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Aluminium and aluminium alloys — Coil coated sheet and strip for general applications — Specifications

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National foreword

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document (EN 1396:2015) has been prepared by Technical Committee CEN/TC 132 “Aluminium and aluminium alloys”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2015 and conflicting national standards shall be withdrawn at the latest by October 2015.

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This document supersedes EN 1396:2007.

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Introduction

Organic coated aluminium and aluminium alloy strip and sheet products can be used to advantage in cases where corrosion resistance and decorative appearance are of primary importance. They have applications throughout the flat products processing industry e.g. in the building, automotive, caravans, appliances, fabricating and packaging industries.

Organic coated aluminium and aluminium alloy flat products can be delivered in numerous types and grades, depending on the base material used (various grades of aluminium), on the coating material and types of coating and on the requirements for the surface appearance and the formability.

The properties of the products can vary within greater or smaller limits depending on the choice and combination of properties required. It is therefore not practicable to specify in detail minimum requirements for all properties for all types of products.

As a general rule, material specifications shall be agreed between manufacturer and user/purchaser using, when appropriate, the guidelines from Annex C.

Guidelines for proper storage and subsequent processing of organic coated aluminium flat products are given in Annex D.

1 Scope

This European Standard specifies the particular requirements for wrought aluminium and wrought aluminium alloys in the form of coil coated sheet and strip for general applications. This product is generally supplied in thicknesses up to 3,0 mm.

It applies to cold-rolled aluminium and aluminium alloy strip coated by the coil coating process both with liquid as well as with powder paints, either in the final width or slit afterwards, and to sheet obtained from such strip.

It does not apply to coil coated sheet and strip used for special applications such as cans, closures and lids which are dealt with in separate EN 541.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 485-1, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 1: Technical conditions for inspection and delivery*

EN 485-4, *Aluminium and aluminium alloys - Sheet, strip and plate - Part 4: Tolerances on shape and dimensions for cold-rolled products*

EN 515, *Aluminium and aluminium alloys - Wrought products - Temper designations*

EN 573-3, *Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 3: Chemical composition and form of products*

EN 12258-1:2012, *Aluminium and aluminium alloys - Terms and definitions - Part 1: General terms*

EN 13523-1, *Coil coated metals - Test methods - Part 1: Film thickness*

EN 13523-2, *Coil coated metals - Test methods - Part 2: Gloss*

EN 13523-3, *Coil coated metals - Test methods - Part 3: Colour difference - Instrumental comparison*

EN 13523-4, *Coil coated metals - Test methods - Part 4: Pencil hardness*

EN 13523-6, *Coil coated metals - Test methods - Part 6: Adhesion after indentation (cupping test)*

EN 13523-7, *Coil coated metals - Test methods - Part 7: Resistance to cracking on bending (T-bend test)*

EN 13523-8, *Coil coated metals - Test methods - Part 8: Resistance to salt spray (fog)*

EN 13523-10, *Coil coated metals - Test methods - Part 10: Resistance to fluorescent UV radiation and water condensation*

EN 13523-19, *Coil coated metals - Test methods - Part 19: Panel design and method of atmospheric exposure testing*

EN 13523-21, *Coil coated metals - Test methods - Part 21: Evaluation of outdoor exposed panels*

EN 13523-22, *Coil coated metals - Test methods - Part 22: Colour difference - Visual comparison*

EN ISO 1520, *Paints and varnishes - Cupping test (ISO 1520)*

EN ISO 4628-2, *Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 2: Assessment of degree of blistering (ISO 4628-2)*

EN ISO 6270-1, *Paints and varnishes - Determination of resistance to humidity - Part 1: Continuous condensation (ISO 6270-1)*

EN ISO 6272-1, *Paints and varnishes - Rapid-deformation (impact resistance) tests - Part 1: Falling-weight test, large-area indenter (ISO 6272-1)*

EN ISO 6272-2, *Paints and varnishes - Rapid-deformation (impact resistance) tests - Part 2: Falling-weight test, small-area indenter (ISO 6272-2)*

EN ISO 6892-1:2009, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2009)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12258-1:2012 and the following apply.

3.1
aluminium
unalloyed aluminium or aluminium alloy

Note 1 to entry: In the USA the term “Aluminum” is used.

[SOURCE: EN 12258-1: 2012]

3.2
aluminium alloy
aluminium which contains alloying elements, where aluminium predominates by mass over each of the other elements and where the aluminium content is not greater than 99,00%

[SOURCE: EN 12258-1:2012]

3.3
metal substrate
base material from cold rolled aluminium or aluminium alloy strip

3.4
coating material
material comprising organic polymers e.g. synthetic resins or plastics, to which pigments, additives and solvents (if required) have generally been added, suitable for coil coating

Note 1 to entry: These can be paints (liquid or powder) or plastic films.

3.5
coil coating
method in which a coating material is applied in a continuous process on a cold rolled metal strip

Note 1 to entry: This process includes cleaning and chemical pre-treatment of the surface and either:

— one-side or two-side, single or multiple application of liquid or powder coating materials which are subsequently cured, or

— laminating with plastic films.

3.6
organic coating
paint or lacquer film on a coated product produced from wet paint or from powder coating, or the laminated organic film

[SOURCE: EN 12258-1:2012]

3.7
top side
side of the strip with the highest decorative demand and which, in normal production, is uppermost

Note 1 to entry: For strip supplied in coil form, the top side is normally the outside of the coil. For sheet supplied in stacks or bundles the top side is normally uppermost.

3.8
reverse side
underside of the strip, generally coated with a backing coat (see 3.12), but possibly pre-treated only or coated with one of the other systems described in 3.10, 3.11 and 3.13, to fulfil special requirements such as foam or glue adhesion, specially defined friction, etc.

3.9
coating system
combination of coatings either on the top side or on the reverse side of the metal substrate

Note 1 to entry: The name of the coating system derives from the top coat coating material (see examples in Annex B).

3.10
single layer coating
single coating either with requirements on appearance, formability, corrosion protection, subsequent painting etc., or as a primer with special properties regarding adhesion and corrosion protection for post-painting applications

3.11
multilayer coating
system comprising a primer or a base coat, possibly intermediate coat(s), and a top coat with particular requirements on appearance, formability, corrosion protection etc.

3.12
backing coat
single coating of any type with no particular requirements for appearance, formability, corrosion protection etc., usually on the reverse side of the coated product

3.13
film coating
organic film applied to a substrate to which an adhesive and, if appropriate, a primer has been applied beforehand

[SOURCE: EN 12258-1:2012]

3.14
master coil / mother coil
coil-coated in coil from which products (coil or sheet) are obtained

3.15
order document
document or set of documents agreed between supplier and purchaser at the time of ordering

Note 1 to entry: An order document can be an order of the purchaser confirmed by the supplier or a quotation of the supplier confirmed by the purchaser.

4 Technical conditions for inspection and delivery

4.1 Ordering information

The order document shall define the product required and shall contain the following information:

a) the form and type of product:

- the form of the product (organic coated coil, sheet or strip);
- the designation of the aluminium or aluminium alloy, in accordance with EN 573-3;

b) the temper of the material for delivery (degree of hardness or heat treatment condition) in accordance with EN 515 and EN ISO 6892-1:2009;

c) the dimensions and shape of the product:

- thickness (of the metal substrate);
- width;
- length of sheet (in the rolling direction);
- internal and external diameters of the coil;
- core size and type.

NOTE Unless otherwise agreed, the length is the largest dimension;.

d) the quantity:

- mass or number of pieces;

e) the coating system (see examples in Annex B):

1) for the top side:

- colour designation (international and/or company code);
- nominal gloss value;
- protective strippable film when required [1)]

2) for the reverse side:

1) If the surface is likely to be damaged during transportation, storage, processing or erection, the coil coated material may, on agreement, be supplied with the additional protection of a temporary strippable film. Type, thickness, adhesion properties, formability, tear strength and light fastness are to be taken into consideration when choosing protective films. Only certain protective films can be exposed to outdoor weathering, and these only for a limited period.

- whether it is a backing coat or not;
- colour designation (international and/or company code);
- nominal gloss value;

f) the type and the design of embossing, when required;

g) any requirements for inspection documents;

h) any special requirements for packing:

- mass per coil and per packing unit;
- number of sheets per stack;
- position of coil axis (vertical or horizontal);
- design of pallet;
- direction of winding;

Optional information to be mentioned in the order:

i) the form and type of product:

- the purchaser application;

j) the number of this European Standard, i.e. EN 1396, or a specification number, or, where none exists, the properties agreed between manufacturer and purchaser;

- the quantity

k) quantity tolerances if required;

l) the coating system

1) for the top side

- special requirements when required such as coat system (single, multiple); type of organic coating (see Table B.1); coating thickness in micrometers, if different from normal (see Table B.1); stripe code etc.;

2) for the reverse side

- special requirements when required such as coat system (single, multiple); type of organic coating (see Table B.1); coating thickness in micrometers, if different from normal (see Table B.1); surface finish if not coated (degreased only, pre-treated etc.); printing of markings, foam adhesion, adhesive bonding etc.;

m) any special requirements agreed between manufacturer and purchaser:

- marking of products;
- flagging of defects;
- instruction on the position of the top side if other than the normal one (see 3.7);

— other characteristics of the products (see Annex C).

4.2 Requirements

4.2.1 Production and manufacturing processes

Unless otherwise specified in the order, the production and manufacturing processes shall be left to the discretion of the manufacturer. Unless it is explicitly stated in the order no obligation shall be placed on the manufacturer to use the same processes for subsequent and similar orders.

4.2.2 Quality control

The manufacturer shall be responsible for the performance of all inspection and tests required by the relevant European Standard and/or the particular specification, prior to shipment of the product.

If the purchaser wishes to inspect the product at the manufacturer's works, he shall notify the manufacturer at the time of placing the order.

4.2.3 Freedom from defects

The product shall be free from defects prejudicial to its suitable and proper use. Its surface shall be of a uniform appearance, colour and texture and be essentially free of blemishes such as flow lines, streaks, blisters or other imperfections.

Tolerance on surface defects is normally greater for products supplied as coils (as compared to sheets) due to the impossibility of removing defects within coils and this should be taken into account by the purchaser when assessing the product. Limiting samples may be agreed.

Uniformity and aesthetic faults shall be noted when visible. Visible examination shall be done at following distances:

— Building façade applications: 5 m for external and 3 m for internal use;

— All other applications: 3 m for external and 2 m for internal use.

4.2.4 Chemical composition

The chemical composition shall comply with the requirements as specified in EN 573-3.

4.2.5 Mechanical properties

The mechanical properties shall be in conformity with those specified in Clause 5 or those agreed upon between the supplier and the purchaser and stated on the order.

4.2.6 Tolerances on shape and dimensions

The tolerances on shape and dimensions specified in EN 485-4 shall apply.

NOTE Tolerances on thickness only apply to the uncoated (bare) metal substrate. For the tolerances on the organic coating thicknesses see 6.1.

Unless otherwise agreed, the purchaser may reject only those products having dimensions not complying with the specified tolerances.

4.2.7 Coating properties

Property requirements relating to the organic coating are specified in Clause 6. Other requirements shall be agreed by the supplier and the purchaser and stated on the order. Annex C gives some guidelines for such requirements.

4.3 Test procedures

4.3.1 Chemical composition

For chemical composition testing see EN 485-1.

4.3.2 Tensile test

For the selection and preparation of samples and test-pieces see EN 485-1.

Testing shall be carried out according to EN ISO 6892-1:2009, and the following additional requirements:

— the test-piece shall be taken with its length transverse to the rolling direction. For narrow widths (less than 300 mm) testing in the rolling direction is permitted. In this case, testing direction shall be reported and specified;

— the test-piece shall have a reduced section 12,5 mm wide;

— unless otherwise agreed testing shall be carried out on the coated material. The thickness of the metal substrate shall be used for the calculation of the cross-section;

— the elongation shall be measured using an original gauge length of 50 mm.

Testing shall be carried out on at least one test-piece taken from each inspection lot. Furthermore testing shall be carried out on:

— one test piece taken from each master coil of more than 1 000 kg;

— one test piece taken from every 10 master coils of 500 kg up to 1 000 kg;

— one test piece taken from every 25 master coils of less than 500 kg.

4.3.3 Coating tests

The coating tests shall be carried out either as agreed upon by the manufacturer and the purchaser or in accordance with the following standards:

— coating thickness (when required): EN 13523-1;

— specular gloss: EN 13523-2;

— colour difference: EN 13523-3 and EN 13523-22.

NOTE Instrumental comparison for colour difference (EN 13523-3) does not give reliable values in the case of embossed or textured coatings, metallic or pearlescent pigmented coatings.

The frequency of testing shall be as for the tensile test.

Other tests may be specified. The methods of testing, if other than the ones in the normative references (see paragraph 2), the acceptance criteria and the frequency of testing shall be agreed between supplier and purchaser. Guidelines for such specification are set out in Annex C.

4.3.4 Retests

Retests shall be carried out in conformance with EN 485-1.

5 Mechanical properties

Properties shall be in conformance with those specified in Table 1, using the rounding rules set out in Annex A. Properties for alloys and/or tempers not covered in Table 1 shall be agreed between manufacturer and purchaser.

Table 1 — Mechanical properties after coating

Alloy designation	Temper	R_m MPa		$R_{p0,2}$ MPa	$A_{50\ mm}$ % specified thickness t (mm) min.		
		min.	max.	min.	$t \leq 0,5$	$0,5 < t \leq 1,5$	$t > 1,5$
EN AW-1050A [Al 99,5]	O	65	95	20	20	22	26
	H42	85	125	65	4	5	6
	H44	100	145	80	3	4	5
	H46	120	160	90	2	3	4
	H48	140	—	120	2	2	3
EN AW-1200 [Al 99,0]	O	75	105	30	19	21	24
	H42	90	135	70	4	5	6
	H44	110	155	90	3	4	5
	H46	130	170	100	2	3	4
	H48	150	—	130	2	2	3
EN AW-3003 [Al Mn1Cu]	H44	140	185	110	4	4	5
	H45	150	205	130	3	4	4
	H46	165	210	140	2	3	3
	H48	180	220	165	2	2	3
	H49	195	—	190	2	2	2
EN AW-3103 [Al Mn1]	H44	140	180	110	4	4	5
	H46	160	200	140	2	3	3
	H48	180	—	160	2	2	3
EN AW-3004 [Al Mn1Mg1]	H42	185	240	130	4	5	6
	H43	195	235	160	3	4	5
	H44	210	265	180	3	4	4
	H46	230	285	200	3	3	3
	H48	260	—	220	2	3	3
EN AW-3005 [Al Mn1Mg0,5]	O	115	165	45	12	14	16
	H41	130	180	80	7	8	9
	H42	140	195	95	5	5	6
	H44	165	215	135	3	3	4

	H46	185	240	160	2	2	3
	H48	210	—	180	1	2	2
EN AW-3104 [Al Mn1Mg1Cu]	H48	240	280	210	3	4	4
	H49	280	—	250	2	2	2
EN AW-3105 [Al Mn0,5Mg0,5]	O	100	155	40	14	15	17
	H42	130	180	105	6	6	7
	H44	150	200	120	3	3	4
	H46	175	225	150	2	2	3
	H48	195	—	170	2	2	2
EN AW-4017 [Al SiMnMgCu]	H42	145	200	120	2	2	2
EN AW-5005 [Al Mg1(B)]	O	100	145	35	15	19	20
	H42	125	165	80	4	5	6
	H44	145	185	110	3	4	5
	H46	165	205	135	2	3	4
	H48	185	—	160	1	2	3
EN AW-5006 [Al Mg1Mn0,5]	H41	140	190	105	7	7	8
	H48	200	250	180	3	3	3
	H49	200	—	190	2	2	2
EN AW-5010 [Al Mg0,5Mn]	H42	110	150	90	5	5	6
	H44	130	170	100	3	3	4
	H45	140	180	110	2	2	3
	H46	150	190	120	2	2	3
	H48	170	210	140	1	1	2
EN AW-5050 [Al Mg1,5(C)]	H44	170	215	130	3	4	5
	H46	190	235	160	2	3	4
	H48	210	250	180	1	2	3
	H49	240	—	220	1	1	2
EN AW-5251 [Al Mg2]	O	160	200	60	13	14	16
	H44	190	230	120	3	5	6
	H46	210	270	165	3	4	5
	H48	250	—	215	2	3	3
EN AW-5052 [Al Mg2,5]	H42	205	260	130	5	6	7
	H44	230	280	150	4	5	6
	H46	250	300	180	3	4	5
	H48	270	—	210	3	3	4
EN AW-5754 [Al Mg3]	O	190	240	80	12	14	16
	H41	205	245	125	8	9	10
	H42	220	270	130	7	8	9
	H44	230	280	160	5	5	6
	H46	260	310	190	4	4	5

	H48	280	—	220	3	3	4
EN AW-5182 [Al Mg4,5Mn0,4]	H48	330	—	300	1	1	2
EN AW-6011 [Al Mg0,9Si0,9Cu]	T8	340	—	320	2	2	2
EN AW-6025 [Al Mg2,5SiMnCu]	O	160	220	60	8	10	10
	H41	170	220	100	4	5	5
	H42	180	230	135	2	3	4
	H46	220	260	185	2	3	4
EN AW 8006 [Al Fe1,5Mn]	O	70	—	45	18	18	20
	H42	85	125	75	5	5	6
	H44	90	130	75	2	2	3
EN AW-8011A [Al FeSi(A)]	O	80	120	30	19	21	24
	H44	125	165	100	3	4	5

6 Organic coating properties

6.1 Tolerances on thickness

When specified in the order document, the thickness of the organic coating shall meet the tolerances given in Table 2.

These tolerances on the specified coating thickness shall apply to the total organic coating thickness on each relevant side, but not including the adhesive film thickness (where applicable).

The measurements shall be carried out on a representative specimen according to EN 13523-1.

Table 2 — Tolerances on total thickness of the organic coating

Dimensions in micrometres

Specified thickness range	3< *t* ≤5	5< *t* ≤10	10< *t* ≤20	20< *t* ≤ 25	25< *t* ≤35	35< *t* ≤60	60< *t* ≤100	100< *t* ≤200	*t* >200
Maximum allowable negative deviation from the specified thickness: for an average of five measurements.	2	2	2	3	3	5	10	15	20
Maximum allowable negative deviation from the specified thickness: for an individual measurement	2	3	4	5	6	8	15	25	40

NOTE 1 The measurements are carried out on flat samples only (i.e.: not embossed).

NOTE 2 Both tolerances are only intended for smooth surfaces. For structured surfaces only negative deviation on the average of ten measurements are applied. Tolerance for individual measurements does not apply.

NOTE 3 Other tolerances as well as the measuring method to be used can be agreed between manufacturer and purchaser; in this case, both these information shall be reported and specified.

NOTE 4 There are no requirements for backing coat.

NOTE 5 There are no requirements for the positive deviation.

NOTE 6 For powder coatings, maximum allowable deviation from the specified thickness is 10 for an average of five measurements and 15 for an individual measurement for all film thicknesses.

6.2 Tolerances on gloss

The tolerances on gloss measured using a 60° head are specified in Table 3.

These tolerances apply to measurements carried out in accordance with EN 13523-2 using a 60° head, unless otherwise agreed. For gloss values below 13, an 85° head should be used, where other tolerances may apply.

Table 3 — Tolerances on gloss

Values in gloss units

Gloss unit range	Tolerances on nominal gloss	Maximum variation within one supply	Gloss type
≤ 10	± 2	± 1	matt
> 10 ≤ 20	± 4	± 2	low gloss
> 20 ≤ 40	± 5	± 3	satin
> 40 ≤ 60	± 7	± 5	semi-gloss
> 60 ≤ 80	± 8	± 7	gloss
> 80	Minimum gloss 80		high gloss
NOTE 1 Other values may be agreed between supplier and purchaser. NOTE 2 Test method and gloss tolerances for textured finishes are agreed between supplier and purchaser. NOTE 3 The measurement are carried out on flat samples (i.e: not embossed)			

6.3 Tolerances on colour

The colour shall match visually the colour specified. If necessary, appropriate colour tolerances should be agreed in advance. Recommendations for the evaluation are defined in Annex C.

7 Inspection documents

Inspection documents shall be issued in accordance with EN 485-1.

8 Marking

Unless otherwise agreed at the time of ordering, the following minimum marking requirements shall apply:

— name or mark of the manufacturer;

— alloy and temper designation for the substrate;

— information on the coating on each surface;

— order number;

— ordered dimensions;

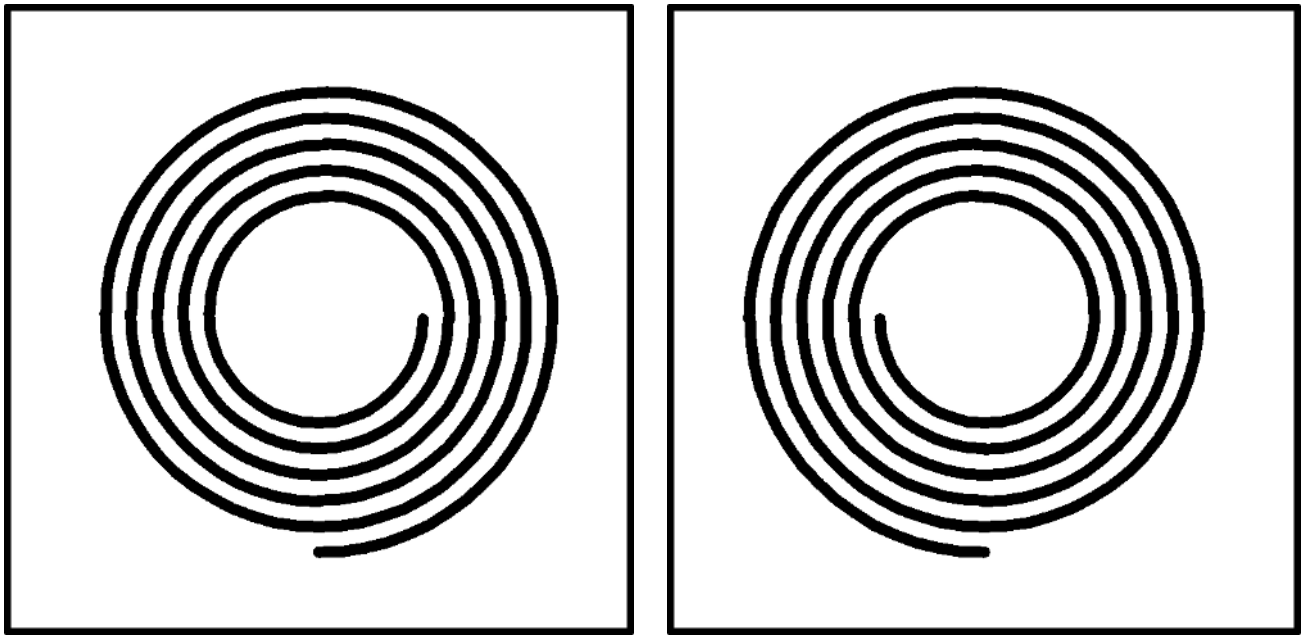
— production batch number and mass.

Each of this items shall be given on a label, which is to be attached to every coil or pack.

9 Packing

The packing requirements shall be agreed between manufacturer and purchaser at the time of ordering.

For coils packed eye to the sky — when observed from the top — the direction of winding is defined as clock-wise or anti-clockwise according to the following sketch:



a) Clockwise **b) Anti-clockwise**

Figure 1 — Direction of winding

10 Arbitration tests

In cases of dispute concerning conformity with the requirements of this European Standard or specification cited on the order, before rejecting the products, testing and examination shall be carried out by an arbitrator chosen by mutual agreement between manufacturer and purchaser.

The arbitrator's decision shall be final.

Annex A
(normative)

Rules for rounding

In recording test results, the number representing the result of a test to determine a given property shall be expressed to the same number of decimal places as the corresponding number in this European Standard.

The following rounding rules shall be used for determination of compliance with this European Standard:

a) when the figure immediately after the last figure to be retained is less than 5, the last figure to be retained remains unchanged;

b) when the figure immediately after the last figure to be retained is greater than 5, or equal to 5 and followed by at least one figure other than zero, the last figure to be retained is increased by one;

c) when the figure immediately after the last figure to be retained is equal to 5 and followed by zeros only, the last figure to be retained remains unchanged if even and is increased by one if odd.

The results of determinations of dimensions (length, width, thickness etc.) and shape (squaring, cambering, straightness, flatness etc.) shall not be rounded. These shall comply with the specification in the relevant European Standard, taking into account permissible tolerances also given in that European Standard.

Annex B
(informative)

Examples of coating systems

EXAMPLE 1 Topside: Two coat system, PVDF, colour xxxx, gloss xxx units, coating thickness xxx µm, with protective strippable film.

Reverse side: Single coat system requiring PU foam adhesion, coating thickness approx. xxx µm.

EXAMPLE 2 Topside: Two coat system, Polyester (SP), colour xxxx, gloss xxx units, coating thickness xxx µm, with protective strippable film.

Reverse side: Two coat system, Polyester (SP), colour xxxx, gloss xxx units, coating thickness xxx µm.

EXAMPLE 3 Topside: Single coat system, Epoxy (EP), colour xxxx, gloss xxx units, coating thickness xxx µm.

Reverse side: Pre-treated only.

EXAMPLE 4 Topside: Laminated with PVC-film, colour xxxx, gloss xxx units, film thickness xxx µm.

Reverse side: Backing coat, approx. xxx µm.

EXAMPLE 5 Topside: Two coat system, Polyester (SP), with stripes, stripe code n° xxxx (drawing N.), colour of base coat xxxx, colour of stripe 1 xxxx, colour of stripe 2 xxxx, gloss xxx units, coating thickness (base coat) xxx µm, coating thickness (stripes) xxx µm.

Reverse side: Backing coat, approx. xxx µm.

Table B.1 — Symbol and typical thickness or thickness ranges of the more common coating materials (for information only)

Dimensions in micrometres

Coating material	Symbol [a]	Typical thickness or thickness ranges [b]
Liquid coatings		
Acrylic	AY	20
Alkyd	AK	15
Epoxy	EP	5
Fluoropolymer	FEVE	10 to 40
Polyamide (PA) modified systems	PUR-PA and SP (PE) -PA	20 to 30
Polyesters	SP and PE	10 to 20
Polyurethane	PUR	20
Polyurethane adhesives	PUR(A)	6
Polyvinylidene fluoride	PVDF	20 to 40
Silicone modified polyester	SP-SI	20
Powder coatings		
Polyester	PE	50 to 80
Epoxy	EP	50 to 80
Laminates [c]		
Polyvinyl chloride	PVC(F)	> 100
Polyvinyl fluoride	PVF(F)	38
Polyester	PET	< 150

[a] The symbols correspond broadly to those in EN ISO 1043-1 or were chosen by analogy.

[b] The typical thickness values relate to the individual coats (excluding primer and adhesive coatings).

[c] Excluding adhesive film thickness of approximately 10 µm.

Annex C
(informative)

Guidelines for organic coatings

C.1 General

Coil coated products shall comply with the relevant requirements of this annex when agreed between supplier and purchaser and stated on the order.

C.2 to C.5 can be used for lot acceptance if so agreed.

C.6.2 to C.6.5 are only intended for surveillance purpose. The frequency of the relevant test is left to the discretion of the manufacturer, who shall maintain records of the lots so tested and make them available for examination at the manufacturer's facility.

C.2 Colour

The colour shall be measured according to EN 13523-3 and shall not differ from the agreed standard by:

White and pastel colours $\Delta E \leq 1$

Other colours $\Delta E \leq 2$

Illuminants and geometry shall be declared. For specific colours, other tolerances can be agreed at the time of inquiry and order.

Within one supply the colour difference between extremes shall not exceed ΔE 0,7 CIELAB unit.

These figures are for guidance only and are not appropriate for all colours. Therefore specific numerical values should be set when necessary.

The measurements should be executed on a mutually agreed colour measurement device. This does not apply to metallic paint finishes, textured coatings and embossed surfaces.

The colour should be evaluated visually according to EN 13523-22.

C.3 Flexibility

Flexibility of the organic coating is assessed by subjecting the material to a bend test. The test should be carried out on a material at ambient temperature.

The bend test should be carried out according to EN 13523-7 in the rolling direction. If the transverse direction is used it shall be specified in the report.

As an alternative to the devices covered in EN 13523-7 the following method may be used to carry out the bending (see also Figure C.1):

— the test piece (at least 250 mm × 30 mm) is bent (at 1 cm from one extremity) over an angle of approximately 100° by hand or by any other convenient means;

— the bent test-piece is then pressed, using a vice or an hydraulic press, until the two faces come into contact. This constitutes the "0T" bend;

if the bent area shows cracks with apparent underlying metal, a second bend is carried out by folding the test-piece over the first bend and then pressing it using the vice or press. This constitutes the "0,5T" bend;

— this procedure is continued until a crack free bend is obtained;

— in case of dispute the test shall be carried out at a temperature of 23 °C ± 2 °C and at a relative humidity of 50 % ± 5 %.

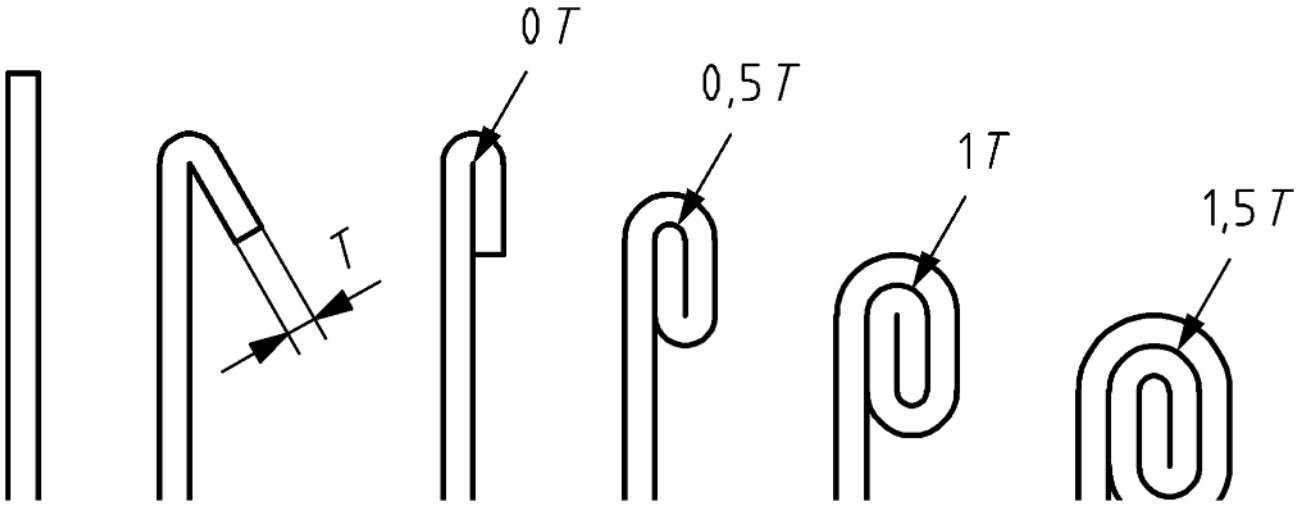


Figure C.1 — Bending values

The frequency of testing shall be as for the tensile test.

Bending values shall not exceed 3T, unless otherwise specified or agreed between supplier and purchaser.

Measured bend radii are governed by the choice of metal substrate, temper, thickness and coating material. Therefore when limit values are required, these shall be agreed between supplier and purchaser and stated on the order in accordance with the shape and folds of the finished product.

C.4 Adhesion

C.4.1 Adhesion of the organic coating is assessed by evaluating the coating surface, after deformation, in specified conditions, of a specimen previously cross-hatched with a cutting tool. Cross-hatching shall be carried out according to EN 13523-6. The specimen shall then be deformed using one of the following methods as appropriate:

— method 1: liquid coating from which the film thickness is up to 50 µm may be reverse impact tested in accordance with EN ISO 6272-1 or EN ISO 6272-2, using the maximum indentation energy that will not rupture the substrate. Tested with tape, there shall be no loss of adhesion of the organic coating.

NOTE Cracking of the paint film is not considered to be a cause for rejection.

— method 2: coatings shall be tested in accordance with EN 13523-6 followed by EN ISO 1520, noting the following:

  — cross-hatching shall comprise two parallel cuts made 5 mm apart, together with two additional similar cuts made at right angles to form a central 5 mm × 5 mm central square. The cuts shall just reach the metal, and each cut shall measure at least 50 mm in length;

— after indentation, an attempt is made to pull the strips away from the substrate in each of the four directions, starting from the central square. The ends of the strips are lifted with a knife, then pulled with pincers. The peeling is observed and expressed in percentage of the distance between the top and the base of the dome;

— for the maximum indentation depth that will not rupture the substrate, peeling shall not exceed 75 %.

C.4.2 Alternatively, all coatings may be subjected to one of the bend tests described in C.3. Tested with tape, no loss of adhesion is allowed for $2T$ bends (radius of the mandrel equal to twice the substrate thickness).

C.5 Pencil hardness

When tested in accordance with EN 13523-4, the hardest pencil that does not rupture the paint should be at least F.

This test is only valid for smooth paints and do not apply for film thicknesses over 50 µm.

C.6 Durability of the organic coating

C.6.1 General

C.6.1.1 The requirements proposed as guidelines in Clause 6 take into account the envisaged application which will affect the choice of the product to be ordered. Accordingly provision is made for four categories of coil coated metal products as follows:

— category 1: pre-painted metal product intended only for further painting after fabrication;

— category 2: pre-painted metal product suitable for the following interior applications:

  a) dry and wet non-corrosive areas;

  b) wet corrosive areas;

— category 3: pre-painted metal product suitable for the following exterior applications:

  a) rural; or urban or light industrial (or mild marine);

  b) tropical (high temperatures, high humidity);

  c) high U.V (ultra-violet);

— category 4: pre-painted metal product suitable for the following applications:

  a) severe industrial — extreme conditions;

  b) very severe coastal marine (less than 3 000 m from the sea, depending also on the landscape);

  c) high U.V plus severe conditions (tropical and marine).

C.6.1.2 Testing may include actual outdoor exposure tests (see C.6.2 and C.6.3) or accelerated laboratory tests (see C.6.4, C.6.5 and C.6.6).

In the case of new products, the expected performance is to be as stated in Tables C.2 and C.3 (for natural UV radiation). In the interim, the performance shall be evaluated using accelerated tests.

For the purpose of these tests the expected resistance of the coating system to corrosion is expressed by means of indices varying from 1 to 3 and the resistance to UV exposure by means of categories R_{uv2}, R_{uv3} and R_{uv4}, defined as follows:

1 and R_{uv2}: low resistance;

2 and R_{uv3}: medium resistance;

3 and R_{uv4}: high resistance.

C.6.1.3 Outdoor exposure tests are carried out by the manufacturers in a variety of sites representing marine, industrial, urban or rural environments or combinations thereof. Panel preparation and method of expo- sure, although essentially similar, can vary from one manufacturer to another. These tests shall be carried out in accordance with EN 13523-19 and EN 13523-21.

The expected performances specified in C.6.2 and C.6.3 apply to panels tested according to these methods.

C.6.1.4 It is to be noted that the performance of the coating system has to be specific to the environment for which it is intended and one or more of the aspects quantified (UV and/or corrosion) are usually required. Table C.1 gives, for each category defined in C.6.1.1, recommended corrosion indices and UV resistance categories which the coating systems should present.

Table C.1 — Recommendations for selection of coil coated material

Category	End use environment	Corrosion resistance index	UV resistance category
1	Pre-painted metal product intended only for further painting after fabrication	—	—
2	Pre-painted metal product suitable for the following interior applications:		
2a	Dry and wet non-corrosive areas	1	R_{uv2}
2b	Wet corrosive areas	3	R_{uv2}
3	Pre-painted metal (product suitable for the following exterior applications:		
3a	Rural or urban light industrial (or light marine)	2	R_{uv3}
3b	Tropical (high temperature, high humidity)	3	R_{uv4}
3c	High UV	2	R_{uv4}
4	Pre-painted metal product suitable for the following applications:		
4a	Severe industrial — extreme conditions	3	R_{uv3}
4b	Very severe costal marine (less than 3 000 m from the sea, depending also on the landscape	3	R_{uv3}
4c	High UV plus severe conditions	3	R_{uv4}

NOTE 1 Corrosion indices and UV resistance categories are rated on the following scale:
1, R_{uv2} = Low 2, R_{uv3} = Medium 3, R_{uv4} = High
NOTE 2 Coatings that do not fulfil the requirements of R_{uv2} classification are classified as R_{uv1}.

C.6.2 Corrosion resistance (outdoor exposure)

Testing shall be carried out according to EN 13523-19 on panels exposed at 90° facing the North. The expected average undercreep on the front side of the panel shall not exceed the values specified in Table C.2. Attacked surface shall not exceed 5 % of total exposed surface.

Table C.2 — Expected performance on panel exposed in H.v.Holland

Exposure duration	3 months		1 year		3 years	
Corrosion resistance index	2	3	2	3	2	3
Average under creep	≤ 1 mm	≤ 1 mm	≤ 2 mm	≤ 1 mm	≤ 4 mm	≤ 2 mm

C.6.3 UV resistance

C.6.3.1 General

Type 1, 2 and 3 specimens are specified in EN 13523-19. Type 1 specimens are exposed in a site providing at least 4500 MJ/m²/year of cumulative solar energy measured horizontally. See C.6.4 and C.6.5 for testing conditions. The aspect of Type 1 specimens shall not exhibit variations more than those reported in Table C.3 for UV resistance categories R_{uv2}, R_{uv3} and R_{uv4}.

Table C.3 — Requirements for the UV resistance for natural and artificial testing conditions

Requirements	UV resistance category				
(duration: two years of natural, 2 000 hours for artificial UV radiation)	R_{uv2}	R_{uv3}		R_{uv4}	
Maximum colour change ΔE^{*}[a] before and after the test (CIELab units)	5	3		3[c]	2[d]
Minimum retained gloss after the test (RG[b]), %	30	50[c]	60[d]	80	

[a] The ΔE^{*} value is not applicable for saturated and other special colours such as metallic and pearlescent. In that case the colour change verification method and its acceptance value shall be agreed at the time of enquiry and order.

[b] The retained gloss (RG) is the ratio of the final gloss value, given in percent. The RG requirement is not applicable to textured finished coatings.

[c] Natural UV radiation.

[d] Artificial UV radiation.

C.6.3.2 Natural outdoor UV radiation resistance tests

The exposure site shall provide at least 4 500 MJ/m²/year of cumulative solar energy measured horizontally. Specimen cleaning conditions can influence test results significantly. Colour change and retained gloss shall be evaluated on correctly cleaned specimens. The cleaning conditions may be changed upon agreement at the time of enquiry and order. Lisbon (PT) – site recommended by ECCA – is an example of a UV radiation exposure. Other sites with the same minimum cumulative solar energy may be selected as well (Florida, Arizona, etc.).

The test duration is 2 years for all UV resistance categories R_{uv2}, R_{uv3} and R_{uv4}.

Table C.4 — Examples of exposures for the different UV resistance categories

UV Resistance category	Example
R_{uv1}	Reverse coating of exterior elements.
R_{uv2}	Regions located north of about latitude 45 °N, with an altitude not greater than 900 m.
R_{uv3}	Regions located south of about latitude 45 °N and north of about latitude 37 °N, with an altitude not greater than 900m.
R_{uv4}	Regions located south of about latitude 37 °N. Every region with an altitude greater than 900 m.

NOTE 1 Examples given are of general guidance since local conditions in relation with sunshine hours and UV radiation can vary considerably even in a small geographical area

NOTE 2 For buildings located next to the sea or large lakes or areas covered with snow, UV radiation can be increased due to reflection from the corresponding surfaces.

C.6.3.3 UV radiation resistance (accelerated test)

UV radiation resistance tests shall be carried out in accordance with EN 13523-10.

UV resistance tests shall not be carried out on coatings of UV resistance category R_{uv1}.

The artificial ageing test under combined action of both UV radiation and condensation is carried out for coating system categories R_{uv2}, R_{uv3} and R_{uv4} by using UVA-340 lamps. The test duration is 2 000 hours (250 cycles). In case other radiation sources are used (such as UVB-313 or Xenon), tolerances might differ from the values stated in Table C.5 and shall be agreed at the time of enquiry and order.

NOTE 1 Other test methods may be agreed at the time of enquiry and order.

NOTE 2 Artificial weathering or exposure to artificial radiation of coatings in fluorescent UV-condensation type machines is carried out in order to establish, after a certain radiation exposure or mutually agreed total number of operation hours, the degree of a change of a property or properties. The properties of the exposed coatings are compared with those of unexposed coatings, prepared from the same coating materials under identical conditions or with coatings whose degradation properties are known. These properties are evaluated by criteria agreed in advance between the interested parties, these criteria usually being of a subjective nature.

NOTE 3 During natural weathering, global radiation and wet conditions are considered essential for the ageing of coatings. Therefore, the use of the artificial weathering apparatus specified in this standard is to simulate exposure to UV light and moisture.

NOTE 4 The results obtained by the use of this method do not necessarily relate directly with results obtained under natural exposure conditions. The relationship between these results needs to be established before the method can be used to predict performance.

C.6.4 Humidity resistance (accelerated test)

When tested for 1 000 h in accordance with EN ISO 6270-1 any blistering should be less than blister size B2(S2) (EN ISO 4628-2).

C.6.5 Acetic acid salt spray fog resistance (accelerated corrosion test)

When tested for 500 h in accordance with EN 13523-8 the average under creep shall not exceed the values specified in Table C.5.

Table C.5 — Maximum values for average under creep and face blistering after accelerated corrosion testing

Test criterion	Testing time h	Corrosion resistance index		
		1	2	3
Under creep corrosion mm	500	4	2	1
	1 000	—	3	2
Face blistering (EN ISO 4628-2)	500	none		
	1 000	B2 (S2)		

NOTE When tested in the neutral salt spray fog, according to EN ISO 7253, coil coated aluminium and aluminium alloys are almost unaffected.

C.6.6 Filiform corrosion test, FFC (accelerated corrosion test)

When tested for 500 h in accordance with ISO 4623-2 the average under creep shall not exceed the values specified in Table C.6.

Table C.6 — Maximum values for average under creep and after accelerated corrosion testing

Test criterion	Testing time h	Corrosion resistance index		
		1	2	3
Under creep corrosion mm	500	L4/M	L2/M2	L1/M1
	1000	—	L3/M3	L2/M2
NOTE 1 L = longest filament, M = most frequent filament NOTE 2 Filiform corrosion (FFC) test (ISO 4623-2) is complementary to the Acetic acid salt spray				

Annex D
(informative)

Guidelines for storage and subsequent processing

D.1 Storage

If possible, storage should be in dry or air-conditioned buildings. Generally the products should be protected from damp and stored in a dry condition.

When packs are stacked, the height of the stack should be limited to prevent pressure marking of the coating. Coils should never be placed or stored on bare ground, but should be supported by wooden blocks or protective mats (e.g. felt).

Any unevenness in solid matter on the surface of the storage areas that could produce pressure points or dents in the sheet should be avoided as, under certain circumstances, they could make the outer laps unusable. Coils with horizontal axis should not be stored on top of each other.

Sheets should be removed from the packing by careful lifting, not by sliding, so as to avoid scratches caused by burrs - often invisible - or by dust and dirt (e.g. pneumatic sheet lifters, rubber suction pads etc. should be used).

D.2 General instructions for processing

Organic coated flat products already have their finished surface in the delivered condition.

Pressing tools used in processing should therefore be suited to the material, and a smooth clean surface is essential. Polished and hard chrome plated tools are recommended.

Manufacturer advice should be sought when processing flat products with protective films.

Where there are particular requirements on flatness it is recommended that a levelling machine be used, as in the processing of uncoated flat products.

D.3 Forming

Organic coated flat products are suitable for forming by most known methods e.g. roll forming, bending, press forming and deep drawing provided that an appropriate combination of substrate and coating are selected and that attention is paid to tool design.

Forming should be carried out on a material at temperature over 20 °C wherever possible.

D.4 Cutting

Organic coated flat products can generally be cut, punched and perforated in the same manner as uncoated flat products, but very high processing speeds should be avoided. Care should be taken to ensure setting of tool clearance. Materials with thick coatings (PVC plastisols and films) should be cut from the bottom side. Any swarf from cutting should be carefully removed from the surface before further treatment.

In case of using steel, copper and aluminium in the same machine, it is recommended to clean the machine before using the aluminium.

D.5 Joining

The common mechanical joining methods, such as the use of screws, rivets, spring fasteners and lock seaming, are suitable. Fasteners should be corrosion protected.

Organic flat coated products can, in principle, be adhesive bonded to each other and to other materials if selected adhesives are used.

Under certain conditions, organic coated flat products can be welded by various methods. The manufacturer advice should be sought.

The physical properties of the product shall not be affected by the joining.

D.6 Cleaning

Only water based mild cleaning agents should be used for cleaning organic coated flat products. The manufacturer advice should be sought in other cleaning agents especially solvents.

Dirt retention can be expressed as the ease with which the product is cleaned according to the paragraph below.

Regular cleaning of organic coatings will maintain the surface in a satisfactory state. Cleaning should be carried out at least once a year or when the appearance has become unsightly or when deposits of atmospheric pollution or matter washed down from building surfaces are apparent. The finishes should be washed with water containing a mild detergent, as recommended by the supplier. Harsh scrubbing or the use of abrasive or solvent cleaners, which will change the finish should be avoided. The cleaning has to be carried out from top to bottom.

D.7 Temporary protective films

The utility of a protective film thus depends essentially on the protection required and the processing operations to be performed. The thickness of the protective film (between 35 and 100 µm transparent or colours film and UV resistance Black/White) shall be agreed upon at the moment of enquiry and order.

All protective films applied to the products shall be removed immediately following the installation of the products, unless otherwise specified by the vendor.

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