

TECHNICAL ACCEPTANCE CONDITIONS FOR ZINC COATINGS

1. Subject matter and scope of the TAC.

The subject of TAC are the requirements to be met by the material delivered for galvanizing and the usable properties that the zinc coating produced at the galvanizing plants of FAM Sp. z o.o. should have.

The TAC below also applies to zinc coated products with passivation service and the appearance of the passivated coating. A zinc coating is also understood as a zinc coating with passivation.

2. Technical requirements to be met by products delivered for hot dip galvanizing.

- Products delivered for galvanizing shall be packed on pallets or racks allowing unloading with fork lifts. The weight of the parcel should not exceed 3 tones. Products delivered without pallets or racks are exposed to mechanical damage during unloading, internal transport and loading, for which the galvanizing plant is not responsible.
Small items should be packed in collective packaging (crates, containers, buckets) or bound and combined with the rest of the delivery.
- The product should consist of components made of a single grade of steel and of similar wall thickness. It should be made of ordinary quality carbon structural steel. Preferably, steels with a silicon content of up to 0.03% or between 0.13 and 0.25% should be used. The use of steels containing 0.03 - 0.13% as well as more than 0.25% silicon can lead to excessively thick and rough coatings, which in extreme cases may fall off the steel substrate. The total silicon and carbon content of the steel should not exceed 0.32%. When phosphorus is included in the steel, the sum of the percentages $Si+2.5 \times P$ (where Si and P represent the percentages of silicon and phosphorus in the steel) shall not exceed 0.09%.
- The product must not contain spaces that are closed or that close when it is immersed, as there is a risk of explosion. In this case it is necessary for the client to drill vent holes. Their location and size must be agreed with the galvanizing plant. The galvanizing plant has no obligation or possibility to check the correct execution of the through-holes. In this case, it relies on the customer's declaration that they have been properly executed in accordance with WTO requirements. The galvanizing plant is therefore not responsible for the lack of properly made concealed holes in the structure intended for galvanizing and its flowing out during galvanizing. If significant irregularities are detected in the holes, the material will not be galvanized without the customer's consent. In case of technologically very complex structures (trailers, platforms and other structures having a large number of welded joints) when the verification of the correctness of the process holes is impossible or would be very time consuming, the galvanizing plant assumes the principle of their correct execution in accordance with the accepted on the order document, i.e. GTCS and TAC. The galvanizing plant is also not responsible for the improper course of the galvanizing process (lack of immersion of the structure, lack of coating due to lack of vent holes).

- The product shall be designed so that it does not carry in its internal and external spaces the individual process media through which it passes during the galvanizing process. Drainage holes should be made as close as possible to the respective edges to allow free drainage of the chemical and zinc baths. The galvanizing plant is not responsible for leaks of process bath media from inside the structure during its use.
- Railings and balustrades that include a handrail should always be suspended with the railing facing upwards. This must be taken into account when making the vent holes and holes for hanging the structure.

It is permissible to galvanize railings and balustrades with the railing facing downwards, after prior agreement with the sales department.

- The product should have holes of (depending on the size of the structure) 8-32mm (recommended min. Ø10). Minimum hole sizes depending on the size of the structure are shown in Table 2.
- The product should have holes or other design features to allow it to be suspended from a wire or hook. The holes should be chamfered - sharp edges can break the wire.
- The product to be galvanized shall be free of impurities on its surface that cannot be removed in the process of degreasing and pickling in hydrochloric acid (lacquers, paints, adhesives, stickers, greases, silicone-based anti-chipping agents, welding slag, scale, sander, etc.). All impurities shall be removed by the supplier, preferably by abrasive blasting. This applies in particular to all welded joints.
- The zinc coating on heavily corroded material may be of a deteriorated quality.
- In case of inherent stresses in the structure, deformation of the product shape is possible due to heating in the zinc bath to 450°C. Sheet-metal parts or sheets which are part of larger structures may become wavy. It is recommended to use embossing to limit deformation.

So-called louvre fences with internal vents can also be deformed due to the high risk of them sticking, which prolongs the time spent in the furnace.

Intrinsic stresses arise independently of cooling after galvanizing, among other things by introducing heat into the structure through welding of components, mixing of steel grades, types and thicknesses.

The galvanizing plant does not perform the operation of straightening of elements that have been deformed during the galvanizing process.

- The product delivered for galvanizing shall be free of weld spatter. The joints should be continuous and non-porous. The galvanizing plant is not responsible for defects on welds caused by inadequate preparation. There shall be no chips, cutting burrs or shot residues in the structure or in the holes.
- There shall be no gap in the product structure with a width of less than 5 mm
- Overlapping surfaces should have vent holes.
- It is not allowed to galvanize products that already have galvanized components.
- Steel or cast iron components welded into steel structures may not be suitable for galvanizing.
- It is advisable to deburr sharp edges. The coating on sharp edges is prone to chipping.
- If it is necessary to protect the threads against zinc coating, use a special protective agent or silicone which is resistant to 800-1000°C. The threads only need to be

lubricated and this should not be done at the last moment before galvanizing. The preparation (silicone), which is in excess or has not yet had time to solidify, combines with the bath during the galvanizing process and soils the construction.

3. Coating material.

The products are galvanized in an alloy complying with the ISO 1461 standard.

4. Requirements to be met by zinc coatings.

4.1 Coating appearance.

- The zinc coating should meet the requirements of EN ISO 1461: "Protective coatings applied to steel and cast iron products by dipping. Requirements and test methods." The sum of the individual not fully galvanized areas must not exceed 0.5% of the total surface area of the object. A single spot with a defect must not be larger than 10 cm². All areas with defects shall be corrected by the galvanizing plant in accordance with item 5.
- White corrosion on the coating cannot be the basis for a complaint, as long as the minimum thickness of the zinc coating on the products is observed.
- It is permissible for there to be overflows in the areas of zinc dripping. Sharp zinc icicles are not permitted. An overflow is a thickening of the zinc to a height of about 5mm with dulled edges. An icicle is a sharply pointed flash.
- Surface irregularities of the substrate material, e.g. rolling slag pits, grooves, depressions in the weld face, corrosion pits, rolling or delamination may remain visible or become apparent after the hot-dip galvanizing process.
- Striped thickening of the zinc coating may occur on the products subjected to the abrasive blasting treatment, however it does not reduce the anticorrosive effect of the coating.
- In the case of discontinuously welded or spot-welded components, leakage of flux residues or zinc ash is possible, resulting in dark or reddish-yellow patches on the zinc coating at the joints.
- Small holes in the components (up to approx. 6mm) may be flooded with zinc alloy. The galvanizing plant does not perform hole calibration and reaming operations or thread machining.
- As a result of the inhomogeneity of the external surface of the product (different chemical composition, geometrical structure of the surface, technological history, thickness, etc.), the zinc coating on the same product may be formed in a different way and look differently.
- The zinc coating to be painted must be properly prepared. Preparation procedures (washing, grinding, polishing, commissioning of components) relate to orders for the manufacture of duplex systems (galvanizing and painting) received and performed exclusively at the Rawa Mazowiecka Plant.
- Grid-type structures may have light overhangs left behind called curtains. Full cleaning of grid-type structures from curtain can only be carried out by arrangement with the sales department.

- Removing the ash will not completely clean the area where the ash is deposited. Under the influence of atmospheric conditions, ash residues can be released leaving a black mark.

The traces of ash (ashes) are treated with high zinc paint. In the long term, the treated areas oxidize more slowly than the remaining galvanized surface causing a characteristic discoloration on the structure.

- It has to be taken into account that, as with zinc plating without passivation, numerous factors influence the deterioration of the appearance and a considerable shortening of the life of the passivation coating – storage in the air and without washers and spacers, chemical influences, corrosive environment.

4.2 The thickness of the zinc coating is in accordance with EN ISO 1461. The maximum thickness value depends on the steel grade, product dimensions, surface development and the duration of the reaction between the steel and the zinc alloy.

Table 1 – Coating thickness of non-centrifuged zinc coated components

Group of galvanized components	Average coating thickness values	
	Minimum coating thickness at μm	Average thickness of coating in μm
Steel parts with a thickness < 1.5 mm	35	45
Steel parts with thickness ≥ 1.5 mm to ≤ 3 mm	45	55
Steel parts with thickness > 3 mm to ≤ 6 mm	55	70
Steel parts with thickness > 6 mm	70	85
Cast iron parts with thickness < 6mm	60	70
Cast iron parts with thickness ≥ 6 mm	70	80

Table 2 – Coating thickness of centrifuged galvanized components

Product and its thickness	Minimum unit coating thickness in μm	Local coating mass (minimum value) ^b g/m^2	Average thickness of coating in μm	Average coating weight (minimum value) ^b g/m^2
Threaded products of diameter:				
> 6 mm	40	285	50	360
≤ 6 mm	20	145	25	180
Other products (incl. castings)	45			
≥ 3 mm	35	325	55	395
< 3 mm		250	45	325

4.3 Coating adhesion.

The hot-dip zinc coating is diffusively bonded to the substrate and withstands the loads occurring during normal use of galvanized products. Overgrowth of the coating due to inappropriate steel grade, product dimensions or surface development can be a problem.

5. Protection of areas not covered with zinc coating.

All areas not covered with zinc should be protected by painting with a professional high zinc paint. For improved aesthetics, a layer of high zinc paint containing aluminum dust can be applied to the zinc paint layer. The total thickness of the applied layers must be at least 30µm more than the thickness requirements of Table 1. Places not covered with zinc should be mechanically cleaned before painting with a wire brush or sandpaper, degreased with solvent and thoroughly dried. Do not paint on wet or insufficiently dried areas. All operations related to the improvement of the surface after galvanizing shall be carried out in the finished products warehouse.

To improve the aesthetics of the repair, a zinc spray can be used depending on the desired effect

WARNING! If the galvanized product is to be additionally protected by a coat of paint, do not spray-paint.

6. Tests of the zinc coating.

6.1 Checking the appearance of the coating.

Examination of the appearance of the zinc coating shall be carried out by visual inspection with the unaided eye from a distance of 1 meter. The appearance of the coating shall conform to the requirements of item 4.1. All products shall be visually inspected.

6.2 Checking the thickness of the zinc coating.

The thickness of the zinc coating should be measured with a magnetic thickness gauge according to EN ISO 1461. The measurement shall be carried out at a minimum of three points distributed as evenly as possible over the surface of the product. To determine the thickness of the coating in one place at least 5 measurements should be taken on an area of approx. 10cm² and the arithmetic mean of the measurements constitutes the local thickness of the coating. The arithmetic mean of the local thicknesses thus measured shall constitute the average value of the coating thickness on the test object. A product meets TAC requirements if the average coat thickness calculated in this way is not less than the values given in Table 1.

Thickness tests shall be carried out on at least one product per batch. In the case of batches of one type, or on one product of each type of element if the batches are made up of different assortments of materials.

6.3 Checking the adhesion of the zinc coating.

There is no need to test the adhesion between the zinc coating and the substrate as the zinc coatings have sufficient adhesion due to the diffusive nature of the bond. In general, thicker zinc coatings require more careful treatment than thinner ones. Bending and forming after zinc plating by single dipping is not normally used.

7. Final arrangements.

- Products are galvanized and treated according to treatment standards A, B and C adopted at FAM Sp. z o.o. Visualization of the standards is available in each of the plants as well as on the company's website.
- Material delivered after 3:00 p.m. and reserved for production "on demand", which does not meet the TAC requirements and it is not possible to obtain the customer's approval for adjustment to TAC requirements will be galvanized the next day after obtaining the necessary information from the customer.
- For structures having internal spaces, the requirements in this TACs do not apply to the internal surfaces, but only to the external surfaces of the object.
The galvanizing plant is not responsible for the quality of the zinc coating in places that cannot be measured, inspected and cleaned, e.g.: the inside of pipes, closed profiles etc.
- In case of special requirements regarding the appearance of the galvanized surface or the thickness of the zinc coating, the galvanizing plant shall be informed in writing before the delivery of the product for galvanizing. This also applies to centrifuged products (standard zinc plating – glossy or high temperature - matt).
- If the zinc coating is to be additionally protected by painting, this must be agreed in writing with the galvanizing plant.
- The galvanizing plant is not responsible for damage caused during transport, storage and installation outside the galvanizing plant. Any possible loss of zinc resulting from the above-mentioned circumstances must be immediately treated by the recipient with zinc paint in accordance with EN ISO 1461. Confirmation of qualitative and quantitative receipt of galvanized material is a signed Stock Issue Confirmation (CI) document.
- In order to maintain the aesthetics of the product (to prevent white corrosion) it is recommended to transport it by covered vehicles and to store galvanized products in covered and ventilated places until the natural pass of the zinc coating.
- A batch of galvanized details found to be non-compliant with TACs requirements may be resubmitted for Quality Control acceptance after rectification of the defects.
- Unjustified call for the removal of warranty defects will result in charging the customer for the costs incurred by FAM Sp. z o.o.

8. Related standards.

PN-EN ISO 1461:2011 Zinc coatings applied to steel and cast iron products by immersion. Requirements and test methods.

Warsaw, 25 October 2021

EXAMPLES OF CUSTOMIZATION OF STEEL PRODUCTS FOR HOT DIP GALVANIZING

TABLE 1 – Zinc flow through the structure - design of openings.

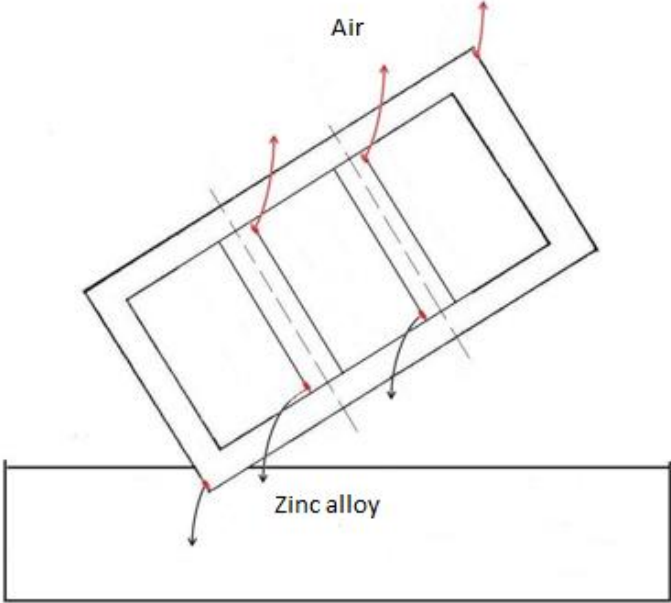
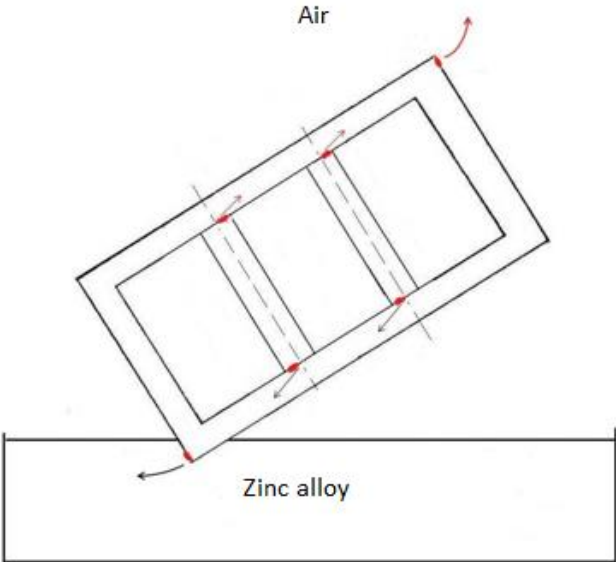
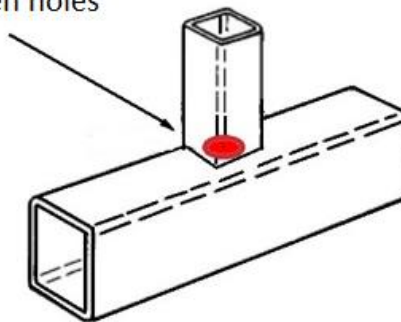
<p>Zinc flow inside a closed structure (profile, tube)</p> <p>Utility penetrations on the outside – overflows may occur</p>	
<p>Zinc flow inside a closed structure (profile, tube)</p> <p>Concealed utility penetrations – for safety reasons, care must be taken when drilling them</p>	

TABLE 2 – Design of openings. The required size of the following openings also applies to the size of the external openings.

The concealed openings shall be selected and arranged so as to ensure smooth pull-out from the sump and the least possible zinc residue inside the structure

Hidden holes





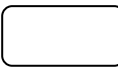
Hollow section dimensions, mm			Minimum hole diameter for a given number of holes, mm		
			1	2	4
15	15	20 x 10	8		
20	20	30 x 15	10		
30	30	40 x 20	12	10	
40	40	50 x 30	14	12	
50	50	60 x 40	16	12	10
60	60	80 x 40	20	12	10
80	80	100 x 60	20	16	12
100	100	120 x 80	25	20	12
120	120	160 x 80	30	25	20
160	160	200 x 120	40	25	20
200	200	260 x 140	50	30	25

TABLE 3 – Design of openings - openings for suspension and drainage.

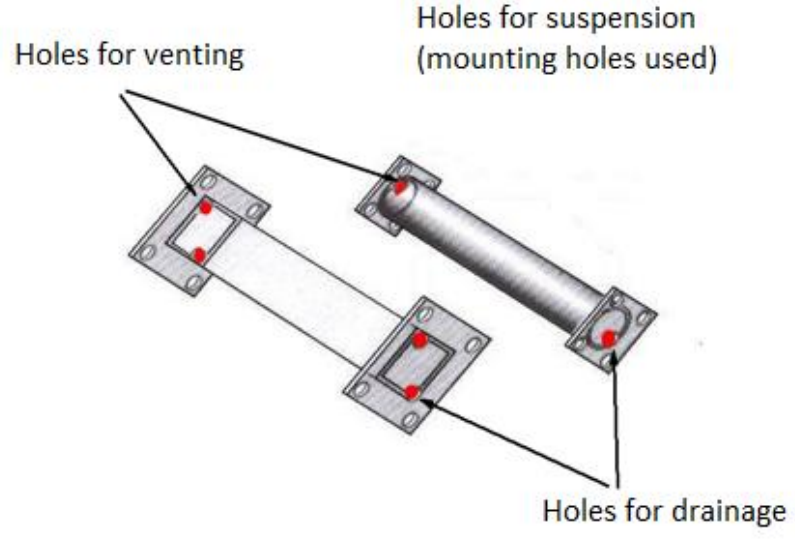
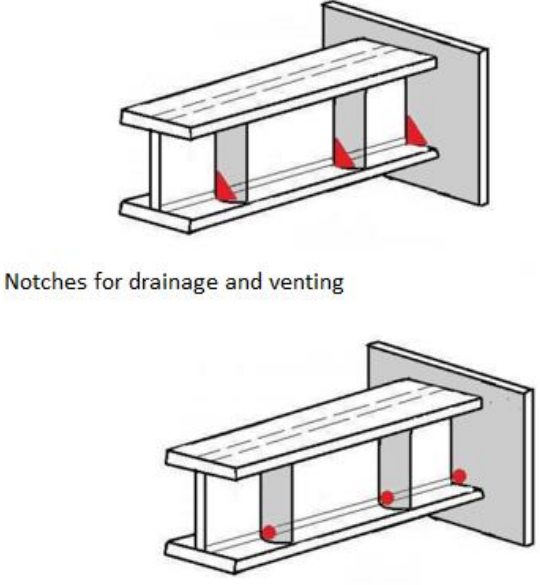
<p>Holes for suspension should allow for easy wire suspension</p>	
<p>Ventilation and drainage must also be ensured for open structures (sections)</p> <p>Bevels or openings made in the structure may be used</p>	

TABLE 4 – Construction for galvanization

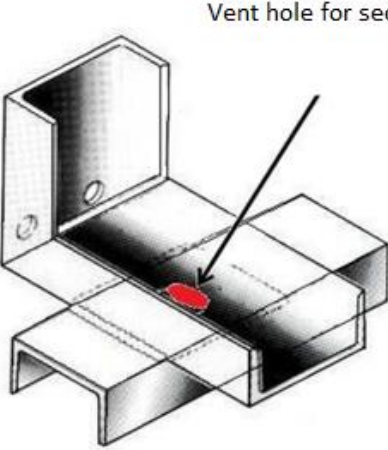
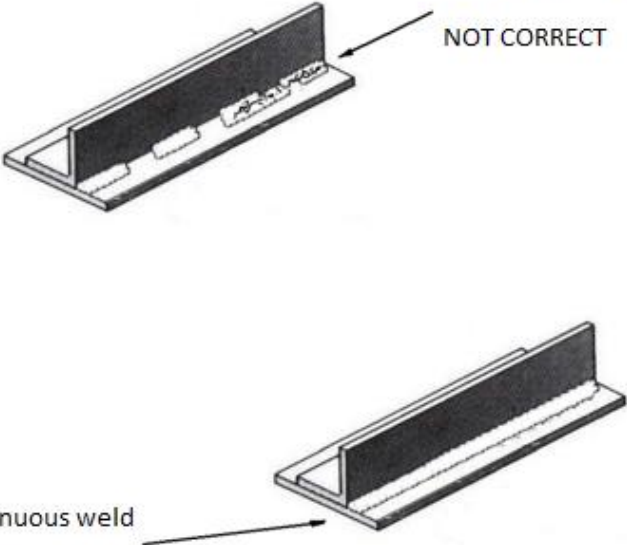
<p>Overlapping surfaces may be deformed by increased air pressure</p>	 <p>Vent hole for section contact surfaces</p>
<p>Incorrectly executed welds cause leakages after galvanizing</p>	 <p>Rough and non-continuous weld NOT CORRECT</p> <p>Continuous weld CORRECT</p>

TABLE 5 – Spatial constructions

The design of the structure shall take into account the technological aspects of galvanizing

Galvanizing of spatial elements is more difficult

