TECHNICAL MEMORANDUM

Customer:	**Excalibur Screwbolts Ltd, Gate 3, Newhall Nursery, Lower Road, Hockley, Essex SS5 5JU**
Customer Order Number:	**Mr J Stevens**
Requirement:	**Estimation of the life of a screwbolt coated with Anochrome 10888**
Identification:	**N/A**
Date:	**10th October 2016**

1. Introduction

Anochrome 10888 is zinc based surface coating which is further enhanced by means of a solvent based seal applied as a very thin (1µm) layer to the surface of the zinc to inhibit atmospheric corrosion of the zinc and thereby improve its operational life. Effectively, the seal reduces the tendency of the external zinc surface to form 'white rust' and thereby extends its life as a sacrificial protection agent to the underlying steel.

Additionally, the zinc flake is applied mechanically to the steel surface so there is no risk of hydrogen embrittlement, allowing the process to be applied to higher grade fasteners without risk.

Salt spray testing to the requirements of ASTM B117[1] has been reported to give good results to 1000 hours [2] .

An opinion has now been requested on what service life might reasonably be predicted for the bolts, based on the testing to 1000 hours.

2. Indemnity

This technical memorandum offers only an opinion on the possible service life of the bolts, and no liability is accepted in the event of premature failure. The service life will depend on the properties of the bolts themselves but also on the bolt manufacturing process, the service conditions, installation procedures, inspection and maintenance, and to some extent on design parameters, most of which are outside the control, and the knowledge to a large extent, of the author of the opinion given.

3. Technical background

It is well known that zinc coatings, which include mechanically applied systems (eg sherardizing), can provide long term corrosion protection to otherwise susceptible materials, and the mechanism of protection has its basis in the galvanic nature of the corrosion process and the fact that zinc will corrode preferentially to steel and thereby protect it. The environment in which the items operate has a significant bearing on

the length of time for which this protection will last, as do the presence of any prior surface damage and the thickness of the coating.

It is worth noting that, from a technical perspective, the use of stainless steel, depending on the operating environment, may not be a practical alternative because of its potential susceptibility to other forms of corrosive attack, for example stress corrosion cracking. Thus, a situation in which an austenitic stainless steel (for example grade 316 or 304) is exposed to a chloride environment and to a tensile stress, may not be conducive to a long service life, and in fact a suitably protected high tensile steel is likely to perform as well or better. In this context, an additional advantage of mechanically applied zinc is freedom from the risk of hydrogen embrittlement, specifically in high strength steels.

4. Lifetime projections

It is generally accepted that there is no reliable direct relationship between the results of salt spray testing and long term service performance. The following is an extract from BS EN ISO 9227:

'There is seldom a direct relation between resistance to the action of salt spray and resistance to corrosion in other media, because several factors influencing the progress of corrosion, such as the formation of protective films, vary greatly with the conditions encountered. Therefore, the test results should not be regarded as a direct guide to the corrosion resistance of the tested metallic materials in all environments where these materials might be used. Also, the performance of different materials during the test should not be taken as a direct guide to the corrosion resistance of these materials in service'

Other international standards, for example MIL-STD-202G[3], make similar statements. However, there is an acceptance that the salt spray test can be reliably used to screen unsuitable coatings and/or to identify surface defects, and zinc coating life predictors exist and are offered for use by the International Zinc Association.

The key to any attempt at prediction is that the conditions of test are likely to vary significantly from service conditions and that service conditions are susceptible to change as a result of a number of factors, such as: manufacturing parameters, design factors, installation parameters, local incidents (creating different local environments, eg leakage), extent and reliability of inspection and maintenance. All of these factors have a bearing on the life of the corrosion protection of a component in service.

5. Discussion

In arriving at an opinion on the possible service life of fasteners coated with Anochrome 10888, the following factors have been taken into consideration:

- The properties of mechanically applied coatings and of zinc coatings in general
- The anticipated corrosion mechanism, ie in this case pitting (galvanic) corrosion is the most likely mechanism
- The results of salt spray test carried out, ie 1,000 hours without significant corrosion
- A knowledge of the severity of the conditions of test

The following factors have not been taken into consideration:

- The possible life enhancement from the use of a sealing coat
- The possibility of manufacturing defects or design influences
- Possible installation damage
- Possible shortcomings in, or lack of, inspection
- Possible shortcomings in, or lack of, maintenance

In addition, a zinc coating life predictor with a copyright attributed to The International Zinc Association (2002)[4] has been used with the following assumptions:

- Rain: 100mm/year max
- Salinity: 1 $mg/m^2/day$
- Sulphur dioxide: 1 $mg/m^2/day$
- Relative humidity: 50%
- Temperature: 10°C
- Sheltering condition: Rain sheltered
- Coating thickness: 35µm

On the basis of the above, the zinc coating lifetime predictor gives an estimated life of 173 years, though it should be noted that this is based on the parameters above and not directly on the outcome of actual testing.

Whilst, in our opinion this is an optimistic prediction, but, given the performance of the coating up to 1,000 hours in a neutral but highly saline environment at a relatively high temperature of 35°C, it would not be unreasonable to expect an extended service life, and 50 years, with all the provisos in terms of manufacturing quality, installation, design, inspection and maintenance, should be achievable.

References

1. ASTM B117
2. Anochrome ® 10888 literature
3. MIL specification MIL-STD-202G, Method 101E, Feb 2002
4. Zinc Coating Life Predictor, copyright 2002 The International Zinc Association
5. Anochrome Design Guide Issue 5

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