INSTITUTE OF CORROSION

Aberdeen Branch

Key Sponsor

ICORR ABERDEEN BRANCH WELCOMES

SHERWIN-WILLIAMS

PROTECTIVE & MARINE COATINGS EMEAI

INSTITUTE OF CORROSION

The Sherwin-Williams Company

AN OVERVIEW

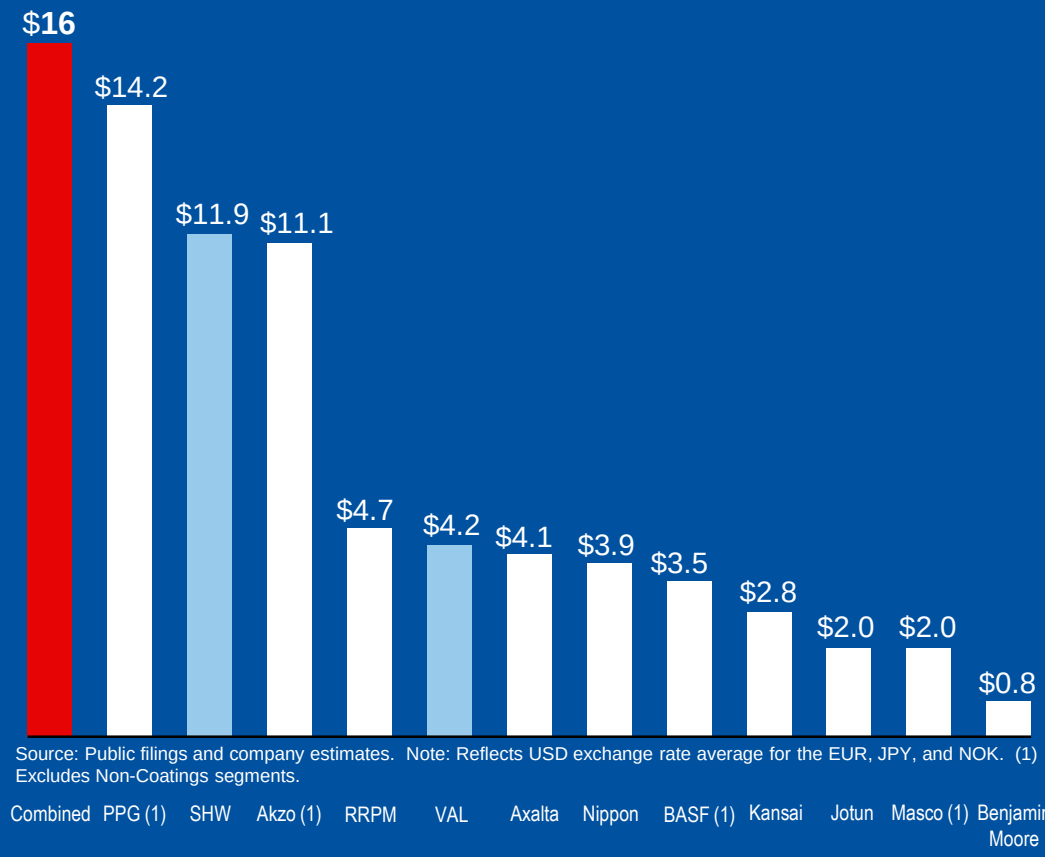
The company

A global solutions provider with

Worldwide locations.

The company

GLOBAL PAINTS AND COATINGS INDUSTRY LANDSCAPE
(CY2016 SALES, $ IN BILLIONS)



Source: Public filings and company estimates. Note: Reflects USD exchange rate average for the EUR, JPY, and NOK. (1) Excludes Non-Coatings segments.

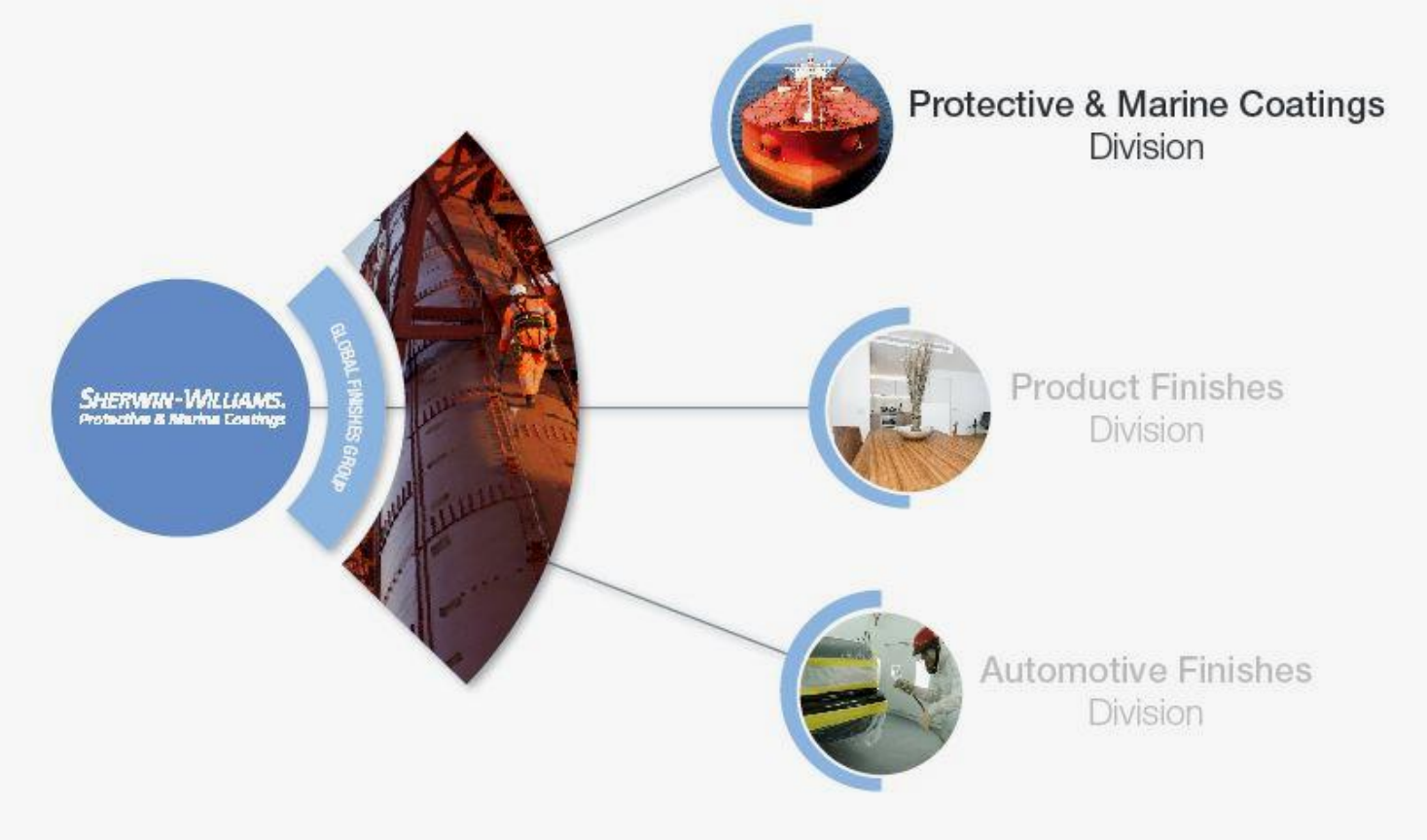
sales of approximately

$16 billion

60,000+
employees

adjusted EBITDA **$2.7 billion**

Global finishes Group



Protective & Marine Coatings Division

Aberdeen Branch

Key Sponsor

Malcolm Morris

Technical Support Manager

Sherwin-Williams

Protective & Marine Coatings

EMEAI

Aberdeen Branch

Biography:

Key Sponsor

Joined coatings industry 1978 (W&J Leigh & Co)
25 years experience in R&D
Technical Services - Site inspection
Technical Support Manager (Specifications, training, enquiries)

Graduate Chemist
NACE level 3 Coatings Inspector
Professional member ICorr, OCCA
UK expert on ISO standards committees

CORROSION CONTROL USING COATINGS

Why Do we need paint?

Decoration
Protection from corrosion
Protection from fire
Communication
Speciality coatings (antifouling, non-skid etc)

Corrosion Control

Design	Fabrication
Inhibitors	Zinc Phosphate
Sacrificial	Metallic Zinc
Barrier	Glass Flake Epoxy, MIO

What is Paint ?

A thin film surface coating

Variety of pigments (powders) dispersed within a film forming polymer binder

Viscosity adjusted by addition of solvents

Other additives e.g. driers, de-foamers, biocides ….etc. Etc.
Paint is applied in liquid form, then dries or ‘cures’ to form a solid film

Pigment Types

Colouring pigments

Give desired shade - Carefully selected to provide optimum durability / cost balance

Functional Pigments

To give desired properties such as … corrosion resistance (zinc phosphate) , moisture / chemical barrier (MIO, glassflake), intumescent properties, non skid, antifouling, etc.

Filler Pigments

Give bulk and body (opacity) to paint film & enhance properties such as weather resistance, flexibility. Also reduce raw cost of formulation

Binders (Resins)

Polymer which forms a protective film & binds pigments together

Often gives generic name to paint type
“Epoxy” “Alkyd” “Polyurethane” etc...

Binders (Resins)

SINGLE COMPONENT

Supplied ready for use - Dry by solvent evaporation and / or reaction with atmospheric oxygen or water vapour

TWO COMPONENT

Material supplied as separate ‘base’ and ‘curing agent’ (additive), which when mixed together, chemically react to form a solid film

Binder Type

- **Binder selection** dictates main properties of a coating
- No such thing as a ‘universal binder’
- Horses for courses depending on end use

Binder Examples

- **Epoxy** – 2 pack systems, very hard and durable polymer

- Typical epoxy uses – Corrosion protection, chemical resistance, abrasion resistance, etc

- Disadvantage of epoxies – Poor UV resistance (Chalks & discolours on exterior exposure)

Binder Examples

UV stable binders include :

- **Polyurethanes** (good performance but isocyanate issues)
- **Acrylic epoxy, polysiloxane** (Isocyanate free alternatives)

Binder Examples

- **Alkyds** – Single pack, air drying coatings

Not as durable as 2 pack systems but easier to use for less demanding applications

- **Acrylics** – Single pack ‘non convertible’ binder

Not widely used due to high VOC content

Mainly confined to thin film intumescent systems

Binder Examples

- **Carbon based polymers** typically used up to 200 degrees C

- **Higher temperatures require inorganic binders** (typically silicates / silicones)

Coating Types

Primer

- Highly pigmented coatings
- Mode of action by barrier effect, to exclude water & oxygen, with or without active anticorrosive pigment.
- Must have excellent adhesion to substrate – Minimise undercutting
- Alternative sacrificial primers (Zinc Rich)

Corrosion Equation

- Anodic reaction

$2Fe \rightarrow 2Fe^{2+} + 4\ e^{-}$

- Cathodic Reaction

$O_2 + 4\ e^{-} + 2\ H_2O \rightarrow 4\ OH^{-}$

- Combined Reaction

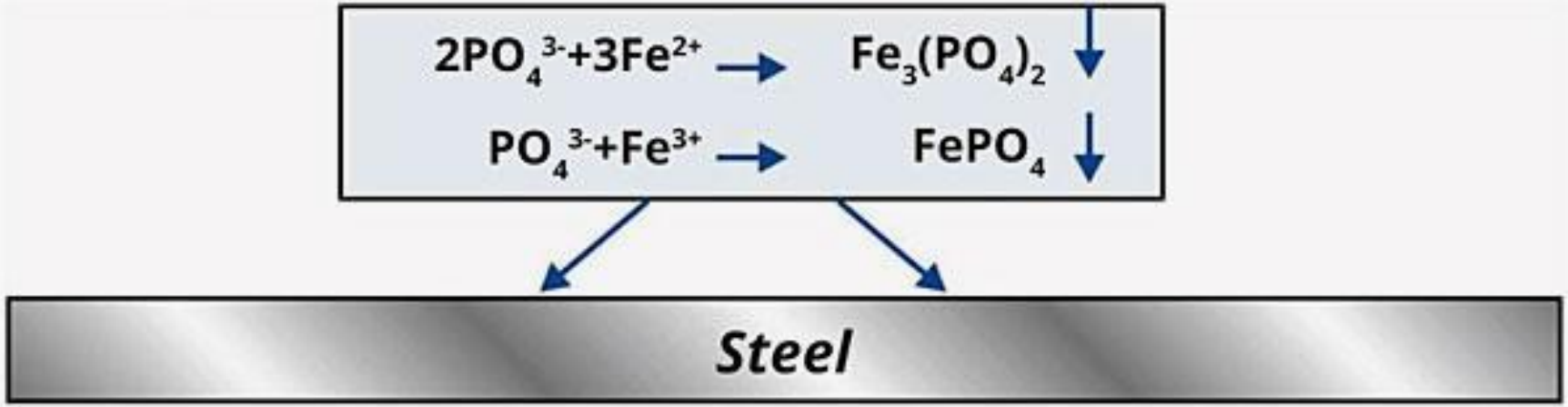
$4Fe^{2+} + 3O_2(gas) + 6H_2O(liquid) \rightarrow 2Fe_2O_3 \cdot 6H_2O(solid)$

RUST !

Active Anti-corrosive

Zinc Phosphate - Most common anticorrosive pigment

Mode of action of phosphate pigments.

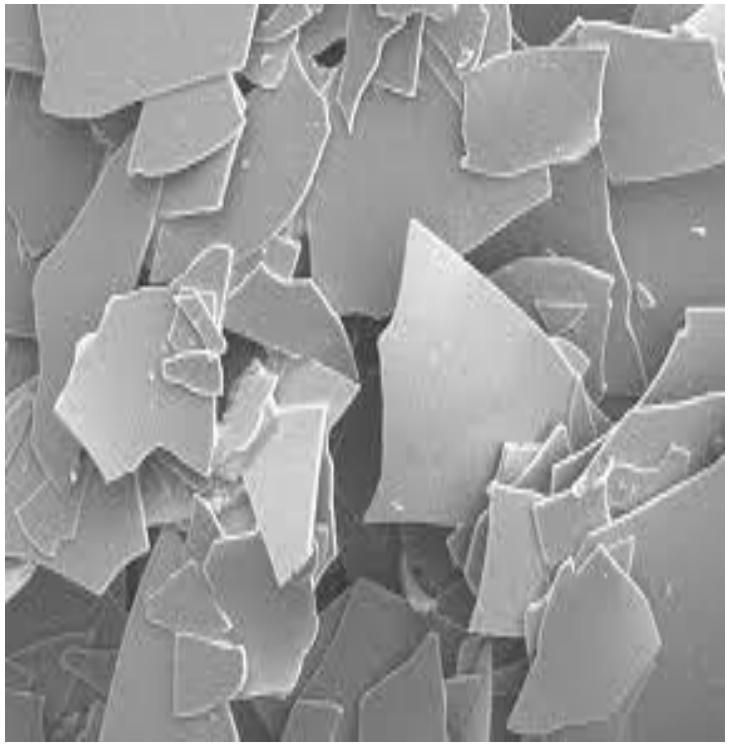


Barrier Protection

- Coatings with a high loading of lamellar (plate like) pigments will present an effective barrier

- **Glass flakes & MIO** typical examples

Barrier Pigments

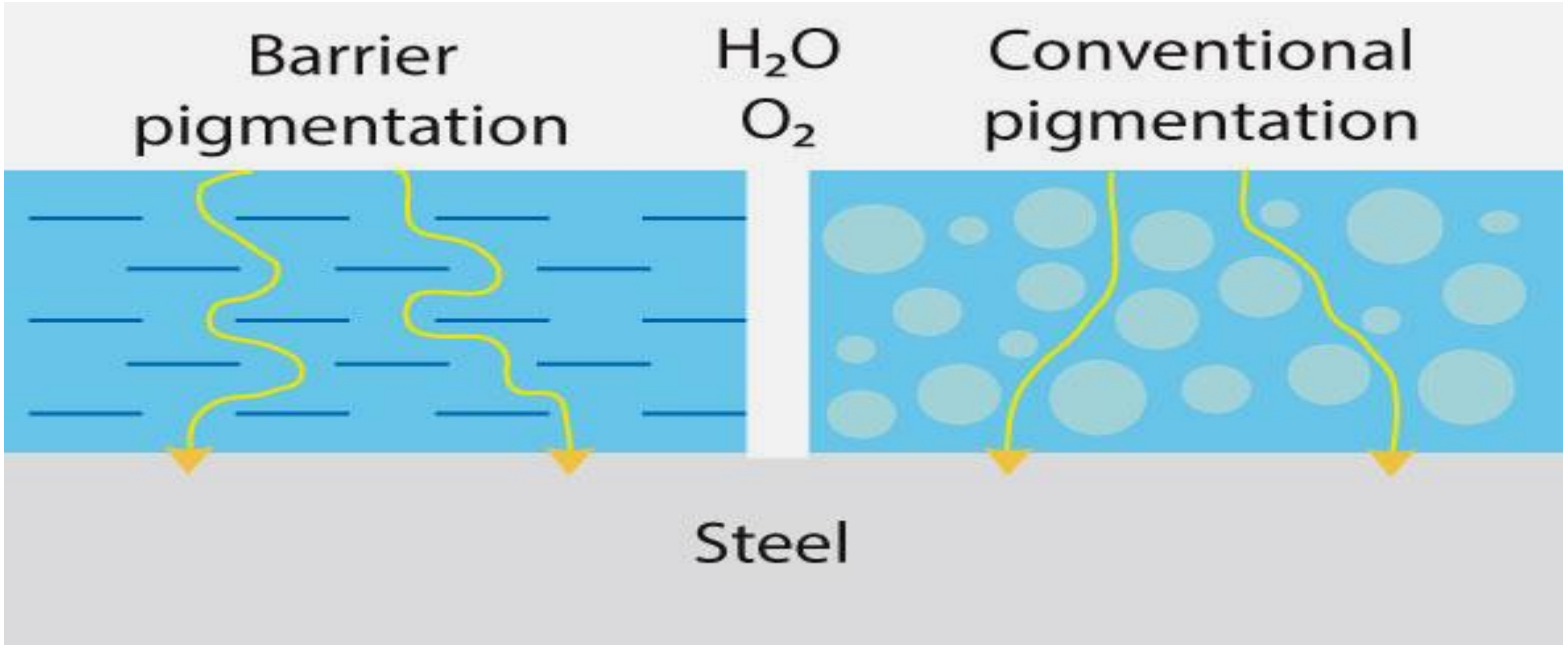


Glass Flake

Micaceous Iron Oxide

Barrier Effect

- Increases the length of the pathway for the diffusion of water and oxygen to the steel substrate



Sacrificial Protection

- The majority of metal corrosion is by electrochemical process
- The more reactive a metal is the more readily it tends to form ions in solution and become anodic
- When two metals are connected together, the more anodic metal will corrode preferentially

Galvanic Series

Anodic (More Reactive)

Zinc
Aluminium 3003-(H)
Aluminium 6061-(T)
Cast Iron *
Carbon Steel
Stainless Steel Type 430, active
Stainless Steel Type 304, active
Stainless Steel Type 410, active
Naval Rolled Brass
Copper
Red Brass
Bronze, Composition G
Admiralty Brass
90CU10NI, 0.82Fe
70CU30NI, 0.47Fe
Stainless Steel Type 430, passive
Bronze Composition M
Nickel
Stainless Steel Type 410, passive

Cathodic (Less Reactive

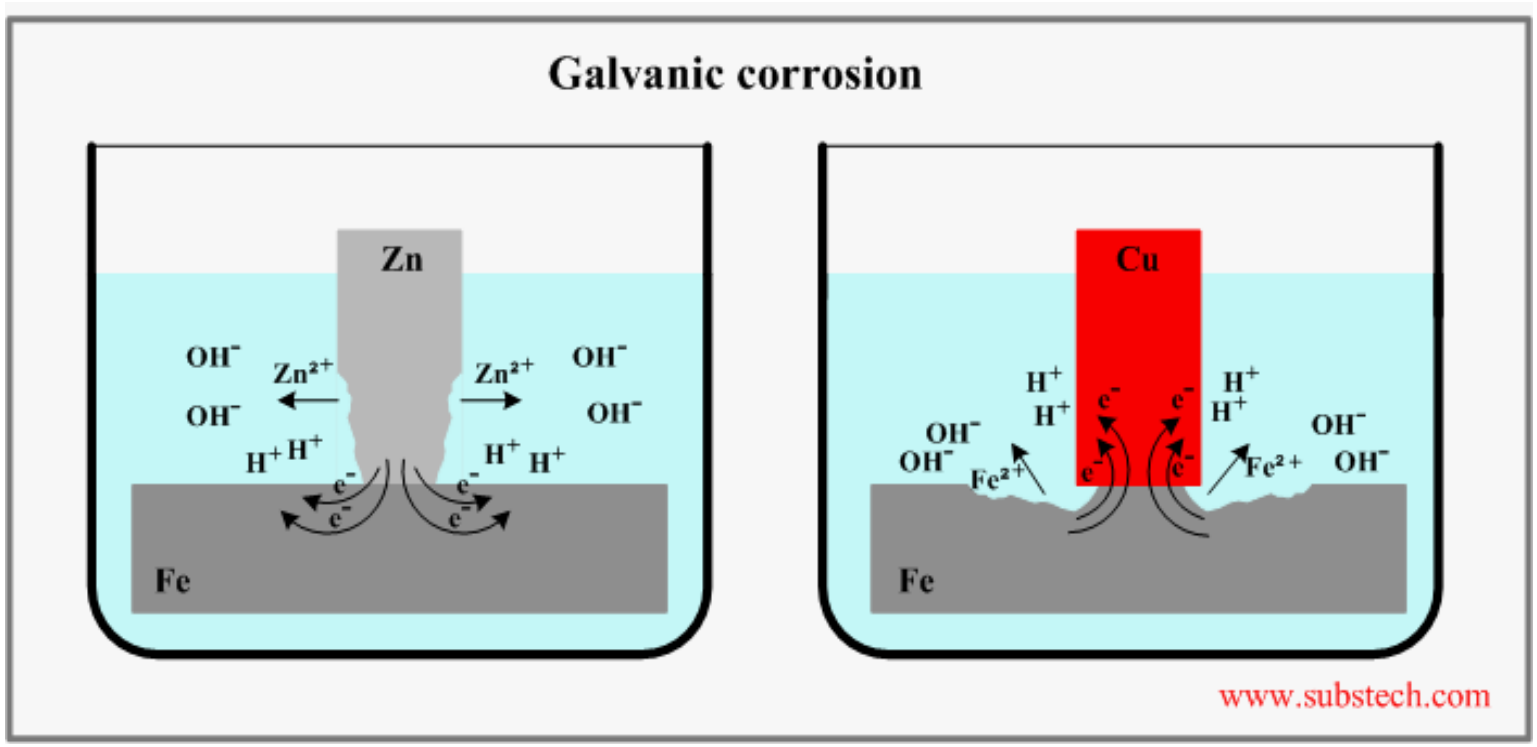
Sacrificial Primers

- Coatings with a high loading of zinc dust will protect steel by preferential reaction

- Zinc corrosion products will seal up small breaks in coating

Adverse Galvanic Effects

BEWARE ! Bimetallic effects can cause accelerated corrosion of mild steel



Coatings Specifications

- Performance driven – Increase LTFMM
  (Life to first major maintenance)
- ISO 12944 /CIRIA / NORSOK / HA / NR
- 20 year plus systems
- Reduced solvent / increased solids content
- Solvent free / water based technologies emerging
- Ever increasing restrictions on raw materials (REACH) & product labelling (GHS)

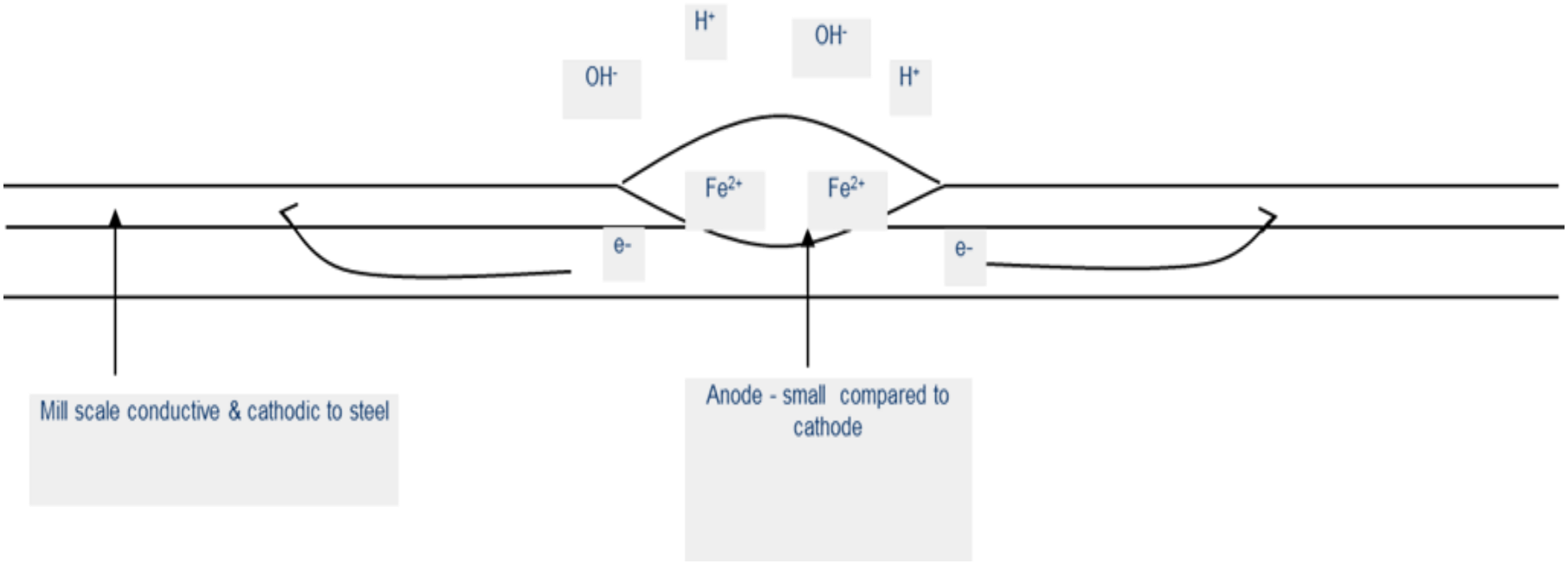
Surface Preparation

Factors Effecting Coating ‘Life Expectancy’

- Oil, grease and soil
- Chemical Salts
- Surface Corrosion
- Mill Scale
- Anchor Pattern (too rough and too smooth)
- Fabrication Defects (weld spatter, sharp edges)
- Condensation
- Existing Coatings

Millscale

Millscale is cathodic to mild steel leading to rapid pitting



Millscale

- Historically **millscale** removed by allowing it to weather and detach, followed by chipping / wire brushing - Inefficient !
- Acid pickling also developed – Dangerous!
- Abrasive blast cleaning now used for all new build steel to remove scale and produce a surface profile
- Power tools, UHP water jetting or wet abrasive blasting alternatives for maintenance but will not remove **millscale**

Visual Standards

Common ISO 8501-1 Standards for *Visual* Cleanliness

St 3 Very thorough hand and power tool cleaning

When viewed without magnification, the surface shall be free from visible oil, grease, dirt and from most of the mill scale, rust, paint coatings and foreign matter. The surface shall be treated thoroughly to give a metallic sheen arising from the metallic substrate

Sa 2½ Very thorough blast-cleaning

When viewed without magnification, the surface shall be free from visible oil, grease, dirt and from mill scale, rust, paint coatings and foreign matter. Any remaining traces of contamination shall only show as slight stains in the form of spots or stripes

Sa 3 Blast-cleaning to visually clean steel

When viewed without magnification, the surface shall be free from visible oil, grease, dirt and shall be free from mill scale, rust, paint coatings and foreign matter. It shall have a uniform metallic colour

Surface Preparation ISO 8501-1

RUST GRADE A

Surface completely covered with mill scale; little or no rust visible

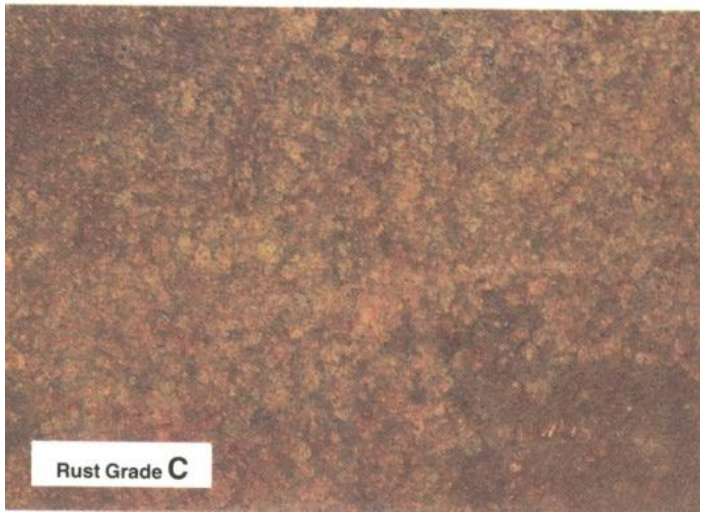
RUST GRADE B

Surface covered with both mill scale and rust.

Surface Preparation ISO 8501-1

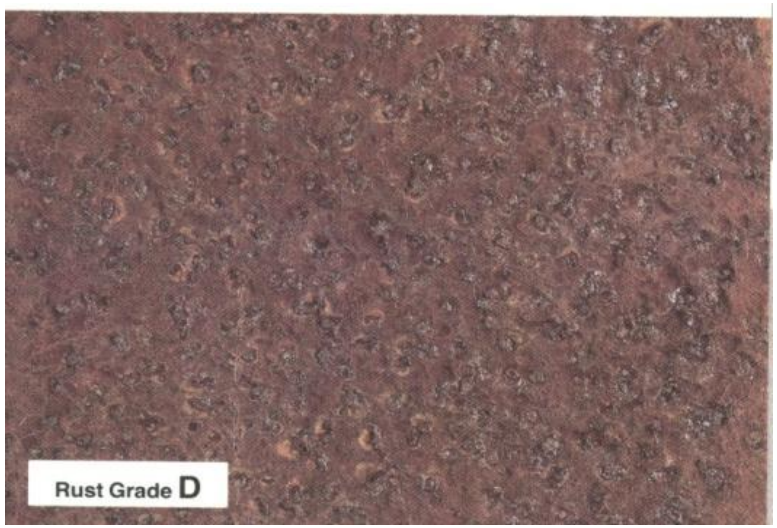
RUST GRADE C

Surface completely covered with rust; little or no pitting



RUST GRADE D

Surface completely covered with rust; pitting visible



Surface Preparation ISO 8501-1

Standard Sa2

Start With Rust Grade B

Standard Sa2

Start With Rust Grade D

Surface Profile

Surface Profile

- Recommended profile quoted in microns (µm) on relevant product datasheet
- Increases surface area
- Creates a rough surface of peaks and troughs, to which the coatings can adhere:

  Too smooth - adhesion failure

  Too rough - rust spots from exposed peaks.

Paint specifications

- **Industry standards**
  - BS EN ISO 12944 – "Corrosion Protection of Steel Structures by Protective Paint Systems"
  - CIRIA / NBS Specifications – "New Paint Systems for Protection of Construction Steelwork"
  - ISO 20340 - Performance Requirements for Protective Paint systems for Offshore and Related Structures

ISO 12944

Classification of Environment:

- C1 Very low (Internal dry)
- C2 Low (Internal damp, external rural & low pollution)
- C3 Medium (Internal wet, external low salinity & Moderate pollution)
- C4 High (Internal chemical plants/swimming pools, external industrial/coastal moderate salinity
- C5I Very High (Aggressive industrial, high pollution)
- C5M Very High (Coastal High salinity)

ISO 12944

Protective Paint Systems :

- Standard defines generic product types
- Tables define generic systems for Corrosivity categories (C1 – C5) and durability
- (Low < 5 years, Medium 5-15 years, High>15 years)

ISO 12944

Protective Paint Systems :

- All protective paint systems must be qualified to accelerated testing regimes (e.g. salt spray)

- Systems may be tested by paint manufacturer or external laboratories

CIRIA Specifications

- E1 – External exposed (Zinc rich primer)
- E2 – External exposed (Zinc phosphate primer)
- I 1 – Internal controlled
- I 2 – Internal controlled, decorative
- I 3 – Cavity steel
- I 4 – Internal exposed (Condensation)
- I 5 – Internal frequently wet

Offshore Specifications

- ISO 20340 – *Performance requirements for protective paint systems for offshore and related structures*
- Prequalification testing for offshore systems
- Basis for NORSOK and many oil company specs

Offshore Specifications

- Pre-qualification must be performed by 3rd party laboratory
- Testing much more onerous than ISO 12944
- Cyclic testing typically required

Changes to ISO 12944 / ISO 20340

Revised ISO 12944 (2018)

- Combine ISO 20340 into 12944 (Part 9)
- C5M will become Cx (Extreme, offshore)
- Durability category VH (Very High > 25 years)

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THANK YOU FOR YOUR ATTENTION
ANY QUESTIONS?