

**HARD ANODIZING**  
**KJ-06.03**  
**ANNEX TO KJ-06**

**Compiled by:**

Technical Department DTT-8/S

**Approved by:**

Process Engineering Office Director  
Chief Process Engineer

## 1. Purpose

The purpose of this document is to regulate the basic requirements for hard anodizing process of aluminum alloys performed by suppliers on parts delivered to Polskie Zakłady Lotnicze Sp. z o.o.

## 2. Subject

The subject of this document are requirements regarding hard anodizing process and control of parts subject to hard anodizing process.

## 3. Scope

The requirements specified herein apply to all suppliers and should be met in the scope specified in a purchase order / agreement / contract.

## 4. Related documents

Scope of application of related documents refers to their current revisions.

PN-EN 2536	Hard Anodizing of Aluminum Alloys
ASTM B 244	Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
PN-EN ISO 4516	Metallic Coatings and other Inorganic Coatings. Microhardness Tests by Vickers and Knoop Methods.
PN-EN ISO 1463	Metallic Coatings and Oxide Layers. Thickness Measurement Method. Microscopic Method.
ASTM B 487	Measurement of Metal and Oxide Coating Thickness by Microscopical Examination at Cross Section.
AMS 2468	Hard Anodic Coating on Aluminum Alloys.
AMS 2469	Hard Anodic Coating on Aluminum and Aluminum Alloys
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys

## 5. Additional information

### 5.1. Classification of coatings

This document applies to inspection of hard anodic coating per types and categories in accordance with PN-EN 2536.

TYPE A: hard anodizing without sealing.

TYPE B: hard anodizing with sealing.

If the type of coating is not specified in the documentation, type A shall be applied.

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.

Categories of aluminum alloys, subject to hard anodizing are as follows:

- Category 1 – alloys containing less than 1 % of copper
- Category 2 – alloys containing 1% to 5 % of copper

The type of anodizing per MIL-A-8625 is TYPE III hard anodizing.

## 5.2. General notes

- a) A detailed process should be developed for each part
- b) Parts subject to anodizing should be free from foreign substances, oxides and dirt like greases, oils, paint, welding flux. Apply a preparation process in order to get a water break free surface before anodizing. Using abrasive materials with iron content for mechanical cleaning is forbidden, as it could accelerate corrosion of aluminum alloys
- c) Parts shall be anodized after complete machining, heat treatment, welding, and penetrant inspection. The surface of the parts subject to anodizing shall be free from surface defects which may cause the produced anodic coating not to satisfy the requirements of this specification. The surface defects may be caused by machining, cutting, scratching, polishing, bending, stretching, etching, chemical composition imbalance and inclusions.
- d) Subsequent process operations shall be carried out without excessive delays in order to avoid parts drying.
- e) Avoid handling parts after deoxidation, if necessary handle wet parts with clean latex or rubber gloves.
- f) Before anodizing, non-metal elements should be removed or protected against contact with the sulfuric acid solution.
- g) Use additional internal cathodes to anodize parts with deep cavities or to internal surface of tubes, when length- to internal diameter ratio is bigger than 10:1.
- h) It is allowed to handle wet parts only in rubber gloves, while dry parts only in clean cotton gloves.
- i) Keep cathode and anode bars clean.
- j) Anodized surfaces should be completely immersed in the bath.
- k) For each batch of hard anodized parts, where coating microhardness test is required, a “witness” specimen should be anodized with the load. The witness specimen should be made of the same material as the anodized part and should be of the same roughness class as the part. Specimen dimensions: minimum 30x30x5mm. The specimen should be used for coating thickness measurement, if the shape or dimensions do not allow to measure the thickness on the part. The specimen should have the size that provides for application of the probe 5 times.
- l) Hard anodic coating may be machined up to removal of maximum 50% of its thickness in order to fit part dimension.

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.

### 5.3. Non-conforming parts

Follow the requirements defined in KJ-06 para.8.3.

## 6. PROCEDURE

### 6.1. Process qualification

Hard anodizing is a special process and requires initial and periodical qualification under production conditions. In the case when a special process realized in accordance with the defined requirements at the supplier has been approved by one of the companies of the corporation to which Polskie Zakłady Lotnicze Sp. z o.o. belongs, this qualification can be automatically recognized. It is acceptable to approve the special process at the supplier on the basis of his manufacturing process upon previous acceptance by the design engineer of Polskie Zakłady Lotnicze Sp. z o.o. Then, such a special process at the supplier is granted the status of a frozen process. Any change to the approved process requires re-acceptance by the design engineer.

During initial qualification of a supplier, Polskie Zakłady Lotnicze Sp. z o.o. reserves the right to participate in the process performed on parts and specimens at a new supplier and the possibility to perform control quality tests on parts or specimens processed by this supplier.

A qualification team at Polskie Zakłady Lotnicze Sp. z o.o. shall conduct a qualification audit of the special process at the supplier, following the below procedure:

#### a) Inspection of devices and review of the metrological confirmation records

Verification if:

- The devices have equipment to control working parameters of the special process with required accuracy
- All measuring equipment used to control the correct course of the process (or some parameters) is in proper place secured from aggressive atmospheric conditions
- Used materials meet technical and quality requirements
- There is a record regarding periodical review of the devices and metrological confirmation of used measuring equipment
- The process does not violate the requirements of the standards regarding environment protection and safety of work.

#### b) Review of documents and special process instructions

The Qualification Team shall check if:

- Technical documentation necessary to perform the process is complete and current
- Process engineering and quality instructions regarding the process are accurate and intelligible, including the related requirements; the instructions shall be

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.

- available on the work stand
- Products identification is ensured by their recording on the work stand.

### c) Knowledge and personnel practical skills

The Qualification Team shall check if:

- The personnel involved in the process have the required qualification documentation
- The personnel is authorized to carry out the processes
- All changes to the personnel are recorded. Change of the personnel may cause necessity to repeat first article inspection

### d) Realization of the special process on a specimen or product

Special process is performed on specimens or products in accordance with the requirements set out by Polskie Zakłady Lotnicze Sp. z o.o. It is required to check the sequence of performed activities and correct determination of the process parameters. It is required also to verify if the tests of specimens and products are performed on controlled and calibrated equipment.

### e) Results analysis

The Qualification Team heaving authorization of auditors prepares a report from audit performed at supplier's facilities. Documents prepared by the supplier during internal qualification are also attached.

#### 6.1.1. Change in the special process

Any change in the devices, conditions of use, instructions, personnel at the supplier must be reported by the process owner to the manager of Supplier Quality Assurance at Polskie Zakłady Lotnicze Sp. z o.o. who will decide on a necessity to carry out a new qualification. The change cannot be introduced until the approval is obtained.

Audit performed by the Qualification Team at the supplier is not required in the case, when a special process conducted on a new equipment has been already qualified on the equipment used previously. In this case a decision about qualification may be issued based on the review of internal qualification documents submitted by the process supplier.

#### 6.2. Quality inspection of the production batch

- a) Inspection processes and the final acceptance of parts shall confirm compliance with the parameters of the qualification process
- b) Conduct visual inspection of parts
- c) Conduct register of records of quality acceptance
- d) The quality records (test sheets, reports of tests, registers, etc.) shall be retained for 10 years or 40 years for critical parts
- e) Periodical analyses of the baths shall be conducted with a frequency to

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.

guarantee good quality of coating. Analysis results, make ups and bath replacements shall be recorded

- f) Control current and temperature parameters
- g) Conduct anodic coating thickness and microhardness tests on the parts within process control
- h) Conduct coating thickness inspection
- i) Control the compressed air used in the process for lack of contamination like water, oil, etc.

### 6.2.1. Inspection methods and requirements

- a) Parts are subject to visual inspection and coating thickness and/or hardness inspection
- b) The following tests for the process approval and process control are conducted on the specimens:
  - Coating thickness by microscopical method
  - MicrohardnessThe test results are compiled in the test reports.
- c) Definition of specimens

Specimens shall be processed with the production parts. Specimens for tests before anodizing shall be carefully visually inspected. They shall not have visible contaminants, defects such as corrosion, inclusions and delamination.

### 6.2.2. Inspection of parts

Note: Wear clean cotton gloves when inspecting the parts.

#### 6.2.2.1. Visual inspection of parts

- a) Conduct visual inspection on 100% parts of every production batch.
- b) The following defects are not acceptable on parts: areas without anodic coating (except places of contact with clamps of a rack), deep scratches injuring anodic coating, etching (pits), blisters, peeling off while rubbing, light stains being the sign of over etching of coating due to local overheating.
- c) The color of hard anodic coating depends on the composition of the alloy and parameters of anodizing. Depending on a type of material, the coatings may be gray, green, black, brown, olive with various intensity of color and shades. At the same coating thickness and different temperature of processing, the shade is usually different (darker at lower temperature).

#### 6.2.2.2. Anodic coating thickness inspection

- a) Anodic coating thickness should be in accordance with the design documentation requirements.
- b) Thickness of hard anodic coating should be  $51 \mu\text{m} \pm 10 \mu\text{m}$  for the orders according to MIL-A-8625 and AMS 2468 and AMS 2469.

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.

- c) Parts are approved on the basis of anodic coating thickness measurement on the part unless the part shape or dimensions do not allow to take measurement. In this case use the specimen for the process.
- d) Measure anodic coating thickness on production parts or on the „witness” specimen using eddy-current gauge or another device approved by Polskie Zakłady Lotnicze Sp. z o.o.
- e) Coating thickness can also be measured in the laboratory on a lateral microsection using a microscopic method.
- f) In order to maintain the process perform anodizing on 3 specimens of 2024 T3 AMS-QQ-A-250/4 material or alloy used in a majority of production in the month. Nominal thickness of coating. Specimen dimensions: length x width x thickness = 3 x 3 x 0,032 inch (76 x 76 x 0,8 mm).

### 6.2.2.3. Hardness inspection of anodic coating

Microhardness should be minimum 300 HV 0,05 (kG/mm<sup>2</sup>) for category 1 alloys (PN-EN 2536), and minimum 250 HV 0,05 (kG/mm<sup>2</sup>) for category 2 alloys with anodic coating thickness 25 to 42 micrometers.

In case of different requirements, microhardness value should be determined in the design documentation or agreed between the customer and contractor.

Microhardness of anodic coating is checked on a witness specimen processed with the load. Microhardness of coating for alloys with high content of copper (PA7, D16, PA6, D1, PA33, AK-8) shall be minimum 250 HV0,05 (250 kG/mm<sup>2</sup>), for alloys with low content of copper – minimum 300 HV0,05 (300 kG/mm<sup>2</sup>) unless the drawing or process sheet indicates otherwise.

### 6.2.3. Inspection of specimens

Compilation of tests on witness specimens for hard anodizing process for the production batch and process control is presented below:

Type of test	Tests frequency	Specimens dimensions [mm]	Quantity	Material
Coating thickness	Each load if required by the Process Sheet	Minimum 30 x 30 x 5	1	Same as the parts
Microhardness	Each load if required by the Process Sheet	Minimum 30 x 30 x 5	1	Same as for coating thickness test

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.

### 6.2.3.1. Coating thickness inspection

Inspection of hard anodic coating thickness shall be conducted by a microscopic method in accordance with PN-EN ISO 1463 or ASTM B 487.

Thickness of hard anodized coating on a specimen shall be in compliance with the requirements of a drawing or technical conditions of parts processed with the specimen.

### 6.2.3.2. Hardness inspection

Microhardness measurement of anodic coating shall be conducted on lateral microsection in accordance with PN-EN ISO 4516 using a Vickers and Knoop method.

### 6.2.3.3. Abrasion resistance test

Abrasion resistance test shall be done on specimens with unsealed anode, a maximum weight loss (abrasion index) should be as follows: for alloys containing 2% copper or higher – 3,5 mg/1000 cycles, for the remaining aluminum alloys – 1,5 mg/ 1000 cycles. Two specimens weighted with accuracy to 1 milligram shall be tested in accordance with ASTM D 4060 using CS-17 abrasive wheels with load 1000 g for 10 000 cycles. The shield should rotate on anodized surface at the rate of 70 revolutions per minute, for 10 000 cycles. The wheels shall be renewed (ground) at least after 10 000 cycles. Abrasion index is defined after 10 000 cycles by dividing the weight loss by 10.

### 6.2.4. Process inspection

Perform process control once a month. Additionally, when the process is not carried out for one month or longer, specimen must be made at the start of production.

The inspection includes the tests for compliance with the following standards:

1. process course parameters in accordance with MIL-A-8625
2. coating appearance in accordance with PN-EN 2536
3. coating thickness in accordance with EN-PN 2536 and MIL-A-8526.
4. microhardness in accordance with EN-PN 2536.

**Note:**

Upon printing the copy is uncontrolled – check its validity before use.