Specifications for the QUALANOD Quality Label for Sulfuric Acid-Based Anodizing of Aluminium

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1 Introduction

Qualanod is a quality label organisation founded in 1974 by several national associations encompassing architectural anodizers in the European Anodizers Association (EURAS), and in conjunction with the European Wrought Aluminium Association (EWAA). EWAA was absorbed into the European Aluminium Association (EAA; now European Aluminium, EA) in 1982 while EURAS was succeeded by European Surface Treatment on Aluminium (ESTAL) in 1994. In 2004, the scope of Qualanod was extended to include sulfuric acid anodizing of aluminium for other applications.

Qualanod is committed to maintaining and promoting the quality of anodized aluminium.

These Specifications cover requirements strictly to be followed by licensees and prospective licensees, and recommendations for licensees. They also provide relevant information for licensees of actions by general licence holders, testing institutes, inspectors and Qualanod. General licence holders are permitted by Qualanod to license anodizing plants to use the Qualanod quality label. The general licence holders also regulate the testing institutes.

These Specifications conform to ISO 7599, a method of specifying for decorative and protective anodizing including architectural anodizing, except where otherwise stated, and also include requirements of ISO 10074, a specification for hard anodizing.

These Specifications are divided into clauses and have a series of appendices. Clauses cover general requirements that apply to any licensee and include the processes of licensing, inspections, the use of the quality label and requirements for product performance tests. Guidance and recommendations on products and processes are also covered in these Specifications.

Each appendix defines a specific type of anodizing (see also clause 5) and gives the associated requirements to conform to these Specifications. The appendices are:

- architectural anodizing
- industrial anodizing
- decorative anodizing
- hard anodizing

In order to find out how to comply with the requirements of these Specifications, a licensee should refer to the relevant appendices depending on the licensable products set out in its licence.

In addition to these Specifications a document called “General Regulations” has further information related to the topics below:

- Ⅰ - Procedure for carrying out inspections of sub-licensees’ plants
- Ⅱ - Procedure for applications from prospective sub-licensees
- Ⅲ - Procedure to renew a sub-licence
- Ⅳ - Procedure for the withdrawal of a sub-licence
- Ⅴ - Procedure for the approval of new processes
- Ⅵ - Procedure to assess the results of an inspection
- Ⅶ - Procedure for Remote inspection
- Ⅷ - Procedure for the discretionary assessment of the capability of processes for industrial, decorative, or hard anodizing

2 Scope

These Specifications specify requirements for sulfuric acid anodizing and products produced by sulfuric acid anodizing.

Sulfuric acid anodizing is defined in ISO 7583 as anodizing in an electrolyte based on sulfuric acid.

These Specifications are not applicable to:

- anodizing in the production of lithographic plates;
- anodizing used as a pretreatment before the application of a powder coating, a paint, an inorganic coating or an adhesive;
- anodizing in the production of a combined coating.

3 Language

The official version of these Specifications is the English language version.

In the English language version, certain verbal forms have particular meanings which correspond to the requirements of the ISO/IEC Directives, Part 2, Annex H.

The following verbal forms indicate requirements strictly to be followed in order to comply with these Specifications and from which no deviation is permitted.

shall
shall not

The following verbal forms indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

should
should not

The following verbal forms indicate a course of action permissible within the limits of these Specifications.

may
need not

The following verbal forms are used for statements of possibility and capability, whether material, physical or causal.

can
cannot

4 References

The following referenced documents can be important for the application of these Specifications. 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 – Technical conditions for inspection and delivery*
EN 573-3	*Aluminium and aluminium alloys – Chemical composition and form of wrought products -- Chemical composition and form of products*
EN 586-1	*Aluminium and aluminium alloys – Forgings – Technical conditions for inspection and delivery*
EN 754-1	*Aluminium and aluminium alloys – Cold drawn rod/bar and tube – Technical conditions for inspection and delivery*
EN 755-1	*Aluminium and aluminium alloys – Extruded rod/bar, tube and profiles – Technical conditions for inspection and delivery*
EN 1090-1: 2009 + A1: 2011	*Execution of steel structures and aluminium structures Part 1: Requirements for conformity assessment of structural components*
EN 12020-1	*Aluminium and aluminium alloys – Extruded precision profiles in alloys EN AW-6060 and EN AW-6063 – Technical conditions for inspection and delivery*
EN 1999-1-1	*Eurocode 9 – Design of aluminium structures – General structural rules*
ISO 1463	*Metallic and oxide coatings – Measurement of coating thickness – Microscopical method*
ISO 2085	*Anodizing of aluminium and its alloys – Check for continuity of thin anodic oxidation coatings – Copper sulfate test*
ISO 2106	*Anodizing of aluminium and its alloys – Determination of mass per unit area (surface density) of anodic oxidation coatings – Gravimetric method*
ISO 2128	*Anodizing of aluminium and its alloys – Determination of thickness of anodic oxidation coatings – Non-destructive measurement by split-beam microscope*
ISO 2135	*Anodizing of aluminium and its alloys – Accelerated test of light fastness of coloured anodic oxidation coatings using artificial light*
ISO 2143	*Anodizing of aluminium and its alloys – Estimation of loss of absorptive power of anodic oxidation coatings after sealing – Dye-spot test with prior acid treatment*
ISO 2360	*Non-conductive coatings on non-magnetic electrically conductive basis materials – Measurement of coating thickness – Amplitude-sensitive eddy-current method*
ISO 2376	*Anodizing of aluminium and its alloys – Determination of electric breakdown potential*
ISO 2859-1	*Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed*
ISO 2931	*Anodizing of aluminium and its alloys – Assessment of quality of sealed anodic oxidation coatings by measurement of admittance*
ISO 3210	*Anodizing of aluminium and its alloys – Assessment of quality of sealed anodic oxidation coatings by measurement of the loss of mass after immersion in acid solution(s)"*
ISO 3211	*Anodizing of aluminium and its alloys – Assessment of resistance of anodic oxidation coatings to cracking by deformation*
ISO 4516	*Metallic and other inorganic coatings – Vickers and Knoop microhardness tests*

ISO 6362-1	*Wrought aluminium and aluminium alloys – Extruded rods/bars, tubes and profiles – Technical conditions for inspection and delivery*
ISO 6581	*Anodizing of aluminium and its alloys – Determination of the comparative fastness to ultraviolet light and heat of coloured anodic oxidation coatings*
ISO 6719	*Anodizing of aluminium and its alloys – Measurement of reflectance characteristics of aluminium surfaces using integrating-sphere instruments*
ISO 7583	*Anodizing of aluminium and its alloys – Terms and definitions*
ISO 7599:2010	*Anodizing of aluminium and its alloys – General specifications for anodic oxidation coatings on aluminium*
ISO 7668	*Anodizing of aluminium and its alloys – Measurement of specular reflectance and specular gloss of anodic oxidation coatings at angles of 20 degrees, 45 degrees, 60 degrees or 85 degrees*
ISO 8251	*Anodizing of aluminium and its alloys – Measurement of abrasion resistance of anodic oxidation coatings*
ISO 8993	*Anodizing of aluminium and its alloys – Rating system for the evaluation of pitting corrosion – Chart method*
ISO 8994	*Anodizing of aluminium and its alloys – Rating system for the evaluation of pitting corrosion – Grid method*
ISO 9227	*Corrosion tests in artificial atmospheres – Salt spray tests*
ISO 10074	*Anodizing of aluminium and its alloys – Specification for hard anodic oxidation coatings on aluminium and its alloys*
ISO 10215	*Anodizing of aluminium and its alloys – Visual determination of image clarity of anodic oxidation coatings – Chart scale method*
ISO 10216	*Anodizing of aluminium and its alloys – Instrumental determination of image clarity of anodic oxidation coatings – Instrumental method*
ISO 11664-4	*Colorimetry – Part 4: CIE 1976 L*a*b* Colour space*
ISO 18771	*Anodizing of aluminium and its alloys - Method to test the surface abrasion resistance using glass-coated abrasive paper*
ISO/IEC 17025	*General requirements for the competence of testing and calibration laboratories*
ISO/IEC 17065	*Conformity assessment – Requirements for bodies certifying products, processes and services*

5 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7583 and the following apply.

5.1 architectural anodizing

anodizing to produce an architectural finish to be used in permanent, exterior and static situations where both appearance and long life are important

5.2 decorative anodizing

anodizing to produce a decorative finish with a uniform or aesthetically pleasing appearance as the primary characteristic

5.3 general licence holder

general licensee
GL
organization that may grant Qualanod sub-licences to anodizing plants

Note: Such organizations include national associations and Qualanod.

5.4 hard anodizing
anodizing to produce a coating where high wear resistance or microhardness is its primary characteristic

5.5 industrial anodizing
anodizing to produce a functional finish where appearance is of secondary importance

5.6 licensable product
product type, as described in the Regulations, for which the sub-licensee may use the quality label

5.7 logo
design owned by the Association for Quality Control in the Anodizing Industry (Qualanod), Zurich

Note 1: There are five logos which are shown in these Specifications clause 7

5.8 lot
articles of the same alloy and temper which comprise a customer's order or the part of it that is in the plant

5.9 lot acceptance test
test on a production lot to determine its conformance to the requirements of these Specifications

5.10 Qualanod
Association for Quality Control in the Anodizing Industry, Zurich

5.11 quality label
label
Qualanod’s certification scheme including its logos

5.12 Regulations
regulations for the use of the Qualanod quality label for sulfuric acid anodizing of aluminium

5.13 Specifications
specifications for the quality label for sulfuric acid anodizing of aluminium issued from time to time by Qualanod.

5.14 sub-licence
licence
statement issued by or in the name of QUANALOD authorizing the use of the quality label according to the current Regulations

5.15 sub-licence holder
licence holder
holder
licensee
anodizing plant authorized to use the quality label

5.16 testing institute
testing laboratory
organization that is accredited under ISO/IEC 17025 for the tests stipulated by QUALANOD and mandated by a general licensee to be responsible for inspecting the anodizing plants of licensees

Note: Inspectors are nominated by testing institutes or by general licensees accredited to ISO/IEC 17065

6 Licensing anodizers

6.1 General

This clause gives general information on the roles of the inspector, the testing institute, the general licensee and Qualanod. It includes actions required of the licensee or prospective licensee.

General licensees operate under the supervision of Qualanod which may take on more or less responsibility depending on the resources of the general licensee.

6.1.1 Plant personnel

It is important that solution analyses and/or tests on finished products are carried out correctly. Consequently, plant personnel including employees of the licensee and sub-contractors who have responsibility for any analysis or test should have received proper training.

6.1.2 Licensable products

A Qualanod licence specifies the licensable products for which the anodizing plant may use the label. Those products are identified by reference to the appendices of these Specifications. The appendices are:

- architectural anodizing
- industrial anodizing
- decorative anodizing
- hard anodizing

The Qualanod secretariat issues licence certificates which identify the licensable products.

6.1.3 Inspections

In order to renew or be granted a Qualanod licence, an anodizing plant is inspected to determine conformity to these Specifications. At an inspection visit, the inspector undertakes inspections for each licensable product for which the anodizing plant wants to use the label. Note that the inspection visit can be fully satisfactory or fully unsatisfactory, or partially satisfactory if it is satisfactory for some of those licensable products but not for others.

An inspection identifies nonconformities and issues. The nonconformities for each anodizing type are listed in the appendices of these Specifications.

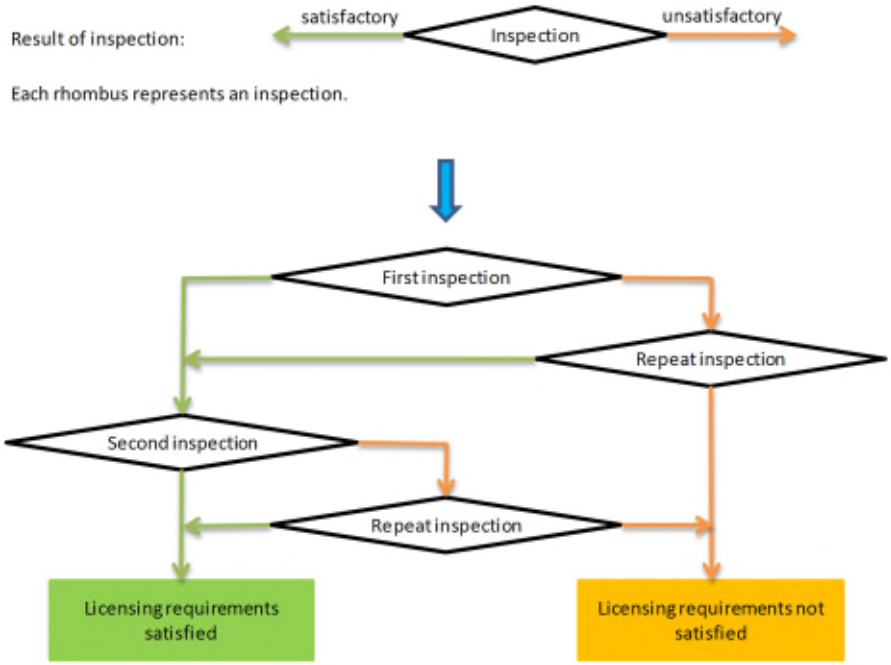
A nonconformity is a failure to comply with a requirement of these Specifications. If one or more are found at a first or second inspection for a licensable product, then a repeat inspection is carried out (see diagram A). If one or more are found at a repeat inspection for a licensable product, then the licensing requirements are not satisfied and the licence for that product is not granted or renewed. Note that the title of diagram A is “Inspection procedure for each licensable product”. Thus, it does not apply to the whole of an inspection visit which might comprise inspections for more than one licensable product.

An issue is a failure to comply with a requirement that is not included in a list of nonconformities. If one or more issues are found at an inspection, then these are recorded on the inspection report form and reviewed at the next inspection. If one or more have not been remedied by the time of the next inspection, and the licensee has not provided a

satisfactory written explanation to the general licensee, then the issue may be treated as a nonconformity.

All information concerning inspection results and their assessment is confidential.

Diagram A. Inspection procedure for each licensable product



6.1.4 Appeals

If the general licensee decides that an inspection of an anodizing plant is not fully satisfactory, the plant is entitled to appeal to the general licensee. The plant shall submit its appeal within ten days of receiving the notification of the decision from the general licensee. If the plant is not satisfied with the result of the appeal, it may appeal to Qualanod. Qualanod's decision is final.

6.2 Granting a licence

6.2.1 Application

If an anodizing plant not holding a Qualanod licence wants to apply for a Qualanod licence, it shall make a written application to a general licensee.

The general licensee is normally the appropriate national association but may be another organization with the authority to grant a licence. The general licensee designates the testing institute responsible for inspections or, if the general licensee is accredited to ISO/IEC 17065, it may nominate the inspector itself.

The anodizing plant and the general licensee agree the licensable products for which the anodizing plant seeks to use the label.

If an anodizing plant already holding a Qualanod licence wants to use the label for one or more additional licensable products, it shall make a written application to a general licensee. It then undergoes the procedure described below for granting a licence.

6.2.2 Inspections

Inspections of anodizing plants are carried out according to the scheme shown in diagram A. No more than four inspections for each licensable product are permitted before the decision on licensing is made. If an anodizing plant seeks a licence for more than one licensable product, then an inspection visit can include all of those licensable products. ***It is not necessary for each licensable product to be dealt with at a separate visit to the plant.***

The date of the first inspection visit is agreed to ensure that the responsible persons of the anodizing plant are present in the plant. Subsequent inspection visits are carried out unannounced unless other arrangements are approved by Qualanod.

The inspector records the results of each inspection visit on the inspection report form provided by Qualanod. At the end of the inspection visit, the inspector's conclusions are signed off by both the inspector and the anodizing plant which may add comments. Subsequently, the inspection report is submitted to the general licensee.

6.2.3 Assessment of the results of inspections

The general licensee assesses the results in the inspection report and decides whether the results are satisfactory. It can consult Qualanod for guidance in reaching its decision. Following its decision, the general licensee sends to the anodizing plant:

1. a copy of the inspection report;
2. notification of the decision;
3. if the results of the inspection visit are not deemed fully satisfactory, a full explanation for the conclusion.

After an unsatisfactory or partially satisfactory inspection visit, another inspection visit can be made only when the anodizing plant has given notification to the general licensee that it has rectified the nonconformities recorded. The general licensee informs the testing institute of the receipt of the notification or, if the general licensee is accredited to ISO/IEC 17065, it informs the inspector.

After an unsatisfactory or partially satisfactory inspection visit, the anodizing plant may withdraw its application for a licence for one or more licensable products. In such circumstances, it shall notify the general licensee by written communication. The general licensee informs the testing institute or, if the general licensee is accredited to ISO/IEC 17065, it informs the inspector.

6.2.4 Licensing

A general licensee can grant a licence to an anodizing plant if at least two inspections are satisfactory for each licensable product for which the plant seeks to use the label. If a licence is granted, the general licensee and the anodizing plant sign the contract provided by Qualanod.

If a licence cannot be granted, the anodizing plant shall not make a new application for a licence until at least six months have elapsed. If a licence cannot be granted for a licensable product, the anodizing plant shall not make a new application for a licence for that licensable product until at least six months have elapsed.

6.3 Renewing a licence

6.3.1 Application

The general licensee initiates the renewal process.

If an anodizing plant does not want its licence renewed for one of more licensable products, it shall inform the general licensee by written communication.

6.3.2 Routine inspections

Inspections of anodizing plants are carried out according to the scheme shown in diagram A. No more than four inspections for each licensable product are permitted per calendar year (1st January to 31st December) before the decision on licensing is made. If an anodizing plant seeks to renew its licence for more than one licensable product, then an inspection visit can include all of those licensable products. ***It is not necessary for each licensable product to be dealt with at a separate visit to the plant.***

The inspections are carried out unannounced unless other arrangements are approved by Qualanod.

The inspector records the results of each inspection visit on the inspection report form provided by Qualanod. At the end of the inspection visit, the inspector's conclusions are signed off by both the inspector and the anodizing plant which may add comments. Subsequently, the inspection report is submitted to the general licensee.

6.3.3 Assessment of the results of inspections

The general licensee assesses the results in the inspection report and decides whether the results are satisfactory. It can consult Qualanod for guidance in reaching its decision. Following its decision, the general licensee sends to the anodizing plant:

1. a copy of the inspection report;
2. notification of the decision;
3. if the results of the inspection visit are not deemed fully satisfactory, a full explanation for the conclusion.

After an unsatisfactory or partially satisfactory routine inspection visit, a repeat inspection visit is carried out within two months of the anodizing plant receiving from the general licensee notification that the inspection was not fully satisfactory.

After an unsatisfactory or partially unsatisfactory inspection visit, the anodizing plant may decide that it does not want its licence renewed for one or more licensable products. In such circumstances, it shall notify the general licensee by written communication. The general licensee informs the testing institute or, if the general licensee is accredited to ISO/IEC 17065, it informs the inspector.

6.3.4 Licensing

A general licensee can renew a sub-licence of an anodizing plant if at least two inspections per calendar year are satisfactory for each licensable product for which the plant seeks to use the label. In other circumstances the executive committee of Qualanod or the general licensee, if it is accredited to ISO/IEC 17065, decides. Note that the validity of a licence for a given year is based on the inspection results from the previous year.

If a licence cannot be renewed, the anodizing plant shall not make a new application for a licence until at least six months have elapsed. If a licence cannot be renewed for a licensable product, the anodizing plant shall not make a new application for a licence for that licensable product until at least six months have elapsed.

6.4 Withdrawal of a licence

The general licensee withdraws the licence if the holder no longer complies with the Regulations and, in particular, in the event of any unauthorized or incorrect use of the quality label.

If, as described above, the licence of an anodizing plant cannot be renewed, the general licensee can withdraw the licence.

In the case of unforeseen circumstances and, if appropriate, after consultation with the responsible testing institute, inspections can be suspended for a maximum period of 12 months from the moment when the general licensee is informed that circumstances have prevented an inspection from being carried out. After this period, the licence is withdrawn.

If the general licensee withdraws the licence from an anodizing plant, it notifies the plant immediately in writing. The withdrawal has effect from the date of receipt of the notification.

If a licence is withdrawn or if the licensee ceases to trade, all tags, labels, bands, stencils, stamps, sleeves, containers, price lists, business notices, business cards and any other objects in or on which the quality label is shown shall be either given to the general licensee or, on the instructions of the latter, kept at the disposal of the general licensee until application for a new licence is made by the legal representatives or successors in business of the previous licence holder. The previous licence is deemed withdrawn until issue of the new licence. However, the legal representatives or successors in business of the previous licence holder are entitled to continue to use the quality label for three months pending the grant of a new licence unless the general licensee issues instructions to the contrary.

If a licence is withdrawn, the anodizing plant shall not make a new application for a licence until at least six months have elapsed.

All licence holders shall respect relevant national laws in the conduct of their operations. If a licence holder is proven not do so, Qualanod can withdraw the licence (to protect Qualanod's image and/or for fair trade principles).

6.5 Change to the licensable products of a licence

If, as described above, the licence of an anodizing plant cannot be renewed for certain licensable products, the general licensee can change the licensable products of the licence.

If the general licensee changes the licensable products of a licence, it notifies the plant immediately in writing. The change has effect from the date of receipt of the notification.

If the licensable products of a licence are changed, the licensee shall not use the quality label in conjunction with any products that are no longer covered by the licence.

7 Regulations for the use of the quality label

7.1 Ownership of the quality label

The logos included in the quality label are owned by Qualanod and shall not be adopted by anyone unless authorized to do so. Anodizing plants can be authorized to use the quality label by a licence granted according to these Regulations.

Qualanod grants a general licence for the quality label to a general licensee with powers to authorize use of the label to individual anodizing plants according to the present Regulations.

7.2 Register of licence holders

Qualanod keeps a register which (in addition to other details which can be resolved now or later) shows name, address and trade description of each licence holder, the date on which the licence was granted to the licence holder, the number assigned to each licence holder, the date of withdrawal of the licence and any other details which Qualanod deems necessary.

The licence holder shall notify the general licensee without delay of any changes in name or address. The latter passes the information to Qualanod for the amendment of the appropriate entry in the register.

7.3 Qualifications of applicant

Authorization to use the quality label is granted on condition that the applicant conducts, or intends to conduct an anodizing business which actually supplies products covered by its licence.

7.4 Products covered by the licence

The quality label shall be used only for sulfuric acid anodizing of aluminium which conforms to these Specifications.

Grant of a licence entitles the licence holder to use the quality label only for the licensable products set out in its licence. The licence specifies those products by reference to the appendices of these Specifications. The licence is not transferable. The appendices are:

- architectural anodizing
- industrial anodizing
- decorative anodizing
- hard anodizing

A licensee shall not sub-contract the whole or a part of a customer's order for licensable products set out in its licence to another plant unless it is also a licensee authorized to produce such products.

7.5 Use of the quality label by licence holders

There are four variants of the logo (Figures 1a to 1d), which may be used with their respective anodizing types and associated products as described in the appendices of these Specifications. There is also a generic variant (Figure 1f) which is used by the Qualanod secretariat and general licensees. The logos shall be used either in black and white (Figure 1e) or in blue and white. They may be used, as appropriate, on the goods themselves, on business stationery, quotations or invoices, price lists, cards, display cards and on all company literature, brochures, catalogues and in newspaper advertisements. The words "Quality Label for Anodizing of Aluminium" (or some other text conforming to national legislation) may be added in the space to the right (Figure 1g).

A logo, 25 x 25 mm, may be stamped or printed directly onto adhesive tape or stickers (Figure 1h) in the above-mentioned colours.

The holder shall not make any alteration or addition to a logo when using it. In the event of the separate use of the holder's own brand or trade marks on, or in connection with his products, these requirements shall not be contravened.

By the use of the logo on a product, the licensee guarantees that the quality supplied conforms to the quality offered or, as appropriate, the quality ordered.

If a company owns more than one anodizing plant and each holds a licence, then each shall use the logos appropriate for its licensed products. This restriction does not apply where each of the anodizing plants is licensed for the same products.

The holder shall, at all times, give the general licensee any information required with respect to his use of the quality label.

Figure 1. The use of the quality label

a) Label for architectural anodizing

b) Label for industrial anodizing

c) Label for decorative anodizing

d) Label for hard anodizing

f) Generic label

e) Example of a label in black and white

QUALITY LABEL FOR ANODIZING OF ALUMINIUM

PEARY LTD
OPEX STREET
ANNATOWN
RESPUBLICIA

g) Example of the use of a label with additional text as can be required

h) Example where the inner motif of a label is stamped or printed directly onto adhesive tape or stickers

7.6 Communications

Any communication from the holder required to be made under these Regulations shall be effective if made by a correctly stamped and addressed letter or email. Cancellation of licences is disseminated by registered mail.

8 Inspections

8.1 General

The aim of an inspection is to verify that the licensee is in compliance with the requirements of these Specifications for the products set out in its licence. The requirements depend on the type of anodizing and are described in the appendices of these Specifications.

Another aim of an inspection is to verify that the licensee does not associate the quality label with unlicensed products.

Each inspection is the responsibility of the testing institute designated by the general licensee or of the general licensee if it is accredited to ISO/IEC 17065. The testing institute or the accredited general licensee nominates a suitably qualified individual who has been approved by Qualanod, referred to as the inspector, to carry out the inspection.

8.2 Scope of the inspections

The inspector determines from the anodizing plant's licence what products it is licensed to produce. The relevant appendix or appendices of these Specifications informs the inspector of the product tests to be performed during the inspection. The appendices are:

- architectural anodizing
- industrial anodizing
- decorative anodizing
- hard anodizing

8.3 Inspection of products

8.3.1 General

The inspector can remove samples from anodizing plant for tests to be carried out at a testing institute.

The inspector verifies that the licensee complies with the requirements of the standards specifying the tests that it carries out.

8.3.2 Use of the quality label

The inspector verifies that the use of the quality label complies with the requirements of clause 7.

8.3.3 Agreements with customers

The inspector verifies that agreements with customers conform to the requirements set out in the subclauses "Agreements with customers" in the appendices.

8.3.4 Laboratory

The inspector verifies that the laboratory and testing apparatus conform to the requirements set out in the subclauses "Laboratory and testing apparatus" in the appendices.

8.3.5 Test pieces

The inspector carries out tests on finished products which the anodizing plant has inspected and passed as satisfactory or on parts which have been packed and/or are ready for dispatch. A welded frame is considered to be one test piece. Each part of a frame that has been mechanically screwed together comprises one test piece. Constructions joined together by heat-insulating, nonconductive material are taken to comprise separate test pieces.

The anodizing plant shall indicate to the inspector which goods have passed the internal quality control and by which type of anodizing they were produced.

If it is not possible to take and test specimens from the production lot because of the shape, size or form of the product, the inspector can carry out the tests on panels preferably made of the same alloy as the production lot and treated simultaneously with it.

The inspector does not carry out tests on finished products that are not covered by the anodizing plant's licence. Such parts shall be clearly identified. The inspector can seek verification of the type of anodizing by, for example, examining the written agreement between the anodizing plant and its customer.

8.3.6 Thickness measurement

The anodic oxidation coating thickness is specified as either a thickness class or as a nominal thickness depending on the type of anodizing. The inspector ascertains the thickness class or nominal thickness required by the customer by reference to the subclauses "Agreements with customers" in the appendices. He measures the coating thickness of finished products using the method of ISO 2360. He follows the procedures of ISO 7599 including its annex C except that all measured and calculated thicknesses are quoted in micrometres to one decimal place.

It is important that sufficient material is available for the tests. In order to avoid an unproductive inspection visit, it is advisable that the plant notifies the appropriate body if it is concerned that sufficient material might not be available during certain periods.

The inspector checks all sheet and strip pieces with a significant surface greater than 2 m². Where a thickness class is specified, no piece shall have an average thickness or local thickness less than the minima required for the thickness class. Where a nominal thickness of up to 50 µm is specified, no piece shall have an average thickness outside ± 20% of the nominal thickness. Where a nominal thickness over 50 µm is specified, no piece shall have an average thickness outside ± 10 µm of the nominal thickness.

For other parts, the inspector applies statistical control on samples taken according to Table 1. He checks at least 30 parts for each type of anodizing. Where a thickness class is specified, Table 1 gives the maximum number of samples which may each have an average thickness less than the minimum required for the thickness class. Where a thickness class is specified, no measured sample shall have a local thickness less than 80% of the minimum required for the thickness class. Where a nominal thickness of up to 50 µm is specified, Table 1 gives the maximum number of samples which may each have an average thickness outside ± 20% of the nominal thickness. Where a nominal thickness over 50 µm is specified, Table 1 gives the maximum number of samples which may each have an average thickness outside ± 10 µm of the nominal thickness.

Table 1. Requirements for sampling different lot sizes

Lot size	Number of randomly-selected samples	Acceptable number of sub-standard samples
1 to 10	all	0
11 to 200	10	1
201 to 300	15	1
301 to 500	20	2
501 to 800	30	3
801 to 1300	40	3
1301 to 3200	55	4
3201 to 8000	75	6
8001 to 22000	115	8
22001 to 110000	150	11

8.3.7 Mass loss test

The inspector carries out mass loss tests as described in the subclauses “Product tests carried out during an inspection” in the appendices.

One mass loss test is carried out for each anodizing line and/or sealing process. Examples of sealing processes are hot water, steam, two-step cold sealing based on a nickel fluoride solution, and medium-temperature sealing based on a nickel salt solution. Thus, if an anodizing plant has two anodizing lines with line 1 including hot-water sealing and line 2 including hot-water sealing and cold sealing, then the inspector carries out two mass loss tests as follows: one mass loss test on a sample from line 1 (hot-water sealing) and one on a cold-sealed sample from line 2.

Each sample for the mass loss test is selected from those selected for the thickness test. It is the sample with the highest dye spot or admittance value and preferably coloured - rather than clear-anodized aluminium.

The method of 9.3.1 or 9.3.2 is applied depending on which method was used by the anodizer for the lot from which the sample was taken.

If the test is performed at the testing institute, it is carried out not more than 2 weeks after sealing.

No sample shall give a mass loss greater than 30 mg/dm^2.

8.3.8 Dye spot and admittance tests

The inspector carries out the dye spot test or the admittance test as described in the subclauses “Product tests carried out during an inspection” in the appendices.

If a mass loss test is required, the inspector carries out ten dye spot or admittance tests, as applicable (see 9.3.3 and 9.3.4), on samples selected at random from those selected for the thickness tests but endeavouring to include material from all anodizing lines and sealing processes.

8.3.9 Surface abrasion resistance test

The inspector carries out the surface abrasion resistance test as described in the subclauses “Product tests carried out during an inspection” in the appendices.

The inspector applies the surface abrasion test to each lot selected for thickness measurement (see Table 1) where all the samples from the lot have an average thickness of 20 µm or greater. He performs the surface abrasion test on the sample with the highest thickness.

8.3.10 In-house control

The inspector verifies that the in-house control conforms to the requirements set out in the subclauses “Production control records” in the appendices, and includes the required product test data and process control data set out in subclauses “Product tests to be applied by the licensee” and “Methods for process control” respectively in the appendices.

8.3.11 Register of complaints

The inspector verifies that a register of complaints has been maintained and adequately describes how complaints have been investigated and actions completed.

8.4 Inspection of processes

The inspector verifies that the processes are carried out in compliance with the requirements set out in the subclauses “Processes” in the appendices. He also verifies by observation that bath analyses are performed correctly.

9 Test methods for products

9.1 General

Every acceptance test shall be carried out as specified in these Specifications. In cases of dispute, the appropriate referee test specified in these Specifications shall be used.

If no method is specified in these Specifications, the test shall be carried out as specified by the customer.

If a test is a lot acceptance test, then the customer shall specify the sampling procedures to be used or that no sampling from the lot is required. For information, see ISO 2859-1.

Unless it is specified as a required test in subclauses “Product tests to be applied by the licensee” in the appendices, any test for production control purposes shall be adopted at the discretion of the licensee.

9.2 Measurement of thickness

Coating thickness shall be measured using one or more of the methods identified in ISO 7599. The method specified in ISO 2360 (eddy current) is the usual method. In cases of dispute, the method specified in ISO 1463 or ISO 9220 (micro-section) shall be the referee method.

For parts of sufficient size, average or local thickness or both shall be determined from thickness measurements by following the procedures of ISO 7599. For small parts, the number of measuring areas may be reduced.

The measurements shall be made on the significant surfaces but not within 5 mm of contact marks or close to a sharp edge.

For coil anodizing, the coating thickness shall be measured at the beginning, in the middle and at the end of each strip.

If specified by the customer, the measurement of thickness shall be dealt with in a lot acceptance test.

9.3 Sealing tests

9.3.1 Mass loss test with predip

This test assesses the ability of the surface of an anodic oxidation coating to resist chemical attack by an acid.

This test shall be carried out as specified by ISO 3210 method 2 using test solution B, phosphoric acid, except that the solution shall not be used after more than 0,5 g of anodic oxidation coating and aluminium have been dissolved per litre of solution. Method 2 includes the prior acid treatment in a nitric acid solution.

There are a number of options to take test specimens. The licensee should adopt an option from the list below where 1) is the most preferred and 3) is the least preferred. Circumstances which might lead the licensee to adopt a less preferred option include those where: i) it is not possible to take specimens from the production lot because of the shape, size or form of the product; ii) multiple lots of different alloys are treated together; iii) the lot comprises only one piece.

1) Test specimens shall be taken from the production lot.

2) Test specimens shall be made of the same alloy as the production lot and treated simultaneously with it.

3) Test specimens may be made of a different alloy from the production lot but shall be treated simultaneously with it. The alloy shall contain at least 97% aluminium. If the licensee

frequently adopts this option, it should always use the same alloy so that it can develop a consistent record.

The practice adopted shall be recorded in the production control system.

The mass loss test shall be carried out not more than 2 weeks after sealing.

9.3.2 Mass loss test without predip

This test assesses the ability of the surface of an anodic oxidation coating to resist chemical attack by an acid.

This test shall be carried out as specified by ISO 3210 method 1 using test solution B, phosphoric acid, except that the solution shall not be used after more than 0,5 g of anodic oxidation coating and aluminium have been dissolved per litre of solution.

There are a number of options to take test specimens. The licensee should adopt an option from the list below where 1) is the most preferred and 3) is the least preferred. Circumstances which might lead the licensee to adopt a less preferred option include those where: i) it is not possible to take specimens from the production lot because of the shape, size or form of the product; ii) multiple lots of different alloys are treated together; iii) the lot comprises only one piece.

1) Test specimens shall be taken from the production lot.

2) Test specimens shall be made of the same alloy as the production lot and treated simultaneously with it.

3) Test specimens may be made of a different alloy from the production lot but shall be treated simultaneously with it. The alloy shall contain at least 97% aluminium. If the licensee frequently adopts this option, it should always use the same alloy so that it can develop a consistent record.

The practice adopted shall be recorded in the production control system.

The mass loss test shall be carried out not more than 2 weeks after sealing.

9.3.3 Dye spot test

This test provides an assessment of the absorptive power of the outer surface of anodic oxidation coatings, which is reduced by sealing.

The absorptive power shall be determined in accordance with ISO 2143.

The test is applicable only to clear and light-coloured anodized aluminium.

The chemical supplier's instructions to prepare the test solutions shall be followed. If the colorant solutions described in the standard ISO 2143 are stored properly, they will remain stable for up to two years. However, their pH values should be checked every 3 months. If the pH of a solution is outside the range prescribed by the chemical supplier, then it should be corrected following the chemical supplier's instructions.

9.3.4 Admittance test

This test measures the electrical admittance of the whole thickness of the anodic oxidation coating, which is reduced by sealing.

The admittance shall be determined in accordance with ISO 2931.

This test is not applicable to any of the following:

- cold sealed parts;
- alloys containing more than 2% of silicon, 1.5% of manganese or 3% of magnesium.

The acceptance limits for the admittance test that are applied to uncoloured finishes are not applicable to electrolytically coloured parts in medium bronze, dark bronze and black. Those are finishes with an L* value less than about 60 on the CIE 1976 L* a* b* scale.

9.4 Appearance

9.4.1 Visible defects

Certain defects are a consequence of the fabrication processes and include die lines, machining lines, welding artefacts, streaks, pick-up and hot spots. Other defects can arise inadvertently such as marks, scratches, indentations and corrosion. Others can be due to processing in the anodizing plant. These include residual salts in threaded holes causing discoloration and air-bubble entrapment preventing solution access to regions of the surface. The acceptability of any of these depends on the requirements of the customer.

The significant surface(s) of anodized parts shall be assessed by visual examination. Where the products are going to be used under natural lighting conditions, unless otherwise agreed, specimens or components shall be compared in diffuse daylight with the sun behind the viewer. If the products are to be used in artificial light, that lighting shall be used for the comparison, and a diffuse source of illumination shall be placed above and behind the viewer.

9.4.2 Surface texture and colour

The comparative assessment of appearance shall be carried out visually or by using an instrumental method.

For a comparative visual assessment, specimens or components shall be set in the same plane and viewed as near as is practicable perpendicular to the plane with the direction of working (eg the rolling, extrusion or machining direction) always the same.

Where the products are going to be used under natural lighting conditions, unless otherwise agreed, specimens or components shall be compared in diffuse daylight with the sun behind the viewer. If the products are to be used in artificial light, this lighting shall be used for the comparison, and a diffuse source of illumination shall be placed above and behind the viewer.

For surface texture, instrumental measurement shall be performed in accordance with the requirements of either ISO 6719 or 7668 following the guidance of ISO 7599. For colour, instrumental measurement shall conform to the requirements of ISO 11664-4.

9.4.3 Light reflection properties

The assessment of light reflection properties shall be carried out in compliance with ISO 7599 using instrumental methods specified in ISO 6719, 7668, 7759, 10215 and 10216 as agreed by the licensee and the customer.

9.5 Corrosion resistance

The corrosion resistance of anodized aluminium shall be determined by using one of the methods specified in ISO 9227. The duration of the acetic acid salt spray test (AASS) shall be 1000 h. Following the requirements of ISO 10074, the duration of the neutral salt spray test (NSS) shall be 336 h. The applicability of these tests is shown in table 2.

The test samples shall have dimensions not less than 150 mm x 70 mm x 1 mm.

These methods are not suitable for unsealed anodic oxidation coatings.

The corrosivity of the salt spray cabinet shall be checked following the method for evaluating cabinet corrosivity specified in ISO 9227. During permanent operation, the time interval between corrosivity checks shall not be more than three months. The test report shall include the date of the last corrosivity check.

9.6 Resistance to wear / abrasion

This includes methods that assess the resistance to wear of the surface of an anodic oxidation coating (surface abrasion resistance) and those that assess the resistance to wear of the whole thickness of an anodic oxidation coating (bulk wear resistance). Some of the methods assess resistance to abrasive wear and others the resistance to erosive wear.

9.6.1 Surface abrasion test

This test assesses the quality of the anodic oxidation coating.

The surface abrasion resistance of an anodic oxidation coating is evaluated by using a glass-coated abrasive paper to determine whether or not the coating is harder than the glass.

The surface abrasion resistance shall be determined by using method 1 of ISO 18771 and considering the following.

- The glass-coated abrasive paper should be held tightly in place around the block and, using light finger-pressure, kept flat against the anodized surface.
- If the anodic oxidation coating is harder than the glass, the abrasive paper slips easily across the surface and the coating is merely burnished. If the glass is harder than the coating, a definite resistance is felt as it bites into the coating.

9.6.2 Abrasive wheel

This test assesses the resistance of an anodic oxidation coating to abrasive wear.

This is the referee test to assess the surface abrasion resistance of an anodic oxidation coating.

The resistance to abrasive wear shall be determined by using the abrasive wheel wear test method described in ISO 8251 except that a PMMA standard specimen shall not be used.

9.6.3 Abrasive jet

This test assesses the resistance of an anodic oxidation coating to erosive wear.

The resistance to a jet of erosive material shall be determined by using the abrasive jet test method described in ISO 8251 except that a PMMA standard specimen shall not be used.

9.6.4 Falling sand

This test assesses the resistance of an anodic oxidation coating to erosive wear.

The resistance to erosion by falling sand shall be determined by using the falling sand abrasion method described in ISO 8251.

9.6.5 Taber abrader

This test assesses the resistance of an anodic oxidation coating to abrasive wear. The method used shall be that described in ISO 10074.

9.7 Microhardness

The microhardness of an anodic oxidation coating shall be determined by using the Vickers microhardness method of ISO 4516.

9.8 Resistance to cracking by deformation

The resistance to cracking by deformation of an anodic oxidation coating shall be determined by using the method specified in ISO 3211.

Assessing resistance to deformation can be relevant for rolled products that are deformed after anodizing.

9.9 Fastness to light and ultraviolet radiation

9.9.1 Light fastness

The light fastness of anodized aluminium shall be determined by using the method of ISO 2135.

This is an accelerated test method using artificial light. It is suitable as a production control test for coloured coatings, the lightfastness of which has been determined by outdoor exposure testing. It is not suitable for coloured coatings with a lightfastness number of less than 6.

9.9.2 Fastness to ultraviolet radiation and heat

The fastness of anodized aluminium to ultraviolet radiation and heat shall be determined by using the method of ISO 6581.

This is a comparative method. It is not suitable for testing coloured coatings that are heat-sensitive.

9.10 Electrical breakdown potential

The electrical breakdown potential of an anodic oxidation coating shall be determined by one of the methods specified in ISO 2376.

The methods are applicable to sealed coatings used primarily as electrical insulators. Note that breakdown potential is affected by relative humidity.

9.11 Coating continuity

The continuity of an anodic oxidation coating shall be determined by the method specified in ISO 2085.

The method is applicable to coatings that have been deformed such as those produced by coil anodizing. It is also applicable to coatings with a thickness less than 5 µm.

9.12 Surface density

The surface density of an anodic oxidation coating shall be determined by the method specified in ISO 2106.

The method is not suitable for coatings on aluminium alloys with a copper content greater than 6%. Note that if the thickness or apparent density of the coating is known, then the surface density can be used to calculate the value of the unknown property.

9.13 Thermal craze resistance

The resistance to heat-induced crazing of an anodic oxidation coating shall be determined as follows.

- Place a specimen of the material to be tested in an oven that has been preheated to 50 °C and is capable of maintaining a temperature which does not vary more than ±3 °C.
- After 30 minutes, visually check the specimen for crazing. If no crazing is present, increase the oven temperature by 5 °C.
- After the oven reaches temperature begin timing for 30 minutes and then recheck the specimen for crazing.
- If no crazing is present, continue to increase the temperature by 5 °C and recheck in 30 minute intervals until crazing is present.

9.14 Summary of product tests for the different types of anodizing

Table 2 provides an overview of the tests carried out by the sub-licensee and the tests of an inspection depending on the anodizing type. It includes references to the sub-clauses that describe the tests and to the appendices and sub-clauses that specify the tests to be carried out. The symbol X indicates a test carried out by the sub-licensee while the symbol o indicates a test carried out by the sub-licensee depending on the agreement with the customer. The sub-licensee may contract the performance of a test to another organization only if it is accredited to ISO 17025 for that test. Note that there are special rules for light fastness tests that specify circumstances where the sub-licensee does not have to carry out the tests. In all cases, certain conditions and particular requirements can apply; these are specified in the appropriate sub-clauses. Thus, it is essential that these are consulted rather than relying solely on Table 2. Shaded cells in Table 2 indicate the tests of an inspection. Note that inspections do not include tests for visible defects, and surface texture, colour and final dimensional tolerances because these can be readily checked by the customer.

Table 2. Product tests carried out by the sub-licensee and those of an inspection

Product test	Sub-clause	Type of anodizing			
		Architectural	**Industrial**	**Decorative**	**Hard**
		both appearance and protection are important	appearance is of secondary importance	decorative finish is the primary characteristic	high wear resistance
		12.7 & 12.11	13.7 & 13.11	14.7 & 14.11	15.7 & 15.11
Coating thickness	9.2	X	X	X	X
Dimensional tolerances			o		o
Mass loss (with predip)	9.3.1	X	X	X	
Mass loss (no predip)	9.3.2				
Dye spot	9.3.3	X	X	X	
Admittance	9.3.4				
Surface defects (no specified distance)	9.4.1		X		X
Surface defects at 5m & 3m	9.4.1	X			
Surface defects at 2m & 0.5m	9.4.1			X	
Texture & colour	9.4.2	X	o	X	
Light reflection	9.4.3	o		o	
Corrosion resistance (AASS)	9.5		o		
Corrosion resistance (NSS)	9.5				o
Surface abrasion resistance (glass-coated abrasive paper)	9.6.1	X			
Surface abrasion resistance (abrasive wheel)	9.6.2	X			
Wear resistance (abrasive wheel)	9.6.2		o	o	X
Wear resistance (abrasive jet)	9.6.3				
Wear resistance (falling sand)	9.6.4				
Wear resistance (Taber method)	9.6.5		o		X
Microhardness	9.7		o		o
Resistance to cracking by deformation	9.8	o	o	o	
Light fastness	9.9.1	X		o	
Resistance to ultraviolet radiation	9.9.2			o	
Electrical breakdown potential	9.10		o		o
Coating continuity	9.11	o	o	o	
Surface density	9.12		o		o
Thermal craze resistance	9.13			o	
Roughness			o		o
Service simulation tests			o	o	o

10 Approval of new processes

This concerns architectural anodizing which is different from the other types of anodizing as explained below.

It is important that new processes which are used in the production of anodized aluminium for external architectural applications are tested and approved by Qualanod. This is because the effects of weathering can be long term and are very variable and cannot be effectively simulated by standard laboratory tests.

If effective laboratory tests or simulations of service conditions can be applied, then the testing and approval of new processes for use in the production of anodized aluminium by industrial, decorative, and hard anodizing is not necessary. However, a supplier may request from Qualanod the testing of any novel process, within the scope of Qualanod, that the supplier wishes to offer to anodizers.

A new process requires testing and approval if it could affect the outdoor service performance of the anodized aluminium. This includes new processes for anodizing and sealing but can include other new processes applied after the anodizing step in an anodizing line.

Licensees that are licensed for products of clause 12, architectural anodizing, shall use only processes for anodizing and subsequent steps in an anodizing line that are well-established for use in architectural anodizing lines or have current approval from Qualanod. Failure to comply constitutes a nonconformity (see clauses 6 and 12). Guidance on some established processes is included in clause 11.

Before a licensee that is licensed for products of clause 12, architectural anodizing, may use a new process, it or the supplier of the process shall enquire of the Qualanod Secretariat whether the use of the process is well-established or has current approval. If neither is the case, then an application may be made to have it assessed for approval. The assessment procedure is specified in a separate document called General Regulations, that is available online and from the Qualanod secretariat. Note that the procedure is intended for processes for architectural anodizing as described in this clause and might not be applicable in other cases.

11 Guidance on products and processes

11.1 General

This clause provides guidance and recommendations. None of its content is mandatory for compliance with these Specifications.

11.2 The aluminium to be anodized

11.2.1 Architectural anodizing

The most commonly used alloys for anodizing for external architectural applications are AA 1000, 5000 and sometimes 3000 series for rolled products, and 6000 series for extruded products. Table 3 gives guidance on alloys suitable for anodizing and includes other alloys normally regarded as having a good anodizing response for decorative and protective applications. These materials do not have the same appearance after anodizing even sometimes for the same alloy. This is because the appearance after pretreatment and anodizing is strongly influenced by the alloy microstructure. Microstructure depends on both the metallurgical processes used and the alloy composition. Furthermore, specifications for alloy composition given in national and international standards are very broad; producers of alloys suitable for anodizing have their own proprietary specifications which are much narrower. As even slight differences in metallurgical microstructure can lead to significant differences in appearance, it is recommended that if possible, material from different lots should not be mixed for single projects.

For aluminium structures covered by Eurocode (EN 1999-1-1) only alloys which are listed in the Eurocode may be used. These alloys are indicated by an asterix in Table 3.

The customer should specify the alloy and attest that the semi-finished product conforms to the relevant standard for technical conditions of inspection and delivery, eg ISO 6362-1, EN 485-1, EN 586-1, EN 754-1, EN 755-1, EN 12020-1. Such standards specify composition in accordance with EN 573-3 and freedom from surface defects. Also, they recommend that semi-finished products intended to be anodized should be subject to an anodizability test by the producer before delivery, and that the frequency and the method of the test should be agreed between the producer and its customer. A suitable test is the treatment of a specimen of the product through an anodizing line to produce the finish agreed by the licensee and its customer; the specimen is subsequently assessed by visual examination.

Alloys other than those given in Table 3 can be used if required by the customer who should specify in writing the anodizing thickness class.

Table 3. Alloys suitable for architectural anodizing

Series (AA)	Alloying constituents	Metal properties	Alloys (AA)	Anodized metal properties
1xxx	None	Soft Conductive	1050A 1080A	Clear Bright
Finishing advice: care should be taken when racking this soft material; good for bright products; susceptible to etch staining.				
5xxx	Magnesium	Strong Ductile	5005* 5005A* 5050 5251 5657 5754*	Clear Good protection
Finishing advice: for 5005 and 5005A, keep Si < 0,1% and Mg between 0,7% and 0.9%; inspect for oxide streaks; 5005 and 5005A are used extensively in architectural applications.				
6xxx	Magnesium and silicon	Strong Ductile	6060* 6063* 6063A* 6463	Clear Good protection
Finishing advice: for a matt finish, keep Fe > 0,22%; for a bright finish, keep Fe < 0,15%; 6060 and 6063 can be the best match for 5005 and 5005A; 6463 can be the best for chemical brightening; variations in Fe content and other elements can influence the final appearance after anodizing.				

11.2.2 Industrial and hard anodizing

Table 4 gives guidance on the selection of alloys for industrial applications. Although hard anodizing can be applied to many alloys, those with more than 5% copper and/or 8% silicon and die casting alloys require special anodizing procedures. Alloys with low contents of alloying elements give the best microhardness and wear resistance and lowest surface roughness.

Table 4. Guidance on alloys for industrial and hard anodizing

Alloy (AA)	Corrosion protection	Wear resistance
1080, 1050A	Excellent	Excellent
1200	Very good	Excellent
2011, 2014A, 2017A, 2024, 2030, 2031	Mediocre	Good
3003, 3103, 3105	Good	Good
4043A	Good	Good
5005, 5050, 5052	Excellent	Excellent
5056A	Good	Excellent
5083	Good	Good
5154A, 5251, 5454, 5754	Very good	Excellent
6005A, 6061, 6463	Very good	Very good
6060, 6063	Excellent	Excellent
6082, 7020, 7022, 7075	Good	Good

Before anodizing, sharp edges should be machined to a radius of at least 10 times the intended coating thickness to avoid burning. Generally, articles should not be subjected to any

heat-treatment, machining, welding, forming and perforating operations after anodizing, although grinding is sometimes used to achieve dimensional tolerances.

11.2.3 Decorative anodizing

To produce particularly decorative effects or a particularly uniform appearance, alloys of anodizing quality should be used. These are produced by special manufacturing techniques. Thus, there is no national or international standard for anodizing quality because the term refers to particular production schedules devised by the manufacturers.

Higher purity aluminium or special alloys should be used to produce a high-lustre surface.

The general effects of alloying elements are as follows.

- Iron. Reduces specular brightness. High iron to silicon ratios lead to dark streaks.
- Silicon. Cloudiness when out of solid solution. Over 5 % silicon leads to dark grey or black coatings.
- Magnesium. Up to 3 % magnesium leads to colourless coatings.
- Copper. Increases specular brightness. Over 2 % copper leads to discoloration.
- Manganese. Up to 1 % manganese can lead to clear, silver, grey, brown or mottled coatings depending on the alloy microstructure.
- Zinc. Up to 5 % zinc can lead to colourless, brown or marbled coatings depending on the alloy microstructure.
- Chromium. 3 % chromium leads to yellow coatings.

Special alloys for integral colour anodizing and "self-colouring" alloys for the sulfuric or sulfuric-oxalic process can be used to produce certain colours.

11.3 Anodic oxidation coating thickness

11.3.1 Architectural anodizing

For anodized aluminium, the degree of protection against pitting corrosion of the aluminium increases with an increase in coating thickness. Thus, product life time is very dependent on the coating thickness. However, there is greater energy expenditure associated with thicker coatings. Thus, over-anodizing is not recommended. For external architectural applications, the choice of thickness class depends on the aggressive nature of the environment and can be determined by national standards.

The use of some dyestuffs necessitates the specification of class 20 or higher to obtain adequate dye absorption and light fastness.

11.3.2 Industrial and hard anodizing

Coatings are generally 15 µm to 150 µm thick. Products such as splines and threads can have coatings up to 25 µm thick. Insulator requirements are often satisfied by coatings of 15 µm to 80 µm thickness. Coatings of 150 µm thickness are used for repair purposes.

11.4 Appearance

11.4.1 Defects

Defects can include marks, scratches, indentations, corrosion, flatness, welding artefacts, streaks, pick-up and hot spots.

11.4.2 Surface texture

ISO 7599 includes a surface preparation designation system. The appearance of the final product depends on the surface treatment immediately prior to anodizing. The requirements for uniformity of appearance relate to the permissible variations in the alloy including variations

caused by the manufacturing process, and to variations in the treatment by the anodizing plant.

The extent of admissible variations in the final appearance and uniformity should be agreed by means of reference specimens that have the required coating thickness and are acceptable to both parties. Also, the method of assessment should be agreed by both parties. It should be noted that it is not possible to specify “upper” and “lower” limits on appearance because a number of different factors contribute. For example, although specular gloss varies on a scale up to 100, it is possible for specimens with similar gloss values to look quite different under visual assessment.

When using instrumental methods to quantify surface texture, it is important to be attentive to any dependence of measuring on specimen orientation (working direction), and to set operating procedures accordingly. For example, specular gloss should be measured by placing the specimen in contact with the instrument so that the plane of incidence and reflection is parallel to the working direction of the metal.

11.5 Equipment of anodizing plants

11.5.1 Tanks

The material and/or lining of the tanks should be chosen in order to avoid any risk of contamination of the solutions.

The volume of the anodizing baths should be in proportion to the amperage to ensure that the required current density can be achieved and the specified temperature maintained.

11.5.2 Cooling of the anodizing electrolyte

The cooling capacity of the system used should be capable of absorbing all the heat generated during the electrolytic process at maximum utilization of the electrical capacity installed, and at the rate it is generated. The heat generated in calories per hour by normal anodizing at the working temperature is approximately

$$0{,}86 \times I \times (V + 3) = K$$

where I is the maximum current in amperes, V is the maximum voltage in volts and K is the cooling capacity in kcal/h. Ambient conditions should be taken into consideration when calculating the total cooling capacity.

11.5.3 Agitation of the anodizing electrolyte

Electrolyte movement relative to the workpieces should be sufficient to remove excess heat generated at the surface of the aluminium during the anodizing process.

It is a vital factor in maintaining the electrolyte temperature around the work pieces because insufficient heat transfer can lead to poor anodic film quality. Adequate agitation can be achieved by hydraulic turbulence or air agitation. For batch processing, agitation of the electrolyte by conventional pump-recirculation is generally not sufficient to maintain proper temperature control in the bath. However, hydraulic turbulence produced by a pumped system with eductor nozzles placed at the bottom of the tank is effective for batch processing. Although the energy required is greater than that needed for low pressure air agitation, the difference can be comparable to the energy loss through evaporation of water from air agitated tanks. Hydraulic turbulence provides greater agitation than air systems, which can improve the thickness uniformity over the loads and reduce the possibility of burning. Furthermore, there is less acid mist evolved from the surface of the solution.

If air agitation is chosen, a minimum of 5 m^3/h per square metre of bath surface should be used (measured with a rotameter); the recommended value is 12 m^3/h per square metre of bath surface. Note that air bubbles increase the resistivity of the solution by up to 35%, which

increases the electrical energy consumption for anodizing. The air flow should ensure that the electrolyte is evenly agitated over the whole surface of the bath. This is best achieved using a large volume of low pressure air from a blower rather than a compressor. The use of compressed air gives high evaporative heat losses especially when used in conjunction with air extraction. Note that it is not “best available technique” (BAT) to use high pressure air agitation because of the high energy consumption. However, if a compressor is used, the dimensions of the pipes and agitation holes should be adjusted to give even agitation.

11.5.4 Heating

The heating capacity of the individual baths should be related to the temperatures to be maintained during the various stages of treatment. In particular, it should be possible to maintain the temperature of the hydrothermal sealing baths at a minimum of 96 °C during the sealing process.

11.5.5 Current supply

The electric equipment and installations (rectifiers and busbars) should be capable of generating the required current density for a load at the maximum installed rectifier capacity.

It should be possible to regulate the direct current supply in steps of no more than 0,5 V.

The rate at which the voltage is applied is not critical. However, a slow reduction in voltage at the end of the cycle can cause the anodic oxidation coating to be attacked.

The scales on voltmeters and ammeters should be such that each division represents a maximum of 2% (volts) and 5% (amperes) of the total scale deflection.

The measuring instruments should be in the precision class 1,5%, and should be checked twice a year.

When using current supplies with complicated frequency waveforms, care should be taken to ensure that the current-measuring instrument measures the true main current. It is very important to work with the correct current density and this means that the actual current supplied to the tank should be measured.

The voltage drop across the busbar to flightbar contact should not be more than 0,3 V; the temperature should not rise to more than 30 °C above the ambient temperature.

11.5.6 Jigs

Aluminium supporting jigs submerged in the electrolyte should have a cross section representing more than 0,2 mm^2/A. Larger sections are required for titanium which has higher resistance.

The number and size of the contacts should be sufficient to conduct the current evenly to all parts in the load and over the whole surface of each part. Pressure on the contacts should be sufficiently high to prevent oxidation of the points of contact and any movement of the parts during electrolysis.

The workpieces should be arranged on the jigs in such a way as to minimize anodic film thickness variation. Workpieces jigged very densely or multiple rows of workpieces without intermediate cathodes can lead to increased film thickness variation. Systems with central cathodes between the rows of workpieces are recommended.

11.6 Processes of anodizing plants

11.6.1 Rinsing

At least one separate rinse should be performed after each stage of treatment in an aqueous solution (surface preparation, anodizing, colouring).

Some stages of treatment require several rinses. This is particularly true of anodizing. As the first rinse is usually very acidic a second rinse is necessary before colouring or sealing.

Anodized workpieces should never be left for more than 1 to 2 minutes in the acid rinse. Workpieces left in an acid rinse for some time show signs of film attack.

11.6.2 Surface Preparation

11.6.2.1 General

Surface preparation before anodizing can fulfil a number of different purposes. They include cleaning to remove unwanted surface material or contaminants such as pick-up, surface oxides and lubricants. Another aim is to make the surface smoother, which increases its specularity. And there are roughening processes which produce particular surface appearances. A further category includes processes to provide the surface with functionality such as adhesion promotion, an example of which is tunnel etching for capacitor foil.

Smoothing processes include the following.

- Mechanical polishing which is often used before the chemical or electrochemical brightening operations.
- Electrochemical brightening (also known as “electropolishing”) to achieve the highest levels of specular reflectivity.
- Bright chemical etching mainly using phosphoric/sulphuric acid mixtures and designed to replace mechanical polishing.
- Chemical brightening to develop more specular reflectivity using phosphoric (+sulphuric)/nitric acid mixtures.

Roughening processes include chemical etching generally in sodium hydroxide based solutions, but sometimes in acid solutions, for matt surfaces and shot blasting with steel shot, which can be used prior to chemical etching to reduce process time and effluent waste.

A classification system for pretreatments is included in ISO 7599 and is presented here with additional categories for shot blasting.”

Symbol	Type of pretreatment	Characteristics and comments
E0	Degreasing and deoxidation only	• applied without further treatment before anodizing • negligible metal removal • mechanical surface defects remain visible • defects due to corrosion can be made visible • defects due to corrosion can be removed by mechanical pretreatment before E0 but it is preferable to handle and store the metal so that corrosion cannot occur
E1	Grinding only	• relatively uniform but dull appearance • surface defects mostly removed but coarse abrasives can leave marks • linishing is a type of grinding process
E2	Mechanical brushing only	• uniformly bright appearance but with visible brush marks • surface defects partly removed

E3	Mechanical polishing only	• smooth and shiny appearance • surface defects partly removed • polishing can be followed by buffing to increase specularity
E4	Grinding followed by brushing	• uniformly bright appearance • mechanical surface defects removed • defects due to corrosion removed
E5	Grinding followed by mechanical polishing	• smooth and shiny appearance • mechanical surface defects removed • defects due to corrosion removed
E6	Etching	• applied after degreasing • satin or matt appearance • mechanical surface defects reduced • defects due to corrosion can be made visible • defects due to corrosion can be removed by mechanical pretreatment before E6 but it is preferable to handle and store the metal so that corrosion cannot occur • usually followed by desmutting
E7	Chemical or electrochemical brightening	• applied after degreasing • very bright appearance • mirror finish • surface defects slightly removed • defects due to corrosion can become visible • usually followed by desmutting
E8	Grinding and polishing followed by chemical or electrochemical brightening	• very bright appearance • mirror finish • mechanical surface defects normally removed • defects due to incipient corrosion normally removed • usually followed by desmutting
E9	Blasting followed by chemical or electrochemical brightening	• matt or dull appearance • shiny smooth surface • surface defects mostly removed • usually followed by desmutting
E10	Blasting followed by etching	• satin or matt appearance • surface defects mostly removed • usually followed by desmutting

11.6.2.2 Mechanical processes

There are a range of mechanical surface-preparation processes that are intended to modify the topography and appearance of the surface of profiles. Grinding and/or polishing eliminate die lines, pick-up, scratches, pits or other superficial blemishes and provide a smooth or lustrous finish. Buffing (after polishing) increases specular reflectivity. Blasting with fine media is used to provide a clean, matt finish. Other methods include scratch-brushing, hammering and pattern rolling.

Grinding was originally carried out using resin-bonded carborundum wheels generally without lubricant. However, grinding stones can become clogged up by the soft metal particles. Currently coarse abrasive particles (emery, aluminium oxide or carborundum) on a moving belt (linishing) or rotating wheel are preferred.

When the objective is to enable anodizing to produce a perfectly transparent coating, mechanical polishing can be followed by chemical or electrochemical brightening, which removes any surface contaminants.

11.6.2.3 Cleaning

There are a range of organic and inorganic contaminants that can occur on aluminium surfaces including the following.

Organic	Inorganic
Forming lubricants Protective oils and greases Polishing compounds Handling grease, *e.g*. fingerprints Faulty organic coatings	Oxides and hydroxides Corrosion products Pick-up Die coating Dust and dirt Swarf Aluminium fines Welding or brazing fluxes Faulty inorganic coatings

Traditionally degreasing was performed using organic solvents to remove the organic contaminants but that has declined for environmental reasons. Alkali or acid solutions were used to remove the inorganic contaminants.

Inadequate degreasing can leave non-uniform patches of oil on the surface. This can lead to non-uniform etching in the next process stage. The effective etch time varies across the surface because the etch has to remove any residual oil before it can attack the underlying aluminium.

An extruded aluminium surface can also have voluminous regions of aluminium hydroxide, magnesium oxide or hydroxide, and other corrosion products, which are possibly non-uniform in distribution over the surface. The fresh surface of a profile exiting the extrusion die sees a high temperature for a few seconds before being quenched and a thin amorphous oxide would be expected, perhaps less than 5-10 nm thick. Yet actual surface oxide may contain local particles greater than 100 nm in size and there is evidence that the surface of the oxide becomes enriched in magnesium. The magnesium diffuses from below the surface region to form oxide or hydroxide possibly after exiting the die or during the ageing cycle. If the magnesium-rich oxide is not removed in the cleaning process, it causes problems during etching. Magnesium oxide is largely insoluble in alkaline etches, which leads to regions of delayed attack of the aluminium.

Nowadays the aluminium extrusion industry mostly uses aqueous solutions for degreasing and cleaning. In addition to the removal of organic substances, cleaning formulations are required to be able to dissolve any inorganic contaminants and replace them with a uniform and consistent oxide film.

Alkaline cleaning is the most common process in the extrusion industry. It uses solutions based on mixtures of sodium hydroxide, trisodium phosphate or sodium carbonate. Sodium hydroxide saponifies grease and lubricants but also dissolves aluminium oxide/hydroxide and aluminium. That means that etching can start in the cleaner solution, which can cause problems with differential etching if non-uniform amounts of resistant contaminant are present. Differential etching can lead to unacceptable variations in product appearance.

Inhibited alkaline cleaners remove grease etc with little or no etching. Common inhibitors, which reduce aluminium etching, include phosphates, fluorides and organic compounds. They react with the aluminium to produce a protective film. Inhibition is not fully effective in sodium

hydroxide solutions, but attack of the aluminium can be almost wholly inhibited in alkaline trisodium phosphate or sodium carbonate solutions. Very importantly, they also allow time for the surface magnesium oxide to dissolve.

The cleaning solutions may also contain surfactants so the solution quickly and uniformly wets the surface.

Acid cleaning is an unusual option for an anodizing line. If it is adopted, then rinsing is needed before a following alkaline etch. Acids are good at dissolving inorganic contaminants such as bulky oxides but are relatively ineffective in removing grease and oils (no saponification). Nitric acid dissolves surface oxides, attacks aluminium very slowly but can degrade to nitrogen dioxide which contributes to NO_x. Spent anodizing acid has been used. Rolled products have been cleaned electrolytically in solutions of sulfuric or phosphoric acid.

Other technologies include corona discharge, higher energy atmospheric plasma jets, and ultrasonic cleaning.

11.6.2.4 Etching

In order to achieve a high level of consistency and uniformity, it is important to properly control the etching process. The anodizing plant should follow closely the instructions from the supplier of the etch chemicals and, where available, the supplier of the semi-fabricated product. In the absence of full instructions, the anodizing plant should take particular measures indicated below.

In order to achieve a consistent product when using an etch based on sodium hydroxide, it is necessary to control within tight tolerances the concentrations of free sodium hydroxide, aluminium and any sequestrant, and the solution temperature. Solution composition can be effectively controlled by using a crystallizer to continuously regenerate the solution or by using a “long-life” etch where the masses of materials entering and leaving the etch solution are balanced.

Whereas during etching, aluminium loses mass at a constant rate, the gloss falls at a decreasing rate. After a certain time depending on the etching conditions, an approximately constant gloss level is achieved. Anodizing plants should identify this regime for their particular etch conditions and set the processing time accordingly. This makes the process very much more controllable and reduces product inconsistency that can arise from poor reproducibility of etching time, excessive drainage time after the load has been withdrawn from the etch tank and excessive rinsing at relatively high pH values.

11.6.2.5 Desmut / neutralization

After brightening or alkaline etching and before anodizing, it can be necessary to desmut the surface. Smut is a mixture of oxides and intermetallic particles which are insoluble in the etch. The smut left after alkaline etching generally appears grey. But copper additions to the alloy form a darker smut which can appear black on 2xxx alloys.

Brightening in copper-containing solutions leaves a conspicuous layer of metallic copper on the aluminium surface. However, this is readily removed.

The purposes of desmutting are as follows.

- Remove surface intermetallic compounds not dissolved in etch
- Neutralize the surface ready for anodizing
- Provide a uniform, thin oxide film to protect against corrosive attack

Various solutions can be used for desmutting. Sulfuric acid is preferred because it is compatible with the anodizing solution. Spent anodizing solution can be used but is only effective on light smut, eg on AA 6063. An additive such as sodium persulfate might be

necessary to oxidize the surface and prevent corrosive attack. Nitric acid was used by most anodizers. It attacks aluminium only very slowly but can degrade to nitrogen dioxide which contributes to NO_x. It is good for removing surface copper after brightening or from AA 2024. Hydrofluoric acid-based desmut solutions remove smut from high silicon alloys.

11.6.3 Architectural and decorative anodizing

11.6.3.1 Established processes

Well-established processes for anodizing are as follows.

- Sulfuric acid anodizing
- Sulfuric / oxalic acid anodizing

Guidance on typical processing conditions is given below. However, the characteristics and performance of anodized aluminium can depend on a combination of conditions. Consequently, deviations from the conditions given below can give acceptable results depending on circumstances.

11.6.3.2 Sulfuric acid electrolytes

The concentration of free H_2SO_4 should be not more than 200 g/l, variable within 10 g/l of the selected value.

The aluminium content should be not more than 20 g/l but preferably within 5 to 15 g/l.

The chloride content should be not more than 100 mg/l.

The acid concentration is only critical at high anodizing temperatures. High acid concentrations lower the anodizing voltage required (about 0,04 V per g/l of H_2SO_4), but also lead to greater drag-out and higher acid consumption. Low aluminium contents increase the sensitivity of the film to high bath temperatures. The higher the aluminium content, the higher the anodizing voltage required (about 0,2 V per g/l of aluminium). Chloride in the anodizing electrolyte can cause pitting during anodizing and has been found to adversely affect resistance to weathering.

11.6.3.3 Sulfuric acid - oxalic acid electrolytes

The concentration of free H_2SO_4 should be not more than 200 g/l, variable within 10 g/l of the selected value.

The concentration of oxalic acid should be at least 7 g/l. 5 g/l of oxalic acid is too low to have an effect and increasing the level improves the film quality. Oxalic acid concentrations of over 15 g/l have no advantage and increase the production costs.

The aluminium content should be not more than 20 g/l but preferably within 5 to 15 g/l.

11.6.3.4 Temperature of sulfuric acid bath

This should be controllable within 1,5 °C of the selected temperature regardless of the size of the load. The maximum acceptable temperature difference in the bath in the vicinity of the workpieces should be 2 °C and within the maximum range prescribed.

Thickness classes and actual bath temperature:

- AA 5 and AA 10 not above 21 °C
- AA 15, AA 20 and AA 25 not above 20 °C

These temperatures represent the maximum temperature at anytime and anywhere in the electrolytic bath during the process. The anodizing electrolyte temperature is the single most critical factor affecting anodic film quality and excessive temperatures caused by poor control, poor agitation or poor jigging are responsible for most anodizing quality problems.

11.6.3.5 Temperature of sulfuric acid-oxalic acid bath

This should be controllable within 1,5 °C of the selected temperature regardless of the size of the load. The maximum acceptable temperature difference in the bath in the vicinity of the workpieces should be 2 °C and within the maximum range prescribed.

For all thickness classes the bath temperature should not be above 24 °C.

This temperature represents the maximum temperature at anytime and anywhere in the electrolytic bath during the process.

11.6.3.6 Current density

For sulfuric acid-based anodizing, the average current density should be:

- 1,2 – 2,0 A/dm² for AA 5, AA 10
- 1,4 – 2,0 A/dm² for AA 15
- 1,5 – 2,0 A/dm² for AA 20
- 1,5 – 3,0 A/dm² for AA 25

A risk factor for quality is the use of low current densities to produce thick coatings (AA 20 and AA 25). High current densities require good contacts and good agitation but are less likely to give quality problems.

AA 25 needs special care. When carrying out electrocolouring to produce very dark bronze or black, the anodizing time should be less than 50 minutes unless special measures are undertaken to control the bath temperature at the surface of the work. The maximum coating thickness should be less than 35 µm.

11.6.3.7 Anodizing electrodes (cathodes)

The cathode to anode (working surface) ratio should be in the region of 1:1,5 to 1:2,5. Aluminium cathodes are recommended. For cathodes on the side of the tank, only one side should be considered; for central cathodes, both sides should be considered. Where there is a high cathode to anode ratio the use of lead lined tanks without shielding can lead to film thickness variation problems. Aluminium electrodes require the lowest operating voltages. The distance between the cathode and the anode should not be less than 150 mm.

11.6.3.8 Transfer of the workpieces after anodizing

When the anodizing cycle has been completed, the workpieces should be transferred from the anodizing electrolyte to the rinse as quickly as possible. They should never be left in an anodizing bath without current. This is another factor that can cause film attack and deterioration in film quality particularly at the film surface.

11.6.4 Colouring

11.6.4.1 Established processes

Well-established processes for colouring anodized aluminium are as follows.

- Using a solution of an organic dyestuff.
- Using a ferric ammonium oxalate or chemically similar solution.
- Electrolytic colouring using a solution containing tin, nickel or cobalt salts.

Integral-colour anodized aluminium uses special alloys and an organic-acid based electrolyte which produces a coloured finish during the anodizing process itself. Those alloys can be used with sulfuric-acid based anodizing.

11.6.5 Sealing for architectural anodizing

11.6.5.1 Established processes

Well-established processes for sealing are as follows.

- hot-water sealing with or without an anti-smut additive
- preseal before hot-water or steam sealing
- steam sealing
- nickel-based, two-step cold sealing

Guidance on typical processing conditions is given below. However, the characteristics and performance of anodized aluminium can depend on a combination of conditions. Consequently, deviations from the conditions given below can give acceptable results depending on circumstances.

11.6.5.2 Hydrothermal sealing

ISO 7583 defines hydrothermal sealing as either steam sealing not below the saturated steam temperature or sealing in an aqueous solution at a temperature no lower than 95 °C.

Hot-water sealing should be carried out in de-ionized water at pH 5,8 to 6,2, and 0,1 to 1,0 % ammonium acetate can be used as a buffer.

Phosphates, fluorides and silicates inhibit the sealing process.

Where an additive is used in the sealing baths (for instance to prevent smutting), special care should be exercised and greater attention paid to the referee test and the mass loss results and, where appropriate, the dye spot test.

The sealing time necessary to get a good sealing should be at least two minutes per micrometre coating thickness unless there is a preseal such as a triethanolamine solution.

For steam sealing the minimum temperature should be the saturated steam temperature.

11.6.5.3 Cold sealing process based on nickel salts and fluorinated salts

ISO 7583 defines cold sealing as a sealing process carried out using an aqueous solution at a temperature no higher than 35 °C.

This section gives guidance for the implementation of "cold sealing" processes based on nickel salts and fluorinated salts (notes 1, 2 and 3). It incorporates the knowledge about these processes gained in the past years, and defines the most important parameters. The process is divided into 2 steps: in the first one the anodic coating is sealed, in the second one the anodic coating is hydrated.

Anodizing conditions

As for other sealing processes it is essential to produce a good quality anodic oxide film according to the conditions stipulated in this clause.

Note 1. Cold sealing processes are based on chemicals which diffuse into the pores of the anodic oxide film and initiate a chemical reaction. It depends not only on the temperature but also on the chemicals used and other process factors. This specification relates only to cold sealing processes based on nickel fluoride.

Note 2. The product available on the market can be a “mixture” of nickel salts and fluorides or fluorinated salts, where nickel fluoride can be only a minor part of the total amount.

Note 3. Since the consumption of fluoride is slightly higher than the stoichiometric amount of nickel, some products on the market contain a slight excess of fluorides.

First step of the sealing process

1) Concentration of the product: nickel ion content at 1,5 ± 0,3 g/l; free fluoride ions at a level within the range 0,3 to 1,0 g/l
2) Bath temperature: 25 to 30 °C
3) pH: 5,8 – 7,0 (preferably 6,5 ± 0,2)
4) Sealing time: 1,0 ± 0,2 min/µm of the anodic coating
5) Phosphate ions in the solution less than 5 mg/l

Rinsing after the first step of the cold sealing process is essential and it is the responsibility of the supplier to prescribe the conditions.

Note 4. An excess of fluorides, especially in presence of a low pH produces a rapid degradation of the solution due to a chemical attack to the oxide surface. This attack is evident especially on polished or brightened parts.

Note 5. An excess of ions different from nickel and fluoride can induce a reduction in the activity of the solution; in this case filtration can help to overcome the problem.

Supplementary requirements

The supplier should give the anodizing plant precise details of the percentage of active chemical components and, if a powder, the percentage of insoluble matter in the products.

The quality of the water for the preparation of the bath should be checked before use; it is advisable to use deionized water to make up the bath.

The operating parameters for cold sealing are critically important and, as indicated below, should be closely controlled to achieve a satisfactory result. It is also important to remember that the parameters are interdependent; for example, a high fluoride ion concentration requires a lower operating temperature and/or a shorter sealing time and a higher pH.

Bath concentration

The most important bath constituents are nickel and fluoride. An excess of free fluoride ions can damage the anodic coating.

In some cases, 5 - 10% of the nickel is substituted by cobalt to minimize the greenish shade.

After analyses, the bath should be replenished with extreme care avoiding its use until the substances added have been fully solubilized.

Sometimes, nickel fluoride can contain insoluble matter. It is advisable to make additions in a mixing chamber outside the bath. Moreover, fluoride is consumed at a higher rate than nickel, and additions of ammonium or potassium fluoride will be required to maintain the correct balance.

Analytical methods for checking the baths should be provided by the supplier. Generally an EDTA method is used for nickel and a potentiometric method with an ion-sensitive electrode for free fluoride.

Note 6. It is advisable to avoid the use of hydrofluoric acid or too acidic fluorinated salts able to unbalance the pH of the solution. Strong variations of pH are never positive for the final quality.

Bath temperature

The bath temperature should be maintained with a sensitive thermostatic device.

This parameter has a great influence on the kinetics of the process. Too high a temperature, particularly when the free fluoride concentration is at a high level, causes damage to the anodic oxide film and results in a powdery surface.

Bath pH

The pH of the solution should be preferably 6,5 ± 0,2. Generally, the higher the pH the better, but it is not possible to go above 7,0 without causing a slight precipitation of nickel hydroxide. The pH affects the amount of nickel precipitated in the pores, and below 5,8 insufficient nickel is deposited, and a chemical attack on the anodic coating can be generated by fluoride.

Note 7. The pH should be measured with utmost care as fluoride in the solution can attack the pH electrodes or damage the glass membrane. This makes it very important to check the pH electrodes at regular intervals.

Rinsing

Rinsing should be sufficiently thorough to minimize the carry-over of fluoride ions into the second step.

Second step of the sealing process

To complete the cold sealing process, the treated parts should be exposed to high humidity for some time, which can be accelerated by dipping the cold sealed parts in a water bath at an elevated temperature. The bath should be operated at a temperature of at least 60°C (preferably 70°C).

This treatment makes the work easier to handle and check, and is an essential part of the treatment.

Thorough rinsing between cold sealing and the elevated-temperature water treatment is absolutely essential as the fluoride ions can inhibit the hydration process.

Cold sealed films are more prone to crazing than conventionally sealed films, especially when exposed in warm, dry environments. This effect is greatly reduced by the hydration treatment at elevated temperature after cold sealing.

Note 8. Although not essential, it can be advantageous to use hard city-water for rinsing before the second step because it causes the precipitation of fluoride.

Quality control

If the cold sealing process including both the first and second step is applied as described above, the sealed work can be tested in the same way as conventionally sealed work.

The most suitable tests are the dye spot test according to ISO 2143 and the mass loss test according to ISO 3210.

11.7 Cleaning and maintenance

11.7.1 General

A simple maintenance programme based on a realistic appraisal of local conditions ensures a maximum useful life for anodized structural components at reasonable cost.

The following documents provide further information on this.

- “Cleaning of aluminium in the building industry”, GDA (Gesamtverband der Aluminiumindustrie e.V.), Düsseldorf, 2006.
- BS 3987, “Specification for anodic oxidation coatings on wrought aluminium for external architectural applications”, BSI (British Standards Institute), London, 1991.
- “Konservierung und Versiegelung eloxierter oder organisch beschichteter Metalloberflächen im Fassadenbereich”, Merkblatt 06, GRM (Gütegemeinschaft Reinigung von Fassaden e.V.), Schwäbisch Gmünd, 2013.

Brief recommendations are given below.

11.7.2 Interior applications

Interior parts can normally be kept clean by wiping them periodically with a soft cloth. If they have not been cleaned for some time, a neutral cleaning fluid and soft cloth can be used, followed by rinsing in clear cold water. They can then be polished with a soft, dry cloth to make them look like new.

11.7.3 Exterior applications

In practice, the frequency with which structural components exposed to the atmosphere should be cleaned depends on the kind of parts and the aggressiveness of the environment.

For external architectural applications where the decorative appearance and protective function are particularly important e.g. porches, entrances, shop fronts, etc., weekly cleaning is recommended. In this case, i.e. with regular cleaning, it is possible to use clean water and chamois leather and then wipe the parts down with a soft dry cloth.

Window frames, windowsills and facades should be cleaned regularly, the frequency depending on the aggressiveness of the environment and the construction of the facades. This is best done with a neutral, synthetic cleaning fluid and a cloth, sponge, chamois leather or soft brush. Then rinse with clear water and rub slightly to dry.

Stubborn dirt can be removed with slightly abrasive cleaning agents or bonded fibres covered with fine neutral polishing powder.

If a preserving agent is applied to the structural components after cleaning, care should be taken that only an extremely thin water repellent film remains. This should not yellow, not attract dust and dirt nor have iridescent effects. Waxes, Vaseline, lanolin and similar substances are not suitable.

Multi-purpose cleaners should meet the same requirements.

Soda solutions, alkalis and acids should always be avoided. Abrasive materials, metallic cloths, wire brushes, etc. should never be used.

12 Appendix – Architectural anodizing

12.1 Introduction

Clauses 2 to 9 contain general provisions that apply irrespective of the type of anodizing. The following are particularly significant.

- Clause 6. Granting and renewing licences.
- Clause 7. Regulations for the use of the Qualanod label.
- Clause 8. Inspections.
- Clause 9. Test methods for products.

12.2 Scope

This clause specifies requirements for anodizing and products where both appearance and protection are important.

ISO 7583 defines architectural anodizing as “anodizing to produce an architectural finish to be used in permanent, exterior and static situations where both appearance and long life are important.”

The specifications of this clause may be applied to anodizing and products that are used in other outdoor applications where both appearance and long life are important. Such applications can include automotive ones.

12.3 Quality label

The use of the quality label shall comply with the requirements of clause 7.

12.4 Agreements with customers

12.4.1 Information to be supplied by the customer

The following information shall be supplied by the customer to the licensee, if necessary in consultation with the aluminium supplier or the licensee or both.

- The intended service use of the article to be anodized.
- The specification of the aluminium to be anodized (alloy and temper).
- The extent of the significant surface(s) of the article(s) to be anodized.
- The sampling procedure for lot acceptance tests (see 9.1)
- The anodic oxidation coating thickness required unless otherwise specified (see 12.4.4).
- Any preferred positions and dimensions of the contact (jigging) marks.
- The surface preparation to be used on the aluminium before anodizing and the limits of variation of the final surface finish.
- The colour of the anodized article and the maximum limits of colour variation.
- The sealing method to be used.

12.4.2 The aluminium to be anodized

Recommendations on the selection of alloys are given in clause 11

12.4.3 Significant surfaces

Significant surfaces are indicated preferably by drawings or by suitably marked samples. In some cases, there can be different requirements for the finish on different parts of the significant surface(s).

12.4.4 Thickness class

Anodic oxidation coatings are graded by thickness class which is determined by the minimum allowed values of the average thickness and the local thickness. The thickness classes are designated by the letters “AA”. The definitions of typical thickness classes are given in Table 12-1. Note that other thickness classes are allowed, e.g. AA 18, and they are defined in a similar manner. Some information on the choice of thickness class is given in clause 11.

Where there is a relevant national standard applying in the country where it is known that the final anodized aluminium product is to be put into service, the thickness class shall be specified as required by that standard.

Table 12-1. Typical thickness classes

Thickness class	Minimum average thickness (µm)	Minimum local thickness (µm)
AA10	10	8
AA15	15	12
AA20	20	16
AA25	25	20

12.4.5 Final dimensional tolerances

Not applicable.

12.4.6 Surface preparation

The surface preparation is indicated preferably by means of reference specimens that are acceptable to both parties.

12.4.7 Colour

The permissible colour variation is indicated preferably by means of reference specimens that are acceptable to both parties. The specimens can represent agreed darkest and lightest limits.

12.5 Complaints

Any complaints by customers to anodizers should be made in writing. The anodizer shall maintain a register of complaints which includes actions taken

12.6 Laboratory and testing apparatus

12.6.1 Laboratory

The anodizing plant shall have laboratory facilities which are in a dedicated room separate from the rest of the anodizing plant and where appropriate conditions are maintained for the tests that are carried out.

12.6.2 Apparatus

12.6.2.1 General

Each apparatus shall conform to the requirements of the appropriate standard for the test concerned. Each apparatus shall be functional and have a data sheet showing the apparatus identification number and calibration checks.

12.6.2.2 Apparatus for product testing

Each anodizing plant shall have at least two instruments for measuring thickness using the eddy current method or one instrument for the eddy current method and one split-beam optical microscope (9.2).

The anodizing plant shall have the following equipment to carry out the mass loss test (9.3.1):

- analytical balance (precision 0,1 mg)
- drying oven
- desiccator
- heating device
- means of agitating the solution
- chemical products

If the anodizing plant uses the dye spot test, it shall have solutions available to carry out the test (9.3.3).

If the anodizing plant uses the admittance test, it shall have at least one instrument for measuring admittance and a reference unit for checking the reading accuracy of the device (9.3.4).

If the anodizing plant uses the surface abrasion test, it shall have validated glass-coated paper (9.6.1).

The anodizing plant shall have access to apparatus to carry out any other product tests described in 12.7 that are required by the customer. Any organizations selected to carry out such a test shall be accredited to ISO 17025 for that test.

12.6.2.3 Apparatus for testing baths

The anodizing plant shall have a pH meter and two buffer solutions.

12.7 Product tests to be applied by the licensee

As indicated below, some tests are not applicable to architectural anodizing.

12.7.1 Required tests

The licensee shall apply the following product quality tests depending on the products it produces. See below for details.

- Thickness
- Mass loss test
- Either the dye spot test or the admittance test or both
- Assessment for visible defects, surface texture and, if appropriate, colour
- Surface abrasion resistance

In addition, colour-anodized aluminium shall have adequate light fastness; conformity details are given below.

There are a number of options to take test specimens. The licensee should adopt an option from the list below where 1) is the most preferred and 3) is the least preferred. Circumstances which might lead the licensee to adopt a less preferred option include those where: i) it is not possible to take specimens from the production lot because of the shape, size or form of the product; ii) multiple lots of different alloys are treated together; iii) the lot comprises only one piece.

1) Test specimens shall be taken from the production lot.

2) Test specimens shall be made of the same alloy as the production lot and treated simultaneously with it.

3) Test specimens may be made of a different alloy from the production lot but shall be treated simultaneously with it. The alloy shall contain at least 97% aluminium. If the licensee frequently adopts this option, it should always use the same alloy so that it can develop a consistent record.

The practice adopted shall be recorded in the production control system.

The licensee shall comply with the requirements of the standards specifying the tests that it applies. The relevant international standards are identified in clause 4.

12.7.2 Thickness

Average and local coating thicknesses shall be measured on products using a method specified in 9.2. These coating thicknesses shall not be lower than the minimum values for the specified thickness class.

If specified by the customer, the measurement of thickness shall be dealt with in a lot acceptance test. The customer shall specify the sampling procedure to be used or that no sampling from the lot is required.

In the absence of instructions on sampling from the customer, coating thickness measurements shall be carried out at least once on the finished products from every flight bar. Coating thickness checking before colouring and sealing is recommended.

The minimum and maximum values of the average and local thicknesses shall be recorded in the production control system.

12.7.3 Dimensional tolerances

Not applicable.

12.7.4 Sealing quality

12.7.4.1 Mass loss test

Anodized products shall be assessed using the method of 9.3.1. The mass loss shall not exceed 30 mg/dm^2.

This shall be the referee test for sealing quality.

The mass loss test shall be carried out at least:

- once a day for each sealing bath if colour-anodized products represent 100% of the total output in the week;
- once every two days for each sealing bath if colour-anodized products represent more than 50% and less than 100% of the total output in the week;
- once a week for each sealing bath if colour anodized products represent less than 50% of the total output in the week;
- once a day for each coil-anodizing line that is in use.

12.7.4.2 Dye spot test

Anodized products shall be assessed using the method of 9.3.3. The rating shall not exceed 2. If the rating is 2, either a mass loss test shall be carried out or the sealing shall be repeated.

This is a production control test.

The dye spot test shall be carried out at least once for each sealing bath in every work shift. It shall always be carried out on the part with the thickest coating.

For coil-anodizing lines, the dye spot test shall be carried out at least once on every coil.

12.7.4.3 Admittance test

Anodized products shall be assessed using the method of 9.3.4. The acceptance limit for the corrected admittance shall be 20 µS. If the corrected admittance value exceeds 20 µS, either a mass loss test shall be carried out or the sealing shall be repeated. The acceptance limit for the admittance is not applicable to electrolytically coloured parts in medium bronze, dark bronze and black. Those are finishes with an L* value less than about 60 on the CIE 1976 L* a* b* scale.

This is a production control test.

The admittance test shall be carried out at least once for each sealing bath in every work shift. It is not necessary to carry out admittance tests on coil-anodized products.

12.7.5 Visible defects

Parts shall be examined visually as required by 9.4.1. The anodized parts shall be viewed from a distance agreed by the interested parties. In the absence of such an agreement, the following viewing distances shall apply.

- 3 m for outdoor applications where the observer can approach within 5 m of the anodized article
- 5 m for other outdoor applications

The metal received by the licensee shall be of sufficient quality to be free of visible defects, depending on the customer's requirements, on significant surfaces after processing through the anodizing line. If there is doubt or dispute whether processing through the anodizing line would sufficiently reduce the visibility of defects or rolling or die lines, the ability to remove or mask them shall be assessed by treating a specimen of the metal through the anodizing line to produce the agreed finish and then by visual evaluation as described above.

12.7.6 Surface texture and colour

The surface texture and colour of anodized components and reference specimens shall be assessed visually as required by 9.4.2. They shall be viewed from a distance agreed by the interested parties. In the absence of such an agreement, the following viewing distances shall apply.

- Those described in 12.7.5 for the comparison of anodized components
- 1 m for the comparison of anodized components with reference specimens agreed by the interested parties

Instrumental methods may be used if agreed by the customer and the anodizer.

The surface texture and colour of anodized components shall be within the permissible limits agreed by the licensee and the customer.

Agreed reference specimens shall be stored in a dry place in the dark.

12.7.7 Light reflection properties

If required by the customer, light reflection properties shall be assessed following 9.4.3. The test frequency and acceptance criteria shall be agreed by the licensee and the customer.

12.7.8 Corrosion resistance

Not applicable if coating thickness is properly specified.

12.7.9 Wear resistance

Not applicable.

12.7.10 Surface abrasion resistance

Anodized aluminium test specimens with an average coating thickness of 20 µm or greater shall be assessed for surface abrasion resistance using the method of 9.6.1 or of 9.6.2. After applying the method of 9.6.1, the abrasive paper shall not exhibit a dense deposit of chalky white powder. After applying the method of 9.6.2, the coating shall have a wear index less than 1.4.

In cases of doubt or dispute, the method of 9.6.2 shall be the referee test. Note that this is a comparative test and requires the use of a standard specimen.

The method of 9.6.1 is a production control test.

A surface abrasion resistance test shall be carried out at least once per shift on the finished products from each anodizing tank.

It is not necessary to carry out abrasion tests on coil-anodized products. However, if required by the customer, an abrasion test shall be carried out at least once on every anodized coil.

12.7.11 Microhardness

Not applicable.

12.7.12 Resistance to cracking by deformation

If required by the customer, anodized rolled-products shall be assessed for resistance to cracking by deformation using the method of 9.8. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

Assessing resistance to deformation can be relevant for rolled products that are deformed after anodizing.

12.7.13 Light fastness

Colour-anodized aluminium shall be coloured using a technique that has been demonstrated to produce a product with a light fastness number of at least 8 as defined by the method of 9.9.1.

Note. It has been demonstrated that electrolytically-coloured anodized aluminium conforms to the specification for light fastness.

If required by the customer, anodic oxidation coatings shall be assessed for resistance to ultraviolet radiation using the method of 9.9.2. The test frequency and acceptance criterion shall be agreed by the licensee and the customer.

12.7.14 Thermal craze resistance

Not applicable.

12.7.15 Coating continuity

If required by the customer, coil-anodized products shall be assessed for coating continuity using the method of 9.11. After the test, visual examination shall reveal no black and/or dark reddish spots on the surface of the specimen.

The coating continuity test shall be carried out once a day for each coil-anodizing line that is in use.

12.7.16 Electrical breakdown potential

Not applicable.

12.7.17 Surface density

Not applicable.

12.7.18 Roughness

Not applicable.

12.7.19 Service simulation tests

As the service lifetime of products of architectural anodizing is so long, outdoor exposure tests are not routinely performed.

12.8 Requirements concerning processes

12.8.1 Pretreatment

The licensee may use whatever processes it deems appropriate to achieve the finish required by the customer. These can include mechanical processes such as blasting, grinding, brushing, buffing and polishing as well as chemical ones such as degreasing, etching, desmutting and neutralization.

12.8.2 Anodizing

Anodizing shall be carried out using solutions based on sulfuric acid. With the exception of oxalic acid, no additives shall be used in anodizing solutions unless approved by Qualanod.

12.8.3 Colouring

Dyes shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices.

Electrolytic colouring processes shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices. For external applications, the quality label shall not be used for black finishes produced using electrolytic colouring with solutions based on copper salts.

12.8.4 Sealing process

Any sealing process applying a principle other than hydrothermal sealing or two-step cold sealing using a solution containing nickel fluoride shall not be used unless it has been approved by Qualanod.

12.8.5 Hot water sealing

For hot water sealing, the temperature shall not be below 96 °C 10 minutes after immersion of the load.

Any additives, eg anti-smut additives, shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices.

12.8.6 Cold sealing

Cold sealing is a sealing process carried out using an aqueous solution at a temperature no higher than 35 °C.

Two-step cold sealing processes using a solution containing nickel fluoride shall be used in accordance with the suppliers' written instructions or, in the absence of such instructions, with the licensee's written standard operating practices. Guidance is provided in 11.6.5.

12.8.7 Other sealing systems

Other sealing systems including medium-temperature sealing that have been approved by Qualanod shall be used in accordance with the suppliers' written instructions or, in the absence of such instructions, with the licensee's written standard operating practices.

12.9 Methods for process control

12.9.1 Etching

Etching baths shall be analysed in accordance with the instructions of the supplier of the etch chemicals. In the absence of such instructions for etch baths based on sodium hydroxide, the analyses of free sodium hydroxide, aluminium and, if appropriate, the sequestrant shall be carried out. In the absence of such instructions for acid etch baths, the analyses shall follow the licensee's written standard operating practices. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day.
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each etching bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked at the beginning of an etch cycle.

12.9.2 Brightening

Brightening baths shall be analysed in accordance with the instructions of the supplier of the brightening chemicals. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each brightening bath shall be checked at regular intervals and at least twice during every work shift when it is being used. It shall be checked at the beginning of a brightening cycle.

12.9.3 Anodizing

Anodizing baths shall be analysed in accordance with the instructions of the supplier of any anodizing additive. In the absence of such instructions, the analysis of free sulfuric acid and dissolved aluminium shall be carried out. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each anodizing bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked at the end of an anodizing cycle.

12.9.4 Sealing

Sealing baths, including all baths of multi-step sealing procedures, shall be analysed in accordance with the instructions of the suppliers of the sealing chemicals or, in the absence of such instructions, with the licensee's written standard operating practices.

For cold sealing, the nickel content of the bath shall be checked at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

The free fluoride content shall be analysed in accordance with the instructions of the supplier of the sealing chemicals. Based on the results of the analyses the bath composition shall be adjusted accordingly.

The pH value of all sealing baths, including all baths of multi-step sealing procedures, shall be measured at regular intervals and at least twice during every work shift when the line is in use. Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each sealing bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked 10 minutes after the immersion of a load and recorded

12.9.5 Storage of products

Aluminium products shall be stored away from the anodizing facilities both before and after anodizing. After anodizing, they shall be protected from condensation and dirt. Every anodized part in stock shall be marked with the coating thickness.

12.10 Production control records

12.10.1 Control system

The anodizing plant shall have a secure system for controlling production and its records shall show at least the following information.

- The customer's name and address, order or serial number.
- The production date.
- The kind of anodizing (clear or coloured).
- The specified coating thickness class and the actual thickness measured (minimum and maximum values of average and local thicknesses).
- The results of the mass loss test.
- The results of the examination for visible defects.
- The results of the assessment of surface texture and, where applicable, colour.
- Where applicable, the results of the dye spot test or admittance test.
- Where applicable, the results of the surface abrasion resistance test.
- Where applicable, evidence that the colouring technique conforms to 12.7.13.
- The results of all other tests required by the customer.
- Measures taken to remedy values not meeting the requirements.

The records shall include the following.

- The results of analyses and temperature monitoring of etch baths, and the number of shifts worked.
- The results of analyses and temperature monitoring of anodizing baths, and the number of shifts worked.
- The product name and application of any proprietary chemicals or processes used, for example in sealing.

- The results of analyses and temperature and pH monitoring of sealing baths.

All the information shall be readily accessible for the inspector.

12.10.2 Traceability

The licensee shall specify and maintain procedures to associate the production clearly with the pertinent drawings, specifications or other documents during all phases of production, delivery and assembly. Individual products, lots or batches shall be identified unmistakably. This identification shall be included in the control system records.

12.11 Inspections

12.11.1 General

The inspector carries out inspections as described in clause 8 with reference to the requirements included here in 12.11. In order to avoid an unproductive inspection visit, it is advisable that the plant notifies the appropriate body if it is concerned that sufficient material for testing might not be available during certain periods.

12.11.2 Nonconformities

The following is a list of nonconformities for architectural anodizing.

- An unsatisfactory coating thickness result. See 12.11.4
- An unsatisfactory mass loss test result. See 12.11.4
- An unsatisfactory surface abrasion resistance test result (for lots where all the pieces tested have an average coating thickness of 20 µm or greater). See 12.11.4
- Incomplete production records. See 12.10.
- The use of an anodizing solution not based on sulfuric acid. See 12.8.2
- The use of any process or product for anodizing or subsequent processes in an anodizing line that is not well-established for use in architectural anodizing lines or does not have current approval from Qualanod. See clause 10
- No functional apparatus for measuring coating thickness. See 12.6
- No functional apparatus and no availability of the required solutions for the mass loss test. See 12.6
- No functional apparatus and no availability of the required solution for the admittance test or no availability of the required solutions for the dye spot test. See 12.6
- No availability of validated glass-coated abrasive paper for surface abrasion resistance testing (if the plant uses the surface abrasion resistance test). See 12.6
- No availability of functional apparatus for any test specified in the Qualanod specifications and required by the customer. See 12.6

12.11.3 Identification of parts passed by internal quality control

The licensee shall indicate to the Qualanod inspector which goods have passed the internal quality control. Goods that are kept in stock ready for dispatch or packed shall be considered to have passed the internal quality control.

The licensee shall clearly identify parts not covered by his licence for architectural anodizing. The inspector may seek verification of the type of anodizing by, for example, examining the written agreement between the anodizer and his customer.

12.11.4 The product tests of an inspection

The inspection can include the following product tests.

- Coating thickness
- Mass loss

- Dye spot or admittance (admittance tests are carried out within 48 h after sealing)
- Surface abrasion resistance

Average and local coating thicknesses are measured on products using the eddy current method specified in ISO 2360 (see 9.2). These shall not be lower than the minimum values for the specified thickness class.

Products are assessed using the mass loss test method of 9.3.1. The mass loss shall not exceed 30 mg/dm^2.

Products are assessed using the dye spot test method of 9.3.3.

Products are assessed using the admittance test method of 9.3.4.

Anodized aluminium test specimens with an average coating thickness of 20 µm or greater are assessed for surface abrasion resistance using the method of 9.6.1 or of 9.6.2. After applying the method of 9.6.1, the abrasive paper shall not exhibit a dense deposit of chalky white powder. After applying the method of 9.6.2, the coating shall have a wear index less than 1.4. If, after carrying out the method of 9.6.1, the result is disputed, then the dispute is resolved by applying the method of 9.6.2.

12.11.5 Processes

The inspector verifies that the processes are carried out in compliance with the requirements of 12.8. He also verifies by observation that bath analyses are performed correctly.

13 Appendix - Industrial anodizing

13.1 Introduction

Clauses 2 to 9 contain general provisions that apply irrespective of the type of anodizing. The following are particularly significant.

- Clause 6. Granting and renewing licences.
- Clause 7. Regulations for the use of the Qualanod label.
- Clause 8. Inspections.
- Clause 9. Test methods for products.

13.2 Scope

This clause specifies requirements for industrial anodizing and products produced by industrial anodizing where appearance is of secondary importance.

Industrial anodizing produces anodic oxidation coatings that are mainly used to obtain:

- resistance to wear through abrasion or erosion;
- electrical insulation;
- thermal insulation;
- build-up (to repair parts out of tolerance on machining or worn parts);
- resistance to corrosion (when sealed).

Industrial anodizing products include: valves, sliding parts, hinge mechanisms, cams, gears, swivel joints, pistons, pulleys, valve blocks, rod ends and food chutes.

There are many products for automotive, medical or kitchen applications where appearance is not insignificant but much more important are resistance to wear processes and/or cleaning using aggressive chemical agents. In such cases, these are particularly demanding of the properties of anodized aluminium.

However, where appearance and protection are of comparable importance, the provisions of clause 12, architectural anodizing, shall apply.

Further, where high quality wear resistance is the primary characteristic, the provisions of clause 15, hard anodizing, shall apply.

13.3 Quality label

The use of the quality label shall comply with the requirements of clause 7.

13.4 Agreements with customers

13.4.1 Information to be supplied by the customer

The following information shall be supplied, when appropriate, by the customer to the licensee, if necessary in consultation with the aluminium supplier or the licensee or both.

- The intended service use of the article(s) to be anodized.
- The specification of the aluminium to be anodized (alloy and temper).
- The extent of the significant surface(s) of the article(s) to be anodized.
- The sampling procedure for lot acceptance tests (see 9.1)
- The anodic oxidation coating thickness required.
- The original and final dimensional tolerances. The customer may specify that these are not required or that they take precedence over the required coating thickness.
- The preferred positions and dimensions of the contact (jigging) marks.
- Any special requirements for surface preparation, eg shot-peening, etching, grinding.

- The colour, if any, of the anodized article.
- The sealing method to be used. The customer may specify no sealing or sealing only to eliminate stickiness.
- Any special requirements for post-treatment, eg impregnation, grinding.
- Any special characteristic required, such as wear resistance, corrosion resistance, microhardness.

13.4.2 The aluminium to be anodized

Recommendations for the selection of alloys are given in clause 11.

The properties and characteristics of anodic oxidation coatings are significantly affected by both the alloy and the method of production. Consequently, materials are classified into five alloy groupings as follows:

- Class 1: all wrought alloys except those of the 2000 series and class 2b;
- Class 2a: alloys of the 2000 series containing less than 5 % copper;
- Class 2b: alloys of the 5000 series containing 2 % or more magnesium and alloys of the 7000 series;
- Class 3a: casting alloys with less than 2 % copper and/or 8 % silicon;
- Class 3b: other casting alloys.

13.4.3 Significant surfaces

Significant surfaces are indicated preferably by drawings or by suitably marked samples; in some cases, there can be different requirements for the finish on different parts of the significant surface(s). Masking can be necessary to enable different requirements to be achieved.

13.4.4 Thickness grade

Anodic oxidation coatings may be graded by thickness class or nominal thickness. Thickness class is determined by the minimum allowed values of the average thickness and the local thickness. The thickness classes are designated by the letters “AA”. The definitions of typical thickness classes are given in Table 13-1. Note that other thickness classes are allowed, eg AA 7 or AA 18, and they are defined in a similar manner. Some guidance on nominal thicknesses is given in clause 11.

Table 13-1. Typical thickness classes

Thickness class	Minimum average thickness (µm)	Minimum local thickness (µm)
AA10	10	8
AA15	15	12
AA20	20	16
AA25	25	20

13.4.5 Surface preparation

ISO 7599 includes a surface preparation designation system.

13.4.6 Final dimensional tolerances

Anodizing leads to an increase in the dimensions of an article, which is equal to about 50% of the coating thickness for each anodized surface.

13.5 Complaints

Any complaints by customers to anodizers should be made in writing. The anodizer shall maintain a register of complaints which includes actions taken

13.6 Laboratory and testing apparatus

13.6.1 Laboratory

The anodizing plant shall have laboratory facilities which are in a dedicated room separate from the rest of the anodizing plant and where appropriate conditions are maintained for the tests that are carried out.

13.6.2 Apparatus

13.6.2.1 General

Each apparatus shall conform to the requirements of the appropriate standard for the test concerned. Each apparatus shall be functional. Each piece of apparatus shall have a data sheet showing the apparatus identification number and calibration checks.

13.6.2.2 Apparatus for product testing

The anodizing plant shall have at least two instruments for measuring thickness using the eddy current method or one instrument for the eddy current method and one split-beam optical microscope (9.2).

The anodizing plant shall have the following equipment to carry out the mass loss test (9.3.1) unless not required by customers:

- analytical balance (precision 0.1 mg)
- drying oven
- desiccator
- heating device
- means of agitating the solution
- chemical products

The anodizing plant shall have solutions available to carry out the dye spot test (9.3.3) unless not required by customers.

The anodizing plant shall have at least one instrument for measuring admittance and a reference unit for checking the reading accuracy of the device (9.3.4) unless not required by customers.

The anodizing plant shall have access to apparatus to carry out any other product tests described in 13.7 that are required by the customer. Any organizations selected to carry out such a test shall be accredited to ISO 17025 for that test.

13.6.2.3 Apparatus for testing baths

The anodizing plant laboratory shall have a pH meter and two buffer solutions.

13.7 Product tests to be applied by the licensee

As indicated below, some tests are not applicable to industrial anodizing.

13.7.1 Required tests

The licensee shall apply the following product quality tests depending on the products it produces. See below for details.

- Thickness
- Mass loss test (unless not required by customers)
- Either the dye spot or admittance test or both (unless not required by customers)
- Visible defects
- Final dimensional tolerances (if required by the customer)

Additionally, the licensee shall apply any of the tests described below that are required by the customer.

There are a number of options to take test specimens. The licensee should adopt an option from the list below where 1) is the most preferred and 3) is the least preferred. Circumstances which might lead the licensee to adopt a less preferred option include those where: i) it is not possible to take specimens from the production lot because of the shape, size or form of the product; ii) multiple lots of different alloys are treated together; iii) the lot comprises only one piece.

1) Test specimens shall be taken from the production lot.
2) Test specimens shall be made of the same alloy as the production lot and treated simultaneously with it.
3) Test specimens may be made of a different alloy from the production lot but shall be treated simultaneously with it. The alloy shall contain at least 97% aluminium. If the licensee frequently adopts this option, it should always use the same alloy so that it can develop a consistent record.

The practice adopted shall be recorded in the production control system.

The licensee shall comply with the requirements of the standards specifying the tests that it applies. The relevant international standards are identified in clause 4.

13.7.2 Thickness

Thickness measurements shall be made using a method of 9.2.

When a thickness class is specified, the average thickness and the local thickness shall not be lower than the minimum values for the specified thickness class.

Where a nominal thickness of up to 50 µm is specified, the average thickness shall not be outside ± 20% of the nominal thickness. Where a nominal thickness over 50 µm is specified, the average thickness shall not be outside ±10 µm of the nominal thickness.

If specified by the customer, the measurement of thickness shall be dealt with in a lot acceptance test. The customer shall specify the sampling procedure to be used or that no sampling from the lot is required.

In the absence of instructions on sampling from the customer, coating thickness measurements shall be carried out at least once on the finished products from every flight bar. Coating thickness checking before colouring and sealing is recommended.

The minimum and maximum values of the average and local thicknesses shall be recorded in the production control system.

13.7.3 Dimensional tolerances

Where relevant, the measurement of final dimensions shall be dealt with in a lot acceptance test.

13.7.4 Sealing quality

13.7.4.1 Mass loss test

Unless not required by the customer, anodized products shall be assessed using the method of 9.3.1 and the mass loss shall not exceed 30 mg/dm^2.

The mass loss test shall be carried out at least:

- once a day for each sealing bath if colour-anodized products represent 100% of total output in the week;
- once every two days for each sealing bath if colour-anodized products represent more than 50% and less than 100% of total output in the week;
- once a week for each sealing bath if colour anodized products represent less than 50% of total output in the week;
- once a day for each coil-anodizing line that is in use.

13.7.4.2 Dye spot test

Unless not required by the customer, anodized products shall be assessed using the method of 9.3.3. The rating shall not exceed 2.

The dye spot test shall be carried out at least once for each sealing bath in every work shift. It shall always be carried out on the part with the thickest coating.

For coil-anodizing lines, the dye spot test shall be carried out at least once on every coil.

13.7.4.3 Admittance test

Unless not required by the customer, anodized products shall be assessed using the method of 9.3.4. The acceptance limit for the corrected admittance shall be 20 µS. If the corrected admittance value exceeds 20 µS, either a mass loss test shall be carried out or the sealing shall be repeated. The acceptance limit for the admittance is not applicable to electrolytically coloured parts in medium bronze, dark bronze and black. Those are finishes with an L* value less than about 60 on the CIE 1976 L* a* b* scale.

This is a production control test.

The admittance test shall be carried out at least once for each sealing bath in every work shift. It is not necessary to carry out admittance tests on coil-anodized products.

13.7.5 Visible defects

Parts shall be examined visually as required by 9.4.1. The significant surface shall be completely anodized. The visual appearance shall be substantially uniform without spalling, blistering or powdery (burnt) areas. Crazing or microcracks are not normally a reason for rejection.

13.7.6 Surface texture and colour

If required by the customer, the surface texture and colour of anodized components shall be within the permissible limits agreed by the licensee and the customer.

13.7.7 Light reflection properties

Not applicable.

13.7.8 Corrosion resistance

If required by the customer, the corrosion resistance shall be assessed using one of the methods of 9.5.

After the NSS test, a test specimen with an anodic oxidation coating thickness of 50 µm shall not show any corrosion pits except those within 1.5 mm of jigging marks or corners.

The AASS test shall be carried out using reference specimens so the comparative performance of the test specimens can be assessed. This may involve the examination of specimens at intermediate times during the test. The rating of corroded specimens shall be decided using one of the systems specified in ISO 8993 and ISO 8994. The acceptance criteria for the AASS test shall be agreed by the licensee and the customer.

These tests are only applicable to sealed oxidation coatings.

13.7.9 Wear resistance

If required by the customer, the wear resistance of anodic oxidation coatings shall be determined by using either the abrasive wheel method of 9.6.2, the abrasive jet method of 9.6.3 or the Taber method of 9.6.5. The selection of the test method shall be agreed by the anodizer and the customer with regard to 9.6.2, 9.6.3 and 9.6.5. The test procedure shall comply with ISO 10074.

The time between anodizing and testing shall be at least 24 h. During this period, the test pieces shall be stored in the test environment.

The test frequency shall be agreed by the licensee and the customer.

The resistance to wear shall have the values given in Table 13-2.

Table 13-2. Acceptance values for wear tests

Material class	Number of double strokes (abrasive wheel method)	Minimum relative mean specific abrasion resistance (abrasive wheel and abrasive jet methods)	Maximum mass loss (Taber method)
Class 1	800 to 100	80%	15 mg
Class 2 (a)	400 to 100	30%	35 mg
Class 2 (b)	800 to 100	55%	25 mg
Class 3 (a)	400 to 100	55%	
Class 3 (b)	400 to 100	20%	

13.7.10 Surface abrasion resistance

Not applicable.

13.7.11 Microhardness

If required by the customer, the microhardness of anodic oxidation coatings shall be determined by using the Vickers microhardness method of. 9.7. The test load shall be 0.49 N for material classes 1, 2a, 2b and 3a. The test load for material class 3b shall be agreed by the licensee and the customer.

The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, anodic oxidation coatings with a thickness of 25 µm to 50 µm shall have the minimum microhardness values given in Table 13-3.

Table 13-3. Acceptance values for the Vickers microhardness test

Material class	Minimum acceptable value ($H_{v\ 0,05}$)
Class 1	400
Class 2 (a)	250
Class 2 (b)	300
Class 3 (a)	250

13.7.12 Resistance to cracking by deformation

If required by the customer, anodized rolled-products shall be assessed for resistance to cracking by deformation using the method of 9.8. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

Assessing resistance to deformation can be relevant for rolled products that are deformed after anodizing.

13.7.13 Light fastness

Not applicable.

13.7.14 Thermal craze resistance

Not applicable.

13.7.15 Coating continuity

If required by the customer, coil-anodized products shall be assessed for coating continuity using the method of 9.11. After the test, visual examination shall reveal no black and/or dark reddish spots on the surface of the specimen.

The coating continuity test shall be carried out once a day for each coil-anodizing line that is in use.

13.7.16 Electrical breakdown potential

If required by the customer, the electrical breakdown potential shall be determined using the method of 9.10.

The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, anodic oxidation coatings 50 µm thick on alloys containing less than 1 % copper shall have a minimum breakdown voltage of 1200 V and other alloys shall have a minimum breakdown voltage of 800 V. These values shall be the mean values of ten measurements.

The method does not give satisfactory results for unsealed coatings.

13.7.17 Surface density

If required by the customer, the surface density shall be determined using the method of 9.12.

The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, the surface density shall be at least 1100 mg/dm^2 for an unsealed 50 µm thick coating or equivalent for coatings of other thicknesses.

13.7.18 Roughness

If required by the customer, the method, test frequency and acceptance criterion shall be agreed by the licensee and the customer.

13.7.19 Service simulation tests

If required by the customer, anodized products shall be assessed using a test or tests specified by the customer to simulate the service conditions. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

13.8 Requirements concerning processes

13.8.1 Pretreatment

The licensee may use whatever processes it deems appropriate to achieve the finish required by the customer. These can include mechanical processes such as blasting, grinding, brushing, buffing and polishing as well as chemical ones such as degreasing, etching, desmutting and neutralization.

13.8.2 Anodizing

Anodizing shall be carried out using solutions based on sulfuric acid.

13.8.3 Colouring

Dyes shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices..

Electrolytic colouring processes shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices. For external applications, the quality label shall not be used for black finishes produced using electrolytic colouring with solutions based on copper salts.

13.8.4 Sealing process

Any sealing process may be used providing that products produced using it satisfy the product requirements of these Specifications.

13.8.5 Hot water sealing

For hot water sealing, the temperature shall not be below 96 °C 10 minutes after immersion of the load.

Any additives, eg anti-smut additives, shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices.

13.8.6 Cold sealing

Cold sealing is a sealing process carried out using an aqueous solution at a temperature no higher than 35 °C.

Two-step cold sealing processes using a solution containing nickel fluoride shall be used in accordance with the suppliers' written instructions or, in the absence of such instructions, with the licensee's written standard operating practices. Guidance is provided in 11.6.5.

13.8.7 Other sealing systems

Other sealing systems including medium-temperature sealing shall be used in accordance with the suppliers' written instructions or, in the absence of such instructions, with the licensee's written standard operating practices.

13.9 Methods for process control

If requirements for the surface texture of anodized components are the subject of an agreement between the licensee and the customer, then, if relevant, the provisions of 13.9.1 or 13.9.2 shall apply.

13.9.1 Etching

Etching baths shall be analysed in accordance with the instructions of the supplier of the etch chemicals. In the absence of such instructions for etch baths based on sodium hydroxide, the analysis of total sodium hydroxide, aluminium and, if appropriate, the sequestrant shall be carried out. In the absence of such instructions for acid etch baths, the analyses shall follow the licensee's written standard operating practices. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day.
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each etching bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked at the beginning of an etch cycle.

13.9.2 Brightening

Brightening baths shall be analysed in accordance with the instructions of the supplier of the brightening chemicals. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each brightening bath shall be checked at regular intervals and at least twice during every work shift when it is being used. It shall be checked at the beginning of a brightening cycle.

13.9.3 Anodizing

Anodizing baths shall be analysed in accordance with the instructions of the supplier of any anodizing additive. In the absence of such instruction, the analysis of free sulfuric acid and dissolved aluminium shall be carried out. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each anodizing bath shall be checked at regular intervals and at least twice during every work shift that the line is in use. It shall be checked at the end of an anodizing cycle.

13.9.4 Sealing

Sealing baths, including all baths of multi-step sealing procedures, shall be analysed in accordance with the instructions of the suppliers of the sealing chemicals or, in the absence of such instructions, with the licensee's written standard operating practices.

For cold sealing, the nickel content of the bath shall be checked at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

The free fluoride content shall be analysed in accordance with the instructions of the supplier of the sealing chemicals. Based on the results of the analyses the bath composition shall be adjusted accordingly.

The pH value of all sealing baths, including all baths of multi-step sealing procedures, shall be measured at regular intervals and at least twice during every work shift when the line is in use. Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each sealing bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked 10 minutes after the immersion of a load and recorded

13.9.5 Storage of products

Aluminium products shall be stored away from the anodizing facilities both before and after anodizing. After anodizing, they shall be protected from condensation and dirt.

13.10 Production control records

13.10.1 Control systems

The anodizing plant shall have a secure system for controlling production and its records shall show at least the following information.

- The customer's name and address, order or serial number;
- The production date;
- The agreed coating thickness and the actual thickness measured (minimum and maximum values of average thickness);
- The results of the mass loss test (unless not required by the customer)
- The results of the examination for visible defects.
- The results of the assessment, where applicable, of surface texture and colour.
- The results of the dye spot or admittance test (unless not required by the customer)
- Final dimensional tolerances (unless not required by the customer).
- The results of the wear resistance test (unless not required by the customer).
- The results of all other tests required by the customer;
- Measures taken to remedy values not meeting the requirements.

The records shall include the following.

- The results of analyses and temperature monitoring of anodizing baths, and the number of shifts worked.
- The product name and application of any proprietary chemicals or processes used, for example in sealing.
- The results of analyses and temperature and pH monitoring of sealing baths.

All the information shall be readily accessible for the inspector.

13.10.2 Traceability

The licensee shall specify and maintain procedures to associate the production clearly with the pertinent drawings, specifications or other documents during all phases of production, delivery and assembly. Individual products, lots or batches must be identified unmistakably. This identification shall be included in the control system records.

13.11 Inspections

13.11.1 General

The inspector carries out inspections as described in clause 8 with reference to the requirements included here in 13.11. In order to avoid an unproductive inspection visit, it is advisable that the plant notifies the appropriate body if it is concerned that sufficient material for testing might not be available during certain periods.

13.11.2 Nonconformities

The following is a list of nonconformities for industrial anodizing.

- An unsatisfactory coating thickness result (unless dimensional tolerances take precedence). See 13.11.4
- An unsatisfactory mass loss test result. See 13.11.4
- Incomplete production records. See 13.10
- The use of an anodizing solution not based on sulfuric acid. See 13.8.2
- No functional apparatus for measuring coating thickness. See 13.6
- No functional apparatus and no availability of the required solutions for the mass loss test (unless never required by customers). See 13.6
- No functional apparatus and no availability of the required solution for the admittance test or no availability of the required solutions for the dye spot test (unless never required by customers). See 13.6
- No availability of functional apparatus for any test specified in the Qualanod specifications and required by the customer. See 13.6

13.11.3 Identification of parts passed by internal quality control

The licensee shall indicate to the Qualanod inspector which goods have passed the internal quality control. Goods that are kept in stock ready for dispatch or packed shall be considered to have passed the internal quality control.

The licensee shall clearly identify parts not covered by his licence for industrial anodizing. The inspector may seek verification of the type of anodizing by, for example, examining the written agreement between the anodizer and his customer.

13.11.4 The product tests of an inspection

The inspection can include the following product tests.

- Coating thickness
- Mass loss unless not required by the customer for the lot selected
- Dye spot or admittance (admittance tests are carried out within 48 h after sealing) unless not required by the customer for the lot selected

Average and local coating thicknesses are measured on products using the eddy current method specified in ISO 2360 (see 9.2). These shall not be lower than the minimum values for the specified thickness class or outside the range for the specified nominal thickness (see 8.3.6).

Products are assessed using the mass loss test method of 9.3.1. The mass loss shall not exceed 30 mg/dm^2.

Products are assessed using the dye spot test method of 9.3.3.

Products are assessed using the admittance test method of 9.3.4.

13.11.5 Processes

The inspector verifies that the processes are carried out in compliance with the requirements of 13.8. He also verifies by observation that bath analyses are performed correctly.

14 Appendix - Decorative anodizing

14.1 Introduction

Clauses 2 to 9 contain general provisions that apply irrespective of the type of anodizing. The following are particularly significant.

- Clause 6. Granting and renewing licences.
- Clause 7. Regulations for the use of the Qualanod label.
- Clause 8. Inspections.
- Clause 9. Test methods for products.

14.2 Scope

This clause specifies requirements for decorative anodizing and products produced by decorative anodizing.

Decorative anodizing is defined in ISO 7583 as “anodizing to produce a decorative finish with a uniform or aesthetically pleasing appearance as the primary characteristic”.

Examples are shower screens, lipstick holders and lighting reflectors.

14.3 Quality label

The use of the quality label shall comply with the requirements of clause 7.

14.4 Agreements with customers

14.4.1 Information to be supplied by the customer

The following information shall be supplied by the customer to the licensee, if necessary in consultation with the aluminium supplier or the licensee or both.

- The intended service use of the article to be anodized.
- The specification of the aluminium to be anodized (alloy and temper).
- The extent of the significant surface(s) of the article(s) to be anodized.
- The sampling procedure for lot acceptance tests (see 9.1)
- The anodic oxidation coating thickness required.
- Any preferred positions and dimensions of the contact (jigging) marks.
- The surface preparation to be used on the aluminium before anodizing and the limits of variation of the final surface finish.
- The colour of the anodized article and the maximum limits of colour variation.
- The sealing method to be used. The customer may specify sealing only to eliminate stickiness.

14.4.2 The aluminium to be anodized

Recommendations on the selection of alloys are given in clause 11.

14.4.3 Significant surfaces

Significant surfaces are indicated preferably by drawings or by suitably marked samples. In some cases, there can be different requirements for the finish on different parts of the significant surface(s).

14.4.4 Thickness grade

Anodic oxidation coatings are graded by thickness class which is determined by the minimum allowed values of the average thickness and the local thickness. The thickness grades are designated by the letters “AA”. Note that other thickness classes are allowed, eg AA 7 or AA 18, and they are defined in a similar manner. The definitions of typical thickness grades are given in Table 14-1.

Table 14-1. Typical thickness grades

Thickness grade	Minimum average thickness (µm)	Minimum local thickness (µm)
AA3	3	Not specified
AA5	5	4
AA10	10	8
AA15	15	12

14.4.5 Final dimensional tolerances

Not applicable.

14.4.6 Surface preparation

The surface preparation is indicated preferably by means of reference specimens that are acceptable to both parties.

14.4.7 Colour

The permissible colour variation is indicated preferably by means of reference specimens that are acceptable to both parties. The specimens can represent agreed darkest and lightest limits.

14.5 Complaints

Any complaints by customers to anodizers should be made in writing. The anodizer shall maintain a register of complaints which includes actions taken

14.6 Laboratory and testing apparatus

14.6.1 Laboratory

The anodizing plant shall have laboratory facilities which are in a dedicated room separate from the rest of the anodizing plant and where appropriate conditions are maintained for the tests that are carried out.

14.6.2 Apparatus

14.6.2.1 General

Each apparatus shall conform to the requirements of the appropriate standard for the test concerned. Each piece of apparatus shall be functional and have a data sheet showing the apparatus identification number and calibration checks.

14.6.2.2 Apparatus for product testing

Each anodizing plant shall have at least two instruments for measuring thickness using the eddy current method or one instrument for the eddy current method and one split-beam optical microscope (9.2).

The anodizing plant shall have the following equipment to carry out the mass loss test (9.3.1 or 9.3.2):

- analytical balance (precision 0.1 mg)
- drying oven
- desiccator
- heating device
- means of agitating the solution
- chemical products

If the anodizing plant uses the dye spot test, it shall have solutions available to carry out the test (9.3.3).

If the anodizing plant uses the admittance test, it shall have at least one instrument for measuring admittance and a reference unit for checking the reading accuracy of the device (9.3.4).

The anodizing plant shall have access to apparatus to carry out any other product tests described in 14.7 that are required by the customer. Any organizations selected to carry out such a test shall be accredited to ISO 17025 for that test.

14.6.2.3 Apparatus for testing baths

The anodizing plant laboratory shall have a pH meter and two buffer solutions.

14.7 Product tests to be applied by the licensee

As indicated below, some tests are not applicable to decorative anodizing.

14.7.1 Required tests

The licensee shall apply the following product quality tests depending on the products it produces. See below for details.

- Thickness
- Mass loss test
- Either the dye spot test or the admittance test or both
- Assessment for visible defects, surface texture and, if appropriate, colour

Additionally, the licensee shall apply any of the tests described below that are required by the customer.

There are a number of options to take test specimens. The licensee should adopt an option from the list below where 1) is the most preferred and 3) is the least preferred. Circumstances which might lead the licensee to adopt a less preferred option include those where: i) it is not possible to take specimens from the production lot because of the shape, size or form of the product; ii) multiple lots of different alloys are treated together; iii) the lot comprises only one piece.

1) Test specimens shall be taken from the production lot.
2) Test specimens shall be made of the same alloy as the production lot and treated simultaneously with it.
3) Test specimens may be made of a different alloy from the production lot but shall be treated simultaneously with it. The alloy shall contain at least 97% aluminium. If the licensee frequently adopts this option, it should always use the same alloy so that it can develop a consistent record.

The practice adopted shall be recorded in the production control system.

The licensee shall comply with the requirements of the standards specifying the tests that it applies. The relevant international standards are identified in clause 4.

14.7.2 Thickness

Average and local coating thicknesses shall be measured on products using a method specified in 9.2. These coating thicknesses shall not be lower than the minimum values for the specified thickness class.

If specified by the customer, the measurement of thickness shall be dealt with in a lot acceptance test. The customer shall specify the sampling procedure to be used or that no sampling from the lot is required.

In the absence of instructions on sampling from the customer, coating thickness measurements shall be carried out at least once on the finished products from every flight bar. Coating thickness checking before colouring and sealing is recommended.

The minimum and maximum values of the average and local thicknesses shall be recorded in the production control system.

14.7.3 Dimensional tolerances

Not applicable.

14.7.4 Sealing quality

14.7.4.1 Mass loss test

Anodized products shall be assessed using the method of 9.3.1 or 9.3.2 and the mass loss shall not exceed 30 mg/dm^2. The method shall be agreed by the licensee and the customer.

This shall be the referee test for sealing quality.

The mass loss test shall be carried out at least:

- once a day for each sealing bath if colour-anodized products represent 100% of total output in the week;
- once every two days for each sealing bath if colour-anodized products represent more than 50% and less than 100% of total output in the week;
- once a week for each sealing bath if colour anodized products represent less than 50% of total output in the week;
- once a day for each coil-anodizing line that is in use.

14.7.4.2 Dye spot test

Anodized products shall be assessed using the method of 9.3.3. The rating shall not exceed 2. If the rating is 2, either a mass loss test shall be carried out or the sealing shall be repeated.

This is a production control test for sealing quality. It is an acceptance test for the absorptivity of an anodized surface.

The dye spot test shall be carried out at least once for each sealing bath in every work shift. It shall always be carried out on the part with the thickest coating.

For coil-anodizing lines, the dye spot test shall be carried out at least once on every coil.

14.7.4.3 Admittance test

Anodized products shall be assessed using the method of 9.3.4. The acceptance limit for the corrected admittance shall be 20 µS. If the corrected admittance exceeds 20 µS, either a mass loss test shall be carried out or the sealing shall be repeated. The acceptance limit for the admittance is not applicable to electrolytically coloured parts in medium bronze, dark

bronze and black. Those are finishes with an L* value less than about 60 on the CIE 1976 L* a* b* scale.

This is a production control test.

The admittance test shall be carried out at least once for each sealing bath in every work shift. It is not necessary to carry out admittance tests on coil-anodized products.

14.7.5 Visible defects

Anodized parts shall be taken using a sampling scheme agreed by the interested parties. The anodized parts shall be free from visible defects on the significant surface(s) when viewed from a distance agreed by the interested parties. In the absence of such an agreement, the parts shall be examined visually as required by 9.4.1 and the following viewing distances shall apply.

- 2 m for internal architectural applications
- 0,5 m for decorative articles

The metal received by the licensee shall be of sufficient quality to be free of visible defects, depending on the customer's requirements, on significant surfaces after processing through the anodizing line. If there is doubt or dispute whether processing through the anodizing line would sufficiently reduce the visibility of defects or rolling or die lines, the ability to remove or mask them shall be assessed by treating a specimen of the metal through the anodizing line to produce the agreed finish and then by visual evaluation as described above.

14.7.6 Surface texture and colour

The surface texture and colour of anodized components and reference specimens shall be assessed visually as required by 9.4.2. They shall be viewed from a distance agreed by the interested parties. In the absence of such an agreement, the following viewing distances shall apply.

- Those described in 14.7.5 for the comparison of anodized components
- 0,5 m for the comparison of anodized components with reference specimens agreed by the interested parties

Instrumental methods may be used if agreed by the customer and the anodizer.

The surface texture and colour of anodized components shall be within the permissible limits agreed by the licensee and the customer.

Agreed reference specimens shall be stored in a dry place in the dark.

14.7.7 Light reflection properties

If required by the customer, light reflection properties shall be assessed following 9.4.3. The test frequency and acceptance criteria shall be agreed by the licensee and the customer.

14.7.8 Corrosion resistance

Not applicable.

14.7.9 Wear resistance

If required by the customer, anodized products shall be assessed for bulk wear resistance using method 9.6.2, 9.6.3 or 9.6.4. The method, the test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

Assessing wear resistance can be relevant for products that are regularly handled by a user.

14.7.10 Surface abrasion resistance

Not applicable.

14.7.11 Microhardness

Not applicable.

14.7.12 Resistance to cracking by deformation

If required by the customer, anodized rolled-products shall be assessed for resistance to cracking by deformation using the method of 9.8. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

Assessing resistance to deformation can be relevant for rolled products that are deformed after anodizing.

14.7.13 Light fastness

If required by the customer, anodic oxidation coatings shall be assessed for light fastness using the method of 9.9.1. The test frequency and acceptance criterion shall be agreed by the licensee and the customer.

Note. It has been demonstrated that electrolytically-coloured anodized aluminium conforms to the specification for light fastness.

If required by the customer, anodic oxidation coatings shall be assessed for resistance to ultraviolet radiation using the method of 9.9.2. The test frequency and acceptance criterion shall be agreed by the licensee and the customer.

14.7.14 Thermal craze resistance

If required by the customer, anodized products shall be assessed for resistance to thermal crazing using the method of 9.13. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, no crazing shall be visually apparent on anodic oxidation coatings treated at a metal temperature below 80°C.

14.7.15 Coating continuity

If required by the customer, coil-anodized products shall be assessed for coating continuity using the method of 9.11. After the test, visual examination shall reveal no black and/or dark reddish spots on the surface of the specimen.

The coating continuity test shall be carried out once a day for each coil-anodizing line that is in use.

14.7.16 Electrical breakdown potential

Not applicable.

14.7.17 Surface density

Not applicable.

14.7.18 Roughness

Not applicable.

14.7.19 Service simulation tests

If required by the customer, anodized products shall be assessed using a test or tests specified by the customer to simulate the service conditions. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

14.8 Requirements concerning processes

14.8.1 Pretreatment

The licensee may use whatever processes it deems appropriate to achieve the finish required by the customer. These can include mechanical processes such as blasting, grinding, brushing, buffing and polishing as well as chemical ones such as degreasing, etching, desmutting and neutralization.

14.8.2 Anodizing

Anodizing shall be carried out using solutions based on sulfuric acid.

14.8.3 Colouring

Dyes shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices..

Electrolytic colouring processes shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices.

14.8.4 Sealing process

Any sealing process may be used providing that products produced using it satisfy the product requirements of these Specifications.

14.8.5 Hot water sealing

For hot water sealing, the temperature shall not be below 96 °C 10 minutes after immersion of the load.

Any additives, eg anti-smut additives, shall be used in accordance with the instructions of the supplier or, in the absence of such instructions, with the licensee's written standard operating practices.

14.8.6 Cold sealing

Cold sealing is a sealing process carried out using an aqueous solution at a temperature no higher than 35 °C.

Two-step cold sealing processes using a solution containing nickel fluoride shall be used in accordance with the suppliers' written instructions or, in the absence of such instructions, with the licensee's written standard operating practices. Guidance is provided in 11.6.5.

14.8.7 Other sealing systems

Other sealing systems including medium-temperature sealing systems shall be used in accordance with the suppliers' written instructions or, in the absence of such instructions, with the licensee's written standard operating practices.

14.9 Methods for process control

14.9.1 Etching

Etch baths shall be analysed in accordance with the instructions of the supplier of the etch chemicals. In the absence of such instructions for etch baths based on sodium hydroxide, the analysis of total sodium hydroxide, aluminium and, if appropriate, the sequestrant shall be carried out. In the absence of such instructions for acid etch baths, the analyses shall follow the licensee's written standard operating practices. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the production is from a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each etching bath shall be checked at regular intervals and at least twice during every work shift that the line is in use. It shall be checked at the beginning of an etch cycle.

14.9.2 Brightening

Brightening baths shall be analysed in accordance with the instructions of the supplier of the brightening chemicals. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each brightening bath shall be checked at regular intervals and at least twice during every work shift when it is being used. It shall be checked at the beginning of a brightening cycle.

14.9.3 Anodizing

Anodizing baths shall be analysed in accordance with the instructions of the supplier of any anodizing additive. In the absence of such instructions, the analysis of free sulfuric acid and dissolved aluminium shall be carried out. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each anodizing bath shall be checked at regular intervals and at least twice during every work shift that the line is in use. It shall be checked at the end of an anodizing cycle.

14.9.4 Sealing

Sealing baths, including all baths of multi-step sealing procedures, shall be analysed in accordance with the instructions of the suppliers of the sealing chemicals or, in the absence of such instructions, with the licensee's written standard operating practices.

For cold sealing, the free fluoride and nickel content of the bath shall be checked at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day;
- once every day the line is in use if the bath is in a coil anodizing line.

The free fluoride content shall be analysed in accordance with the instructions of the supplier of the sealing chemicals. Based on the results of the analyses the bath composition shall be adjusted accordingly.

The pH value of all sealing baths, including all baths of multi-step sealing procedures, shall be measured at regular intervals and at least twice during every work shift when the line is in use. Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each sealing bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked 10 minutes after the immersion of a load and recorded

14.9.5 Storage of products

Aluminium products shall be stored away from the anodizing facilities both before and after anodizing. After anodizing, they shall be protected from condensation and dirt. Every anodized part in stock shall be marked with the coating thickness.

14.10 Production control records

14.10.1 Control system

The anodizing plant shall have a secure system for controlling production and its records shall show at least the following information.

- The customer's name and address, order or serial number;
- The production date;
- The kind of anodizing (clear or coloured);
- The agreed coating thickness class and the actual thickness measured (minimum and maximum values of average and local thicknesses);
- The results of the mass loss test;
- The results of the examination for visible defects.
- The results of the assessment of surface texture and, where applicable, colour.
- Where applicable, the results of the dye spot test or admittance test;
- The results of all other tests required by the customer;
- Measures taken to remedy values not meeting the requirements.

The records shall include the following.

- The results of analyses and temperature monitoring of etch baths, and the number of shifts worked.
- The results of analyses and temperature monitoring of brightening baths, and the number of shifts worked.
- The results of analyses and temperature monitoring of anodizing baths, and the number of shifts worked.
- The product name and application of any proprietary chemicals or processes used, for example in sealing.
- The results of analyses and temperature and pH monitoring of sealing baths.

All the information shall be readily accessible for the inspector.

14.10.2 Traceability

The licensee shall specify and maintain procedures to associate the production clearly with the pertinent drawings, specifications or other documents during all phases of production, delivery and assembly. Individual products, lots or batches must be identified unmistakably. This identification shall be included in the control system records.

14.11 Inspections

14.11.1 General

The inspector carries out inspections as described in clause 8 with reference to the requirements included here in 14.11. In order to avoid an unproductive inspection visit, it is advisable that the plant notifies the appropriate body if it is concerned that sufficient material for testing might not be available during certain periods.

14.11.2 Nonconformities

The following is a list of nonconformities for decorative anodizing.

- An unsatisfactory coating thickness result. See 14.11.4
- An unsatisfactory mass loss test result. See 14.11.4
- Incomplete production records. See 14.10
- The use of anodizing solution not based on sulfuric acid. See 14.8.2
- No functional apparatus for measuring coating thickness. See 14.6
- No functional apparatus and no availability of the required solutions for the mass loss test. See 14.6
- No functional apparatus and no availability of the required solution for the admittance test or no availability of the required solutions for the dye spot test. See 14.6
- No availability of functional apparatus for any test specified in the Qualanod specifications and required by the customer. See 14.6

14.11.3 Identification of parts passed by internal quality control

The licensee shall indicate to the Qualanod inspector which goods have passed the internal quality control. Goods that are kept in stock ready for dispatch or packed shall be considered to have passed the internal quality control.

The licensee shall clearly identify parts not covered by his licence for decorative anodizing. The inspector may seek verification of the type of anodizing by, for example, examining the written agreement between the anodizer and his customer.

14.11.4 The product tests of an inspection

The inspection can include the following product tests.

- Coating thickness
- Mass loss
- Dye spot or admittance (admittance tests are carried out within 48 h after sealing)

Average and local coating thicknesses are measured on products using the eddy current method specified in ISO 2360 (see 9.2). These shall not be lower than the minimum values for the specified thickness class.

Products are assessed using the mass loss test method of 9.3.1 or 9.3.2 depending on which method was used by the anodizer for the lot selected. The mass loss shall not exceed 30 mg/dm2.

Products are assessed using the dye spot test method of 9.3.3.

Products are assessed using the admittance test method of 9.3.4.

14.11.5 Processes

The inspector verifies that the processes are carried out in compliance with the requirements of 14.8. He also verifies by observation that bath analyses are performed correctly.

15 Appendix - Hard anodizing

15.1 Introduction

Clauses 2 to 9 contain general provisions that apply irrespective of the type of anodizing. The following are particularly significant.

- Clause 6. Granting and renewing licences.
- Clause 7. Regulations for the use of the Qualanod label.
- Clause 8. Inspections.
- Clause 9. Test methods for products.

15.2 Scope

This clause specifies requirements for hard anodizing and products produced by hard anodizing.

Hard anodizing is defined in ISO 7583 as “anodizing to produce a coating where high wear resistance or microhardness is its primary characteristic”.

Examples of hard anodized products are similar to some of those of industrial anodizing but the quality requirements, particularly wear resistance, are higher.

15.3 Quality label

The use of the quality label shall comply with the requirements of clause 7.

15.4 Agreements with customers

15.4.1 Information to be supplied by the customer

The following information shall be supplied, when appropriate, by the customer to the licensee, if necessary in consultation with the aluminium supplier or the licensee or both.

- The specification of the aluminium to be anodized (alloy and temper).
- The extent of the significant surface(s) of the article(s) to be anodized.
- The sampling procedure for lot acceptance tests (see 9.1)
- The anodic oxidation coating thickness required.
- The original and final dimensional tolerances. The customer may specify that these are not required or that they take precedence over the required coating thickness.
- The preferred position and dimensions of the contact (jigging) marks.
- Any special requirements for surface preparation, eg shot-peening, etching, grinding.
- Any special requirements for post-treatment, eg impregnation, grinding, sealing.
- Any special characteristic required, such as corrosion resistance, electrical breakdown potential and electrical insulation.

15.4.2 The aluminium to be anodized

Recommendations for the selection of alloys are given in clause 11.

15.4.3 Significant surfaces

Significant surfaces are indicated preferably by drawings or by suitably marked samples. In some cases, there can be different requirements for the finish on different parts of the significant surface(s). Masking can be necessary to enable different requirements to be achieved.

15.4.4 Thickness grade

Some guidance is given in clause 11.

15.4.5 Final dimensional tolerances

Anodizing leads to an increase in the dimensions of an article, which is equal to about 50% of the coating thickness for each anodized surface.

15.4.6 Surface preparation

ISO 7599 includes a surface preparation designation system.

15.4.7 Colour

Not applicable.

15.5 Complaints

Any complaints by customers to anodizers should be made in writing. The anodizer shall maintain a register of complaints which includes actions taken

15.6 Laboratory and testing apparatus

15.6.1 Laboratory

The anodizing plant shall have laboratory facilities which are in a dedicated room separate from the rest of the anodizing plant and where appropriate conditions are maintained for the tests that are carried out.

15.6.2 Apparatus

15.6.2.1 General

Each apparatus shall conform to the requirements of the appropriate standard for the test concerned. Each piece of apparatus shall be functional and have a data sheet showing the apparatus identification number and calibration checks.

15.6.2.2 Apparatus for product testing

Each anodizing plant shall have at least two instruments for measuring thickness using the eddy current method or one instrument for the eddy current method and one split-beam optical microscope (9.2).

The anodizing plant shall have available apparatus for measuring wear resistance (9.6.2, 9.6.3, 9.6.5)

The anodizing plant shall have access to apparatus to carry out any other product tests described in 15.7 that are required by the customer. Any organizations selected to carry out such a test shall be accredited to ISO 17025 for that test.

15.6.2.3 Apparatus for testing baths

If the anodizing line has one or more sealing baths, the anodizing plant laboratory shall have a pH meter and two buffer solutions.

15.7 Product tests to be applied by the licensee

As indicated below, some tests are not applicable to hard anodizing.

15.7.1 Required tests

The licensee shall apply the following product quality tests depending on the products it produces. See below for details.

- Thickness
- Visible defects
- Wear resistance
- Final dimensional tolerances (if required by the customer)

Additionally, the licensee shall apply any of the tests described below that are required by the customer.

There are a number of options to take test specimens. The licensee should adopt an option from the list below where 1) is the most preferred and 3) is the least preferred. Circumstances which might lead the licensee to adopt a less preferred option include those where: i) it is not possible to take specimens from the production lot because of the shape, size or form of the product; ii) multiple lots of different alloys are treated together; iii) the lot comprises only one piece.

1) Test specimens shall be taken from the production lot.
2) Test specimens shall be made of the same alloy as the production lot and treated simultaneously with it.
3) Test specimens may be made of a different alloy from the production lot but shall be treated simultaneously with it. The alloy shall contain at least 97% aluminium. If the licensee frequently adopts this option, it should always use the same alloy so that it can develop a consistent record.

The practice adopted shall be recorded in the production control system.

The licensee shall comply with the requirements of the standards specifying the tests that it applies. The relevant international standards are identified in clause 4.

15.7.2 Thickness

Thickness measurements shall be made using a method of 9.2.

Where a nominal thickness of up to 50 µm is specified, the average thickness shall not be outside ± 20% of the nominal thickness. Where a nominal thickness over 50 µm is specified, the average thickness shall not be outside ±10 µm of the nominal thickness.

If specified by the customer, the measurement of thickness shall be dealt with in a lot acceptance test. The customer shall specify the sampling procedure to be used or that no sampling from the lot is required.

In the absence of instructions on sampling from the customer, coating thickness measurements shall be carried out at least once on the finished products from every flight bar. Coating thickness checking before colouring and sealing is recommended.

The minimum and maximum values of the average and local thicknesses shall be recorded in the production control system.

15.7.3 Dimensional tolerances

Where relevant, the measurement of final dimensions shall be dealt with in a lot acceptance test.

15.7.4 Sealing quality

Not applicable.

15.7.4.1 Mass loss test

Not applicable.

15.7.4.2 Dye spot test

Not applicable.

15.7.4.3 Admittance test

Not applicable.

15.7.5 Visible defects

Parts shall be examined visually as required by 9.4.1. The significant surface shall be completely anodized. The visual appearance shall be substantially uniform without spalling, blistering or powdery (burnt) areas. Crazing or microcracks are not normally a reason for rejection.

15.7.6 Surface texture and colour

Not applicable.

15.7.7 Light reflection properties

Not applicable

15.7.8 Corrosion resistance

If required by the customer, the corrosion resistance shall be assessed using the neutral salt spray test method of 9.5. The duration of the test shall be 336 hours.

After the test, a test piece with an anodic oxidation coating thickness of 50 µm shall not show any corrosion pits except those within 1.5 mm of jigging marks or corners.

This test is only applicable to sealed anodic oxidation coatings.

15.7.9 Wear resistance

The wear resistance of anodic oxidation coatings shall be determined by using either the abrasive wheel method of 9.6.2, the abrasive jet method of 9.6.3 or the Taber method of 9.6.5. The selection of the method and the procedure shall comply with ISO 10074.

The time between anodizing and testing shall be at least 24 h. During this period, the test pieces shall be stored in the test environment.

The number of double strokes used in the abrasive wheel test shall be 800 to 100.

The test frequency shall be agreed by the licensee and the customer.

The relative mean specific abrasion resistance of the abrasive wheel and abrasive jet methods shall be greater than 80%.

The mass loss of the Taber method shall not be greater than 15 mg.

15.7.10 Surface abrasion resistance

Not applicable.

15.7.11 Microhardness

If required by the customer, the Vickers microhardness of anodic oxidation coatings shall be determined by using the method of 9.7. The test load shall be 0,49 N.

The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, the following criteria shall apply. The microhardness value, $H_{v\ 0,05}$, of coatings not thicker than 50 µm shall not be less than 400. The microhardness value, $H_{v\ 0,05}$, of coatings thicker than 50 µm shall not be less than 350.

15.7.12 Resistance to cracking by deformation

Not applicable.

15.7.13 Light fastness

Not applicable.

15.7.14 Thermal craze resistance

Not applicable.

15.7.15 Coating continuity

Not applicable.

15.7.16 Electrical breakdown potential

If required by the customer, the electrical breakdown potential shall be determined using the method of 9.10.

The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, anodic oxidation coatings 50 µm thick shall have a minimum breakdown voltage of 1200 V. The value shall be the mean of ten measurements.

The method does not give satisfactory results for unsealed coatings.

15.7.17 Surface density

If required by the customer, the surface density shall be determined using the method of 9.12.

The test frequency and the acceptance criterion shall be agreed by the licensee and the customer. In the absence of such an agreement, the surface density shall be at least 1100 mg/dm^2 for an unsealed 50 µm thick coating or equivalent for coatings of other thicknesses.

15.7.18 Roughness

If required by the customer, the method, test frequency and acceptance criterion shall be agreed by the licensee and the customer.

15.7.19 Service simulation tests

If required by the customer, anodized products shall be assessed using a test or tests specified by the customer to simulate the service conditions. The test frequency and the acceptance criterion shall be agreed by the licensee and the customer.

15.8 Requirements concerning processes

15.8.1 Pretreatment

The licensee may use whatever processes it deems appropriate to achieve the finish required by the customer. These can include mechanical processes such as blasting, grinding, brushing, buffing and polishing as well as chemical ones such as degreasing, etching, desmutting and neutralization.

15.8.2 Anodizing

Anodizing shall be carried out using solutions based on sulfuric acid.

15.8.3 Colouring

Not applicable.

15.8.4 Sealing process

Not applicable.

15.8.5 Hot water sealing

Not applicable.

15.8.6 Cold sealing

Not applicable.

15.8.7 Other sealing systems

Not applicable.

15.9 Methods for process control

15.9.1 Etching

Not applicable.

15.9.2 Brightening

Not applicable.

15.9.3 Anodizing

Anodizing baths shall be analysed in accordance with the instructions of the supplier of any anodizing additive. In the absence of such instructions, the analysis of free sulfuric acid and dissolved aluminium shall be carried out. The analysis frequency shall be at least:

- once a day for each bath if three shifts are worked per day;
- once every two days for each bath if two eight-hour shifts are worked per day;
- once every three days for each bath if one eight-hour shift is worked per day.

Based on the results of the analysis the bath composition shall be adjusted accordingly.

The temperature of each anodizing bath shall be checked at regular intervals and at least twice during every work shift when the line is in use. It shall be checked at the end of an anodizing cycle.

15.9.4 Sealing

Not applicable.

15.9.5 Storage of products

Aluminium products shall be stored away from the anodizing facilities both before and after anodizing. After anodizing, they shall be protected from condensation and dirt.

15.10 Production control records

15.10.1 Control systems

The anodizing plant shall have a secure system for controlling production and its records shall show at least the following information.

- The customer's name and address, order or serial number.
- The production date.
- The agreed coating thickness and the actual thickness measured (minimum and maximum values of average thickness).
- The results of the examination for visible defects.
- Final dimensional tolerances (unless not required by the customer).
- The results of the wear resistance test.
- The results of all other tests required by the customer.
- Measures taken to remedy values not meeting the requirements.

The records shall include the following.

- The results of analyses and temperature monitoring of anodizing baths, and the number of shifts worked.
- The product name and application of any proprietary chemicals or processes used.

All the information shall be readily accessible for the inspector.

15.10.2 Traceability

The licensee shall specify and maintain procedures to associate the production clearly with the pertinent drawings, specifications or other documents during all phases of production, delivery and assembly. Individual products, lots or batches must be identified unmistakably. This identification shall be included in the control system records.

15.11 Inspections

15.11.1 General

The inspector carries out inspections as described in clause 8 with reference to the requirements included here in 15.11. In order to avoid an unproductive inspection visit, it is advisable that the plant notifies the appropriate body if it is concerned that sufficient material for testing might not be available during certain periods.

15.11.2 Nonconformities

The following is a list of nonconformities for hard anodizing.

- An unsatisfactory coating thickness result (unless dimensional tolerances take precedence). See 15.11.4
- Incomplete production records. See 15.10
- The use of anodizing solution not based on sulfuric acid. See 15.8.2
- No functional apparatus for measuring coating thickness. See 15.6
- No functional apparatus for wear resistance testing. See 15.6
- No availability of functional apparatus for any test specified in the Qualanod specifications and required by the customer. See 15.6

15.11.3 Identification of parts passed by internal quality control

The licensee shall indicate to the Qualanod inspector which goods have passed the internal quality control. Goods that are kept in stock ready for dispatch or packed shall be considered to have passed the internal quality control.

The licensee shall clearly identify parts not covered by his licence for hard anodizing. The inspector may seek verification of the type of anodizing by, for example, examining the written agreement between the anodizer and his customer.

15.11.4 The product tests of an inspection

The inspection can include the following product tests.

- Coating thickness

Average coating thicknesses are measured on products using the eddy current method specified in ISO 2360 (see 9.2). These shall not be outside the range for the specified nominal thickness (see 8.3.6).

15.11.5 Processes

The inspector verifies that the processes are carried out in compliance with the requirements of 15.8. He also verifies by observation that bath analyses are performed correctly.