UNIQUE CHARACTERISTICS AND ADVANTAGES OF ZINGA

ZINGA is in fact much more effective than any other existing anti-corrosion system. This efficiency is based on a number of unique characteristics and advantages, as explained in the following summary.

1. ZINGA protects the metal against rust in two ways: an active, cathodic, galvanic protection due its high zinc content and a passive barrier protection due to the zinc salt on top of the surface, and due to the binder in ZINGA that reduces the disintegration of the zinc.

2. The application of ZINGA is very easy. It can be painted onto the surface with a brush or a roll. It can also be sprayed with a pistol. There is no need for sophisticated equipment that can only be found in a workshop. ZINGA can be applied on site.

3. ZINGA can be applied in a wide range of weather conditions. ZINGA can be applied on a damp surface (but not on drops of water). Humidity can even intensify the cathodic action and accelerate the formation of the zinc salts on the surfaces that offer the barrier protection. ZINGA can be applied at very high or low temperatures (up to 40° C or 104° F and down to -15° C or 5°F).

4. ZINGA has a zinc content of 96 % in the dry layer. In order to obtain a real cathodic protection you need at least 92 % of zinc in the dry layer. That is scientifically proven.

5. The surface preparation can be reduced to a minimum: the metal must be clean (free from dirt, grease, oil, salts, paint, and mill scale) and rough. It is not always necessary to grit-blast the metal first.
   - Application on bare metal: Mostly grit-blasting is necessary, but in some cases the substrate already has the required roughness degree due to former grit-blasting or due to corrosion.
   - Application on top of hot-dip galvanisation: Old and corroded hot-dip only needs to be cleaned and already has the required roughness degree. New hot-dip can be treated in order to obtain the required roughness.
   - Application on an old ZINGA layer: When ZINGA is applied on an old ZINGA layer, then the surface just needs to be cleaned.

6. ZINGA is always applied under ambient temperatures, so that delicate metal structures cannot be deformed. No energy is wasted to warm up ZINGA, which is necessary for hot-dip galvanisation wherefore you need temperatures up to 460 °C.

7. ZINGA has a quick drying time. A new layer of ZINGA can be applied after 1 hour. Topcoats can be applied after 6 to 24 hours, depending on layer thickness and atmospheric conditions.

8. ZINGA does not peel off and is not brittle. In case of mechanical damage the ZINGA layer will be compressed or squashed, but it will not crack due to its flexibility.

9. One of the most decisive advantages of using ZINGA is that the zinganisation system can be recharged. Each new layer of ZINGA blends perfectly with the previous one. Additional layers all blend to one single, homogeneous ZINGA layer. There is no risk for accumulation of layers that are different in structure, which could cause peeling off. You cannot distinct different layers, as is the case with galvanising by hot-dip. Moreover, this capacity of recharging reduces the surface preparation to an absolute minimum. Other coating systems, for instance with paints, demand an elaborate and often expensive surface preparation before the application of a new layer.

10. This property of recharging can be of use if you still have to do some drilling or welding on the surface, or if the structures still have to be transported. In that case the first layer is meant as a primer. It can intercept possible damages. Even welding is possible on top of ZINGA. Afterwards, the final layer of ZINGA can be applied and local damages can be repaired. The new layer makes the former layer liquid again and the result is one homogeneous ZINGA layer. When there is no need to recoat the whole structure, you can apply a small quantity of ZINGA on the damaged spots and the whole structure is free from rust again. Repairs will be invisible after a certain time.

11. Structures that have been metallised or galvanised by hot-dip will begin to rust after a certain period. Such worn-out and damaged structures can also be recharged by ZINGA.

12. Moreover ZINGA is based on protected zinc. The zinc particles are protected by a special resin that allows the formation of the galvanic couple, but that also gives an additional protection. Therefore protection with ZINGA is a superior alternative for galvanisation by hot-dip.

13. The zinc granules have been specially shaped so that they have a bigger contact surface through which they can attach to one another. For your information: the zinc used in ZINGA is made by the Belgian company Umicore, well-known all over the world, since they are the number 1 manufacturer in the world of these atomised zinc dust pigments, further electronically prepared for Zingametall. This atomisation process provides unique qualities and a very high zinc purity. This is also one of the reasons why ZINGA does not have one single true competitor in the world.

14. ZINGA is uniquely characterised by the fact that it sacrifices itself or that it is "consumed". Together with the quality of not peeling off, this results in the depletion of each applied layer: between 2 – 15 µm per year depending on the environmental conditions. This is an important factor in monitoring the application and the evaluation of the lifetime of the system. Hence, it is a true benefit in terms of maintenance and budget scheduling.

15. With ZINGA, a customized and personal solution can be offered. Customers are not always in need of a long term corrosion protection or don't have the budget for it. In case of a limited budget and desired protection time of for instance only 5 – 7 years, the layer thickness can be reduced and this will have an effect on the price per m2. In other words: ZINGA is the most "flexible" customized solution.

16. ZINGA can be topcoated by a large number of compatible paints. Such duplex systems will more than double the lifetime of ZINGA. In order to reinforce the duplex qualities of the ZINGA system a topcoat can be applied. We can supply you with different compatible paints: acryl, epoxy, polyurethane; with or without micaceous iron oxides, the so-called MIO's. These paints can be applied directly on ZINGA (using the mist/ full coat technique).

17. These topcoats can be bought from the same supplier. You just need to speak to one contact person and only that one company can be held responsible for the total application.

18. ZINGA is composed of non-toxic elements according to European Standards and can be used in contact with potable water.

19. ZINGA is heat resistant up to 120° C. ZINGA can also intercept occasional and short thermal shocks up to 150° C.

20. a) ZINGA has an unlimited pot and shelf life.
    b) ZINGA is a one component coating.

ZINGANISATION – INSTRUCTIONS FOR USE

ZINGANISATION: the anticorrosion protection of steel products by means of the cold application of **ZINGA**, creating an active cathodic corrosion protection.

1. Surface preparation

1. All exposed surfaces that are to be **ZINGA** coated, must be UHP blasted to WJ -1 Standard (NACE-5 / SPCC-SP12) in order to remove old coatings, rust and any contaminants. This should be followed by grit blasting SA 2 ½ (according to ISO 8501-1,) with a roughness of Rz 50 to 70 µm, according to DIN 4768, or an Ra of minimum 12.5 to maximum 15 µm.

2. The blasting process must be completed by an adequate dedusting of the surfaces (according to ISO 8502-3: 1992 max. class 2 standard).

   For specific recommendations contact your **ZINGA** representative.

2. Preparation of the materials

1. **ZINGA** must be thoroughly stirred to achieve a homogeneous liquid before application. **ZINGA** will stand for a maximum of 20 minutes before re-mixing becomes necessary. It is recommended to stir the liquid continuously.

2. The diluting of **ZINGA** with Zingasolv :
   - for brush and roll application: ready for use
   - low pressure spraying technique: 0 to 25 % (in volume)
   - airless spraying technique: min.120 bar: 0 to 5 % (in volume)

   The viscosity of the **ZINGA** at delivery is ± 60 seconds with DIN ford 4 cup.
   The temperature of the liquid must remain between 15° and 25°C. Application of **ZINGA** at lower or higher temperatures will influence the smoothness of the film when drying.

   For specific recommendations contact your **ZINGA** representative.

3. Coating

1. **ZINGA** as unique or single system should be applied as a two coat system in order to obtain a dry film thickness (DFT) of 120 µm above the peaks of the blasted profile. The absolute minimum is defined as no reading should be less than 120 µm (80/20 rule). There is no maximum DFT specified. The effectiveness of the cathodic protection of the coating will not increase above 265 µm. The maximum DFT per coat should not exceed 100 µm.

2. In case the **ZINGA** will be overcoated with a compatible paint, **ZINGA** has to be applied in <u>one layer only</u> of which the DFT should be between 60 µm and 80 µm. The **ZINGA** layer must be completely dry and decontaminated before overcoating. Please also read the data sheet of the paint.
   The paint system that will be applied on top of the **ZINGA**, will preferably be sprayed as a mist coat (a very thin layer) first, after which the desired layer thickness can be applied.

3. Application conditions:

- Maximum relative humidity: 95%.
- Difference between the temperature of the object and the dew point: preferably > 3°C.

Under certain circumstances **ZINGA** may be applied at less restrictive conditions.

For specific recommendations contact your **ZINGA** representative.

4. The first layer must be applied with a brush or by airless method. Once the colour of the first coat has turned to a uniform light grey, the second coat may be applied.

5. The second (and the third) layer can be rolled or sprayed. The pretouch of the welding must be applied by brush.

6. Prior to the application of the second coat the surface must be inspected and proved free of contaminants. If the surface of the first coat has been contaminated it should be HP-washed or steam-cleaned depending upon the nature of the contaminant to restore the original surface cleanliness of the first coat. In case the following **ZINGA** application can only be applied the next day, zinc salts can be formed on the surface. These salts must be removed using the above mentioned techniques or by brushing the surface with a nylon brush and clean water. Rinsing afterwards is obligatory.

7. After application of the second coat the object should not be handled until a uniform colour change of the coating to a light grey has been observed. Drying time under normal conditions (temperature, ventilation and humidity) is within one hour. **ZINGA**'s hardening time can be accelerated by wetting the finished topcoat with fresh water if required.

   For specific recommendations contact the **ZINGA** representative.

8. During the application of the different layers of **ZINGA**, the structures must not get into contact with water. For immersion purposes fresh water should be sprayed onto the coated surface, once the last **ZINGA** layer is touch-dry, until the **ZINGA** is completely saturated and does not absorb any more water. Only after this treatment, the coated structures may be immersed.

   For specific recommendations contact your **ZINGA** representative.

9. From the beginning of the application until one week after the last application all possible measures should be taken to ensure that no oils come in contact with the freshly zinganised structures, until the **ZINGA** layer has polymerised completely. If oils do come in contact with the **ZINGA** layer, it should be HP washed (40 bars) or steam cleaned.

4. Damage repair system

1. If the coating is damaged but bare steel is not exposed:
   Repair as per second coat application as described above only for the damaged area.

2. If the coating is damaged to the bare steel:
   Repeat the entire application process for the damaged area.

GENERAL SPECIFICATIONS ZINGA

The anti corrosion protection of steel products by means of a cold application of ZINGA, creating an active cathodic corrosion protection.

GOAL

To provide an overview of the specific surface preparation and application instructions for each type of surface, and system recommendations, complementary to the technical data sheet of ZINGA.

COMPOSITION OF ZINGA

The coating is a one compound system, consisting of:
- » Zinc dust
- » Volatile substances (solvent)
- » Binding agents (organic)

The dry film has a **zinc content of 96%**.
The zinc has a **purity degree of minimal 99.995%**.

The solvent is a petroleum derivative with the following characteristics:
- » Distillation at 101.3 Kpa (ASTM D 1078):
    - Boiling point: 166°C
    - Drying point: 185°C
- » Flash point: ≥ 40°C and < 60°C
- » Kauri-butanol index: at least 80°C
- » Exempt of: lead, cadmium, xylene, toluene, MEK and methylene chloride

SURFACE PREPARATION

MAIN RULES

In order to obtain a cathodic protection, an **electric contact** is required between ZINGA and its substrate. Therefore the substrate must be clean (SA 2,5) and rough (Rz. 50-70 μm).

It is very important to keep the following working order in mind:
1. Eliminate all dirt, grease, oil and salts.
2. Totally remove all old paint, rust and mill scale.
3. Roughen the steel surface.
4. De-dust the surface.

GENERAL GUIDELINES TO OBTAIN DEGREE OF CLEANLINESS AND ROUGHNESS

- » Grit blasting with angular grit:
    - Cleanliness: **SA 2½** cf. ISO 8501-1:2007
    - Roughenss: G (**Rz 50-70 μm**) or Ra 12,5 μm-15 μm according ISO 8503 -2 :2012
- » 'Slurry blasting' (reduces dust)
- » Sponge blasting (high blasting media recycling)
- » Bristle blaster (power tool) - for small surfaces / touch-ups

ADDITIONAL INFORMATION CONCERNING GRIT-BLASTING

It is very important that the grit used for blasting, consists of **different sizes of granules**, as described in the norm ASTM C136. A grit mixture with small and bigger granules will give optimal results. The composition of the grit mixture and the size of the granules can be analysed by the sieve test described in ISO 0787-18.

A variable grit mixture will produce a very variable surface structure with many high and low peaks, which is ideal for ZINGA. For instance a mixture of garnet grit of 30 to 80 mesh is very good. Of course you should always make sure that the grit is clean and does not contain any salt, oil or grease.
The compressor must produce a blasting pressure of 6 to 8 bar at the blasting nozzle. Also make sure that the air that is coming out of the compressor is dry and free from grease and oil. For this purpose you can use an air cooler and a water trap. The presence of contamination in the compressed air can be tested by the Blotter test according to ASTM D4285.

SYSTEM RECOMMENDATIONS

AS A SHOP PRIMER BEFORE PROCESSING

A layer of 30 to 40 µm DFT can be applied in the workshop. The dry film thickness has to be measured according EN 10238 –1996. A thin layer of ZINGA allows transportation to the construction site and preventing corrosion. The steel structures can be overcoated after assembly with ZINGA, to obtain cathodic galvanic protection or with any other paint (no cathodic protection), without the need to reblast. Zinganised structures can be welded or bend during assembly..

AS A UNIQUE SYSTEM

This system is strongly recommended because of the **easy maintenance**. In time the layer will become thinner as the ZINGA sacrifices itself due to the cathodic protection. A new layer of ZINGA can be applied directly once the surface has been properly cleaned and it will recharge the previous ZINGA layer. The DFT of ZINGA that should be applied depends upon the remaining ZINGA layer.

ZINGA is used as a stand-alone system, applied in **at least 2 passes** to obtain a total minimum DFT of 120 µm above the peaks of the roughness profile, with an absolute minimum of 100 µm. 180 µm is the maximum total DFT that we would prescribe for film galvanisation as a unique system. Applying more than 180 µm would not improve the efficiency of the cathodic protection any more.
The application is done correctly if the following conditions are met (according ISO 19840):

» At least 80% of the measured values are above the prescribed DFT
» The other 20% should be above 80% of the prescribed DFT
» No values are above the maximum DFT (250-300 µm DFT)

Please note that the recommended DFT always concerns the DFT that is **above the peaks of the roughness profile**. Take into account the fact that a certain quantity of ZINGA will disappear into the cavities of the profile. When the surface has an Rz of 60 µm, it can be assumed that an extra DFT of 30 µm (half of the Rz value) of ZINGA should be added up to the recommended DFT. It is important that you are well aware of the exact type of measurement of your DFT measuring device. Sometimes it also measures part of the DFT in the cavities of the profile.

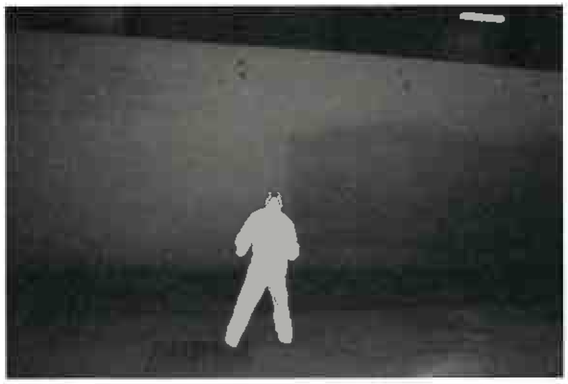
AS PRIMER IN A DUPLEX SYSTEM

If there is no specific need or requirement to topcoat ZINGA with a different product, we always advise to use ZINGA as a unique system, because of its corrosion protective, easy application and recharging capacities.

In a duplex system, ZINGA should be applied in **one single application**, preferably by spraying, to obtain a maximum DFT of 60 µm. On surfaces where the risk for mechanical damage is minimal, one could apply up to 80 µm of ZINGA, provided that the longer drying time is respected. If an aluminium topcoat (type Alu ZM) is used, the ZINGA layer can be applied in 2 layers of each 60 µm DFT.

The surface of the ZINGA should be **free of zinc salts and other contaminations** prior to application of a topcoat. In case the application of the compatible paint on top of ZINGA can only be done after 24 hours, then the ZINGA surface should first be washed preferably bysteam-cleaning at 140 bar at 80°C.

Use the **mist coat & full coat technique** to avoid pinholes when ZINGA is top coated. This means that the first paint layer (mist coat) on ZINGA should be between 25 and 30 µm DFT (standard dilution). Two hours after the mist coat is touch-dry, a full coat should be applied in order to build up the layer to the required DFT.



Application of mist coat on ZINGA

Application of full coat on ZINGA

Remark:
Only quick-drying compatible paints can be applied on top of ZINGA.
For the application and drying data of the sealer/topcoat, please check the relevant technical data sheet.
Zingametall offers sealers and topcoats which can be applied directly on ZINGA. For the use of other sealers and topcoats on ZINGA, it is strongly recommended to perform a compatibility test.
The application of **Zingalufer**, a one component PU sealer of Zingametall or **Zingaceram HS**, a two component Epoxy sealer, seals off the ZINGA surface, assuring protection against agressive solvents. After curing, any topcoat can be applied.

For more information, see document 'Mist/Full Coat Technique'.

ADDITIONAL INFO

Recharging system

ZINGA can be applied on top of a hot-dip galvanisation layer, a metallisation layer or an old ZINGA layer in order to **renew or enhance the cathodic protection**. The DFT of ZINGA that should be applied depends upon the existing zinc layer. ZINGA recharges or re-galvanises the old active layer and will offer a better cathodic protection. ZINGA will start acting as the anode, sacrificing itself as time goes by and thus saving the hot-dip galvanisation or the metallisation. Only after the ZINGA coating has been used up, the hot-dip galvanisation or metallisation layer will take over the cathodic protection and will start functioning as anode. ZINGA can also reload old ZINGA layers: after removal of the Zinc corrosion products, old ZINGA and new ZINGA will fuse together as the old ZINGA is reliquified by the solvents in the new ZINGA.

Stripe-coat on sharp edges and in corners

It is recommended to apply a stripe-coat of ZINGA by brush **on all sharp edges, nuts and bolts and weld areas** before the application of the first full layer of ZINGA to ensure that all these areas have a similar DFT to that of any adjacent surface. Please note that on new steel the sharp edges may **need to be rounded off** to a minimum radius of 4 mm prior to the gritblasting and the application of a stripe coat. After the stripe-coat has dried completely, the first full coat can be applied to all surfaces.
In case of high degree of humidity, it is recommended to apply the stripecoat on top of the first ZINGA layer.

This technique of stripe-coating should also be done with all subsequent paint layers that are applied over ZINGA.

Immersion of a zinganised structure

When a freshly Zinganised structure is immersed in water, until one week after the application all possible measures should be taken to ensure that no oils (even fish oils) come in contact with ZINGA until it has cured completely. In the event of oil spillage or fish oil present in the water pollution, **pollution barriers** should be used around the structure. If oils do come in contact with ZINGA, it should be washed preferably by steam-cleaning at 140 bar at 80°C.

SPECIFIC INSTRUCTIONS FOR DIFFERENT TYPES OF SURFACES

NEW AND OLD STEEL WITHOUT (GALVANISED) COATING

Follow the general guidelines to obtain cleanliness and roughness.
After the surface preparation the total surface must be completely coated with ZINGA up to the required DFT.

NEW HOT-DIP GALVANISATION OR NEW METALLISATION (ZINC-SPRAYING)

The newly hot-dipped or metallised substrate should first be degreased, preferably by steam cleaning at 140 bar at 80°C.
Normally a newly metallised surface is rough enough for the application of a ZINGA layer, but newly hot-dipped substrates have to be roughened in order to obtain a good adhesion.

There are different options:

- **(Sweep) blasting:** blasting the surface with angular non-metallic grit. This standard of blasting will remove approximately 10 to15 µm of zinc as well as all the surface contaminants. It will also provide an acceptable profile for the ZINGA to bond with. If the blast angle exceeds 45°, the blast profile will be too deep. The nozzle size must be a minimum of 10 mm. Regulate the blast-nozzle pressure at 3 bar. A test section should be done to measure the zinc thickness before and after the blast. Once the sweep-blasting is completed the surface should be de-dusted with non contaminated compressed air according to the standard ISO 8502-3 (class 2).
- **Sponge blasting**: The pliant nature of Sponge Media abrasives allow its particles to flatten on impact, exposing the abrasive. After leaving the surface, the media expands, creating a vacuum – entrapping most of what would normally have become airborne contaminant. Up to 95% of the abrasives is recyclable.
- **Bristle blasting**: mechanical abrasion cleaning process that is performed on metallic surfaces by a brush-like rotary power tool. A bristle blaster tool is the only power tool which can obtain proper SA 2.5 cleaning, suitable for application of ZINGA (or any high performance coating). **Recommended for use of small applications and touch up.**
- Steel brush (less optimal - not advised)

After the surface preparation the total surface must be completely coated with ZINGA up to the required DFT.

HOT-DIP GALVANISED OR METALLISED STRUCTURES WITH ONLY UP TO 5% RUST

First of all **HP water washing (300 bar)** is necessary to remove dirt, grease, oil, salts, paint and rust. The rust can also be removed manually with a bristle blaster (advised) or a steel brush. If the structure to be treated is only slightly oxidised or just weathered, the rusty areas must be **locally touched-up** with one or more layers of ZINGA. In most cases the formation of rust has created an adequate roughness profile to obtain a good adhesion between ZINGA and the formerly galvanised or metallised steel. However, if this is not the case, the surface must first be roughened as described above: either by sweep blasting or with a bristle blaster. After doing the local touch-ups the total surface should be completely coated with ZINGA, in order to recharge the existing hot-dip galvanisation or metallisation layer.

HOT-DIP GALVANISED OR METALLISED STRUCTURES WITH OVER 5% RUST

If the structure to be treated shows over 5% of rust, then this means that the cathodic protection of the steel is for **over 50% used** and local touch-ups will not be sufficient. A surface preparation using **blasting techniques** is preferred. Follow the general guidelines to obtain cleanliness and roughness.

After the surface preparation the total surface must be completely coated with ZINGA up to the required DFT.

Remark:
ZINGA applied on previously galvanised surfaces will offer a real cathodic protection. It will be the anode that will offer itself to protect the galvanised surface beneath. Only when the film galvanised layer has depleted itself, the old galvanised surface will have to protect the metal surface. At that moment the hot-dip becomes the anode.

MAINTENANCE AND REPAIR

In absence of grease, oil, zinc salts and other surface contaminants (chlorides, ...), ZINGA is overcoatable without having to blast to the bare steel. If necessary, use sweep blasting or sponge blasting techniques, a high pressure cleaning, steam cleaning or a nylon or steel brush to remove the contaminants.
To make sure the zinc salts are removed from the weather ZINGA surface: conduct a test by applying some Zingasolv on a white cotton cloth and rub on the surface. If the cloth colors grey (because of the reliquifying of the ZINGA), the surface is ready for overcoating.

DAMAGED OR WEATHERED ZINGA APPLIED AS A UNIQUE SYSTEM

In time the layer will become thinner as ZINGA sacrifices itself due to the cathodic protection. A new layer of ZINGA can be applied directly on an old layer of ZINGA once the surface has been **properly** cleaned and it will recharge the previous ZINGA layer. The DFT of ZINGA that should be applied depends upon the remaining ZINGA layer. It is however recommended to recharge the surface before any rust appears in order to save on preparation expenses and to ensure that the cathodic protection remains optimal.

DAMAGED OR WEATHERED ZINGA APPLIED AS PRIMER IN A DUPLEX SYSTEM

If the topcoat is damaged and has become permeable then it should be removed, for example by high-pressure water-blasting, in order to reveal the ZINGA layer underneath. If the ZINGA is also weathered (but not damaged to the bare metal) a new ZINGA layer can be applied after washing the surface preferably by steam-cleaning at 140 bar at 80°C.

When repairing duplex systems with damages down to the bare metal, those spots have to be adequately cleaned and roughened before the application of a new layer of ZINGA. Please follow the general guidelines to obtain cleanliness and roughness

For more specific and detailed recommendations concerning the application of ZINGA, please contact the Zingametall representative. For detailed information about the health and safety hazards and precautions for use, refer to the ZINGA safety data sheet.

Waiver*

OVERVIEW MAIN TEST REPORTS ON ZINGA

To view the actual reports, please visit contact a Zingametall representative.

GALVANIC PROTECTION

ISO 12944 - COT*

ISO 12944-6: Paints and varnishes -- Corrosion protection of steel structures by protective paint systems

The ISO 12944 standard is intended to assist engineers and corrosion experts in adopting best practice in corrosion protection of structural steel with coatings at new construction and repairs. ISO12944 is progressively superseding regional standards to become a truly global benchmark in corrosion control

Different ZINGA systems (see below) have been subjected to extensive testing such as water condensation test, neutral salt spray test, chemical resistance test and water immersion test. After a prescribed exposure test (depending on respresentative environment), the coating is assessed for adhesion, blistering, rusting, cracking and flaking.

Environments are classified according corrosivity from C1 to C5. Meaning:

- C1: Indoor, nutral atmosphere (classrooms, offices, ...)
- C2: Rural areas, low pollution (Rural buildings, traffic lights, ...)
- C3: Urban and industrial atmospheres, moderate sulphur dioxide levels, production areas with high humidity (City buildings, factories, sign posts, ...)
- C4: Industrial or coastal (with moderate salinity) zones (chemical factories, swimming pools, shipyards, ...)
- C5I: Industrial zones with high humidity and aggressive environment, continuous condensation and high pollution (heavy chemical factories, oil and gas facilities, ...)
- C5M: Coastal zones and marine zones with high salinity, continuous condensation and high pollution (Marine, offshore, estuaries, ...)

And three environments for structures in immersion:

- Im1: Clear, fresh or potable water
- Im2: Sea or brackish water (harbors with locks, jetties, offshore structures; make sure there is no stray current)
- Im3: Soil (underground storage, iron poles)

After exposure, the coating is evaluated as H(igh), M(edium) or L(ow); reflecting in a life expectancy of:
Low: Life expectancy less than 5 years
Medium: Life expectancy between 5 and 15 years
High: Life expectancy more than 15 years

Tested Zingametall sytems:

Systems with High Classification in C4 environment:

- ZINGA 2 x 60 µm DFT

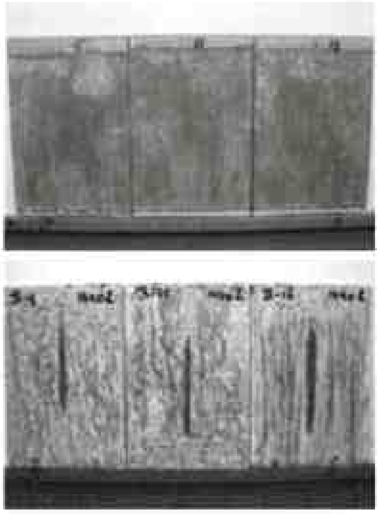
Systems with High Classification in C5 environment:

- ZINGA 2 x 90 µm DFT
- ZINGA 1 x 60-80 µm DFT + Zingalufer 1 x 80 µm DFT
- ZINGA 1 x 60-80 µm DFT + Zingaceram HS 1 x 120 µm DFT
- ZINGA 1 x 60-80 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram PU 1 x 60 µm DFT
- ZINGA 1 x 60-80 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram EP 1 x 60 µm DFT

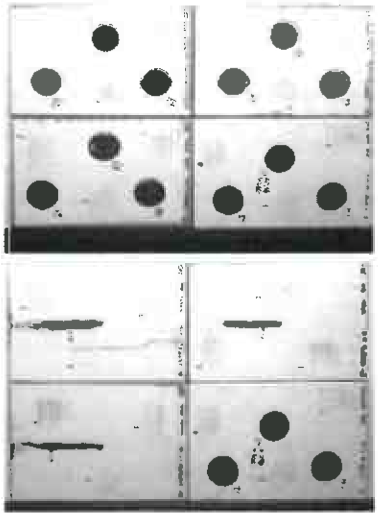
* COT bv (Netherlands)

Systems with Medium Classification in Im2 and Im3:
- ZINGA 2 x 60 µm DFT
- ZINGA 2 x 90 µm DFT

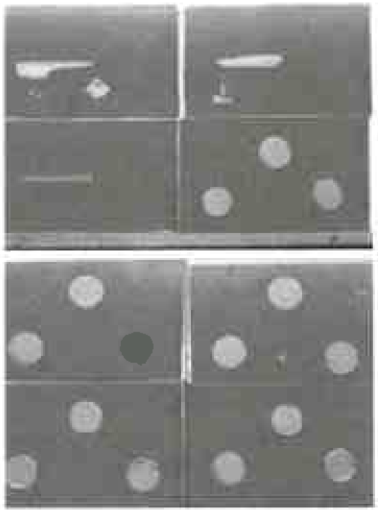
Systems with High Classification (Life expectancy > 15 years) in Im2 and Im3:
- ZINGA 1 x 60-80 µm DFT + Zingatarfree 2 x 100 µm DFT



ZINGA 2 x 90 µm DFT after 720 h condensation (above) and 1440 h salt spray (under)



ZINGA + Zingaceram HS + Zingaceram EP after 720 h condensation (above) and 1440 h salt spray (under)



ZINGA + Zingaceram HS + Zingaceram PU after 720 h condensation (above) and 1440 h salt spray (under)

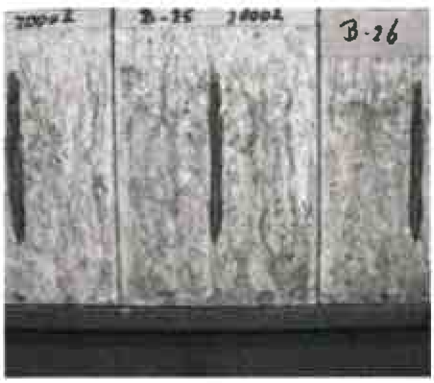
ASTM B117 / ISO 9227 (SALT SPRAY TESTING) - COT / NCKU

ASTM B117: Standard practice for operating salt spray (fog) apparatus

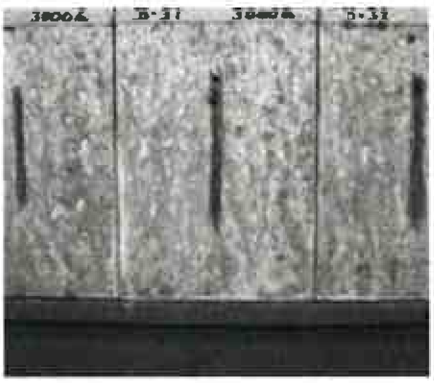
ISO 9227: Corrosion tests in artificial atmospheres -- Salt spray tests

ZINGA 120 µm DFT passed a 10.000 hours salt spray test (without scratch!) according ASTM B117 with 1% red rust on the surface.

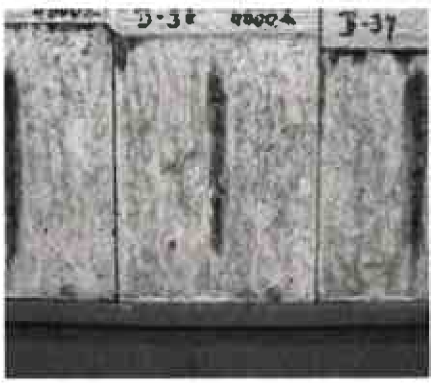
ZINGA 180 µm DFT passed a 4200 hours salt spray test (with scratch, demanding higher galvanic protection) according ISO 9227 with 1-5% red rust on the surface.



ZINGA 2 x 90 µm DFT after 2000 h salt spray



ZINGA 2 x 90 µm DFT after 3000 h salt spray



ZINGA 2 x 90 µm DFT after 4000 h salt spray

NORSOK M-501 / ISO 20340 - COT

NORSOK M-501: Surface preparation and protective coating
ISO 20340: Paints and varnishes -- Performance requirements for protective paint systems for offshore and related structures

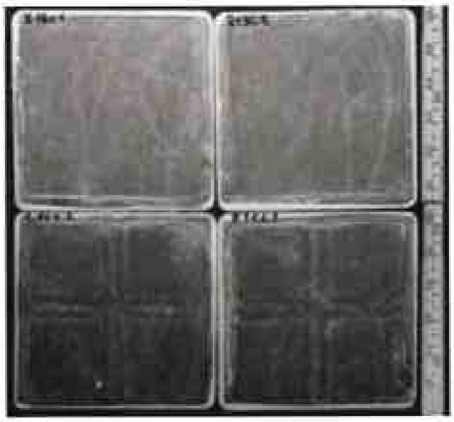
NORSOK M-501 is an industry standard for adequate surface preparation and use of coating materials, developed with the emergence of the Norwegian oil industry.
ISO 20340 deals with performance requirements for protective paint systems for offshore and related structures (i.e. those exposed to the offshore environment, as well as those immersed in sea or brackish water).

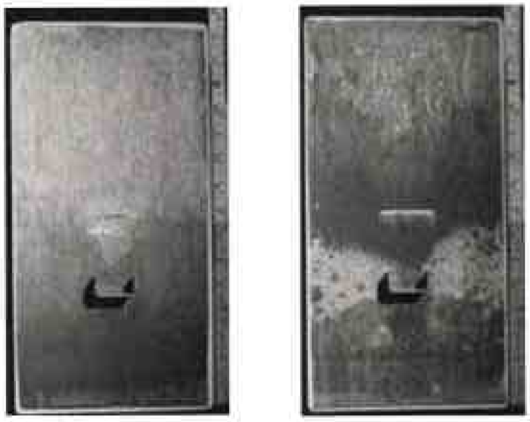
ZINGA has passed the 4200 hours seawater immersion test and the 4200 hours cyclic test without any formation of rust, blisters, cracks, flakes or cathodic disbondment. The pull-off adhesion test on ZINGA resulted in values of more than 7 MPa.

IMO MSC.215 (82) (BALLAST TANK TEST) - DNV*

IMO MSC.215 (82): performance standard for protective coatings for dedicated seawater ballast tanks in all types of ships and double-side skin spaces of bulk carriers

ZINGA was applied on blast-cleaned test panels that were placed in a ballast tank filled with sea water with wave movement and cyclic heating. Other test panels were placed in a condensation chamber.
No corrosion of the steel substrate could be demonstrated. Based on the results of the testing, ZINGA meets the requirements of a B3 classification - due to insufficient adhesion (but this poses no threat to ZINGA, whereas paints rely on this to perform). In the report is stated that ZINGA has a beneficial corrosion protective performance. For B1 classification, we refer to ZINGA BT.





ZINGA 2 x 60 µm DFT after 180 days in a condensation chamber (left) or a wave tank (right)

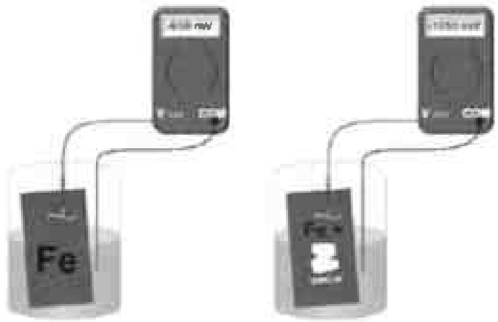
BS3900-F10 (CATHODIC DISBONDMENT TEST) - BODYCOTE*

BS3900-F10: Methods of test for paints. Determination of resistance to cathodic disbonding of coatings for use in marine environments

ZINGA applied at 60 and 100 µm DFT was exposed during 26 weeks at -1,0 volt. The results was no cathodic disbondment at all.

ELECTRO-POTENTIAL MEASUREMENTS - COT

The sample ZINGA has been applied on sandblasted steel test panels of the specified quality. The test panels were partially immersed in 1.5% NaCl electrolyte at 23°C.
After 24 h immersion, the electrical potential of the panels has been determined, using a Standard Silverchloride Electrode (Ag/AgCl) as reference Electrode. Reported averaged measurements have been corrected for electrode drift and translated to SCE values.
The panels coated with ZINGA, have an averaged potential of -1110 mV (SCE); compared to -682 mV of blanc steel. The current density remains positive during the entire test, which indicates cathodic protetion by the coating.



ZINGA IN COMPARISON WITH HDG

ELECTRO-POTENTIAL MEASUREMENTS - UGENT / BNF*

In 2009, The University of Ghent (prof. dr. Defrancq) conducted several electrochemical tests to compare the galvanic protection of ZINGA to the established protection of Hot-Dip Galvanising. it was demonstrated that the short circuit flow of equal layer thicknesses of ZINGA and HDG have equal maximal current for an equal amount of time.
Therefore it is concluded that the electrochemical background of galvanic protection in ZINGA is equal to HDG.

In 1992, the renown research association BNF, performed extensive electrochemical testing on ZINGA and HDG.
In the experiment, the open circuit voltage and galvanic current between ZINGA and bare steel were measured over a range of area ratios. These results were compared with those from identical tests in which the ZINGA was replaced by hot-dipped galvanised steel.
The corrosion rate of the ZINGA coated specimens after 7 days exposure was 0.035mm/year, roughly 113 of the corrosion rate of galvanised steel panels under similar conditions (0.1 l mm/year). In the tests where the ZINGA coated and galvanised panels were coupled to mild steel samples, the potential of the coupled electrodes always remained below -800mV SCE, which showed that both ZINGA and galvanised steel offer good galvanic protection to the steel.

ASTM B117/ISO 9227 (SALT SPRAY TESTING) - SABS*

In this test is demonstrated that the loss in weight of ZINGA is 1/10 of the loss in weight of hot-dip galvanising after a 400 hours salt spray test. The layer thickness of ZINGA diminishes because ZINGA is being consumed, contrary to a paint that will start to peel off after a certain period of time. This illustrates the fundamental difference between a paint and a galvanising system.

* BNF - British Non-Ferrous Metals Research Association (UK) / SABS - South African Bureau of Standards (South Africa)

FIELD TEST - SERVICE MARITIME DE LA VENDÉE

Two buoys (one treated with ZINGA, the other one hot-dip galvanised) have floated in the Atlantic
Ocean for four years. After those four years, the buoy treated with ZINGA showed no trace of rust
while the hot-dip galvanised buoy was severely corroded in several places.

Left: Buoy treated with ZINGA + topcoat

Right: Buoy treated with HDG + topcoat

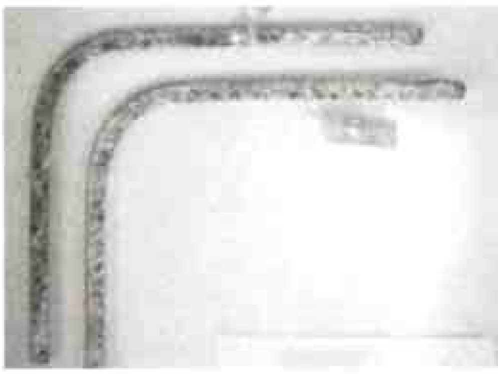
ZINGA ON REBARS

ASTM B117 / ISO 9227 (SALT SPRAY TESTING) - SAI / JU / AUPTT*

Steel Authority of India (2006):
A comparison was made between uncoated steel rebars, fusion bonded epoxy coated rebars (FBEC), hot-dip galvanised rebars (HDG) and zinganised rebars (ZINGA). The corrosion rate per year was measured after immersion and salt spray. This test demonstrated several advantages of ZINGA: the greater degree of galvanic protection, the lower sacrificial zinc consumption due to the dispersion of zinc dust in the binder and the additional barrier protection created by the binder.
ZINGA > FBEC > HDG > Uncoated

Jadavpur University (2006):
A comparison was made between uncoated steel (Mild steel and Stainless steel) rebars, fusion bonded epoxy coated rebars (FBEC), hot-dip galvanised rebars (HDG) and zinganised rebars (ZINGA). The salt spray test pointed out that the zinganised rebars have a corrosion resistance that is about 2 times higher than that of hot-dip galvanised rebars. ZINGA is also least susceptible for stress corrosion cracking.
in NACE solution: ZINGA > HDG > FBEC > Stainless steel > Mild steel

Amirkabir University Poly Technic Tehran (2008):
The zinganised rebars passed the 500 hours salt spray test without formation of rust, peeling or blistering, not even in places where the coating was mechanically damaged. The rebars that were not zinganised were heavily corroded.



* SAI - Steel Authority of India (India) / JU - Jadavpur University (India) / Amirkabir University Poly Technic Tehran (Iran)

ISO 1519 (BEND TEST) - COT

ISO 1519: Paints and varnishes -- Bend test (cylindrical mandrel)

ZINGA has been applied at a layer thickness of 60 µm DFT on test panels and bent by a mandrel tester at 23°C and 50% RV. The diameter of the mandrels are 32 mm, 25 mm, 20 mm, 16 mm, 13 mm, 12 mm, 10 mm, 8 mm, 6 mm, 5 mm, 4 mm, 3 mm and 2 mm.
Immediately after bending, the coating has been examined under good illumination with normal corrected vision.

ZINGA showed no cracks when bending on a cylindrical mandrel with a diameter of 12 mm.

RILEM / CEB / FIP RC6 (PULL OUT TEST) - UGENT

RILEM/CEM/FIP Recommendation RC6-1978: Technical Recommendations for the Testing and Use of Construction Materials: Bond test reinforcing steel - 2. Pull-out test

Three rebars with enhanced adhercnce L = 1000 mm; ø =18 mm were tested.

- One rebar is embedded in concrete in the uncoated condition.
- Two rebars were first coated with a ZINGA coating of 25 µm over a length of 500 mm and subsequenty. after 72 hours of drying time, embedded in concrete.

The rebars were embedded in the center of concrete cubes and a plastic tube is slipped over the rebar in such a way that only 90 mm of the rebar is in contact with the concrete.
After 28 days cure, the pull-out test was performed.

An average adhesion force for ZINGA on rebars of 17.03 N/mm was found. This was comparable to the uncoated rebars (18.90 N/mm).
It was concluded by Prof. Dr. Eng. Defrancq that the adhesion to concrete of rebars coated with ZINGA is not advesely affected compared to the adhesion of non coated rebars.

CLEAVE ADHESION TEST - B-HOLDING*

A custom test was designed to test the adhesion of (zinganised) rebars to the concrete. A rebar coated with ZINGA, an untreated and a sandblasted rebar were imbedded in concrete.
The rebars were aged using SO_2 (Kesternich).

The concrete was cleaved, in order to set free the steel reinforcement.

Conclusion:
It is clearly more difficult to cleave the rebar bloc containing the steel rod protected with ZINGA. The adherence of the concrete to the Zinganised rod is better. The actual cleavage happens in the concrete (in contrast to the other two rebars, which cleaved neatly between steel and concrete), which indicates a strong adherence.

* B-Holding (Belgium)

(NON) TOXICITY OF ZINGA

AS/NZS 4020 (CONTACT WITH DRINKING WATER TEST) - AWQC*

AS/NZS 4020 (2005): Testing of products for use in contact with drinking water

ZINGA was put through extensive testing by the Australian Water Quality Centre.
The water in contact with ZINGA was tested on taste (1000 mm^2/L) and appearance (15000 mm^2/L), on growth of aquatic micro-organisms (6300 mm^2/L), cytotoxic and mutagenic activity (15000 mm^2/L) and an analysis of a metal extraction (15000 mm^2/L) was performed.

The results demonstrate compliance to AS/NZS 4020 for ZINGA.

BS 6920 (CONTACT WITH DRINKING WATER TEST) - WRAS*

BS 6920: Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of the water.

Even though ZINGA is a metallic coating, it was tested according to the standard BS 6920 to determine whether or not the quality of potable water is affected when it is in contact with a ZINGA layer.

The water was analysed on taste, appearance, growth of micro organisms, extraction of harmful substances and extraction of metals. The obtained results complied with the requirements and ZINGA was found suitable for contact with potable water.

Since its review in 2008, ZINGA could no longer be tested according this standard excluding al metallic coatings.

ZINGA RELIQUIFICATION

MICROSCOPIC ANALYSIS - UGENT

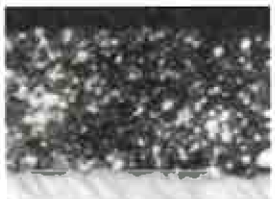
A custom test was designed to demonstrate that a newly applied ZINGA layer makes the former layer liquid again so that both layers blend together to one single homogeneous layer. The new layer recharges the old one.

A thin gold film layer was applied on top of ZINGA and photographed. Afterwards, a second layer of ZINGA was applied an the layer was photographed again. The same procedure was repeated with a zinc rich coating.

The first picture shows dispersion of the gold layer through the blended ZINGA layer, while the second depicts two separated layers with the gold layer in between.

The ZINGA film galvanising system is very easy to maintain and to recharge: there is no need for gritblasting, contrary to the surface preparation that is required when a traditional paint has been used.

Gold particles on top of ZINGA



Gold particles blend in two layers of ZINGA

Gold particles in between the two layers of epoxy paint

MACROSCOPIC ANALYSIS - STANGERS

Dried "caked" ZINGA was reliquidised using new ZINGA on different plates, brushes and different times of drying.
It was found that "ZINGA is easy to apply by brush and resoftens caked ZINGA or dry ZINGA films as claimed by the manufacturer. This property enables ZINGA to be built up into thick composite layers avoiding the discrete films achieved with conventional coatings."

End conclusion: "It is evident that the product has special properties which place it, as far as we know, into a unique category."

SURFACE SPREAD OF FLAMES OF ZINGA

EN 13501-1 (FIRE TEST) - EFECTIS

EN 13501-1 (2007) + A1 (2009): Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests

Determination of the ignitability properties of the product, by direct small flame impingement according to EN ISO 11925-2:2010, with the objective to obtain the reaction to fire classification according to EN 13501-1:2007+A1:2009.

Determination of the reaction to fire properties of the product, when exposed to the termal attack by a single burning item according to EN 13823:201, with the objective to obtain the reaction to fire classification according to EN 13501-1:2007+A1:2009.

A total of twelve single ignitability tests were carried out according to EN ISO 11925-2.

A total of three single burning item tests were carried out according to EN 13823.

ZINGA 2 x 90 µm DFT Reaction to fire classification: **B - s1, d0**

BS 476-6 (FIRE TEST) - SGS YARSLEY TECHNICAL SERVICES

BS 476-6: Fire Tests on Building materials and structures – Method of test for fire propagation for products

This Part of BS 476 specifies a method of test, the result being expressed as a fire propagation index, that provides a comparative measure of the contribution to the growth of fire made by an essentially flat material, composite or assembly. It is primarily intended for the assessment of the performance of internal wall and ceiling linings.

The results of the test according to the BS 476: part 6 show that ZINGA has a class 0 surface. ZINGA did not ignite during exposure to heating.

FRICTION COEFFICIENT OF ZINGA

GB 50017-2003 & GB 50205-2001 (ANTI-SLIP COEFFICIENT) - CNCSQSTC*

GB 50017-2003 Code for design of steel structures
GB 50205-2001 Code for Acceptance of Construction Quality of Steel Structures

In Octobre 2005, ZINGA coated plates have been tested according GB 50017 and GB 50205 to assess the slip friction coefficient (μ) of high strength bolts adjoining steel sections.

The results demonstrate that ZINGA coated surfaces of high strenght bolts have increased friction (compared to bare steel or galvanised steel) with results of μ between 0.5 and 0.7. This is beneficial for construction.

ASTM A325 & A490 (ANTI-SLIP COEFFICIENT) - KTA TATOR*

ASTM A490: Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

Plates coated with 100 μm DFT of ZINGA, were loaded onto a horizontal rod, based on contact surfaces having similar coating thickness. A clamping force of 49 kips (= 218 kN) was applied to the test assembly, then a compressive load was applied to the machined edge of the middle plate at a rate no-to-exceed 25 kips/minute, to induce a slip. The slip load for each test assembly is divided by two times the clamping force to obtain the slip coefficient.

ZINGA exhibited a slip coefficient of 0.52 and passed the 1,000 hour Creep Deformation test. ZINGA is therefore certified class B.

WELDING OF ZINGA

WELDING TEST - UGENT

A set of 3 x 2 plates, covered with a layer of ZINGA, the thickness of which was respectively 15 μm DFT, 40 μm DFT and 60 μm DFT. After a polymerisation period of seven days the two plates covered with the same coating thickness were welded together by hand.

None of the 3 specimens shows any deficiency, neither in the welding seams nor in the steel itself.

WELDING TRIALS - CONFIDENTIAL*

Before their use of ZINGA on rail tracks, X investigated not only the performance of the coating, but also its weldability.
On trials, they performed weld trials with ZINGA coated tracks and found that the process was not negatively affected by the coating. No localised melting of the zinc based coating had occurred and there was no evidence of die burns or pick up in either the rails or the copper dies.

The four foot length was subsequently bend tested and despite the apparent slippage broke at 1430 kN. This comfortably passed the Network Rail specification minimum of 1220 kN. The grab marks induced by the compressional strength of 1,5 tons, required to hold the rail-track ends together during the welding operation illustrate how ZINGA was crushed into the metal during this phase.

* China National Construction Steel Quality Supervision and Test Center (China) / KTA Tator (USA) / Global Steel Manufacturer

ISO 12944

SMALLER LAYER THICKNESS
SAME RESULT · COST EFFECTIVE

➔ For Engineers and corrosion experts: offers a conceptual framework for making the best choice in corrosion protection of steel structures.

*Duplex = ZINGA + [illegible]

	System with ZINGA®	Alternative system: Paint system	Alternative system: Zinc + Paint
C4 High = C5 I/M Medium	ZINGA® 2 x 60 µm DFT	Paint min. 300 µm DFT	Hot dip galvanisation 80 µm + Paint 160 µm DFT
C5 I/M High	ZINGA® 2 x 90 µm DFT ZINGA® in duplex	Paint min. 320 µm DFT	Hot dip galvanisation 80 µm + Paint 320 µm DFT
Im2 & Im3	ZINGA® 1 x 60-80 µm DFT + 2 x 100 µm DFT Zingatarfree	Paint min. 500 µm DFT	Zink (R) Paint 60 µm DFT +

CORROSION ZONES

C5 M: Coastal zone with high salinity
C5 I: Industrial zone with high humidity and agressive environment
Im2: immersion in salt water
Im3: Subterranean

LIFE EXPECTATION

Medium: Life expectation between 5 and 15 years.
Hoog: Life expectation more than 15 years.

ISO 12944 ADVANTAGES

+ Confidence that the specified corrosion protection will be fit for purpose.
+ Life expectation based on scientific tests.
+ A universally accepted standard.

ALTERNATIVES ACCORDING TO C5 I/M HIGH

Paint System
4 x 80 µm DFT Epoxy or PU Paint
Total layer thickness **320 µm DFT**

ZINGA Film Galvanising System
2 x 90 µm DFT ZINGA®
Total layer thickness **180 µm DFT**

MORE INFO?
Ask our ZINGA experts!

www.zinga.eu

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www.zinga.eu

ZINGAMETALL SYSTEMS

ZINGA 2 x 60 µm DFT

The system ZINGA 2 x 60 µm DFT is suitable for a C5I environment (atmospherically) with a Medium life expectancy and Im2 and Im3 environment (immersion) with a Medium life expectancy.

A C5I Medium classification equals to a C5M Medium or C4 High classification.

Since 1988, several pulp and paper factories in Canada used ZINGA in 2 layers of 60 µm DFT to treat their structures. In 2005 (17 years after application), no touch-ups were necessary in this corrosive C5I environment.

ZINGA 2 x 90 µm DFT

The system ZINGA 2 x 90 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy and Im2 and Im3 environment (immersion) with a Medium life expectancy.

A C5I High classification equals to a C5M High classification.

The phosphate Mine in Togo (Office Togolais des Phosphates) was treated in 1994 with 2 layers of ZINGA. In 2006 (12 years after application), no trace of rust was found. In 2014, 20 years after application, the structures were still in good condition.

ZINGA 1 x 60 µm DFT + Zingalufer 1 x 80 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingalufer 1 x 80 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.

This system should be overcoated with a topcoat, to give a coloured finish.

Since 2006, Shell Morocco uses the system with Zingalufer as a basis to protect its hydrocarbon storage tanks. Not a small defect was detected and Shell is continuing to use the system because of high satisfaction.

ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.

This system should be overcoated with a topcoat, to give a coloured finish.

In 2012-2013, the 6 penstocks and hoist crane of the Akasombo Dam have been treated with the Zingaceram system. This system has a life expectancy of >15 years in an industrial zone with high humidity and aggressive environment.

ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram PU 1 x 60 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram PU 1 x 60 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.
This system gives a coloured finish for use in **outdoor** conditions.

Over the period 2013-2016, the Izmit Bay Suspension Bridge (Marmara Bridge) in Turkey -the fourth largest suspension bridge in the world- has been treated with the Zingaceram system. It has a life expectancy of >15 years in the harsh maritime environment.

ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram EP 1 x 60 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram EP 1 x 60 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.
This system gives a coloured finish for use in **indoor** conditions.

In april 2005, the interior of 22 wind mills of Zephyros in Taiwan has been treated with the Zingaceram system. This system has a life expectancy of > 15 years in a maritime zone with high humidity and aggressive environment.

ZINGA 1 x 60 µm DFT + Zingatarfree 2 x 100 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingatarfree 2 x 100 µm DFT is suitable for a **Im2 or Im3** environment with a **High** life expectancy.

This system gives a black finish for use in **immersion** (soil or water).

Since 2012, GUGLER Water Turbines GmbH (Austria) uses the system with Zingatarfree as a basis to protect the underground parts of water tubes. This system will provide a life expectancy of >15 years on structures immersed in soil.

ISO 12944 ON ZINGA TEST RESULTS

To view the actual reports, please visit www.zinga.eu.

WHAT IS ISO?

The ISO (International Organization of Standardization) is the world's largest developer and publisher of international standards. ISO is a network of the national standards institutes of 162 countries, one member per country (see: http://www.iso.org/iso/iso_members), with a central secretariat in Geneva, Switzerland, that coordinates the system.

ISO is a non-governmental organization that forms a bridge between the public and private sectors. On the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

Therefore, ISO enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society.

WHAT IS ISO 12944?

ISO 12944-6: Paints and varnishes -- Corrosion protection of steel structures by protective paint systems

The ISO 12944 standard is intended to assist engineers and corrosion experts in adopting best practice in corrosion protection of structural steel with coatings at new construction and repairs. ISO 12944 is progressively superseding regional standards to become a truly global benchmark in corrosion control (see also: http:/ww.iso.org/iso/catalogue_detail.htm?csnumber=41862).

Selecting specifications that comply with ISO 12944 provides:
- Confidence that the corrosion protection you specify will be fit for purpose
- An objective approach to coating selection
- A simplified matrix of coating systems to select from
- A meaningful coating design life
- A universally accepted standard

The properties of this ISO 12944 standard allow your customer (be it architects, engineers, corrosion experts or simply a customer wanting guidance) to know that what we present them is really tested and approved by an independent test centre according to an international and very complete standard. Different ZINGA systems (see below) have been subjected to extensive testing such as water condensation test, neutral salt spray test, chemical resistance test and water immersion test. After a prescribed exposure test (depending on respresentative environment - see below), the coating is assessed for adhesion, blistering, rusting, cracking and flaking.

Environments are classified according corrosivity from C1 to C5. Meaning:

Corrosivity class	Characteristics	Examples
C1	Indoor Neutral atmosphere No pollution No salinity	Classrooms Offices Living rooms ...
C2	Rural areas Low pollution Low salinity	Rural buildings Road infrastructure in rural areas ...
C3	Urban areas Light industrial zones Moderate pollution Production areas with high humidity	City buildings Factories Road infrastructure in urban areas ...
C4	Industrial zones High pollution Coastal zones with moderate salinity Production areas with very high humidity	Chemical factories Swimming pools Shipyards ...
C5 I	Industrial zones High humidity Aggressive environment Continuous condensation High pollution	Heavy chemical factories Oil and gas facilities ...
C5 M	Coast zones Marine zones (Very) high salinity Continuous condensation High pollution	Marine Offshore Estuaries ...

And three environments for structures in immersion:

Corrosivity class	Characteristics	Examples
Im1	Clear, fresh water Potable water	Potable water tanks Pipelines for utility water ...
Im2	Sea water Brackish water	Harbors with locks Jetties Offshore structures ...
Im3	Soil	Underground storage tanks Iron poles Pylon foots ...

After exposure, the coating is evaluated as H(igh), M(edium) or L(ow); reflecting in a life expectancy of:

Low	Medium	High
< 5 years	Between 5 and 15 years	> 15 years

ZINGAMETALL SYSTEMS TESTED

ZINGA 2 x 60 µm DFT

The system ZINGA 2 x 60 µm DFT is suitable for a C5I environment (atmospherically) with a Medium life expectancy and Im2 and Im3 environment (immersion) with a Medium life expectancy.

A C5I Medium classification equals to a C5M Medium or C4 High classification.

Examples of existing systems for atmospheric conditions that fall into that same category (C4 High) are:

According ISO 12944-5

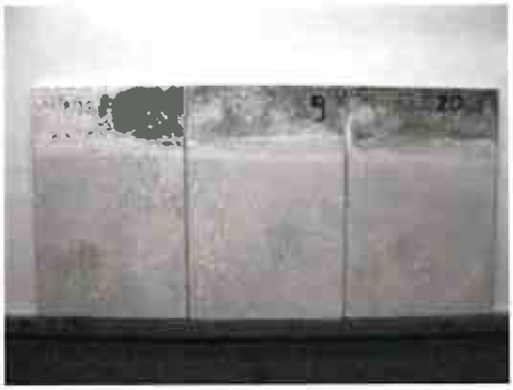
Paint system	3 x 100 µm Epoxy Paint	80 µm Hot-dip + 1 x 80 µm DFT Primer + 2 x 80 µm DFT Ep or PU	100 µm Metallisation + Sealer coat + 2 x 160 µm DFT Ep or PU
Total thickness	300 µm DFT	320 µm DFT	420 µm DFT

Examples of existing systems for conditions that fall into that same category (Im2 and Im3 Medium) are:

According ISO 12944-5

Paint system	1 x 60 µm Zn Rich Epoxy primer 3 x 100 µm Epoxy or PU Paint	1 x 80 µm Epoxy primer 3 x 100 µm Epoxy Paint
Total thickness	360 µm DFT	380 µm DFT


ZINGA 2 x 60 µm DFT after 720 h condensation.


ZINGA 2 x 60 µm DFT after 2000 h immersion.


Since 1988, several pulp and paper factories in Canada used ZINGA in 2 layers of 60 µm DFT to treat their structures. In 2005 (17 years after application), no touch-ups were necessary. This agrees with the ISO 12944-6 test results for ZINGA 2 x 60 µm DFT predicting a life expectancy of >15 years in an industrial zone.

ZINGA 2 x 90 µm DFT

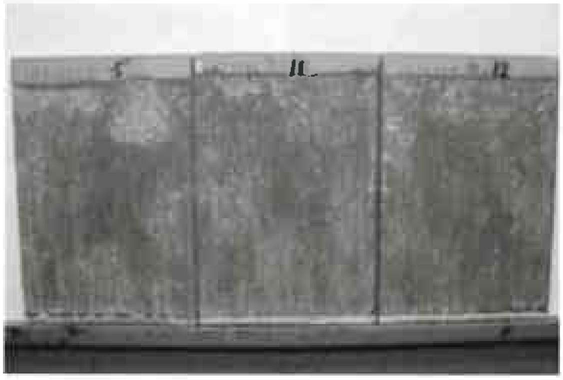
The system ZINGA 2 x 90 µm DFT is suitable for a C5I environment (atmospherically) with a High life expectancy and Im2 and Im3 environment (immersion) with a Medium life expectancy.

A C5I High classification equals to a C5M High classification.

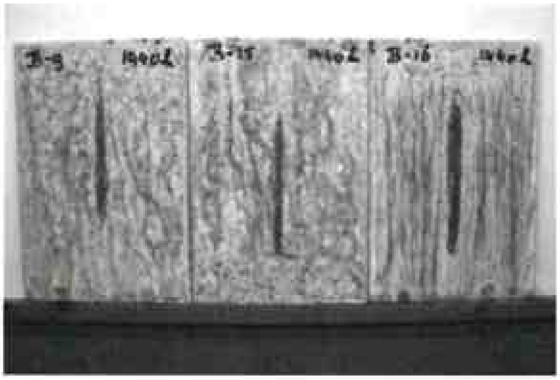
Examples of existing systems for atmospheric conditions that fall into that same category are:

According ISO 12944-5

Paint system	60 µm Zinc Rich paint 2-3 layers Epoxy Paint (= 340 µm DFT)	80 µm Hot-dip + 1 x 80 µm DFT Primer + 2 x 120 µm DFT Ep or PU	100 µm Metallisation + Sealer coat + 2 x 225 µm DFT Ep or PU
Total thickness	400 µm DFT	400 µm DFT	550 µm DFT



ZINGA 2 x 90 µm DFT after 720 h condensation.



ZINGA 2 x 90 µm DFT after 1440 h salt spray.

The phosphate Mine in Togo (Office Togolais des Phosphates) was treated in 1994 with 2 layers of ZINGA. In 2006 (12 years after application), no trace of rust was found. This agrees with the ISO 12944-6 test results for ZINGA 2 x 90 µm DFT predicting a life expectancy of >15 years in an industrial zone with high humidity and aggressive environment.

ZINGA 1 x 60 µm DFT + ZINGALUFER 1 x 80 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingalufer 1 x 80 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.

A C5I High classification equals to a C5M High classification.

This system should be overcoated with a topcoat, to give a coloured finish.

Since 2006, Shell Morocco uses the system ZINGA 1 x 60 µm DFT + Zingalufer 1 x 80 µm DFT as a basis to protect its hydrocarbon storage tanks. Not a small defect was detected and Shell is continuing to use the system because of high satisfaction. There is no doubt that this system will provide a protection that agrees with the ISO 12944-6 test results predicting a life expectancy of >15 years in an industrial zone with high humidity and aggressive environment.

ZINGA 1 x 60 µm DFT + ZINGACERAM HS 1 x 120 µm DFT

The system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.

A C5I High classification equals to a C5M High classification.

This system should be overcoated with a topcoat, to give a coloured finish.

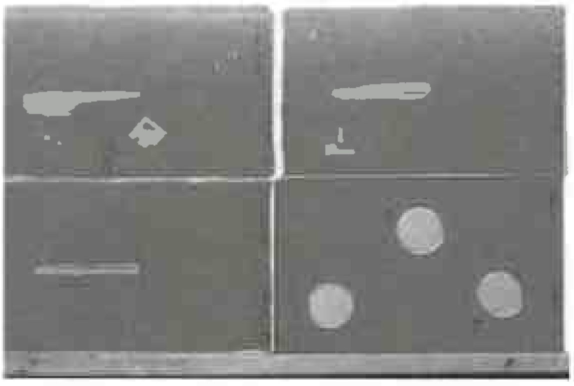
In 2012-2013, the 6 penstocks and hoist crane of the Akasombo Dam have been treated with the system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram PU 1 x 60 µm DFT. This system will provide a protection that accords to the ISO 12944-6 test results predicting a life expectancy of >15 years in an industrial zone with high humidity and aggressive environment.

ZINGA 1 x 60 µm DFT + ZINGACERAM HS 1 x 120 µm DFT + ZINGACERAM PU 1 x 60 µm DFT

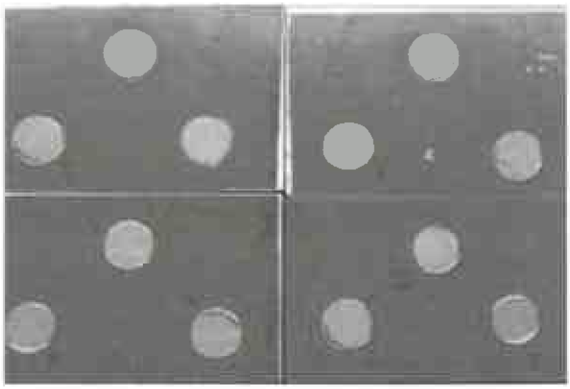
The system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram PU 1 x 60 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.

A C5I High classification equals to a C5M High classification.

This system gives a coloured finish for use in **outdoor** conditions.



ZINGA + Zingaceram HS + Zingaceram PU after 1440 h salt spray



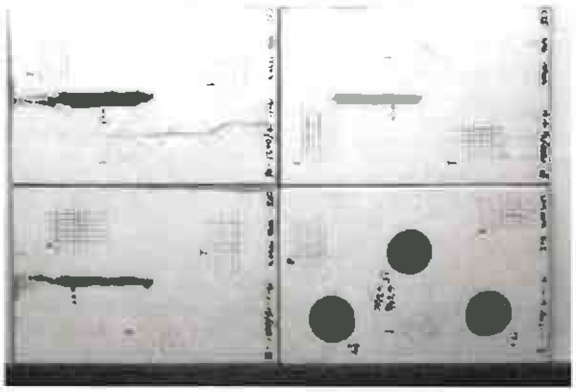
ZINGA + Zingaceram HS + Zingaceram PU after 720 h condensation

ZINGA 1 x 60 µm DFT + ZINGACERAM HS 1 x 120 µm DFT + ZINGACERAM EP 1 x 60 µm DFT

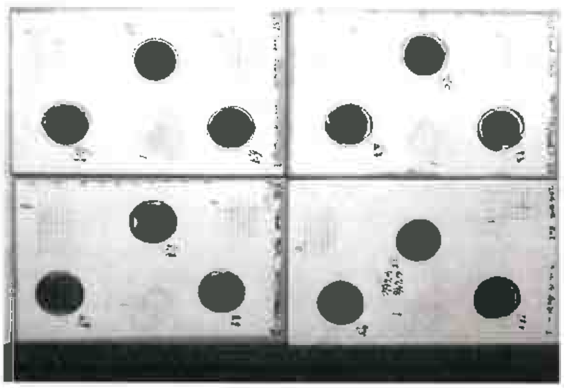
The system ZINGA 1 x 60 µm DFT + Zingaceram HS 1 x 120 µm DFT + Zingaceram EP 1 x 60 µm DFT is suitable for a **C5I** environment (atmospherically) with a **High** life expectancy.

A C5I High classification equals to a C5M High classification.

This system gives a coloured finish for use in **indoor** conditions.



ZINGA + Zingaceram HS + Zingaceram EP after 1440 h salt spray



ZINGA + Zingaceram HS + Zingaceram EP after 720 h condensation

ZINGA 1 x 60 µm DFT + ZINGATARFREE 2 x 100 µm DFT

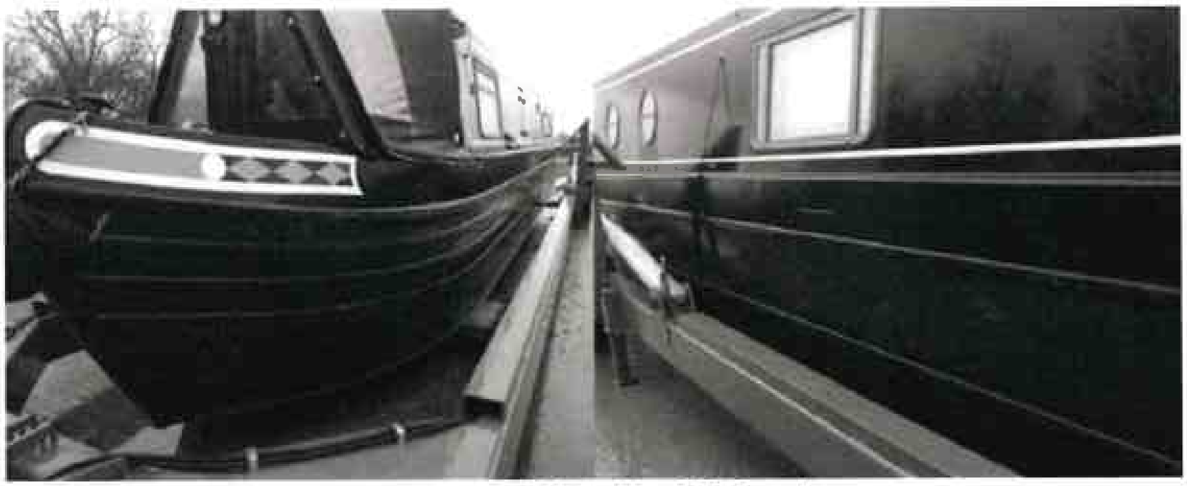
The system ZINGA 1 x 60 µm DFT + Zingatarfree 2 x 100 µm DFT is suitable for a **Im2 or Im3** environment with a **High** life expectancy.

This system gives a black finish for use in **immersion** (soil or water).

Examples of existing systems for conditions that fall into that same category (Im2 and Im3 High) are:

Paint system	1 x 60 µm Zn Rich Epoxy primer + 3 x 160 µm Epoxy Paint	100 µm Metallisation + Sealer coat + 3 x 150 µm DFT Epoxy Paint
Total thickness	540 µm DFT	550 µm DFT

Since 2012, GUGLER Water Turbines GmbH (Austria) uses the system ZINGA 1 x 60 µm DFT + Zingatarfree 2 x 100 µm DFT as a basis to protect the underground parts of water tubes. This system will provide a protection that accords to the ISO 12944-6 test results predicting a life expectancy of >15 years on structures immersed in soil.



In the UK, several boats, mostly narrow boats, the system ZINGA 1 x 60 µm DFT + Zingatarfree 2 x 100 µm DFT has been used on the lower hull to protect the steel parts in water immersion. This system will provide a protection that accords to the ISO 12944-6 test results predicting a life expectancy of >15 years on structures immersed in water.

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REPORT

Testing of ZINGA 2 x 90 µm
dry film thickness
according to ISO 12944-6

Haarlem, November 1st, 2012

Client	:	Zingametall bvba Industriepark – Rozenstraat 4 B – 9180 Eke (Belgium) Contact person: Mr. F. Peirsegaele
Project number	:	20090602
Report number	:	LAB10-0770-REP Revision 1
Handled by	:	Mr. N. Blokker

CONTENTS

1 INTRODUCTION

1.1 Order

By order of Zingametall bvba in Eke, Belgium, the Centrum voor Onderzoek en Technisch advies (COT bv) in Haarlem has tested Zinga 2 x 90 µm dry film thickness according to ISO 12944-6.

The order has been given by signing the COT quotation LAB10-0234-OFF on 24 February 2010

1.2 Samples

Samples	:	44 coated steel test panels with 2 layers Zinga (2 x 90 µm DFT); Batch number B965
COT sample number	:	22-02-10/0175 B
Received	:	19 February 2010

2 PAINT APPLICATION

The Zinga system has been applied at Zingametall bvba.

Specified Dry Film Thickness	:	2 layers, 90 µm dry film thickness per layer
Required durability	:	ISO 12944-6 C5-I ISO 12944-6 C5-M ISO 12944-6 Im3

Test times:

Water Condensation test	:	Start 16-03-2010	End 15-04-2010
Neutral Salt Spray test	:	Start 16-03-2010	End 14-05-2010
Chemical Resistance test	:	Start 08-03-2010	End 20-04-2010
Water Immersion test	:	Start 01-04-2010	End 24-06-2010

3 RESULTS

3.1 Assessment before tests

Cross-cut test ISO 2409	Panel 10	Panel 17	Requirement
Minimum - maximum DFT (µm)	147 - 185	157 - 197	
Average DFT (µm)	169 ± 13	175 ± 13	
Classification	0	0	0 or 1

3.2 Assessment after Water Condensation test

720 hours ISO 6270	Panel 5	Panel 11	Panel 12	Requirements
Minimum - maximum DFT (µm)	147 - 179	169 - 183	159 - 175	
Average DFT (µm)	163 ± 11	177 ± 4	167 ± 5	
ISO 4628-2 (blistering)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-3 (rusting)	Ri 0	Ri 0	Ri 0	Ri 0
ISO 4628-4 (cracking)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-5 (flaking)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 2409 Cross-cut test (Classification)	0	0	0	0 or 1

3.3 Assessment after Neutral Salt Spray test

1440 hours ISO 9227 NSS	Panel 9	Panel 15	Panel 16	Requirements
Minimum - maximum DFT (µm)	135 - 173	159 - 181	183 - 211	
Average DFT (µm)	156 ± 11	172 ± 7	195 ± 8	
ISO 4628-2 (blistering)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-3 (rusting)	Ri 0	Ri 0	Ri 0	Ri 0
ISO 4628-4 (cracking)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-5 (flaking)	0(S0)	0(S0)	0(S0)	0(S0)
Annex A (corrosion of the substrate from the scribe) (mm)	<0.5	<0.5	<0.5	Not exceed 1 mm
ISO 2409 Cross-cut test (Classification)	0	0	0	0 or 1

3.4 Assessment after Chemical Resistance test

Instead of immersion, in accordance with ISO 2812-1, the system has been tested according to ISO 3231 with 0.2 L SO_2 during 30 cycles.

30 cycles ISO 3231	**Panel 1**	**Panel 2**	**Panel 3**	**Requirements**
Minimum - maximum DFT (µm)	165 - 195	175 - 215	139 - 177	
Average DFT (µm)	181 ± 10	196 ± 14	160 ± 13	
ISO 4628-2 (blistering)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-3 (rusting)	Ri 0	Ri 0	Ri 0	Ri 0
ISO 4628-4 (cracking)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-5 (flaking)	0(S0)	0(S0)	0(S0)	0(S0)
Annex A (corrosion of the substrate from the scribe) (mm)	0	0	0	Not exceed 1 mm
ISO 2409 Cross-cut test (Classification)	0	0	0	0 or 1

3.5 Assessment after Water Immersion test

2000 hours ISO 2812-2 (5% m/m sodium chloride)	**Panel 18**	**Panel 19**	**Panel 21**	**Requirements**
Minimum - maximum DFT (µm)	167 - 223	167 - 191	159 - 189	
Average DFT (µm)	199 ± 19	176 ± 8	177 ± 10	
ISO 4628-2 (blistering)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-3 (rusting)	Ri 0	Ri 0	Ri 0	Ri 0
ISO 4628-4 (cracking)	0(S0)	0(S0)	0(S0)	0(S0)
ISO 4628-5 (flaking)	0(S0)	0(S0)	0(S0)	0(S0)
Cross-cut (Classification)	0	0	0	0 or 1

4 CONCLUSION

The system 2 layers Zinga, batch number B965, dry film thickness 90 µm per layer (COT sample number 22-02-10/0175 B), meets the requirements of the following corrosivity categories of ISO 12944-6:

C5-I-High and C5-M-High
Im2-Medium and Im3-Medium

CENTRUM VOOR ONDERZOEK
EN TECHNISCH ADVIES (COT bv)

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Manager Laboratory

N. Blokker
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