BS EN 4473:2010

BSI Standards Publication

Aerospace series — Aluminium pigmented coatings for fasteners — Technical specification

National foreword

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The UK participation in its preparation was entrusted to Technical Committee ACE/12, Aerospace fasteners and fastening systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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ISBN 978 0 580 65104 5

ICS 49.040

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 September 2010.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 4473

September 2010

ICS 49.040

English Version

Aerospace series - Aluminium pigmented coatings for fasteners - Technical specification

Série aérospatiale - Revêtements alumino-organiques pour fixations - Spécification technique

Luft- und Raumfahrt - Aluminium pigmenttete Beschichtungen für Fixierungen - Technische Lieferbedingungen

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Ref. No. EN 4473:2010: E

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Foreword

This document (EN 4473:2010) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

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1 Scope

This European Standard defines the qualification test conditions for aluminium pigmented coatings applicable to fasteners in titanium, titanium alloys, nickel base alloys and corrosion resisting steels. The aluminium pigmented coatings are not applicable to fasteners in non-corrosion resistant steels.

Temperature class: 315 °C [1)]

Type I : Coating with chromate and a cetyl alcohol lubricant.

Type II : Coating without chromate and an cetyl alcohol lubricant.

Type III : Coating with chromate, no additional lubricant.

Type IV : Coating without chromate, no additional lubricant.

2 Normative references

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

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

EN ISO 2812-1, *Paints and varnishes — Determination of resistance to liquids — Part 1: Immersion in liquids other than water (ISO 2812-1:2007)*

EN 4474, *Aerospace series — Aluminium pigmented coatings — Coating methods*

EN 6117, *Specification for bolts with cetyl alcohol* [2)]

EN 9133, *Aerospace series — Quality management systems — Qualification Procedure for Aerospace Standards Parts*

TR 4676, *Aluminium pigmented coatings — List of commercial products* [3)]

NASM 1312-5, *Fastener Test Methods; Method 5: Stress durability* [4)]

NASM 1312-12, *Fasteners Test Methods, Method 12: Thickness of metallic coatings* [4)]

MIL-A-8625, *Anodic coatings for aluminium and aluminium alloys* [5)]

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1) Maximum operating temperature.

2) Published as ASD Prestandard at the date of publication of this standard.

3) Published as ASD Technical Report at the date of publication of this standard.

4) Published by: Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, USA.

5) Published by: Department of Defense (DOD), the Pentagon, Washington, D.C. 20301 USA.

3 Terms and definitions

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

3.1
production lot
product quantity of known composition (aluminium pigmented resin) prepared as one mixing using the same equipment

3.2
seam
open surface defect

3.3
blister
local convexity caused by a sub-surface inclusion of gas or liquid

3.4
nodule
localized buildup or unmixed solid particles

3.5
pit
void, hole in the surface as caused, for example, by corrosion

3.6
porosity
fine holes or pores within the coating

3.7
functional surfaces
functional surfaces are defined as surfaces in contact with mating structure and threaded portion such as

— screws: under head bearing surface, shank, lead-in radius and thread surface if applicable;

— nuts: bearing surfaces, thread surface;

— spherical washers: bearing surfaces;

— swaged collars: all surfaces.

3.8
generic part
familly of similar parts such as:

— screws;

— nuts and threaded collars;

— lockbolts;

— swaged collars;

— solid rivets;

— blind bolts;

— bushes;

— spherical washers.

4 Technical specifications

4.1 Product

TR 4676 gives the list of aluminium pigmented coating commercial products.

Product to be applied shall conform to environmental, work safety and public health European regulations.

4.2 Product composition

The preparation method and product composition shall be defined by the manufacturer. The latter must peremptorily notify its users of any change subsequent to qualification.

The product shall not contain chemical compounds as listed below : lead, graphite, type II and IV shall not contain hexavalent chromate.

4.3 Product application

Product must be applied in accordance with EN 4474. The resin curing temperature must be lower than the last ageing treatment of the material to be coated by at least 10 °C. Product may be applied in several coats but shall only have one curing (polymerization), pre heating (flash-off) is acceptable for each coat.

5 Quality assurance

5.1 Qualification

EN 9133

All coating qualification tests shall be done on fasteners and according to Table 1.

For fastener qualification only 6.1 to 6.3 apply.

5.2 Acceptance

Acceptance is done through fasteners lots for appearance, thickness and adhesion. Sampling 3 per generic part or coating application process and test method in accordance with 6.1 (Appearance), 6.2 (Thickness) and 6.3 (Adhesion).

6 Requirements

See Table 1.

All the tests are to be carried out after application according to EN 4474.

When cetyl alcohol is added to type III or IV, they shall be qualified according to type I or II.

Table 1

Section	Characteristic	Requirement	Inspection and test method	Sampling for qualification
6.1	**Appearance**	The coating shall be smooth, uniform color, and shall be free of pinholes, porosity, blisters, nodules, pits, or other harmful imperfections.	Visual examination	10 per generic part
6.2	**Thickness**	External threaded fasteners: The coating thickness shall be between 5 µm and 13 µm on all functional surfaces as defined in 3.7. Internal threaded fasteners: The coating thickness shall be between 5 µm and 20 µm on all functional surfaces as defined in 3.7.	Determination of coating thickness shall be made by any of the methods specified in NASM 1312-12. In case of conflict the micrographic examination shall be chosen.	10 per generic part or coating application process
6.3	**Adhesion**	The coating must remain continuously bonded to the basis material. Class 0	ISO 2409 If fastener geometry does not alllow ISO 2409 adhesion test, the coating must be cut through to the base material on the largest plain surface of the part. Press the tape firmly to the cut on the plain surface of the fastener and remove the tape in one abrupt motion perpendicular to the fastener surface. Any evidence of coating separation when examined at approximately 4X is cause for rejection.	5 per generic part, material type or coating application process
6.4	**Heat resistance**	The coating must remain continuously bonded to the basis material. No powder shall be detected by visual inspection. Class 0	Expose the coated test part to 315 °C for 4 h. Air cool and carry out the adhesion test (see 6.3). ISO 2409.	4 screws

continued

Table 1 *(continued)*

Section	Characteristic	Requirement	Inspection and test method	Sampling for qualification
6.5	**Resistance to fuels and hydraulic fluids**	The coating shall not show evidence of blistering or loss of adhesion. Class 0	Immersion according to EN ISO 2812-1 inside : — Kerosene: Method 1 = Full immersion 1 000 h at 70 °C min in Kerosene or equivalent containing 0,2 % methyl cellosolve; — Hydraulic fluid: Method 1 = Full immersion 1 000 h at 70 °C min in phosphate ester hydraulic fluid type IV A. Adhesion test as per ISO 2409	2 screws
6.6	**Resistance to stripper agents and to solvents**	The coating shall no show evidence of blistering or loss of adhesion. Class 0	Immersion of the coated test pieces: 24 h at room temperature in three products: — benzylic alcohol and dimer acid; — diestone. Adhesion test as per ISO 2409	2 screws
6.7	**Embrittlement**	72 h at a tensile load of 80 % of minimum specified UTS, fasteners shall withstand the imposed loading conditions without any breaking or craking.	NASM 1312-5	4 screws per material type identified as sensitive
6.8	**Galvanic corrosion**	The countersinks and the surface area of the aluminium blocks around the coated fasteners shall show, by visual observations, no more corrosion than the corresponding areas with the cadmium plated fastener control blocks. General surface corrosion on the back of the panels shall not be considered in evaluating the protective qualities of the coating.	Place coated countersunk head titanium bolts in a 7075 T6 aluminium alloy block defined in Annex A. The assembled block shall be exposed for 336 h in neutral salt spray (NSS) ISO 9227.	3 screws

continued

Table 1 *(continued)*

Section	Characteristic	Requirement	Inspection and test method	Sampling for qualification
6.9	**Paint Adhesion**	Class 0 at initial stage Class 3 after water immersion	Place coated countersunk head bolts in a 7075 T6 aluminium alloy block defined in Annex A: — Specimen manufacture: — plate shall be anodised and coated with aircraft primer paint prior to drilling and countersinking; — fastener installation; — appropriate solvent cleaning + scouring pad + tack rag + chromate free external paint scheme. — Tests preparation: — Cross cut according to ISO 2409. — Adhesion tests: — on initial stage; — after water immersion 336 h at room temperature (Distilled or deionised water with 5,5 < Ph < 6,5) and resitivity R > 1 MΩ.cm).	6 screws
6.10	**Electrical conductivity and lightning**	The ohmic resistance shall be below 10 mΩ. No overheating above 50 °C shall be detected. No sparking shall occurrs during lightning test. The lightning test is not mandatory.	Tests to be performed on 4,8 mm bolt diameter with interference of (40 ± 10) µm. The coating to qualify shall be applied to the element on which it is applicable (bolt, nut, lockbolt, collar, …). In case the coating shall be qualified on bolt, the nut to be used shall be cadmium plated steel. In case the coating shall be qualified on lockbolt, the collar to be used shall be Chemical Conversion Coating on aluminium. In case the coating shall be qualified on nut, the bolt to be used shall be Resin Based Aluminium on titanium. Ohmic resistance to be measured between points A and B (see specimen in Annex B) under a current of 10 A. Swept lightning current and lightning current transfer in accordance with Annex C.	48 per generic part

continued

Table 1 *(continued)*

Section	Characteristic	Requirement	Inspection and test method	Sampling for qualification
6.11	**Interference fit**	This test is only applicable to the following generic parts: — screws; — lockbolts. Types I and II: The average of the 5 installations shall have an installation force of 34 000 N or less, without a single installation force higher than 37 000 N. Types III and IV: The average of the 5 installations shall have an installation force of 11 000N or less, without a single installation force higher than 13 000 N. For all coating types, insertion load versus travel F = f (Δl) curves shall be recorded and shall not present any discontinuities except at the interface. The removal load shall not exceed more than 25 % of the highest value measured during installation.	Cetyl alcohol additional lubrication per EN 6117. Types I and II: — Five samples of 12,7 mm (1/2") diameter fasteners shall be coated per the requirements of this specification. — Samples shall be installed in two 7075 T6 plates 25,4 mm thick each (both plates must be positioned and then assembled prior to holes drilling and chamfering). Hole surface texture $R_a \leq 0{,}8$ µm. — Interference fit shall be (145 ± 10) µm. The edges of the holes shall be chamfered to a diameter up to 1,40 mm larger than the hole. A radius up to 0,9 mm shall be applied to the chamfer edges. Type III and IV: — Five samples of 6,35 mm (1/4") diameter fasteners shall be coated per the requirements of this specification. — Samples shall be installed in two 7075 T6 plates 12,7 mm thick each (both plates must be positioned and then assembled prior to holes drilling and chamfering). Hole surface texture $R_a \leq 0{,}8$ µm. — Interference fit shall be (50 ± 10) µm. The edges of the holes shall be chamfered to a diameter up to 1,20 mm larger than the hole. A radius up to 0,7 mm shall be applied to the chamfer edges.	5 screws or lockbolts

continued

Table 1 *(continued)*

Section	Characteristic	Requirement	Inspection and test method	Sampling for qualification
6.12	**Labelling**	Product must be identified with a label upon which is legibly recorded: — product designation; — production lot number; — manufacturing date; — shelf-life; — manufacturer's name and address; — certificate of conformity.	Visual examination	Non applicable
6.13	**Delivery**	Product delivery must precede by at least one year the shelf-life. Product must be accompanied by Material Safety Data Sheet in compliance with country specific regulation.	Visual examination	Non applicable

Annex A
(normative)

Test coupons for paint adhesion test

Test coupons as shown in Figure A.1, shall be machined from 7075-T6 aluminium alloy.

The block shall be anodized per MIL-A-8625, Type I, unsealed for painted specimen, class 1 (sealed, non-dyed) for unpainted specimen, prior to drilling and countersinking the fastener hole.

The specimens shall be assembled with the appropiate collar (or nut) and fastener system.

Hole size shall be such as to allow 50 µm to 100 µm clearance between the hole diameter and the fastener shank diameter.

After installation of fasteners and collars, the test coupon shall be cleaned with methyl-ethyl-ketone to remove all grease and fingerprints, rinsed in tap water and air-dried.

D is the diameter of the hole.

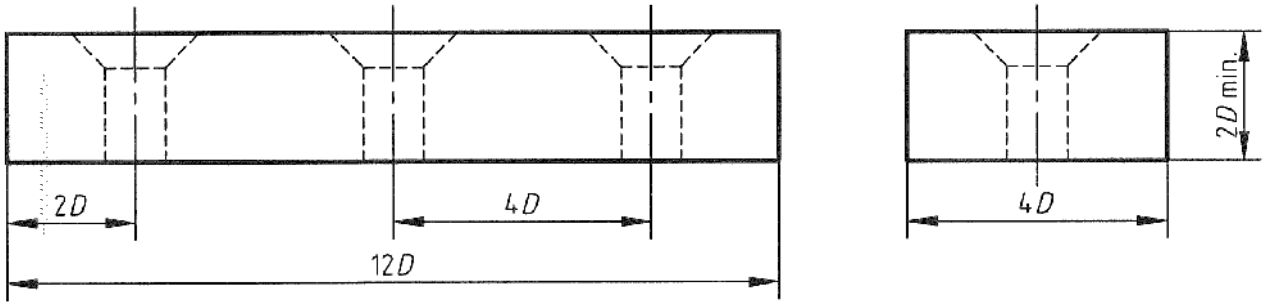
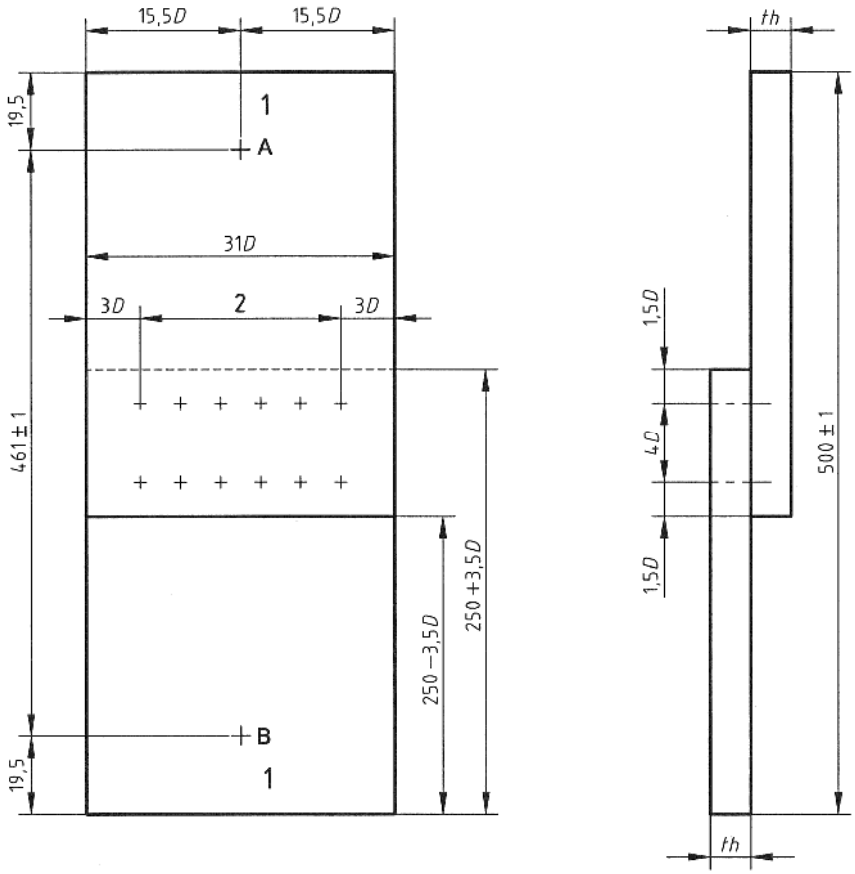


Figure A.1

Annex B
(normative)

Test specimen for ohmic resistance measurement

See Figure B.1.



Key

1 Marking area

2 5 divisions – 5 D pitch

Figure B.1

— Units are in mm,
— D is the diameter of the hole,
— Number of fasteners of the same type as the structure fasteners: 12,
— Material: 2024T3,
— Protection: Anodic coating per MIL-A-8625 Type I unsealed + primer paint + external paint scheme (except bores). Finish touch-up on bolt head and nut after assembly,
— Installation on cured sealant interfay,
— A and B: measurements points,
— General tolerances: ± 0,2 mm (except holes),
— Plates roughness before painting: R_a = 1,6 µm,
— Plate thickness th is included between 1,5 mm and 3 mm.

Annex C
(normative)

Lightning current simulation and swept lightning

C.1 Lightning current simulation

On the test specimens submitted to ohmic resistance measurements, and for those R < 10 mΩ (see test specimens distribution table), the following simulations are made:

— Swept lightning current,

— Lightning current transfer.

C.2 Test specimens distribution

See Table C.1.

Table C.1 — Test specimen distribution table

Specimen	**Ohmic resistance measurement** R (mΩ)	**Lightning simulation if** R < 10 mΩ		**Spare test specimens**
		Swept lightning	Lightning current transfer	
1	X	Type A	—	—
2	X	Type B	—	—
3	X	—	X	—
4	—	—	—	X

C.3 Swept lightning (on countersunk head fastener)

C.3.1 Current waveforms

D + B + C

— D = impulse component: peak value → 100 kA ± 10 %, action integral → $\int_0^t I^2.dt = 0{,}25.10^6\ A^2$

— B = component of 2 kA ± 10 % mean value and Q = 10 C ± 20 % max. load

— C = continuous component of load Q limited to 20 C ± 20 % (min. I = 400 A ± 10 %, min. Δt = 50 ms)

C.3.2 Test method

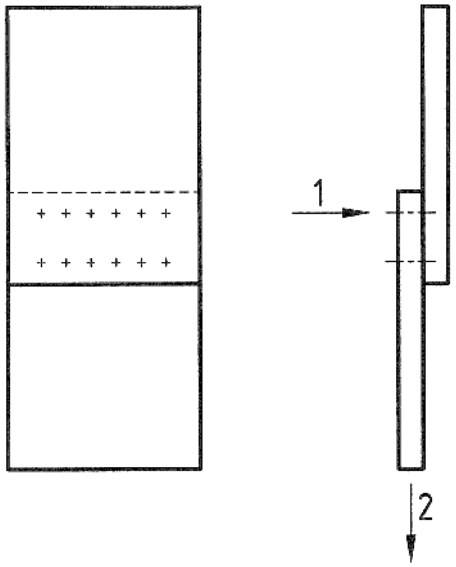
The simulation test of swept lightning condition is performed in stationary arc mode according to the following method:

— Installation of the test specimen on a test bench including a cylindrical electrode with a 10 mm diameter and a spherical end. This spherical end must be placed at a distance of 50 mm from each impact point (each fastener head);

— Arc ignition (precursor phase) with a carbon fibre of 150 µm diameter, connected to the electrode and placed at approximately 2 mm from the impact point considered (each fastener head).

C.3.3 Specimens

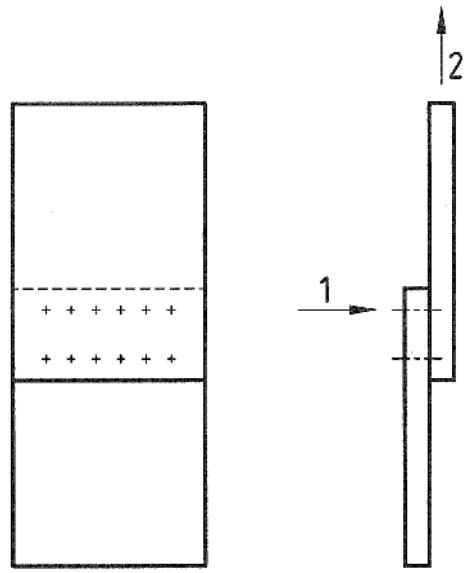
See Figures C.1 and C.2.



Key

1 Input (electrode)
2 Output (current return)

Figure C.1 — Type A specimen



Key

1 Input (electrode)
2 Output (current return)

Figure C.2 — Type B specimen

C.4 Lightning current transfer condition (on protruding head fastener)

C.4.1 Current waveforms

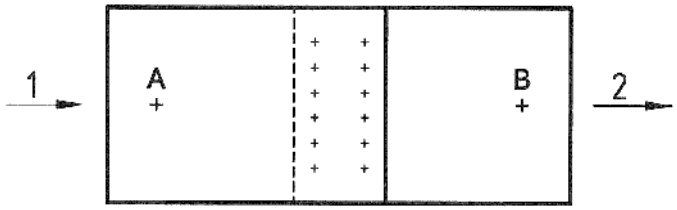
A + C

— A = impulse component: peak value → 50 kA ± 10 %, action integral → $\int_0^t I^2.dt = 0{,}25.10^6 A^2.s$

— C = continuous component of electrical load Q = 50 C ± 20 % (min. I = 100 A ± 10 %)

C.4.2 Test method

The current transfer is made by direct connection, respectively on each test specimen end of the active electrode and of the return circuit. See Figure C.3.



Key

1 Input (electrode)
2 Output (current return)

Figure C.3

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