
**Structural steels — Cold-formed, welded,
structural hollow sections — Technical
delivery requirements**

*Aciers de construction — Profils creux pour la construction soudés formés à
froid — Conditions techniques de livraison*



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Contents

	Page
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Classification and designations	3
4.1 Classification	3
4.2 Designations	3
5 Information to be supplied by the purchaser	4
5.1 Mandatory information	4
5.2 Options	4
5.3 Example	5
6 Requirements	5
6.1 General	5
6.2 Steel manufacturing process	5
6.3 Condition of feedstock material	6
6.4 Structural hollow section manufacturing process	6
6.5 Delivery conditions	6
6.6 Chemical composition	6
6.7 Mechanical properties	7
6.8 Technological properties	8
6.9 Surface condition	8
6.10 Non-destructive testing of welds	9
6.11 Tolerances and mass	9
7 Inspection	9
7.1 Types of inspection and testing	9
7.2 Types of inspection document	9
7.3 Inspection and testing	10
8 Samples	10
8.1 Frequency of tests	10
8.2 Preparation of samples and test pieces	12
9 Test methods	13
9.1 Chemical analysis	13
9.2 Mechanical tests	14
9.3 Visual examination and dimensional inspection	14
9.4 Non-destructive testing of welding	15
9.5 Retests, sorting and reprocessing	15
10 Marking	15

Annexes

A Structural hollow sections of non-alloy steels — Chemical composition and mechanical properties 16

B Structural hollow sections of fine-grain steels — Chemical composition and mechanical properties..... 18

C Location of samples and test pieces 21

Bibliography..... 24

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

Annexes A, B and C form a normative part of this International Standard.

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Structural steels — Cold-formed, welded, structural hollow sections — Technical delivery requirements

1 Scope

This International Standard specifies the technical delivery requirements for cold-formed, welded, steel 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 Requirements for tolerances, dimensions and sectional properties are given in ISO 4019.

NOTE 2 For hot-finished structural hollow sections, see ISO 630-2.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 148:1983, *Steel — Charpy impact test (V-notch)*.

ISO 377:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*.

ISO 404:1992, *Steel and steel products — General technical delivery requirements*.

ISO 643:1983, *Steels — Micrographic determination of the ferritic or austenitic grain size*.

ISO 2566-1:1984, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels*.

ISO 4019:—¹⁾, *Structural steels — Cold-formed, welded, structural hollow sections — Dimensions and sectional properties*.

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*.

ISO 9001:2000, *Quality management systems — Requirements*.

ISO 9304:1989, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Eddy current testing for the detection of imperfections*.

ISO 9402:1989, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Full peripheral magnetic transducer/flux leakage testing of ferromagnetic steel tubes for the detection of longitudinal imperfections*.

1) To be published. (Revision of ISO 4019:1982)

ISO 9606-1:1994, *Approval testing of welders — Fusion welding — Part 1: Steels*.

ISO 9764:1989, *Electric resistance and induction welded steel tubes for pressure purposes — Ultrasonic testing of the weld seam for the detection of longitudinal imperfections*.

ISO 9765:1990, *Submerged arc-welded steel tubes for pressure purposes — Ultrasonic testing of the weld seam for the detection of longitudinal and/or transverse imperfections*.

ISO 9956-1:1995, *Specification and approval of welding procedures for metallic materials — Part 1: General rules for fusion welding*.

ISO 9956-2:1995, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding*.

ISO 9956-3:1995, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for arc welding of steels*.

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

ISO 12096:1996, *Submerged arc-welded steel tubes for pressure purposes — Radiographic testing of the weld seam for the detection of imperfections*.

ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*.

3 Terms and definitions

For the purposes of this International Standard, 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 whereby the main forming is done 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 (subsequent heating above 580 °C may lower the strength values)

NOTE 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 designations

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, limits on values of various elements with particular reference to sulfur and phosphorus, and in 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 Designations

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

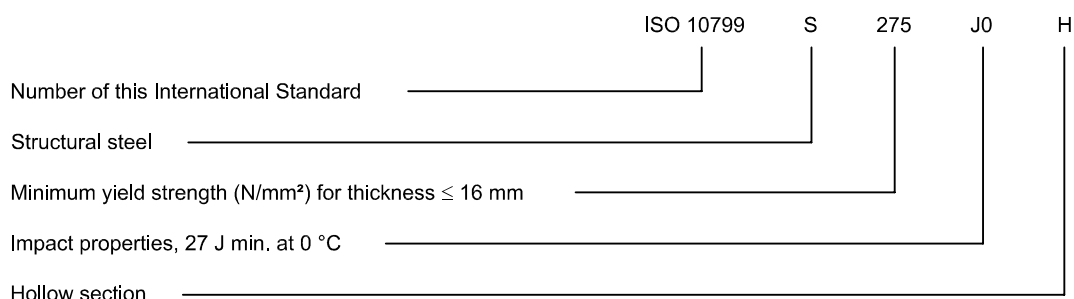
- the number of this International Standard (i.e. ISO 10799);
- the capital letter S for structural steel;
- the indication of the minimum specified yield strength for thicknesses ≤ 16 mm, expressed in newtons per square millimetre (N/mm²);
- the capital letters JR for the qualities with specified impact 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:

- the number of this International Standard (i.e. ISO 10799);
- 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/mm²);
- 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

	ISO 10799	S	355	NL	H
Number of this International Standard					
Structural steel					
Minimum yield strength (N/mm ²) for thickness ≤ 16 mm					
Normalized fine-grain steel with impact properties, 27 J min. at - 50 °C					
Hollow section					

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:

- the quantity (mass or total length or number);
- the type and range of length or the length (see ISO 4019);
- details of the product form:
 - CFCHS = cold-formed welded circular hollow section;
 - CFRHS = cold-formed welded square or rectangular hollow section;
- the steel designation (see 4.2);
- the dimensions (see ISO 4019);
- the options required (see 5.2);
- the type of inspection document required (see 7.2 and Tables 2 and 3).

5.2 Options

A number of options are given in this International Standard, listed below with their subclause references. In the event that the purchaser does not indicate the 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).

Options:

- Product analysis shall be carried out (see 6.6.1).
- A maximum carbon equivalent value in accordance with Table A.2 shall be provided for non-alloy grades (see 6.6.2).
- The Cr, Cu, Mo, Ni, Ti and V cast analysis contents shall be reported in the inspection certificate or report for non-alloy grades (see 6.6.2).
- A maximum carbon equivalent value in accordance with Table B.3 shall be provided for the fine-grain steels S275, S355 and S420 (see 6.6.3).

- 5 The cast-analysis limits for grade S460 (see 6.6.3) shall be:
- $V + Nb + Ti \leq 0,22 \%$; and
 - $Mo + Cr \leq 0,30 \%$.
- 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).
- 7 The material shall be suitable for hot-dipped galvanized coating (see 6.8.2).
- 8 Weld repairs to the body of non-alloy structural steel hollow sections shall not be permitted (see 6.9.4).
- 9 Specific inspection and testing for non-alloy grades of qualities JR and J0 shall be applied (see 7.1.1).

5.3 Example

	9 t	12-10 random lengths	CFRHS -	ISO 10799 -	S355NH -	100 × 100 × 8 -	Options 1, 4 :	3.1.B
Quantity and type of length (see ISO 4019)								
Product form								
Number of this International Standard								
Steel grade								
Size and thickness (see ISO 4019)								
Options 1 and 4 from this International Standard								
Type of inspection document selected from ISO 10474								

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 or submerged arc welding without subsequent heat treatment (see 6.5). 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 of the internal weld bead.

6.4.3 For quality assurance requirements, see ISO 404. If the purchaser specifies quality assurance, the appropriate standard is ISO 9001:2000.

6.5 Delivery conditions

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 with a greater than 508 mm outside diameter it could 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, 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 carbon equivalent value (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 can 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		Permissible deviation of the product analysis from specified limits for the cast analysis
	mass fraction %		mass fraction %
C ^a	$\leq 0,20$		+0,02
	$> 0,20$		+0,03
Si	$\leq 0,60$		+0,05
Mn	non-alloy $\leq 1,60$		+0,10
	fine grain $\leq 1,70$		$-0,05$ $+0,10$
P	non-alloy $\leq 0,045$		+0,010
	fine grain $\leq 0,035$		+0,005
S	non-alloy $\leq 0,045$		+0,010
	fine grain $\leq 0,030$		+0,005
Nb	$\leq 0,050$		+0,010
V	$\leq 0,20$		+0,02
Ti	$\leq 0,05$		+0,01
Cr	$\leq 0,30$		+0,05
Ni	$\leq 0,80$		+0,05
Mo	$\leq 0,20$		+0,03
Cu	$\leq 0,35$		+0,04
	$0,35 < \text{Cu} \leq 0,70$		+0,07
N	$\leq 0,025$		+0,002
Al _{total}	$\leq 0,20$		-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 can 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:

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

NOTE A maximum CEV can 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 specified in clause 7 and in the delivery condition specified in 6.5, the mechanical properties shall comply with the relevant requirements of Tables A.3, B.4 and B.5.

NOTE Stress relief annealing at more than 580 °C or for over 1 h could 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 are to be agreed at the time of the enquiry and order.

6.7.2 For impact tests, standard V-notch test pieces (see ISO 148) 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 a 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, from the actual width of the test piece to that of the standard test piece.

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

6.7.3 For fine-grain steel hollow sections of thicknesses that do not permit test pieces of a width ≥ 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 have been 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 JO are not required to be verified.

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

6.8 Technological properties

6.8.1 Weldability

The steels specified in this International Standard shall be suitable for welding by all appropriate welding processes.

NOTE 1 With increasing product thickness, strength level and 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, design requirements, electrode efficiency, welding process and weld metal properties.

6.8.2 Hot-dipped 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-dipped 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 4019 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 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 steel structural 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 9956-1 to ISO 9956-3. 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 International Standard.

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 (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 4019.

6.11.2 Mass

Mass shall be determined using a density of 7,85 kg/dm³.

NOTE Dimensions, sectional properties and mass per unit length for a range of standard sizes of cold-formed structural hollow sections are given in ISO 4019. 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 of 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 of 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 document

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

The test report shall contain the following information:

- commercial transactions and parties involved;
- description of products to which the test report applies;

- information on tests, as follows:
 - tensile test reports,
 - chemical composition — a cast analysis;
- authentication.

7.2.2 For products supplied with specific inspection and testing, an inspection certificate (3.1.A, 3.1.B or 3.1.C) or inspection report (3.2) in accordance with ISO 10474:1991, 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 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 issues the certificate.

The inspection certificate or report shall contain the following information:

- commercial transactions and parties involved;
- description of products to which the inspection certificate applies;
- information on tests, as follows:
 - tensile test — test-piece shape and test results,
 - impact test — test-piece type and test results,
 - the cast analysis and, if applicable, the product analysis;
- 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

When 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.

8 Samples

8.1 Frequency of tests

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

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

Inspection and test 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 (2.2) ^a	Inspection certificate (3.1.A, 3.1.B or 3.1.C) ^a or Inspection report (3.2) ^a
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 ^b
	3	Impact test quality J2 only	6.7 9.2	Not applicable	One set per test unit ^b
	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 ^b
	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 ^b (only when option 6 is requested)

^a According to ISO 10474:1991.

^b For test unit see 8.1.3.

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

Inspection and test 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) ^a	
Mandatory requirements	1	Cast analysis	6.6 9.1	One per cast	
	2	Tensile test	6.7 9.2	One per test unit ^b	
	3	Impact test	6.7 9.2	One set per test unit ^b	
	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 requirements	6	Product analysis	6.6 9.1	One per test unit ^b	

^a According to ISO 10474:1991.

^b For test unit see 8.1.3.

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, when 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 <i>D</i> mm	External perimeter mm	Mass t
$\leq 114,3$	≤ 400	≤ 40
$> 114,3, \leq 323,9$	$> 400, \leq 800$	≤ 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, as appropriate, shall apply.

Test pieces may be non-proportional, but in cases of dispute proportional test pieces having a gauge length $L_0 = 5,65\sqrt{S_0}$ shall be used (see 9.2.1). For thicknesses of less than 3 mm, a gauge length of $L_0 = 80$ 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. 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 no further than 2 mm from a rolled surface;
- b) for nominal thicknesses ≤ 12 mm, when test pieces with reduced sections are used, the width shall be ≥ 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.

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 $L_0 = 5,65\sqrt{S_0}$ using the conversion tables given in ISO 2566-1.

For thicknesses of less than 3 mm the percentage elongation may be reported for a gauge length of 80 mm or 50 mm (see 8.2.3.2). 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 and assessed in accordance with ISO 404, as follows.

- 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 International Standard, 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 will be deemed not in accordance with this International Standard 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 4019.

9.4 Non-destructive testing of welding

9.4.1 General

When the welds of welded structural hollow sections are subjected to non-destructive testing (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 9304 to acceptance level L4, except that the rotating tube/pancake coil technique shall not be permitted;
- b) ISO 9402 or ISO 9764, with the exception that the acceptance level shall be based on the use of N 15 internal/external notches and that for the application of ISO 9402, 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 L4 in accordance with ISO 9765, or by radiography in accordance with ISO 12096 and with an image quality class R2.

Butt welds used to join lengths of strip or plate together in the helically submerged arc weld process shall be permitted, provided that 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 using suitable and durable methods such as painting, stamping, adhesive labels or attached tags with the following:

- the abridged designation, for example, ISO 10799 - 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 - S235JR + trademark.

EXAMPLE 2 ISO 10799 - 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 N-binding elements present. The N-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 thickness 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} ($L_0 = 5,65\sqrt{S_0}$) ^{c d}	Impact properties	
	Nominal thickness		Nominal thickness		Nominal thickness	Temperature	Minimum average absorbed energy for standard test pieces ^e
	mm		mm		mm	°C	J
	≤ 16	> 16, ≤ 40	< 3	≥ 3, ≤ 40	≤ 40		
S235JRH ^b	235	225	360-510	340-470	24	20	27
S275J0H ^b	275	265	430-580	410-560	20	0	27
S275J2H						-20	27
S355J0H ^b	355	345	510-680	490-630	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 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, 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. % ^e	N max. %
S275NH	GF	0,20	0,40	0,50-1,40	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	0,90-1,65	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	1,00-1,70	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 N-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 the copper content.

Table B.2 — Chemical composition — Cast analysis for product thicknesses less than or equal to 40 mm^a, 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 max. % ^e	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 N-binding elements are present, the minimum total Al content does not apply.

^e The total sum of Cr, Cu and Mo shall be no greater than 0,60 %.

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

Steel grade	Maximum CEV for nominal thicknesses ≤ 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	—
S450MH ^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 ≤ 40 mm^a, feedstock material condition N

Steel grade	Minimum yield strength R_{eH} N/mm ²		Tensile strength R_m N/mm ²	Minimum percentage elongation A_{min} $(L_0 = 5,65\sqrt{S_0})$ ^{b c}	Impact properties	
	Nominal thickness mm		Nominal thickness mm	Nominal thickness mm	Temperature °C	Minimum average absorbed energy for standard test pieces ^d J
	≤ 16	$> 16, \leq 40$	≤ 40	≤ 40		
S275NH	275	265	370-540	24	—20	40
S275NLH					—50	27
S355NH	355	345	470-630	22	—20	40
S355NLH					—50	27
S460NH	460	440	550-720	17	—20	40
S460NLH					—50	27

^a Only circular hollow sections available in thicknesses over 24 mm.^b For section sizes ≤ 60 mm $\times$ 60 mm and equivalent round and rectangular sections, the minimum value for elongation is 17 % for all thicknesses.^c For thicknesses < 3 mm, a gauge length 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.