INTERNATIONAL STANDARD

ISO 11950

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Cold-reduced electrolytic chromium/chromium oxide-coated steel

Fer chromé électrolytique laminé à froid

Reference number
ISO 11950:1995(E)

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.

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.

International Standard ISO 11950 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 9, *Tinplate and blackplate*.

It cancels and replaces ISO 8110-1:1988 and ISO 8111-1:1988.

Annexes A and B form an integral part of this International Standard. Annexes C and D are for information only.

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Cold-reduced electrolytic chromium/chromium oxide-coated steel

1 Scope

This International Standard specifies requirements for single and double cold-reduced electrolytic chromium/chromium oxide-coated steel (ECCS) in the form of sheets or coils for subsequent cutting into sheets.

Single-reduced ECCS is specified in nominal thicknesses that are multiples of 0,005 mm, from 0,17 mm up to and including 0,49 mm. Double-reduced ECCS is specified in nominal thicknesses that are multiples of 0,005 mm, from 0,14 mm up to and including 0,29 mm.

This International Standard applies to coils and sheets cut from coils in nominal minimum widths of 500 mm.

Annex D lists the relevant clauses for the selected product.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1024:1989, *Metallic materials — Hardness test — Rockwell superficial test (scales 15N, 30N, 45N, 15T, 30T and 45T).*

ISO 6892:1984, *Metallic materials — Tensile testing.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 electrolytic chromium/chromium oxide-coated steel (ECCS): Low-carbon mild steel sheet or coil, electrolytically treated to produce on both surfaces a duplex film of metallic chromium adjacent to the steel substrate with a top layer of hydrated chromium oxide or hydroxide .

3.2 single cold-reduced: Term used to describe those products where the steel substrate has been reduced to the desired thickness in a cold-reduction mill and subsequently annealed and temper rolled.

3.3 double cold-reduced: Term used to describe those products in which the steel base has had a second major reduction after annealing.

3.4 standard grade ECCS: Material in sheet form which is the product of line inspection. It is suitable, under normal conditions of storage, for established lacquering and printing over the entire surface of the sheet and does not contain any of the following:

a) pinholes, i.e. any perforation through the whole thickness of the material;

b) thickness outside the tolerance range specified in 10.3;

c) surface defects which render the material unsuitable for the intended use;

d) damage or shape-related defects which render the material unsuitable for the intended use.

3.5 batch annealed; box annealed (BA): Annealed by the process in which the cold-reduced strip is annealed in tight coil form, within a protective atmosphere, for a predetermined time-temperature cycle.

3.6 continuously annealed (CA): Annealed by the process in which cold-reduced coils are unwound and annealed in strip form within a protective atmosphere.

3.7 finish: Appearance of the surface of ECCS, governed by the surface characteristics of the steel base which result from controlled preparation of the work rolls during the final stages of rolling.

3.7.1 shot blast finish: Finish resulting from the use of temper-mill work rolls that have been shot blasted.

3.7.2 smooth finish: Finish resulting from the use of temper-mill work rolls that have been ground to a high degree of polish.

3.7.3 stone finish: Finish characterized by a directional pattern, resulting from the use of final-mill work rolls that have been ground to a lower degree of polish than those used for the smooth finish.

3.8 coil: Rolled flat strip product which is wound into regularly superimposed laps so as to form a coil with almost flat sides.

3.9 longitudinal bow; line bow: Residual curvature in the strip remaining along the direction of rolling.

3.10 transverse bow; cross bow: Mode of curvature in the sheet such that the distance between its edges parallel to the direction of rolling is less than the sheet width.

3.11 centre buckle; full centre: Intermittent vertical displacement or wave in the strip occurring other than at the edges.

3.12 edge wave: Intermittent vertical displacement occurring at the strip edge when the strip is laid on a flat surface.

3.13 feather edge; transverse thickness profile: Variation in thickness, characterized by a reduction in thickness close to the edges, at right angles to the direction of rolling.

3.14 burr: Metal displaced beyond the plane of the surface of the strip by shearing action.

3.15 rolling width: Width of the strip perpendicular to the direction of rolling.

3.16 consignment: Quantity of material of the same specification made available for dispatch at the same time.

3.17 bulk package; bulk: Packaging unit comprising a base platform or pallet, the sheets and packaging material. (See pallet.)

3.18 pallet: Base platform on which a coil is placed to facilitate ready transportation.

3.19 stillage platform: Base platform on which sheets are stacked to facilitate packing and ready transportation.

3.20 sample unit: 750 m of coil cut into sheets, for the purposes of sampling.

3.21 line inspection: Final inspection of the finished product performed by instruments and/or visual examination at normal production-line speeds.

3.22 anvil effect: Effect which a hard anvil can produce on the numerical hardness value obtained when a hardness test is performed on very thin sheet supported on such an anvil.

4 Information to be supplied by the purchaser

4.1 General

The following information shall be given in the enquiry and order to assist the manufacturer in supplying the correct material:

a) the designation as given in clause 5 excluding the annealing code, unless a specific type of annealing is required;

b) the quantity, expressed on an area or mass basis;

c) for single-reduced ECCS, the finish required (see 6.2.1);

d) any further special requirements.

NOTE 1 Appropriate classifications are suitable for shaping operations such as stamping, drawing, folding, beading and bending, and assembly work such as joint forming and welding. The end use should be borne in mind when the classification is selected.

4.2 Options

In the event that the purchaser does not indicate his wish to implement any of the options included in this International Standard and does not specify his requirements at the time of the enquiry and order, the product shall be supplied on the following basis:

a) for double-reduced ECCS, with a stone surface finish (see 6.2.2);

b) for coils, the location of each joint shall be indicated by a piece of non-rigid material and punched holes (see 11.3);

c) for coils, they shall be dispatched with their cores vertical and an internal diameter of 420 mm (see 15.1);

d) for sheets, the direction of the runners of the stillage platform is at the discretion of the producer but shall be consistent within a consignment (see 15.2);

e) for sheets, the rolling width shall be either of the two specified dimensions (see note 2);

f) with a coating of DOS or BSO (see 6.3).

4.3 Additional information

In addition to the information in 4.1 and 4.2, the purchaser may wish to provide further information to the supplier to ensure that the order requirements are consistent with the end use of the product.

The purchaser shall inform the supplier of any modifications to his fabrication operations that will significantly affect the way in which the ECCS is used.

NOTE 2 When ordering cold-reduced ECCS, the purpose of manufacture for which the material is intended should be stated. When double cold-reduced ECCS is used for built-up can bodies, the rolling direction should be around the circumference of the can so as to minimize the hazard of flange cracking. In such cases, the direction of rolling should be clearly designated on the contract.

5 Designation

5.1 Single-reduced ECCS

For the purposes of this International Standard, single-reduced ECCS is designated in terms of a temper classification based on the Rockwell HR30Tm hardness values given in table 2.

Single-reduced material covered by this International Standard shall be designated by the following characteristics in the given sequence:

a) a description of the material (either ECCS coil or sheet);

b) the number of this International Standard;

c) the temper designation in accordance with table 2;

d) the type of annealing used by the manufacturer (see 9.1);

e) the type of finish (see 3.7);

f) the dimensions, in millimetres:

— for coils, strip thickness × width,

— for sheets, thickness × width × length.

EXAMPLE

Single cold-reduced ECCS sheet, in accordance with this International Standard, of steel grade TH61 + CE, continuously annealed (CA), stone finish, with a thickness of 0,22 mm, a width of 800 mm and a length of 900 mm shall be designated:

ECCS sheet ISO 11950 - TH61+CE - CA - stone - 0,22 × 800 × 900.

5.2 Double-reduced ECCS

For the purposes of this International Standard, the mechanical properties in which double-reduced ECCS complying with this International Standard is supplied are designated in terms of a system of mechanical property classifications based on 0,2 % proof stress given in table 3.

Double-reduced material covered by this International Standard shall be designated by the following characteristics in the given sequence:

a) a description of the material (either ECCS coil or sheet);

b) the number of this International Standard;

c) the mechanical property designation (see table 3);

d) the type of annealing used by the manufacturer (see 9.1);

e) the dimensions, in millimetres:

— for coils, strip thickness × width,

— for sheets, thickness × width × length.

EXAMPLE

Double cold-reduced ECCS coil, in accordance with this International Standard, of steel grade TH620+SE, continuously annealed (CA), with a thickness of 0,18 mm and a width of 750 mm shall be designated:

ECCS coil ISO 11950 - T620+CE - CA - 0,18 × 750.

6 Manufacturing features

6.1 Manufacture

The methods of manufacture ECCS are the province of the manufacturer and are not specified in this International Standard.

The purchaser shall be informed if any alteration is made to the method of manufacture that will affect the properties of the ECCS.

NOTE 3 It is recommended that the manufacturer supplies to the purchaser such details of the manufacturing process as may assist the purchaser in his efficient use of the ECCS.

6.2 Finish

6.2.1 Single-reduced ECCS

Single cold-reduced ECCS can be supplied with either a smooth, stone or shot blast finish, and the finish required shall be specified at the time of ordering [see 4.1 c)].

6.2.2 Double-reduced ECCS

Double cold-reduced ECCS is usually supplied with a stone surface finish (see 3.7.3).

NOTE 4 Special surface finishes may be available and should be agreed upon at the time of ordering.

6.3 Oiling

Under normal conditions of transport and storage, ECCS shall be suitable for surface treatments such as established lacquering and printing operations.

ECCS coils and sheets are supplied with an oil coating. The oil shall be one that is recognized (i.e. by the relevant national or international authority) as being suitable for food packaging. Unless otherwise agreed at the time of ordering [see 4.2 f)], DOS (dioctyl sebacate) or BSO (butyl stearate oil) shall be used.

6.4 Defects

6.4.1 Coils

The producer is expected to employ his normal quality control and line inspection procedures to ensure that the ECCS manufactured is in accordance with the requirements of this International Standard.

However, the production of ECCS coils in continuous-strip mill operations does not afford the opportunity for removal of all ECCS that does not comply with the requirements of this International Standard.

At the time of shearing, sheets not conforming to the standard grade shall be set aside by the purchaser or his agent.

The quantity of sheets complying with this International Standard shall be at least 90 % of any one coil.

NOTE 5 Items c) and d) in 3.4 cannot be verified by specific tests and should be the subject of a special agreement between the producer and user.

If, when processing ECCS coil, the purchaser (or his agent) encounters recurring defects which in his opinion seem excessive, it is essential, where practicable, that he stops processing the coil and advises the supplier.

The purchaser is expected to have adequate handling, roller levelling and shearing equipment and inspection facilities, and to take reasonable care during these operations.

6.4.2 Sheets

Sheets shall not contain any defects as defined in 3.4, when sampled as described in 12.2.

7 Specific requirements

Standard grade ECCS shall comply with the appropriate requirements of clauses 8 to 11.

When tests are carried out to verify compliance with the requirements of clauses 8 to 10, sample sheets shall be selected from consignments in accordance with clause 12.

Coils shall be dispatched as described in 15.1 and sheets shall be packaged as described in 15.2.

8 Chromium/chromium in oxide coating mass

The minimum and maximum average values of coating mass of the samples selected in accordance with clause 12 shall be as given in table 1, when tested as described in 13.2. No individual value shall be less than 30 mg/m^2, for metallic chromium and 5 mg/m^2 for chromium in the oxides.

NOTE 6 The total is made up of chromium metal and chromium in oxides. The amounts of each are determined separately.

Table 1 — Average chromium/chromium in oxide coating mass

Form of chromium	Average coating mass on each surface, mg/m^2	
	Minimum	Maximum
Metallic chromium	50	140
Chromium in oxides	7	35

9 Mechanical properties

9.1 General

For the purposes of this International Standard, single-reduced ECCS is classified into temper grades based on Rockwell HR30Tm hardness values and double-reduced ECCS classification is based on the 0,2 % proof stress properties.

Other mechanical properties will significantly influence the performance of ECCS in processing, and the subsequent intended end use will vary depending on the steel type and the methods of casting, annealing and temper rolling employed.

NOTE 7 By agreement, the type of annealing for ECCS, i.e. BA or CA (see 3.5 or 3.6) may be specified when ordering.

9.2 Single-reduced ECCS

The hardness values for single-reduced ECCS shall be as given in table 2, when tested as described in C.3.

9.3 Double-reduced ECCS

The proof stress shall be as given in table 3, when tested as described in 13.3.

NOTE 8 For routine testing, the proof stress may be determined using the springback test as described in annex B. However, in cases of dispute, the method described in 13.3 is used.

10 Tolerances on dimensions and shape

10.1 General

Tolerances on dimensions (i.e. thickness and linear dimensions) and shape (i.e. edge camber, out-of-squareness, lateral weave) are specified in 10.2 and 10.3, together with appropriate methods of measurement.

Table 2 — Hardness values (HR30Tm) for single-reduced ECCS

Steel grade (previous designation)	$e \leqslant 0{,}21$		$0{,}21 < e \leqslant 0{,}28$		$e > 0{,}28$	
	Nominal	Range for sample average	Nominal	Range for sample average	Nominal	Range for sample average
TH50+CE (T50)	53 max.		52 max.		51 max.	
TH52+CE (T52)	53	± 4	52	± 4	51	± 4
TH55+CE (T55)	56	± 4	55	± 4	54	± 4
TH57+CE (T57)	58	± 4	57	± 4	56	± 4
TH61+CE (T61)	62	± 4	61	± 4	60	± 4
TH65+CE (T65)	65	± 4	65	± 4	64	± 4

NOTES

1 It is important to distinguish HR30Tm from HR30T, the former denoting that depressions on the under surface of the test piece are permitted (cf. ISO 1024).

2 e is the thickness, in millimetres.

Table 3 — Proof stress values of double-reduced ECCS

Steel grade (previous designation)	Average 0,2 % proof stress	
	Nominal N/mm²	Permitted range N/mm²
T550+CE (DR550)	550	480 to 620
T580+CE (DR580)	580	510 to 650
T620+CE (DR620)	620	550 to 690
T660+CE (DR660)	660	590 to 730
T690+CE (DR690)	690	620 to 760

NOTE 9 Other geometrical features may be present in sheets cut from cold-reduced ECCS supplied in cold form, such as burr, edge wave, centre buckle, longitudinal bow and transverse bow. This International Standard does not specify methods of measurement and does not specify limits for these geometrical features, certain of which are subject to the equipment employed by the purchaser. The producer should endeavour to keep the occurrence and magnitude of burr, edge wave, centre buckle and transverse bow to a minimum. He should also endeavour to minimize the variation of the longitudinal bow.

10.2 Coils

10.2.1 Length

The difference between the actual length and the producer's indicated length, measured on any single coil, shall not exceed ± 3 %.

The accumulated difference between the actual lengths and producer's indicated lengths, measured on at least 100 coils, shall not exceed 0,1 %.

NOTE 10 The purchaser normally verifies the length of strip in a coil by multiplying the average length of the sheets sheared from the coil by the number of sheets obtained and adding the accumulated lengths of any other portions of the coil as received. The average length of the sheets sheared from the coil is normally determined by measuring the lengths of at least ten sheets, taken at random, to an accuracy of 0,2 mm. Total lengths may be measured by other methods, provided that the method adopted is acceptable to both the producer and purchaser.

10.2.2 Width

The width of each sample sheet, selected in accordance with clause 12, shall be measured to the nearest 0,5 mm. The width shall be measured across the centre of the sheet, at right angles to the direction of rolling, with the sheet lying on a flat surface. The measured width shall be not less than the ordered width and shall not exceed the ordered width by more than 3 mm.

10.2.3 Thickness

10.2.3.1 General

The transverse thickness profile shall be measured using the micrometer method described in 13.1.2. All other thicknesses shall be determined by the weighing method (see 13.1.1) or by direct measurement using the micrometer method. However, in cases of dispute and for all retests, except for the transverse thickness profile, the weighing method shall be used.

10.2.3.2 Individual sheets

When shearing a coil, sheets shall be eliminated if they deviate from the nominal thickness by more than ± 8,5 %.

10.2.3.3 Average thickness of a consignment

The average thickness of a consignment, determined by the weighing method described in 13.1.1, on the sample sheets selected in accordance with 12.1, shall not deviate from the ordered nominal thickness by more than

a) ± 2,5 % for consignments comprising more than 15 000 m; or

b) ± 4 % for consignments comprising 15 000 m or less.

10.2.3.4 Thickness variation across the width

The thickness of each of the two individual test pieces, determined in accordance with 13.1.1, shall not deviate from the actual average thickness of the whole sheet by more than 4 %.

10.2.3.5 Feather edge (transverse thickness profile)

The minimum thickness, when measured by the micrometer method described in 13.1.2, shall not differ from the actual centre thickness of the sheet by more than 8 %.

10.2.4 Edge camber of coils

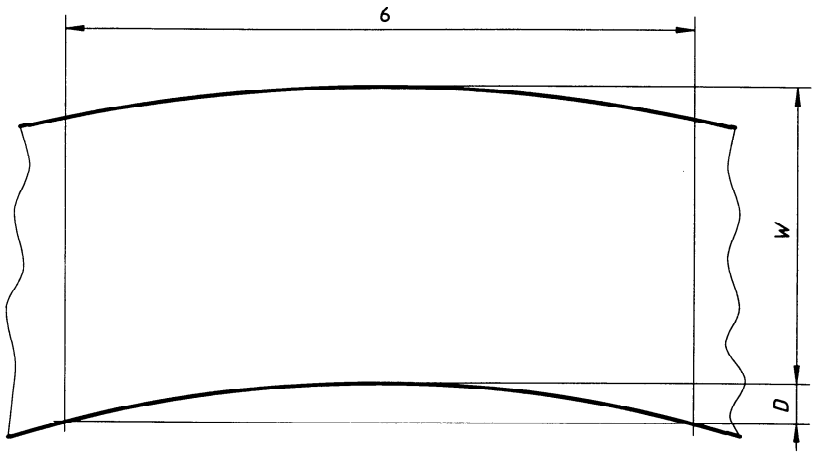
Edge camber is the maximum deviation (in the plane of the sheet) of an edge from a straight line forming a chord to its extremities (see figure 1).

The edge camber, expressed as a percentage of the chord length, is calculated using the following formula:

$$\text{Edge camber} = \frac{\text{Deviation } (D)}{\text{Length of chord (6 m)}} \times 100$$

The edge camber, measured over a distance (chord length) of 6 m, shall not exceed 0,1 % (i.e. 6 mm).

Dimensions in metres



W: rolling width

D: deviation from a straight line

Figure 1 — Edge camber of coils

10.2.5 Lateral weave (short pitch camber) of coils

Lateral weave is the deviation of a mill-trimmed edge from a straight line lying in the same plane and forming a chord to it over a relatively short distance.

The lateral weave, measured over a chord length of 1 m, shall not exceed 1,0 mm when measured prior to shearing.

NOTE 11 If the coil is used for scroll shearing, the permissible values should be agreed upon between the manufacturer and purchaser.

10.3 Sheets

10.3.1 Linear dimensions of sheets

Each sample sheet shall be such that a rectangle of the ordered dimensions can fit into it. To determine the linear dimensions, lay each sample sheet, selected in accordance with 12.2.2, on a flat surface and measure the length and width to the nearest 0,5 mm across the centre of the sheet.

The dimensions of each sample sheet shall be not less than the ordered dimensions and neither dimension shall exceed the ordered dimension by more than 3 mm.

10.3.2 Thickness of sheets

10.3.2.1 General

The transverse thickness profile shall be measured using the micrometer method described in 13.1.2. All other thicknesses shall be determined by the weighing method (see 13.1.1) or by direct measurement using the micrometer method. However, in cases of dispute and for all retests, except for the transverse thickness profile, the weighing method shall be used.

10.3.2.2 Individual sheets

The thickness of each of the individual sample sheets, selected from a consignment in accordance with 12.2.2, shall not deviate from the ordered nominal thickness by more than ± 8,5 %.

10.3.2.3 Average thickness of a consignment

The average thickness of a consignment, determined by the weighing method described in 13.1.1 on the sample sheets selected in accordance with 12.2.2, shall not deviate from the ordered nominal thickness by more than

a) ± 2,5 % for a consignment of more than 20 000 sheets; or

b) ± 4 % for a consignment of 20 000 sheets or less.

10.3.2.4 Tolerances on local thickness within a sheet (crown)

The thickness of each of the two individual test pieces, determined by the weighing method described in 13.1.1, shall not deviate from the actual average thickness of the whole sheet by more than 4 %.

10.3.2.5 Feather edge (transverse thickness profile)

The minimum thickness, when measured by the micrometer method described in 13.1.2, shall not differ from the actual centre thickness of the sheet by more than 8 %.

10.3.3 Edge camber of sheets

Edge camber is the maximum deviation (in the plane of the sheet) of an edge from a straight line forming a chord to it (see figure 2).

The edge camber, expressed as a percentage of the chord length, is calculated using the following formula:

$$\text{Edge camber} = \frac{\text{Deviation } (D)}{\text{Length of chord } (L)} \times 100$$

For each sample sheet, the edge camber shall not exceed 0,15 %.

10.3.4 Out-of-squareness of sheets

Out-of-squareness is the deviation of an edge from a straight line drawn at a right angle to the other side of the sheet, touching one corner and extending to the opposite edge (see figure 3).

The out-of-squareness, expressed as a percentage, is calculated using the following formula:

$$\text{Out-of-squareness} = \frac{\text{Deviation } (A)}{\text{Sheet dimension } (B)} \times 100$$

For each sheet in the sample, the out-of-squareness shall not exceed 0,20 %.

11 Joints within a coil

11.1 General

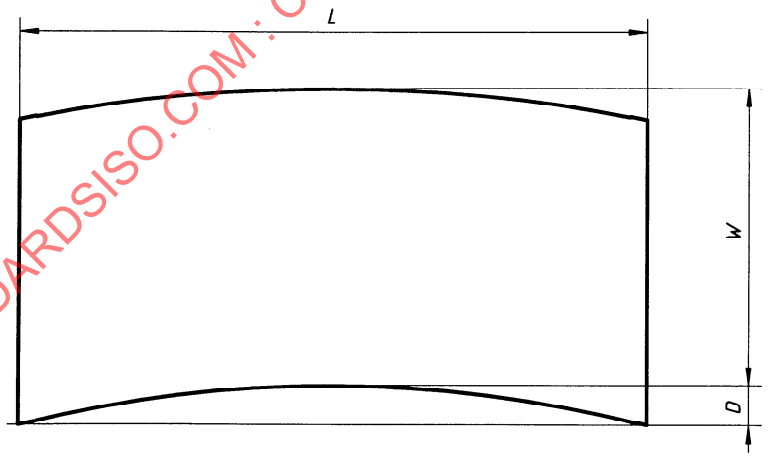
The producer shall ensure continuity of the coils within the limits of the lengths ordered, if necessary by means of electrically welded joints made after cold reduction. Requirements relating to the numbers, locations and dimensions of the joints permitted within a coil are given in 11.2 to 11.4.

11.2 Number of joints

The number of joints in a coil shall not exceed three in lengths of 10 000 m.

11.3 Location of joints

The location of each joint in a coil shall be indicated clearly.

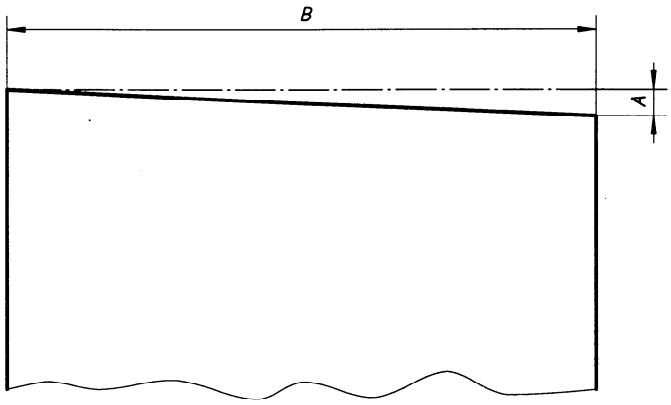


L: length of chord

W: rolling width

D: deviation from a straight line

Figure 2 — Edge camber of sheet



A: deviation

B: length or width of the sheet measured at a right angle to an edge

Figure 3 — Out-of-squareness of sheets

NOTE 12 The location of each joint may be indicated, for example by the insertion of a piece of non-rigid material and punched holes. However, alternative methods may be agreed between the producer and purchaser at the time of enquiry and order.

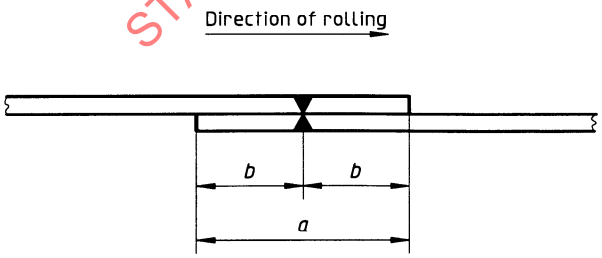
11.4 Dimensions of joints

11.4.1 Thickness

The total thickness of any joint shall not exceed three times the nominal thickness of the material forming the joint.

11.4.2 Overlap

In any lap joint, the total length of overlap shall not exceed 10 mm. The free overlap shall not exceed 5 mm (see figure 4).



a: total length of overlap

b: free overlap

Figure 4 — Joint overlap

12 Sampling

12.1 Coils

12.1.1 General

When tests are carried out to assess compliance with the requirements for coating mass (see clause 8), tolerances on dimensions and shape (see clause 10) and mechanical properties (see clause 9), samples of the ECCS coil shall be selected in accordance with 12.1.2.

After the coils in a consignment have been cut into rectangular or scrolled sheets, the sheets deemed not to be of standard grade ECCS shall be excluded. The standard grade sheets that remain shall be sampled on the basis of units of strip 750 m in length, in accordance with 12.1.2.3.

NOTE 13 Because the samples have to be cut from coils in the consignment, the taking of samples is usually carried out by the purchaser during his normal shearing operation.

The purchaser shall allow the producer, or his representatives, to be present during the sampling and subsequent testing and to be able to confirm that the identities of the samples and test pieces correspond with the coils in the consignment supplied.

12.1.2 Selection of samples

12.1.2.1 Lots and units

For the purpose of sampling, each consignment of coils shall be considered as one lot.

12.1.2.2 Selection of sample units

For lots comprising up to and including 20 units, 4 sample units shall be selected at random.

For lots comprising more than 20 units, 4 units shall be selected at random from each 20 units and from any remaining part of 20 units.

12.1.2.3 Selection of sample sheets

From each sample unit selected in accordance with 12.1.2.2, the following sample sheets shall be taken at random:

a) for verification of the coating mass and mechanical properties: two sheets;

b) for verification of the dimensions and shape: five sheets.

12.2 Sheets

12.2.1 General

If tests are carried out to ascertain whether the sheets in a consignment comply with the requirements for coating mass (see clause 8), tolerances on dimensions and shape (see clause 10), and mechanical properties (see clause 9), sample sheets shall be selected in accordance with 12.2.2.

12.2.2 Selection of sample sheets

12.2.2.1 Number of bulk packages

Sample bulk packages shall be selected at random from the total number of bulk packages, at a rate of 20 % rounded to the nearest greater whole number of bulk packages and subject to a minimum of four bulk packages.

For consignments comprising less than four bulk packages, each bulk package shall be taken as a sample.

12.2.2.2 Number of sheets

From each of the sample bulk packages selected in accordance with 12.2.2.1, take at random:

a) for verification of standard grade material (see 3.4), sheets at the rate of 1 % per bulk package;

b) for verification of mechanical properties and coating mass, two sheets;

c) for verification of dimensions, sheets at the rate of 0,5 % per bulk package, to the nearest whole number of sheets.

NOTE 14 The rate of sampling is specified on a percentage basis (except for verification of mechanical properties and coating masses) because the number of sheets per bulk package may vary, for example between 1 000 and 2 000.

13 Test methods

13.1 Thickness

13.1.1 Weighing method for determination of thickness

13.1.1.1 Determine the thickness of each sample sheet as follows:

a) weigh the sheet to give the mass, to the nearest 2 g;

b) measure the length and width of the sheet, to the nearest 0,5 mm, and calculate the area;

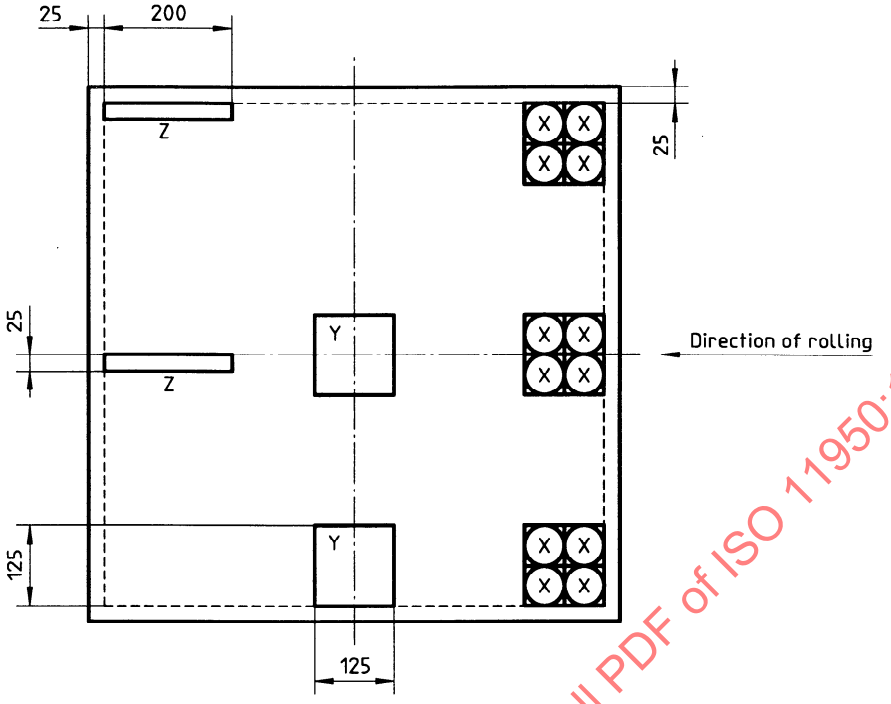
c) calculate the thickness of the sheet, to the nearest 0,001 mm, using the following formula:

$$\text{Thickness (mm)} = \frac{\text{Mass (g)}}{\text{Area (mm}^2\text{)} \times 0{,}007\,85\ \text{(g/mm}^3\text{)}}$$

13.1.1.2 To determine the average thickness for a consignment, calculate the arithmetic mean of the calculated thicknesses of all the sample sheets representing the consignment.

13.1.1.3 To determine the variation in thickness within each sample sheet, take two test pieces Y (see figure 5) from the sheet. Weigh each test piece to the nearest 0,01 g, measure the length and width of each test piece to the nearest 0,1 mm, and calculate the thickness of each test piece to the nearest 0,001 mm using the formula given in 13.1.1.1 c).

Dimensions in millimetres



X: test pieces for the coating mass

Y: test pieces for hardness and determination of local thickness variation within a sheet

Z: test pieces for tensile or springback tests

Figure 5 — Location of test pieces

13.1.2 Micrometer method for measurement of thickness

Measure the thickness using a hand-operated, spring-loaded micrometer to an accuracy of 0,001 mm:

a) for transverse thickness profile, 6 mm from the mill-trimmed edge;

b) for all other thicknesses, at least 10 mm from the mill-trimmed edge.

NOTE 15 It is recommended that the micrometer should have a ball-ended shank and a curved surface base anvil.

13.2 Chromium/chromium in oxide coating mass

13.2.1 Test pieces

From each sheet selected in accordance with clause 12, four discs, each of area not less than 2 500 mm^2, shall be taken from each of the three sets of positions marked X in figure 5. The test area of each disc shall be of accurately determined area and not less than 2 000 mm^2. The edge test pieces shall be taken not less than 25 mm from the edges and the sheet.

Two of the four discs from each position shall be used for separate determinations of the masses of chromium in the metallic chromium layer and the chromium oxide layer on one surface of the sheet, and the other two discs shall be used for the corresponding determinations on the other surface.

13.2.2 Method of determination

The masses of metallic chromium and chromium in oxides shall be expressed, in milligrams per square metre, to the nearest 1 mg/m^2.

For routine quality control purposes, the coating masses may be determined by any of the recognized and acceptable analytical methods but, in cases of dispute and for all retests, the methods described in annex A shall be the referee methods.

Any tests carried out using the methods in annex A shall be done on untreated material, in the as-produced state.

13.3 Tensile tests

13.3.1 Test pieces

For each sheet selected in accordance with clause 12, cut two rectangular test pieces approximately 200 mm × 25 mm wide with the direction of rolling parallel to the length of the test piece, at the position marked Z in figure 5. Ensure that the edge test pieces clear the edges of the sheet by a minimum of 25 mm.

13.3.2 Test method

Determine the 0,2 % proof stress as described in ISO 6892 using the conditions specified in annex B of ISO 6892:1984 for thin products and test piece type 1, i.e. width 12,5 mm ± 1 mm and original gauge length L_0, of 50 mm.

Carry out one test on each of the test pieces selected in accordance with 13.3.1, i.e. two tests per sheet selected.

Calculate the representative proof stress for the consignment as the arithmetic mean of all the proof stress results on all the sample sheets taken from the consignment.

14 Retests

14.1 Coils — Dimensions, coating mass and mechanical properties

If any of the results obtained are unsatisfactory, the measurements for that particular property shall be repeated twice on new samples; on each occasion using the sampling specified in 12.1. If the results on both repeated tests meet the stated requirements, the consignment represented shall be deemed to comply with this International Standard, but if the results of either of the retests fail to meet the stated requirements, the consignment represented shall be deemed not to comply with this International Standard.

14.2 Sheets

14.2.1 Standard grade

In the event of the samples inspected for standard grade not complying with the defined requirements in 3.4, further sheets shall be taken at random and inspected at a rate of 5 % per bulk package.

14.2.2 Dimensions, coating mass and mechanical properties

If any of the results obtained are unsatisfactory, the measurements for that particular property shall be repeated twice on new samples; on each occasion using the sampling specified in 12.2. If the results on both repeated tests meet the stated requirements, the consignment represented shall be deemed to comply with this International Standard, but if the results of either of the retests fail to meet the stated requirements, the consignment represented shall be deemed not to comply with this International Standard.

15 Dispatch and packaging

15.1 Coils

Unless otherwise requested at the time of ordering, coils shall be dispatched with their cores in a vertical position [see 4.2 c)] (the other option would be with the cores horizontal). The internal diameters of the coils shall be either (420 $^{+10}_{-15}$) mm or (508 $^{+10}_{-15}$) mm.

NOTE 16 ECCS strip is usually supplied in consignments of coils with outside diameters of at least 1 200 mm, but a limited number of coils with smaller outside diameters may be included in the consignment.

15.2 Sheets

The sheets shall be supplied in bulk packages in which the numbers of sheets are multiples of 100.

NOTES

17 The sheets are customarily packed on a stillage platform forming a bulk package weighing approximately between 1 000 kg and 2 000 kg.

18 If the purchaser has any preference for the direction of the runners of the stillage platform, his requirements should be agreed with the producer and stated on the order [see 4.2 d)].

Annex A
(normative)

Methods for the determination of metallic chromium and chromium in the oxides on the surface of electrolytic chromium/chromium oxide-coated steel

A.1 Determination of chromium in the oxides

A.1.1 Principle

This method covers the determination of chromium present as oxides on the surfaces of untreated ECCS. The method involves the dissolution of the oxide in sodium hydroxide followed by oxidation of the dissolved chromium with hydrogen peroxide. The absorbence of the coloured chromate ion is measured photometrically and the mass of chromium is then obtained by reference to a calibration curve.

The effective range of the method is from 3 mg/m^2 to 50 mg/m^2 and the reproducibility is better than ± 3 mg/m^2.

A.1.2 Reagents

During the analysis, use only reagents of recognized analytical grade, unless otherwise specified, and only deionized or distilled water.

Freshly prepare and, where necessary, filter all solutions.

A.1.2.1 Chromium standard solution.

Dissolve 0,113 2 g of anhydrous potassium dichromate, primary standard grade, previously dried at 120 °C for 1 h, in approximately 200 ml of water and dilute to 500 ml in a volumetric flask. Pipette a 50 ml aliquot of this solution into a volumetric flask and dilute to 1 litre with water.

1 ml of this standard solution contains 0,004 mg of Cr.

A.1.2.2 Sodium hydroxide, 300 g/l solution.

Dissolve 300 g of sodium hydroxide in approximately 700 ml of water, cool and dilute to 1 litre.

A.1.2.3 Hydrogen peroxide, 60 g/l solution.

Use a solution supplied at this concentration or dilute a concentrated solution (e.g. 300 g/l).

Ensure that the solution is at the recommended concentration. Hydrogen peroxide solutions may decompose if kept under non-ideal conditions.

A.1.3 Apparatus

Ordinary laboratory apparatus and

A.1.3.1 Spectrometer, capable of measuring absorbence in the range 365 nm to 375 nm and of reading extinction to ± 0,001.

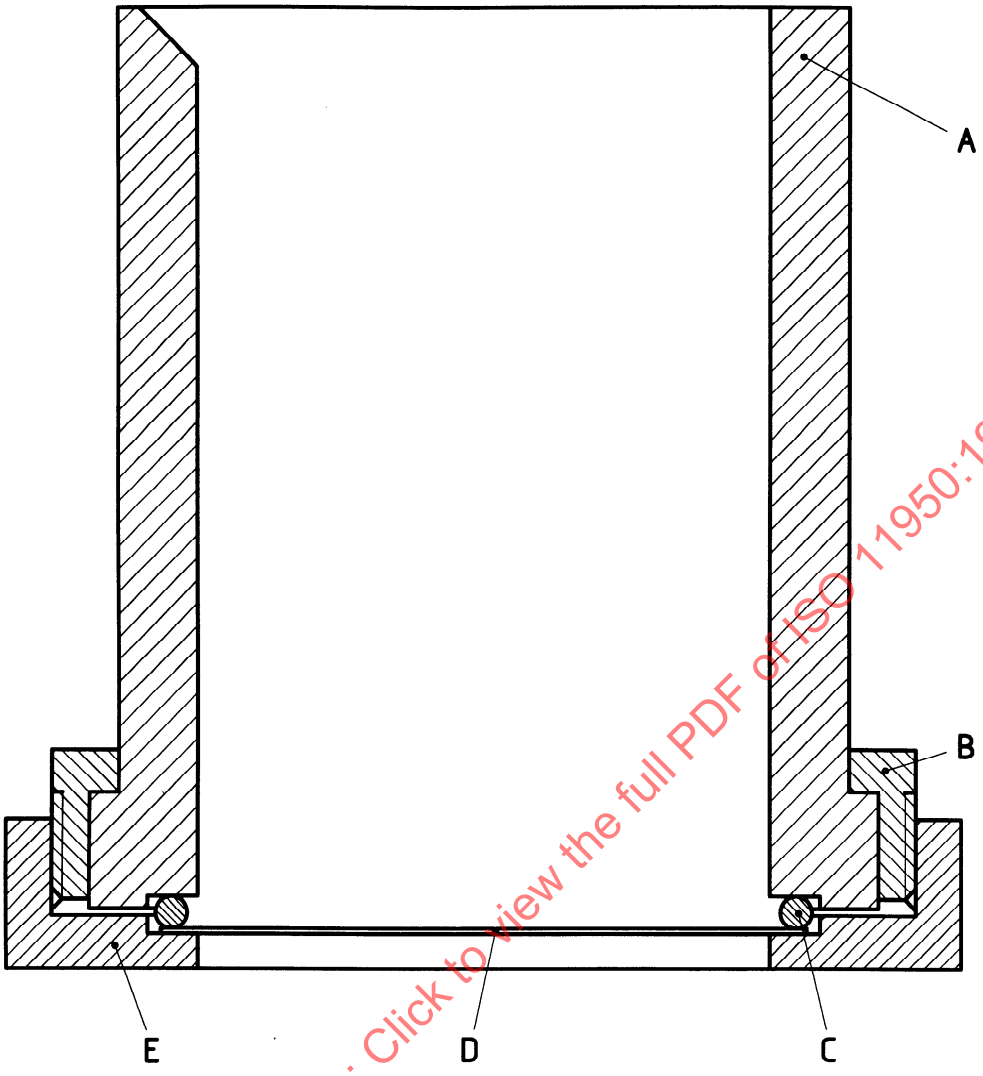
A.1.3.2 Sample holder, of the type shown in figure A.1, to permit stripping from an area of not less than 2 000 mm^2 from one surface of a sample.

A.1.4 Preparation of the chromium calibration curve

Pipette 0 (blank), 10 ml, 20 ml, 30 ml, 40 ml and 50 ml aliquots of chromium standard solution (A.1.2.1) into a series of 400 ml beakers, add 40 ml of the sodium hydroxide solution (A.1.2.2) and dilute to about 90 ml with water. Add 10 ml of hydrogen peroxide solution (A.1.2.3), cover with a watch glass and boil until the excess peroxide is completely decomposed, replacing any loss of evaporated water by rinsing the wall of the beaker and the cover glass. Cool the solution, transfer to a 100 ml flask, dilute to 100 ml and mix well. Measure the absorbence using a cell of appropriate length and with water as a reference at the optimum wavelength for the specific instrument selected within the range 365 nm to 375 nm to obtain maximum sensitivity. Correct for the absorbence of the reagent blank and plot absorbence against milligrams of chromium per 100 ml.

A.1.5 Procedure

Handle sample material with care to prevent surface contamination. Do not subject samples to any thermal stoving process before carrying out the following test. Take a disc of the material appropriate to the size of the sample holder and fix it in position in the holder. Add 40 ml of hot sodium hydroxide solution (A.1.2.2) and place the cell on a hotplate to maintain the temperature of the stripping solution at about 90 °C for 10 min. Transfer the contents of the cell quantitatively to a 250 ml beaker, add 10 ml of hydrogen peroxide solution (A.1.2.3) and boil until the excess peroxide is decomposed. Cool, transfer to a 100 ml volumetric one-mark flask, make up to the mark with water and shake well. Measure the absorbance at the selected wavelength (see A.1.4) using water as a reference. Correct for the absorbence of the reagent blank and obtain the mass of chromium, in milligrams, in the solution from the calibration curve.



Key

A Recommended wall thickness 10 mm. Material: polytetrafluoroethylene (PTFE) or polypropylene. Cell height not critical, provided that capacity exceeds 120 ml and platinum cathode and reference electrode can be fitted

B Stainless steel stepped collar (threaded and pinned to PTFE)

C Rubber O-ring: 3 mm diameter cross-section

D Sample disc: 2 000 mm^2 exposed to solution in cell

E Stainless steel base plate (thread to match collar and recessed to hold sample disc)

Figure A.1 — Dual-purpose sample holder showing details of construction

A.1.6 Calculation

Calculate the coating mass, m_1, in milligrams per square metre, of chromium in the oxide, from the following equation:

$$m_1 = \frac{m_2 \times 10^6}{A}$$

where

m_2 is the mass of chromium, in milligrams, in the test solution;

A is the area, in square millimetres, of sample exposed to sodium hydroxide attack in the sample holder.

A.2 Determination of metallic chromium

A.2.1 Principle

A photometric method is described for the determination of metallic chromium on the surface of ECCS. The principles of the method are as follows.

The chromium oxide is first removed chemically. Metallic chromium is then stripped electrolytically in sodium carbonate solution, the completion of the reaction being indicated by a sharp rise in the cell voltage. The resultant solution is treated with hydrogen peroxide to ensure complete oxidation of the electrolytically stripped chromium to the hexavalent state. The absorbance of the coloured chromate ion is determined photometrically and the mass of chromium is then obtained by reference to a calibration curve.

The effective range of the method is from 30 mg/m^2 to 300 mg/m^2 and the reproducibility is better than ± 5 mg/m^2.

A.2.2 Reagents

Use reagents of analytical reagent grade, unless otherwise specified, and use deionized or distilled water throughout. Freshly prepare and, where necessary, filter all solutions.

A.2.2.1 Chromium solution standard.

Dissolve 1,132 g of anhydrous potassium dichromate, primary standard grade, previously dried at 120 °C for 1 h, in approximately 200 ml of water and dilute to 1 litre in a volumetric flask. Pipette a 50 ml aliquot of the solution into a volumetric flask and dilute to 1 litre with water.

1 ml of this standard solution contains 0,02 mg of Cr.

A.2.2.2 Sodium hydroxide, 300 g/l solution.

Dissolve 300 g of sodium hydroxide in approximately 700 ml of water. Cool and dilute to 1 litre.

A.2.2.3 Sodium carbonate, 53 g/l solution.

Dissolve 53 g of anhydrous sodium carbonate in water and dilute to 1 litre.

A.2.2.4 Hydrogen peroxide, 60 g/l solution.

Use a solution supplied at this concentration or dilute a concentrated (e.g. 300 g/l) solution.

Before use, ensure that this solution is a the recommended concentration. Hydrogen peroxide solutions may decompose if kept under non-ideal conditions.

A.2.3 Apparatus

Ordinary laboratory apparatus and

A.2.3.1 Cell and electrodes: A cell as shown in figure A.2 for the electrolytic stripping of the metallic chromium (see figure A.3), and consisting of a sample holder, a platinum gauze cathode and a reference electrode (standard calomel).

It is essential that the cell/sample holder exposes a minimum sample area of 2 000 mm^2 from which the metallic chromium is electrolytically stripped.

A.2.3.2 Power supply, with direct current stabilizer with a built-in milliammeter setting to 30 mA and an on/off switch.

A.2.3.3 Voltmeter, with a full scale of 0 V to 2 V.

A.2.3.4 Spectrometer, capable of measuring absorbance in the range 365 nm to 375 nm and of reading extinction to ± 0,001.

A.2.4 Preparation of the chromium calibration curve

Pipette 0 (blank), 5 ml, 10 ml, 15 ml, 20 ml, 30 ml, 40 ml and 50 ml of the chromium standard solution (A.2.2.1) into a series of eight 250 ml beakers, add 120 ml of sodium carbonate solution (A.2.2.3) and dilute to about 170 ml with water. Add 10 ml of hydrogen peroxide solution (A.2.2.4), cover with a watch glass and boil until the excess peroxide is completely decomposed, replacing any loss of evaporated water by rinsing the wall of the beaker and the cover glass. Cool the solution, transfer to a 200 ml one-mark volumetric flask, dilute to the mark with water and mix well. Measure the absorbence, using a cell of suitable length and with water as a reference, at the optimum wavelength for the specific instrument selected within the range 365 nm to 375 nm to obtain maximum sensitivity. Correct for the absorbance of the reagent blank and plot absorbance against milligrams of chromium/200 ml for the different cell lengths (e.g. 2 cm, 4 cm, 5 cm) which have been used.

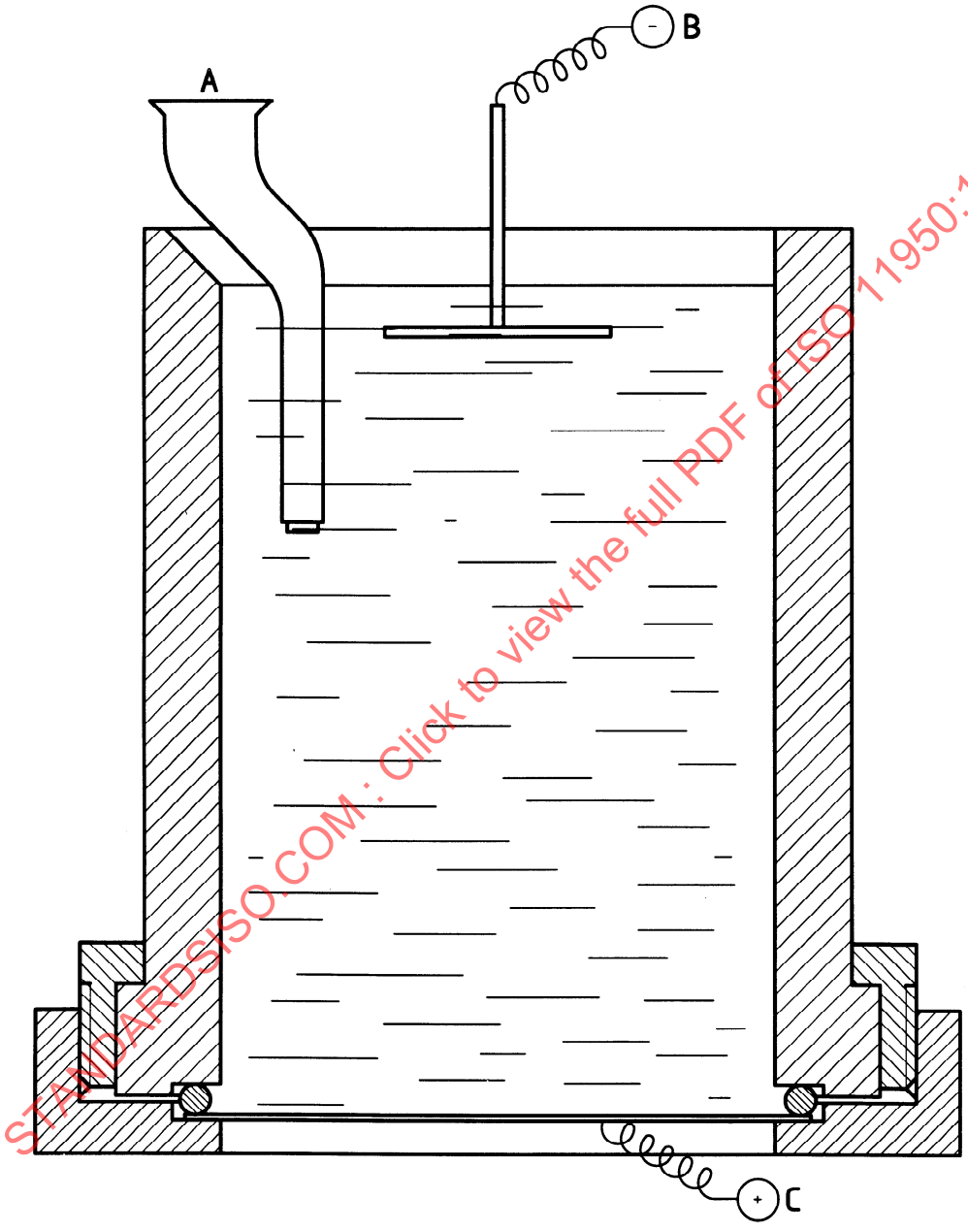
A.2.5 Procedure

A.2.5.1 General

Handle sample material with care to prevent surface contamination. Do not subject samples to any thermal stoving process before carrying out the following test. Take a disc of the material appropriate to the size of the sample holder.

Normally, the determination of metallic chromium will follow the determination of chromium in the oxide and the same sample discs may be used for both purposes. Where metallic chromium is to be determined without a previous determination of chromium in the

oxide, remove the chromium oxide in accordance with A.2.5.2.



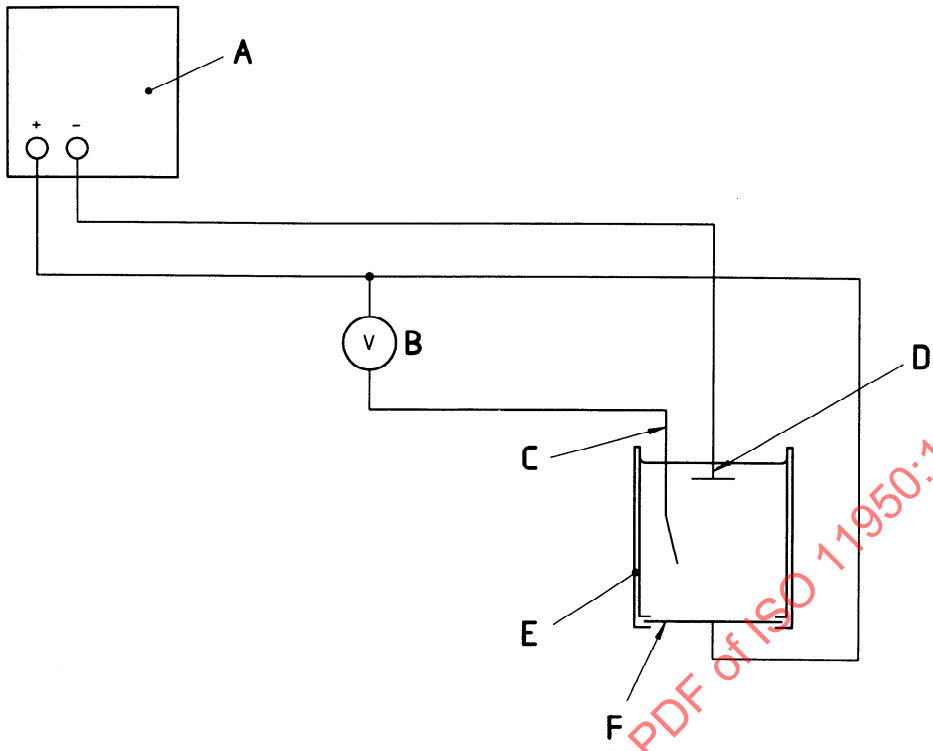
Key

A Reference electrode

B Platinum cathode

C Sample (anode)

Figure A.2 — Electro-stripping of chromium metal using the dual-purpose cell



Key

A D.C. stabilizer, 30 mA

B Voltmeter 0 V to 2 V

C Reference electrode

D Platinum cathode

E Sample holder

F Sample (anode)

Figure A.3 — Electro-circuit for stripping chromium metal

A.2.5.2 Removal of chromium oxide layer

Remove the surface oxides from the sample by treating with 40 ml of sodium hydroxide solution (A.2.2.2) in a glass beaker at 90 °C for 10 min. Rinse the sample with water and attach to the sample holder (see figure A.1).

A.2.5.3 Removal and determination of metallic chromium

After the washed, oxide-free sample has been attached to the sample holder (A.2.5.2), connect the leads as shown in figure A.3, add 120 ml of sodium carbonate solution (A.2.2.3) and simultaneously switch on the power supply. Maintain current density at a constant within the rate 0,5 mA/cm^2 to 1,5 mA/cm^2. The end point of the reaction is indicated by a large potential jump. (The potential difference between the beginning and end of the dissolution is about 400 mV. This is noted by incorporating in the electrical circuit a voltmeter with the positive terminal connected to the d.c. stabilizer and the negative terminal to the reference electrode.)

Quantitatively transfer the contents of the sample holder/cell to a glass beaker, add 10 ml of hydrogen peroxide solution (A.2.2.4) and boil until the excess peroxide is decomposed. Cool the solution, transfer to a 200 ml one-mark volumetric flask, dilute to the mark with water and mix well. Using a cell of appropriate length, measure the absorbance at the selected wavelength (see A.2.4) using water as a reference.

A.2.6 Calculation

Calculate the coating mass, m_3, in milligrams per square metre, of metallic chromium from the following equation:

$$m_3 = \frac{m_2 \times 10^6}{A}$$

where

m_2 is the mass of chromium, in milligrams, in the test solution;

A is the area, in square millimetres, of sample exposed to electrolytic attack in the sample holder/cell.

Annex B
(normative)

Springback test for routine determination of proof stress for double-reduced material

This is not the reference method. In all cases of dispute, the method described in 13.3 (i.e. ISO 6892) is to be used.

B.1 Principle

The springback test provides a simple and rapid means of estimating the tensile yield strength of double-reduced products from measurement of thickness and angle of springback of a rectangular strip test piece, after bending through 180° around a cylindrical mandrel and then releasing.

B.2 Test pieces

The test pieces used are identical to those for the tensile test described in 13.3.1.

B.3 Test method

Make one test on each of the test pieces obtained in accordance with B.2 (i.e. two tests per sheet selected). Carry out the test using the Springback Temper Tester model G.67[1].

In making the test, strictly observe the operational instructions provided with the Springback Temper Tester. The principal steps in the test are:

a) measure the thickness of the ECCS test pieces, to the nearest 0,001 mm;

b) insert the test piece into the tester and fix it firmly in the testing position by gently tightening the clamping screw using light finger pressure;

c) bend the test piece through an angle of 180° around the mandrel by a gentle swing of the forming arm;

d) return the forming arm to its "start" position and read and record the springback angle by sighting directly over the test piece;

e) remove the test piece from the tester and, using the recorded thickness of the test piece and the springback angle, determine the appropriate springback index value from a suitable conversion formula (e.g. Bower) agreed between the producer and purchaser.

NOTE 19 Calibrate each new Springback Temper Tester using the standard tensile test (see 13.3) or another "reference" Springback Temper Tester. In addition, since malfunctions arising, for example from excessive wear or inadvertent abuse of the test equipment, may not be readily apparent, it is recommended that the Springback Temper Test readings should be regularly compared with readings from the standard tensile test or a "reference" Springback Temper Tester. It is also recommended that such direct cross-checks be further supplemented by the frequent use of reference samples of known proof stress.

1) The Springback Temper Tester model G.67 is an example of a suitable product available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this product.

Annex C
(informative)

Recommended Rockwell hardness values for double-reduced ECCS

C.1 General

Recommended hardness values, determined as described in C.2 and C.3, are given in table C.1.

Table C.1 — Hardness values (HR30Tm) for double-reduced ECCS

Steel grade (previous designation)	Average Rockwell hardness (HR30Tm)[1]	
	Nominal	Range for sample average
T550+CE (DR 550)	73	± 3
T580+CE (DR 580)	74	± 3
T620+CE (DR 620)	76	± 3
T660+CE (DR 660)	77	± 3
T690+CE (DR 690)	80	± 3

1) It is important to distinguish HR30Tm from HR30T, the former denoting that depressions on the under surface of the test piece are permitted (cf. ISO 1024).

C.2 Test pieces

The hardness tests shall be carried out prior to lacquering or printing.

NOTE 20 If hardness tests are required on material which has been lacquered and printed, the organic coating should be removed.

From each of the sample sheets obtained in accordance with clause 12, take two test pieces 125 mm × 125 mm from the positions marked Y in figure 5.

NOTE 21 The test pieces (Y) taken for the determination of thickness variations within the individual sample sheets may also be used for the hardness determinations, where appropriate.

Before carrying out the hardness tests in accordance with C.3, artificially age the specimens at 200 °C for 20 min.

Polish material with a shot blast finish using emery paper of grade 600.

C.3 Test method

Determine the Rockwell HR30Tm indentation hardness either

a) directly, in accordance with ISO 1024; or

b) indirectly, on relatively thin sheets (e.g. 0,22 mm and thinner), by determining the HR15T hardness in accordance with ISO 1024 and then converting the HR15T values to HR30Tm values using table C.2.

Make three hardness measurements on each of the test pieces taken in accordance with C.2.

Calculate the representative hardness for the consignment as the arithmetic mean of all the hardness measurements on all the sample sheets taken from the consignment.

To measure the indentation hardness, use a Rockwell superficial hardness testing machine, employing the 30Tm or 15T scales (see ISO 1024), as appropriate.

Carry out the tests on test pieces from which all organic coatings have been removed. Avoid testing near the edges of the test pieces because of a possible cantilever effect.