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Zinc Coatings for Batch-Galvanized Components

Surface Protection Requirements

Previous issues

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Changes

The following changes have been made to TL 217: 2009-08:

- Standard restructured
- Section 1 "Scope" revised
- Section 3 "Surface protection types" and Section 4 "Requirements, structure, applications, tests" updated
- Section 4.3 "Zinc coatings for special use cases" added
- Section 5.3 "Coating thickness" as per DIN 50018 – AHT 2.0S removed for OfI-c310 and OfI-c610
- Section 5 "Requirements and tests" revised
- Further technical and editorial changes

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Page 1 of 8

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Contents

	Page
1 Scope	2
2 Designation	2
3 Surface protection types	3
4 Requirements, structure, applications, tests	3
4.1 Basic requirements	3
4.2 Structure	4
4.2.1 Cr(VI)-free passivation layers	4
4.2.2 Coatings with sealing	4
4.3 Zinc coatings for special use cases	5
4.3.1 Zinc coatings for small weld parts	5
4.3.2 Zinc coatings for subsequent coatings (e.g., cathodic electrocoating)	5
4.3.3 Zinc coatings for brake calipers	5
4.3.4 Zinc coatings on wheel bolts	5
4.3.5 Zinc coatings with lubricant coating	5
5 Requirements and tests	5
5.1 Base material	5
5.2 Surface protection types/appearance	5
5.3 Coating thickness	6
5.4 Bond strength	6
5.5 Corrosion properties	6
5.5.1 Requirements with respect to zinc corrosion in systems with passivation and/or sealing	6
5.5.2 Requirements with respect to base metal corrosion	7
6 Applicable documents	8

1 Scope

This Technical Supply Specification (TL) specifies requirements for Cr(VI)-free, electrolytically deposited zinc coatings on steel parts as well as for hot-dip-galvanized parts (batch galvanizing) according to code letter c of Volkswagen standard VW 13750.

Zinc coatings with passivation layers are not suitable for use at long-term elevated temperatures > 100 °C.

The use of surface protection (OfI) type OfI-c340 is preferred for welded parts.

Specific applications are described in section 4.3.

NOTE: The surface protection types with protection class 6, e.g., OfI-c643 – **due to the system used in zinc coatings – do not offer** the expected heavy corrosion protection as can be expected from other protection systems of protection class 6 (e.g., surface protection systems as per TL 244, TL 245, TL 233).

2 Designation

The surface protection types listed in table 1 apply; see also VW 13750, section "Designation."

3 Surface protection types

Table 1 – Surface protection types

Surface protection type	Characteristics/appearance
Ofl-c310, Ofl-c610	Unalloyed zinc coating (any electroplating method), without post-treatment, silver-colored
Ofl-c330, Ofl-c630	Zinc coating (hot-dip galvanized), without post-treatment, silver-colored
Ofl-c340, Ofl-c640	Unalloyed zinc coating (any electroplating method), thin-layer passivation, silver-colored to bluish iridescence
Ofl-c341, Ofl-c641	Unalloyed zinc coating (any electroplating method), thin-layer passivation, additionally with organic or inorganic sealing, silver-colored to slightly bluish iridescence
Ofl-c342, Ofl-c642	Unalloyed zinc coating (any electroplating method), thick-layer passivation, bluish, greenish, reddish, yellowish iridescence
Ofl-c343, Ofl-c643	Unalloyed zinc coating (any electroplating method), thick-layer passivation, additionally with organic or inorganic sealing, silver-colored, slightly bluish, reddish, yellowish iridescence
Ofl-c347, Ofl-c647	Unalloyed zinc coating (any electroplating method), thick-layer passivation, but additionally treated with a lubricant as per TL 52132, silver-colored, slightly bluish, reddish, greenish iridescence

4 Requirements, structure, applications, tests

4.1 Basic requirements

Approval of first supply and changes as per VW 01155

Avoidance of hazardous substances as per VW 91101.

10 finished parts are required for complete testing.

Basic requirements

Unless certain sections of a part marked in the drawing are excluded from the surface coating, the entire surface of the parts must have the required surface protection with the specified properties.

Deviating from this, the minimum coating thickness for fasteners must be determined as per DIN EN ISO 4042.

Special requirements

For components with process-related weak spots such as bending radii or shank and threaded areas of fasteners, the corrosion protection requirements in these areas are reduced to 2/3. This exception does not apply to wheel bolts (see section 4.3.4).

The specifications in DIN EN ISO 4042 concerning the maximum possible thickness of the electroplated coating in the thread profile must be taken into account.

The protective coatings must not have any pores, cracks, damage, or other flaws impairing corrosion protection and/or the specified appearance.

Moreover, the coating must securely adhere to the base material and must not flake off in the event of slight deformation.

The production process must be designed and controlled in a way as not to impair the use properties of the finished part. In particular, the pretreatment and heat treatment methods must be suitably selected and combined to ensure that no hydrogen embrittlement occurs.

All heat treatments to avoid hydrogen embrittlement must be performed as soon as possible after depositing, within 4 hours at most, and before any further treatment of the coatings (see DIN EN ISO 4042).

If, in exceptional cases deviating from the specifications in the first sentence of section "Zinc and zinc alloy coatings" in VW 13750, electrolytically deposited zinc coatings are used for high-strength steel parts with an ultimate tensile strength $R_m > 1\,000$ MPa, the galvanizing process must be agreed upon with the quality assurance laboratories of the brands.

4.2 Structure

4.2.1 Cr(VI)-free passivation layers

In order to improve the corrosion resistance of electrolytically deposited zinc coatings to salt water and condensed water, a post-treatment in passivation solutions is the usual practice.

If the passivation solution used contains no Cr(VI) compounds, the resulting conversion layers will also be Cr(VI)-free.

The use of colorless and blue passivation treatments, referred to as "thin-layer passivation treatments" (OfI-c341, OfI-c641), with typical coating thicknesses of approx. 0.05 µm to 0.1 µm, is preferred on parts in the passenger compartment and luggage compartment areas. If required, they may also be additionally sealed (see section 4.2.2).

Further improvement of the corrosion protection is achieved by thick-layer passivation treatments (OfI-c342, OfI-c642). The coating thicknesses in this case are typically 0.2 µm to 0.5 µm. Due to their visual appearance (iridescent), additional sealing is necessary in order to prevent complaints on the end-customer side in the case of visible components (see section 4.2.2).

When passivation is used, it must not adversely affect further processing of the components (e.g., painting).

4.2.2 Coatings with sealing

In the sealing process (OfI-c343, OfI-c643), organic and/or inorganic materials are applied to the previously formed conversion layers and partially embedded.

The additional sealing can increase the thickness of the layer structure by 0.5 µm to 2.0 µm.

Compared to unsealed coatings, sealed coatings provide the following advantages:

- Increased corrosion resistance (delays zinc corrosion and base metal corrosion with no change in the zinc coating thickness)
- Change in the sliding properties (reduces the coefficients of friction and related spread for fasteners)
- Coloring (distinctly diminishes the iridescence produced by thick-layer passivation treatments, thereby improving the appearance)

4.3 Zinc coatings for special use cases

4.3.1 Zinc coatings for small weld parts

For small weld parts such as weld studs, weld bolts, welded pins, and weld nuts, the use of surface protection type OfI-c340 is preferred.

Weld elements, e.g., as per VW 60708-1 and VW 60708-2, with surface protection OfI-c340 can be treated with a lubricant as per TL 52132 to improve their feed capability. The lubricant must not impair welding suitability.

4.3.2 Zinc coatings for subsequent coatings (e.g., cathodic electrocoating)

For electroplated zinc coatings on components whose surfaces are not finally surface-treated after electro-galvanizing (e.g., zinc-coated components mounted in the body-in-white, e.g., hinges), no thick-layer passivation or phosphating treatments are permissible due to potential problems with coating adhesion.

The use of non-passivated systems (OfI-c310/c610) is preferred. However, necessary transport and storage protection of the zinc-coated parts, e.g., by oiling them, must be ensured here. This transport or storage protection must comply with Quality Specification QP A001.

As an alternative, thin-layer passivation treatments (OfI-c340/c640) can be used in order to prevent any zinc corrosion from occurring during transport if OfI-c310/c610 is used. However, sufficient adhesion of the paint finish must be verified (as per TL 218).

4.3.3 Zinc coatings for brake calipers

Brake calipers with surface protection OfI-c343 must always meet the requirements in VDA 237-299, type 05.

4.3.4 Zinc coatings on wheel bolts

Parts must have the specified surface protection, with the specified properties, over their entire surface. For wheel bolts, the reduced requirements for weak points as per section 4.1 do not apply.

4.3.5 Zinc coatings with lubricant coating

Zinc coatings with lubricant coating as per TL 52132 must meet the coefficient-of-friction requirement as per VW 01129.

5 Requirements and tests

5.1 Base material

Material as per drawing and/or master data list (MDL)

5.2 Surface protection types/appearance

See table 1

5.3 Coating thickness

The coating thickness must be determined either as per DIN EN ISO 1463, DIN EN ISO 2177, DIN EN ISO 2178, DIN EN ISO 21968, or DIN EN ISO 3497.

For requirements, see table 2.

Table 2 – Coating thickness specifications

Protection class	Components of a general nature	Metric threaded parts and welded parts of a general nature	Weld studs, weld bolts, welded pins, weld nuts
3	8 µm to 35 µm	8 µm to 14 µm	6 µm to 12 µm
6	15 µm to 35 µm	15 µm to 23 µm	-

5.4 Bond strength

Thermal shock test based on DIN EN ISO 2819.

The specimen is aged for 30 min at (220 ± 10) °C and is then submerged in water at a temperature of 15 °C to 25 °C.

Requirement: no bubble-shaped or large-scale detachment of the zinc coating

5.5 Corrosion properties

The corrosion resistance of the systems must be ensured in the as-received condition and also after a 24-hour period of heat aging at 120 °C. These are minimum requirements and must always be adhered to.

5.5.1 Requirements with respect to zinc corrosion in systems with passivation and/or sealing

Test method: salt spray tests as per DIN EN ISO 9227– neutral salt spray test

For test durations and requirements, see table 3.

This test is omitted for systems without subsequent passivation and/or sealing, as well as for weld studs, weld bolts, welded pins, and weld nuts.

Table 3 – Requirements with respect to zinc corrosion

Surface protection type	Test duration in h		Requirement
	Barrel-plated goods	Rack-plated goods	
Ofl-c310, Ofl-c330, Ofl-c610, Ofl-c630	-	-	No zinc corrosion after the prescribed test duration
Ofl-c340, Ofl-c640	6	12	
Ofl-c341, Ofl-c641	48	72	
Ofl-c342, Ofl-c642, Ofl-c347, Ofl-c647	72	96	
Ofl-c343, Ofl-c643	96	168	

5.5.2 Requirements with respect to base metal corrosion

Test method: salt spray tests as per DIN EN ISO 9227– neutral salt spray test

For test durations and requirements, see [table 4](#).

Table 4 – Requirements with respect to base metal corrosion

Surface protection type	Test duration in h	Requirement
Ofl-c310, Ofl-c330	48 (24 for weld studs, weld bolts, welded pins, and weld nuts)	No base metal corrosion after the prescribed test duration and no zinc corrosion after the test durations as per table 3
Ofl-c340, Ofl-c610, Ofl-c630	96 (48 for weld studs, weld bolts, welded pins, and weld nuts)	
Ofl-c341	144	
Ofl-c342, Ofl-c347, Ofl-c640	168	
Ofl-c343, Ofl-c641, Ofl-c642, Ofl-c647	240	
Ofl-c643	360	

6 Applicable documents

The following documents cited in this standard are necessary to its application.

Some of the cited documents are translations from the German original. The translations of German terms in such documents may differ from those used in this standard, resulting in terminological inconsistency.

Standards whose titles are given in German may be available only in German. Editions in other languages may be available from the institution issuing the standard.

QP A001	Prelube, Hot Melt, Blank Washing Oil, Drawing Compound, Slushing Oil (General); Quality Requirements
TL 218	Body Color Multicoat Paint on Metallic Exterior Body Components; Requirements
TL 52132	Lubricant for Threaded Fasteners with Electrolytically Applied Coatings or Made of Stainless Steel; Requirements
VW 01129	Limit Values for Coefficients of Friction; Mechanical Fasteners with Metric ISO Threads
VW 01155	Vehicle Parts; Approval of First Supply and Changes
VW 13750	Surface Protection for Metal Parts; Surface Protection Types, Codes
VW 91101	Environmental Standard for Vehicles; Vehicle Parts, Materials, Operating Fluids; Avoidance of Hazardous Substances
DIN EN ISO 1463	Metallic and oxide coatings - Measurement of coating thickness - Microscopical method
DIN EN ISO 2177	Metallic coatings - Measurement of coating thickness - Coulometric method by anodic dissolution
DIN EN ISO 2178	Non-magnetic coatings on magnetic substrates - Measurement of coating thickness - Magnetic method
DIN EN ISO 21968	Non-magnetic metallic coatings on metallic and non-metallic basis materials - Measurement of coating thickness - Phase-sensitive eddy-current method
DIN EN ISO 2819	Metallic coatings on metallic substrates - Electrodeposited and chemically deposited coatings - Review of methods available for testing adhesion
DIN EN ISO 3497	Metallic coatings - Measurement of coating thickness - X-ray spectrometric methods
DIN EN ISO 4042	Fasteners - Electroplated coatings
DIN EN ISO 9227	Corrosion tests in artificial atmospheres - Salt spray tests
VDA 237-299	Oberflächenschutz für Bremssättel aus Gusseisen