A&I Coatings FAQ Sheet No. 17

Facts about Steel Coatings & Atmospheric Corrosivity

Two of the factors involved in steel coating are: protection of the steel from rust by the primer and build coat, and the decorative and protective role of the topcoat.

Some points…

- The degradation of any object needs mechanical, electrical or chemical energy. The main source for changing the nature of a substance is the energy from solar radiation.
- 5 – 6 % of radiation is UV radiation and it is this that destroys all organic products.
- The "micro" climate includes dew, which is more aggressive to paint than rain, as it is often saturated with pollutants.

There are five different atmospheric corrosivity categories in AS/NZS 2312:2002. These are based on the corrosion rates of mild steel given in ISO 9223, plus one tropical category which is not determined by corrosion rate.

- Category A: Very low. Environments in this category are most commonly found inside heated or air conditioned buildings with clean atmospheres, such as most commercial buildings. They may also be found in semi-sheltered locations remote from marine or industrial influence and in heated or non-air conditioned buildings. The only external environments in Australia or New Zealand are some alpine regions although generally these environments will extend into Category B.

- Category B: Low. Environments in this category include dry, rural areas as well as other regions remote from the coast or sources of pollution. Most areas of Australia and New Zealand beyond at least 50 kilometres from the sea are in this category, which can however extend as close as 1 kilometre from seas that are relatively sheltered and quiet. Typical areas occur in arid and rural inland regions, most inland cities and towns such as Canberra, Ballarat, Toowoomba, Alice Springs and Hamilton (New Zealand) and suburbs of cities on sheltered bays, such as Melbourne, Hobart, Brisbane and Adelaide (except areas within 3 to 6 kilometres of the coast near Adelaide). Unheated or non-air-conditioned buildings where

some condensation may occur, such as warehouses and sports halls, can be in this category. Proximity to the coast is an important factor.

- Category C: Medium. This category mainly covers coastal areas with low salinity. The extent of the affected area varies significantly with factors such as wind, topography and vegetation. Around sheltered areas, such as Port Phillip Bay, Category C extends beyond about 50 metres from the shoreline to a distance of about one kilometre inland. For a sheltered bay or gulf, such as near Adelaide, this category extends from the shoreline to about 3 to 6 kilometres inland. Along ocean front areas with breaking surf and significant salt spray, it extends from about 1 kilometre inland to between 10 to 50 kilometres inland, depending on the strength of prevailing winds and topography.
- Much of the metropolitan areas of Wollongong, Sydney, Newcastle, the Gold Coast, Auckland and Wellington are in this category.
- In South Australia, the whole of Yorke Peninsula falls within this or a more severe category, and in the south-east of the state, from Victor Harbor to the Victorian border, this category extends between 30 and 70 kilometres inland. Such regions are also found in urban and industrial areas with low pollution levels and although uncommon in Australia and New Zealand, exist for several kilometres around major industries, such as smelters and steelworks, and in the geothermal areas of New Zealand.
- Micro-environmental effects, such as those resulting from proximity to airports and sewage treatment works, may also place a site into this category. Interior environments with Category C corrosivity can occur in humid production rooms, such as food-processing.

- Category D: High. This category occurs mainly on the coast. Around sheltered bays, Category D extends up to 50 metres inland from the shoreline. In areas with rough seas and surf, it extends from about several hundred metres inland to about 1 kilometre inland. As with Categories B and C, the extent depends on winds, wave action and topography. Industrial regions with an aggressive atmosphere may also be in this category, but in Australia and New Zealand these are only likely to be found within 1.5 kilometres of the plant. This category extends inside the plant where it is best considered as a micro-environment. Damp, contaminated interior environments such as occur in swimming pool enclosures, dye works, paper manufacturers, foundries, smelters and chemical processing plants may also extend into this category.

- Category E: Very high. (E-I: Industrial E-M: Marine) This category is common offshore and on the beachfront in regions of rough seas and surf beaches. The region can extend inland for several hundred metres. (In some areas of Newcastle, for example, it extends more than half a kilometre from the coast). This category may also be found in aggressive industrial areas, where the environment may be acidic. For this reason, Category E is divided into Marine and Industrial for purposes of coating selection. Some of the damp and/or contaminated interior environments in Category D may occasionally extend into this category.

- Category F: Inland Tropical. A tropical environment is found in coastal areas of north Queensland, Northern Territory, north-west Western Australia, Papua-New Guinea and the Pacific Islands, except where affected by salinity. Corrosivity in inland regions is generally low (similar to that of category B), but the aggressiveness of the environment to organic coatings means that special protection is required.
- If a site is considered to be in more than one category, for example an industry on the coast in a tropical region, then a selected coating should, if possible, be capable of resisting each of the environments.

OTHER ENVIRONMENTS

- Steelwork may be immersed in water, buried in soil, or exposed to other environments not specifically defined in any of the above listed categories. Structures in such environments are subject to corrosion problems often of a completely different nature to atmospheric corrosion. Not only are different coating systems sometimes used, but a number of other corrosion prevention options, such as cathodic protection or selection of different materials should be considered. The selection of such prevention methods requires specialist advice.
- Steelwork can also be dramatically affected by local environment effects (micro-environment or microclimate). These should be taken into account in design and Specification of coatings, for instance;
    a. At locations where the metal surface remains damp for an extended period, such as where surfaces are not freely drained or are shaded from sunlight.
    b. On unwashed surfaces exposed for instance to coastal salt, but protected from cleansing rain.

This table shows the corrosivity zones used in AS/NZS 2312:2002, their ISO 9223 equivalent, and the expected one-year corrosion rates of steel within each category.

TABLE 1 - CORROSIVITY CATEGORIES

Corrosivity categories	ISO 9223 Category	Corrosion rate for steel - µm/year	Typical exterior environment	Examples of interior environments
A: Very low	C1	<1.3	Few alpine areas	Offices, shops
B: Low	C2	1.3 to 25	Arid/rural/urban	Warehouses, sports halls
C: Medium	C3	25 to 50	Coastal	Food processing plants, breweries, dairies
D: High	C4	50 to 80	Sea-shore (calm)	Swimming pools, livestock, buildings
E: Very High	C5	80 to 190	Sea-shore (surf)/offshore	Plating shops, chemical plants
F: Inland Tropical	-	-	Non-coastal tropics	-

NOTE: To convert corrosion rates expressed in grams per square metre per year to microns per year, divide by 7.9 (the density of steel in g/cm^2).

Atmospheric Corrosion of Metals

- Metals are made by processing from a stable metal oxide to a less stable pure metal.
- It is a law of nature that all unstable products will revert to the stable metal oxide, hence iron to rust, zinc to zinc oxide etc.
- The major factors which cause rusting are humidity and dew formation, the presence of oxygen, soluble contaminants such as salt, and the stimulating effects of acid pollutants in the atmosphere. Steel corrosion rates are therefore very low in dry environments, higher in damp environments, and very high in the presence of moisture and salt or other contaminants.
- In acidic environments, the corrosion rate of steel increases as the pH decreases.
- Alkaline environments generally give low corrosion rates for steel, except at very high pHs.
- Zinc is used as a protection for steel because it corrodes at a much slower rate.
- Zinc coatings form a barrier against oxygen, humidity, and acid pollutants. Zinc forms a salt on the surface which is very tough.

Preparation for Painting Iron and Steel Surfaces

- Wherever possible, reference should be made to AS 1627, Parts 0 to 7 and Part 9 which covers a range of treatments for the preparation and pre-treatment of steel surfaces prior to protective coating by painting.
- If oil or grease contaminants are present, their complete removal should precede commencement of surface preparation. This is particularly important if abrasive blast cleaning or power tool cleaning is to be used, as these methods can drive contaminants into the substrate profile.
- Solvent cleaning is not a suitable process for the removal of corrosive salts or detrimental weld flux. The degreasing of a large area is seldom completely achieved by liquid solvent cleaning. Its use, however, may be justified on small areas if care is exercised.
- Experience has shown that the use of aqueous alkaline detergent cleaners with high pressure water cleaners, water jetting or scrubbing equipment is the most efficient way of emulsifying and removing oil and grease and particulate matter from structural steel.
- Hot rolled steel always comes out with a layer of iron oxide or mill scale. Mill Scale must be removed to get a long lasting paint system in exterior applications.
- Removal of mill scale and rust is normally by abrasive blast cleaning. This is to Class 1 Light blast cleaning, Class 2 thorough blast cleaning, or Class 2.5 Very thorough or near white blast cleaning, or Class 3 to white metal.
- Hand tool cleaning, wire brushing etc won't remove all mill scale but this may not be an issue in an internal application.
- Pressure cleaning and jetting. Water applied under pressure can be used in a variety of manners to prepare surfaces for coating. This method employs a pump to pressurize the water which is fed through a lance directed at the surface to be cleaned. Even ultra high pressure water jetting won't however create a profile on new steel without the addition of an abrasive.
- The removal of soluble salts requires the use of high pressure water jetting, wet abrasive blasting or other processes that use the application of water under pressure.
- As soon as possible after preparation steel should be painted to prevent rerusting and contamination by salts etc.

The coating should have a …

- Barrier effect to keep out moisture, oxygen and other pollutants.
- Electrical insulating effect so that galvanic cells are not formed.
- Passivating effect so that acidic ions etc are neutralized.
- Zinc phosphate epoxies provide a good passivating.
  effect, but need a clean surface to be really effective.
- Micaceous iron oxide pigmented coatings provide excellent barrier coatings over the zinc phosphate.

Polyurethanes provide very good weathering durability, and Fluoropolymers much better again. Therefore a typical heavy duty Spec might be…

a. Blast cleaning to Class 2.5
b. Epoxy zinc phosphate primer (V586)…75µm
c. Micaceous iron oxide epoxy (V416 MIOX)……150µm
d. Two Pack Fluoropolymer (V790)……..60µm

Water based protective coatings are being used more now for environmental reasons and A&I Coatings have achieved very comparable results to solvent based coatings.

Durability Considerations

- Due consideration should be given to maintenance or renewal requirements at the planning and design stage.
- AS2312 expresses durability in terms of the following five ranges;
  - Short Term; 2-5 years
  - Medium Term; 5-10 years
  - Long Term; 10-25 years
  - Very long Term; 15-25 years
  - Extra long Term; 25+ years
- Durability is expressed in terms of coating life to first major maintenance, assuming that the coating has been applied to the requirements of the Standard, and to the recommendations of the coating manufacturer. Durability range is a technical consideration that can help the owner set up a maintenance programme.
- A ‘guarantee time’ is a legal matter in the setting up of the contract.
- A guarantee should be provided to protect against a fault in the coating product or its application, which would general manifest itself within a short period of time.

- Note that coating type is only one factor in determining the durability of a protective coating system. Surface preparation, application procedures, design, local variations in climate and other factors will all influence the durability of coatings.
- Note… it is always advised to have an inspection regime whereby coating faults or failures due to damage, human error in application etc. are caught early and rectified… a stitch in time saves nine.