples for impact test

See Figures C.4 and C.5.

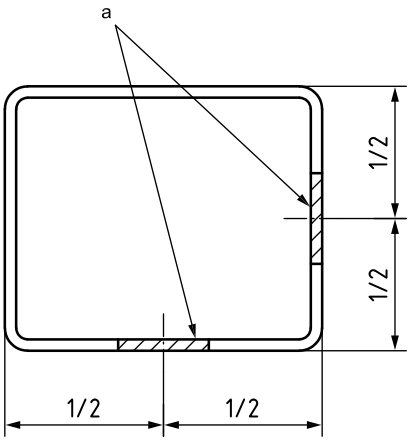


Key

location of samples

a At any point on circumference remote from the weld.

Figure C.4 — Circular section



Key

location of samples

a Alternative positions (on any side except a side containing the weld).

Figure C.5 — Square or rectangular sections

C.2 Test pieces

Test pieces are taken from the samples indicated in Figures C.1 to C.5.

Bibliography

[1] ISO 6929, *Steel products — Definitions and classification*

[2] ISO 9001, *Quality management systems — Requirements*

[3] ISO 12633-1, *Hot-finished structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery conditions*

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