APPEARANCE OF ANODISED FINISHES

The purpose of this guide document is to provide helpful information to assist anodisers to improve uniformity in the production of anodized aluminium components for the architectural sector.

The final appearance of an anodized surface depends on the following factors: base material, colour, gloss (glossy or satin) and any mechanical treatments (brushing, grit blasting, special effects).

Below is information on which elements can affect the final appearance, the control modes, and the importance of choosing reference samples to obtain consistency in the finish produced.

Two methods can be used for assessing the appearance:

- ***Visual assessment***
  This is the method generally used. When it is part of contractual arrangements, a reference range is advisable. Visual assessment is the default procedure for obtaining a general overview of the article, not just isolated areas as is the case with instrumental measurements.

- ***Instrumental measurements (gloss meter and spectrophotometer)***
  Instrumental measurements can be a handy tool during the production process for verifying colour constancy. They allow a numerical and less subjective evaluation of the colour differences between the production batches, but sometimes they do not reproduce human vision which shall be used for the final assessment.

An important aspect is the selection of the reference samples. The surface finish (satin finish, polishing, brushing, etc.) affects the perception of colour; it would, therefore, be appropriate for the initial reference specimens to be the same either for the definition of gloss or for colour.

1. Elements that affect the appearance of anodized finishes

Several factors can affect the surface appearance.
The level of influence of process steps on the components that determine the final appearance is outlined in Table 1; the table also includes the characteristics of the aluminium used.

The number of asterisks is directly proportional to the level of influence.

	Brightness	Colour	Mechanical finish
Aluminium chemical composition	*** [1)]	** [1)]	/
Extrusion or rolling and heat treatments of Aluminium	**	** [2)]	
Mechanical treatments	**	** [2)]	****
Brightening/Mechanical polishing	****	* [2)]	/
Etching	****	*** [2)]	**
Anodizing conditions (including thickness)	** [3)]	**	/
Colour/Electro colouring	/	****	/
Sealing	*	** [4)]	/
Final scratch-resistant polishing	****	**	/
Pickling and re-anodising	****	***	****

TABLE 1 – INFLUENCE OF PROCESS STEPS ON SURFACE APPEARANCE

NOTES:
1) The elements present in the alloy can affect the brilliance and colour; the main elements that affect this are Fe, Cu and Zn
2) Surface finish and/or gloss affect visual colour perception
3) Only in the case of polished or very shiny finishes
4) Different technologies of sealing solutions can affect the final shade of both natural aluminium and coloured finishes
5) It is recommended to remake the mechanical finish after pickling the pieces.

2. Criteria for raw aluminium

For material destined for the same order, the raw aluminium must come, if possible, from the same supplier. The alloy composition shall be as constant as possible (within the alloy specification given).

For 6060 and 6063 alloys, too high variations in the Fe, Cu and Zn content can lead to a different final aspect.

In the case of rolled products, the material should be from the same slab and, in the case of orders requiring more slabs, of slabs from the same casting where possible.

Care must also be taken, on the part of those who create the facade, so that the sheets are positioned maintaining the rolling direction always in the same direction, to avoid obtaining a different perception of colour.

3. Evaluation methods

3.1. Visual assessment

According to the Qualanod specification, *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.

The personnel deputed to the colour control in production should be properly formed and their visual perception should be verified*.*

In the case of specific orders, see paragraph 4.

3.2. Instrumental measurements (gloss meter and spectrophotometer)

Instrumental evaluation is carried out by means of a glossmeter, to measure surface gloss, and by spectrophotometer, to measure colour.

Note: Not all products can be measured because of the shape of the product.

3.2.1. *Brightness measurements by means gloss-meter*

Although a gloss tolerance is rarely specified in the contracts, a uniform surface finish is also essential to meet any colorimetric tolerance. It is always necessary to define the angle of the incident light to be used for the execution of the measurements (ISO 7668) and make two sets of measurements, one parallel and the other perpendicular to the direction of extrusion or rolling.

- The instrumental measurement by glossmeter is reliable for smooth, satin or glossy finishes, while in the case of "structured" finishes (e.g. brushing) it is always necessary to perform a visual evaluation with the reference samples.
- When gloss measurements are made on a structured finish, they must **always** be made in the same direction of mechanical finishing.
- Since the base material also affects the finish, in case the first industrial production has a significant deviation of the gloss from the agreed samples it is necessary to inform the customer for approval.

3.2.2. *Colour measurements by spectrophotometer*

- It is important to specify the type of spectrophotometer used.
- If the contract includes ΔE measurements, the instruments used by the anodiser and by his customer for verifying the production shall have the same geometrical characteristics (angle or sphere).
- Moreover, the colour space, the formula for calculating the ΔE and the illuminant used shall be defined. Using different tools or parameters can lead to incompatible results.
- In the case of a sphere spectrophotometer it is also necessary to indicate whether the measurement is performed with the specular component included (SPIN) or not (SPEX).
- Colour measurements on samples with particularly different gloss values may lead to readings that do not correspond to visual perception: the reference sample (target) must have the same degree of brilliance expected for the supply. The reference limit samples for the definition of glosses and for that of colour need to be agreed.

4. Reference samples

The correct definition of reference samples is often not given sufficient importance.

The surface finish (etched, polished, brushed, etc.) affects the perception of the colour, and it is therefore advisable that the initial limit samples be the same for the definition of glosses and for that of colour. Moreover, the initial limit samples must also represent the range of acceptability especially for a different range of profile shapes.

Visual assessment:
This method is widely used because it allows accurate assessment of colour, gloss, and visual perception, which aligns with that observed by the customer or passer-by when viewing architectural finishes.

It is generally recommended that reference samples be obtained from typical components (the most visual ones), i.e., capping sections, mullions, or panels, and a range limit set is created to show acceptable colour variation; in addition, for extruded material, it may be prudent to also agree on a “texture” or die line sample. The agreed range limits can show variations due to material structure changes, alloy selection, and anodising treatments.

Generally, the visual assessment should be the preferred contractual parameter for any anodised project. Multiple sets of limit samples should be issued for signature and approval through the contractual chain, i.e., from the anodiser to his customers, the facade contractor, the architect, and the client. These range limits should be agreed upon before anodising commences.

In the case of specific orders, if the characteristics of the aluminium used for production are notably different from those of the raw material used for the original limit range, a new range may need to be defined when the first significant production is processed. The new limit sets shall be agreed upon and signed and will be the ultimate reference sets.

Instrumental measurements:

Where an instrumental assessment for in-house or external use is foreseen, it is essential to establish the following elements:

- ➔ **Target**: Reference specimen for colour measurements by spectrophotometer, identified during the first significant production.
- ➔ **Acceptance range (ΔE):** maximum acceptable difference from target values expressed in colourimetric coordinates L*, a* and b*.

Below are the steps to identify the target and verify batch consistency.

a) In the case of colour evaluation, it is essential to agree on an initial reference range (already available or agreed upon by pre-production) to be used for the first production.

b) The actual reference sample (**target**) is **established on the first significant production** and, if possible, representative of the components of the contract. The procedure is as follows::
   - make an orderly reading of a statistical number of samples
   - the average value of the production becomes the **TARGET of the order** to be used as a reference also for subsequent productions
   - the target must be visually inside the “initial limit” specimens but can be a “non-central" value
   - the average of the measurements on the three colourimetric coordinates is calculated: these values will constitute the colourimetric coordinates of the target of the contract, verifying, however, that these values fall within the established range; in this case, it would not be possible to see the point e).

c) Where possible, a physical sample should be defined by identifying the sample with the lowest ΔE in respect of the mean of the measurements among those sampled; if the physical sample is chosen, **the colourimetric coordinates of this sample will be the target of the order**; the physical sample will be shared between the parties and will be the reference in case a visual inspection is also necessary.

d) Once the target has been identified, it is verified that the uniformity of the lot falls within the established ΔE value

e) As the base material also affects the finish, in case the first production has a significant deviation from the agreed initial range it is necessary to inform the customer immediately for approval.

f) This procedure ensures greater consistency of the material produced, not only of the first batch but also of the subsequent ones.

Following is a block diagram of the procedure described above:

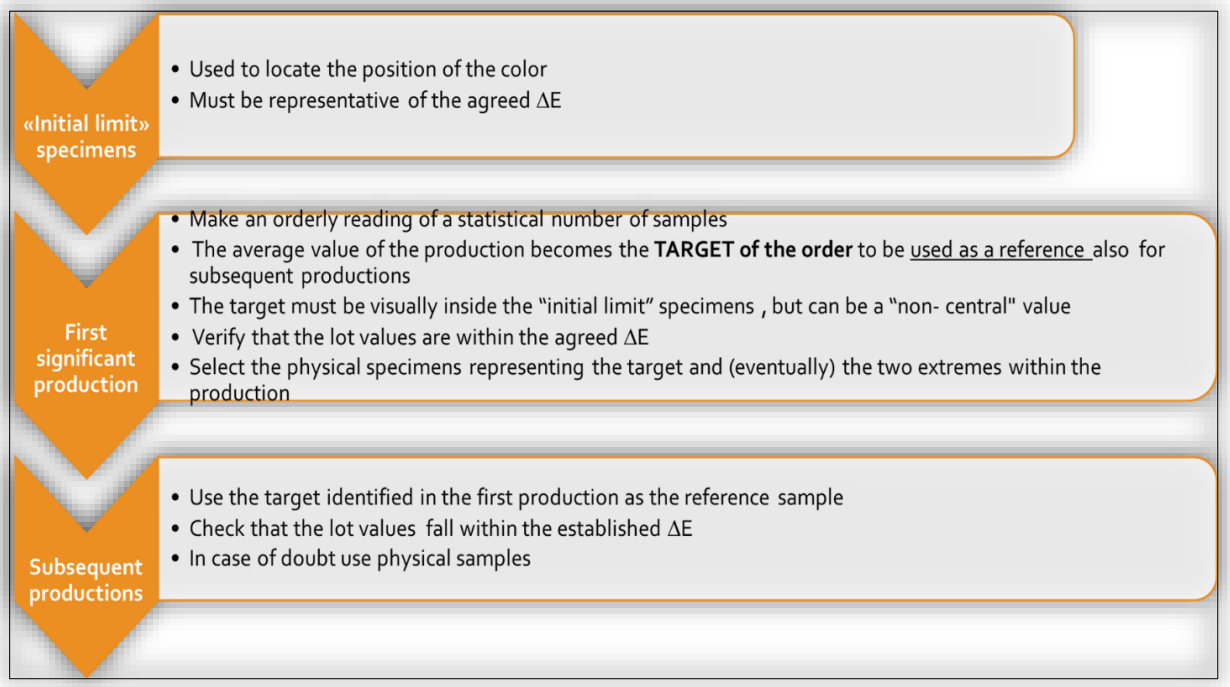
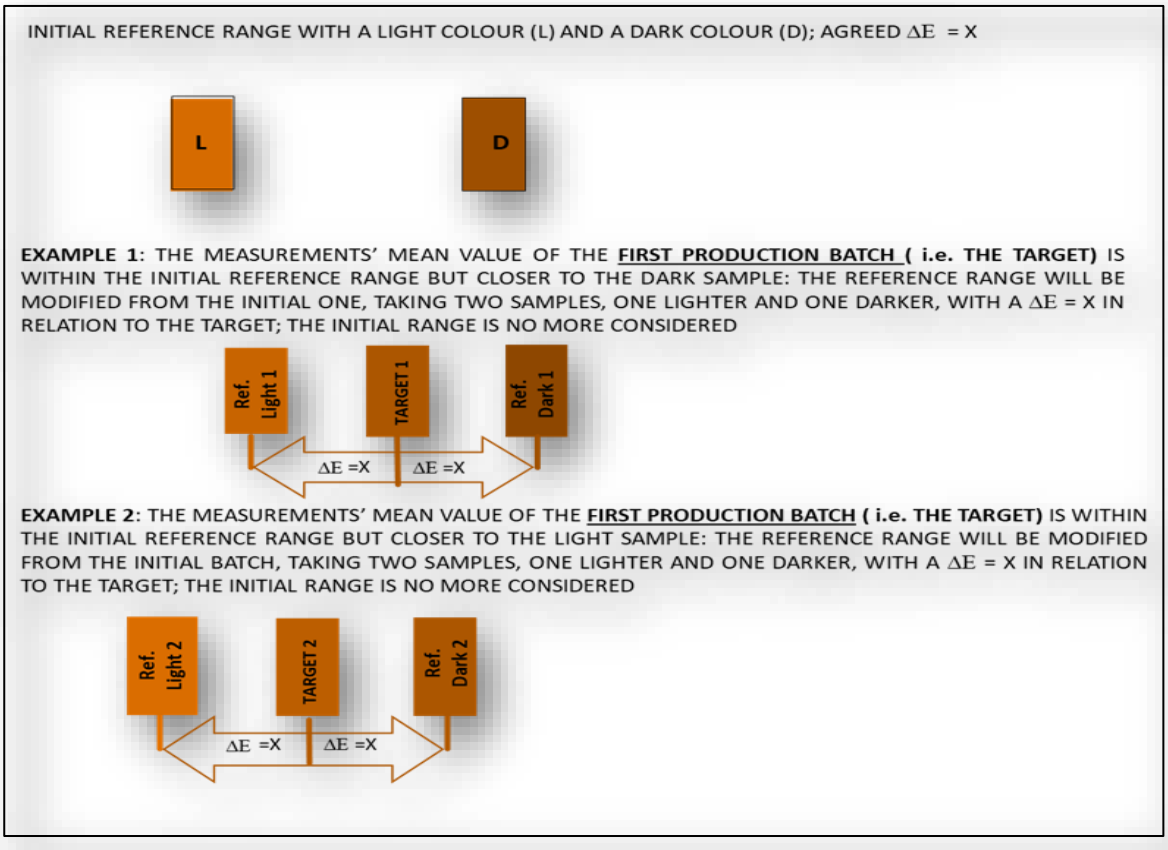


Fig.1 – block diagram of the target definition of a job

In Fig. 2 two examples are given to understand how the reference range is determined by the target defined with the first significant production and how the fork can change from the initial one.



.Fig.2 – Examples of reference ranges as a function of target position