APPENDIX

Fitz's Atlas
of coating defects

COATING BREAKDOWN SCALES

The Extent of Coating Breakdown Scales on the following pages should be used in conjunction with the following Standards :

European Scale of Corrosion
ISO 4628
ASTM 610

The above Standards illustrate the type of coating failure observed on a small area of a given substrate.

The scales are used to represent the failure mode expanded over a much larger surface area such as tank surfaces or a large pipe surface.

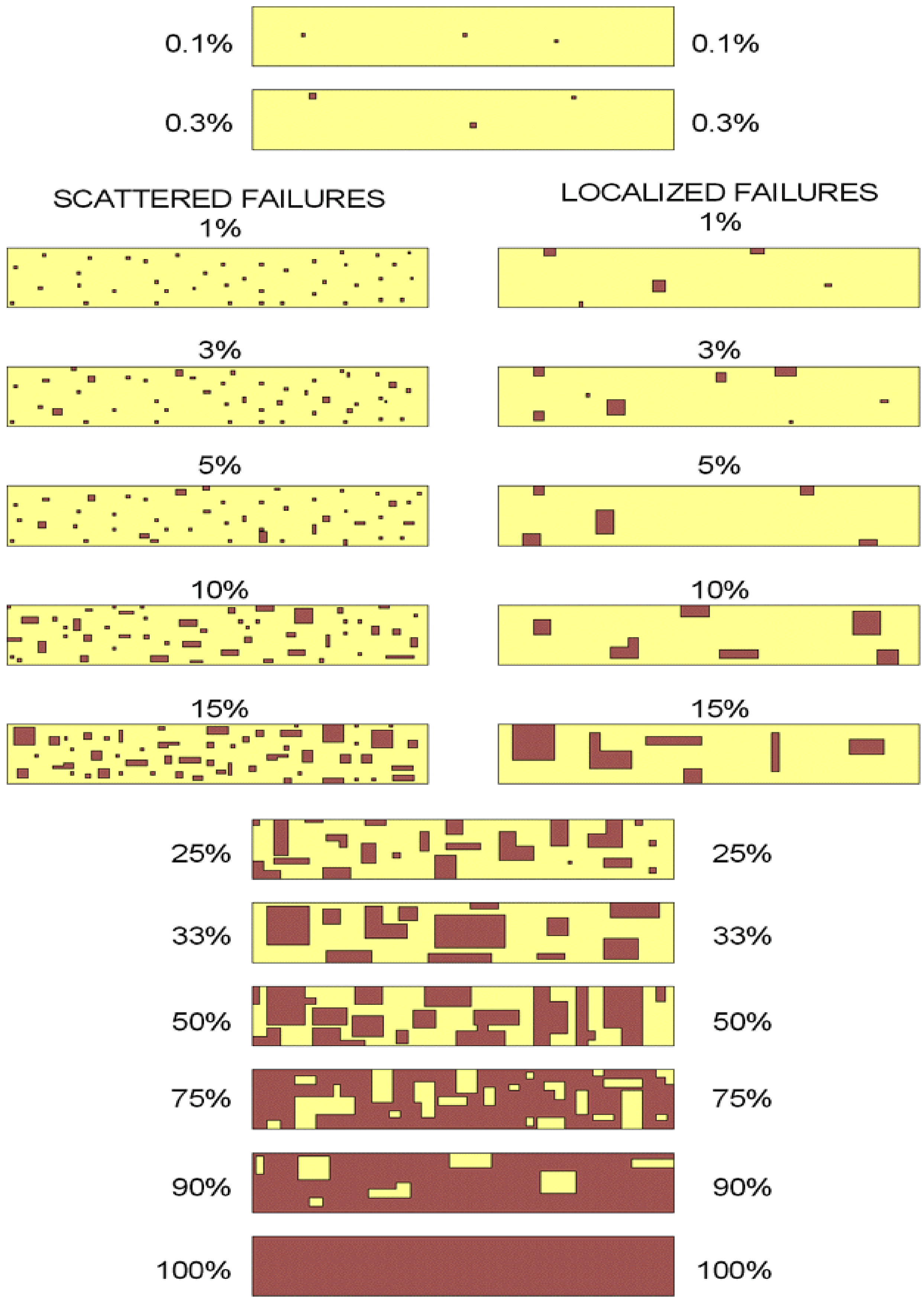
It can be seen that in most cases where “scattered” failure has taken place it would be uneconomical to attempt a patch repair. Total removal and replacement of the coating system is warranted. However, where the coating has failed in a “localised” mode, a patch repair can often be economically justified.

Wherever possible the assessor or surveyor should view and categorise coating failure modes on a global scale rather than isolated or localised area.

DEGREE	% AREA RUSTED
Ri 0	0
Ri 1	0.05
Ri 2	0.5
Ri 3	1
Ri 4	8
Ri 5	40/50

DEGREE OF RUSTING (ISO 4628-3)

COATING BREAKDOWN SCALES



EXTENT OF FAILURE (See appendix 2.2)

PAINT COMPATIBILITY CHART

		TOPCOAT					
		Acrylated Rubber	Alkyd	Amine Epoxy	Bitumen	Chlorid Rubber	Coal Tar Epoxy
EXISTING TOPCOAT	Acrylated Rubber	E	X	X	X	X	X
	Alkyd	F[1,4]	E[2]	X	F[4]	P	X
	Amine Epoxy	F[1,4]	X	E [2,3]	F[1]	F[3]	G[3]
	Bitumen	X	X	X	E	X	X
	Chlor. Rubber	X	x	X	F[1,4]	E	X
	Coal Tar Epoxy	F [3,4]	x	G [3,4]	F [3,4]	F [3,4]	E[3]
	Epoxy Ester	F[1,4]	E[2]	X	F[4]	P	X
	Ethyl Zinc Silicate	F[1,4]	X	G[4]	F[1,4]	G[4]	F[1,4]
	M.C. Urethane	F[1,4]	F[1,4]	F [2,3]	F[1,4]	F[4]	F [3,4]
	Polyamide Epoxy	F[1,4]	P	F [2,3]	F[1,4]	F[4]	G[3]
	Silicone Alkyd	F[1,4]	E[2]	X	F[4]	P	X
	Urethane (2 pack)	F[1,4]	F[1,4]	F [2,3]	F [3,4]	F[1,4]	F [3,4]
	Urethane Acrylic	F[1,4]	F[1,4]	F	F[1,4]	F[1]	F[4]
	Vinyl	X	X	F[4]	F[1,4]	F[1]	X

E = Excellent
G = Good
F = Fair
P = Poor
X = Not recommended

[1] = Guide only-conduct test patch
[2] = Apply primer or undercoat first-same generic type as new topcoat
[3] = Flash blast-abrade overall
[4] = Apply tie/sealer coat

PAINT COMPATIBILITY CHART

		TOPCOAT						
		Ethyl Silicate	M.C. Urethane	Polyamide Epoxy	Silicone Alkyd	Urethane (2 pack)	Urethane Acrylic	Vinyl
EXIATING TOPCOAT	Acrylated Rubber	X	X	X	X	X	X	X
	Alkyd	X	P[1]	P[1]	G[2]	X	F[1,4]	P[1]
	Amine Epoxy	x	F[3]	G [2,3]	X	F[3]	F[3]	F[3]
	Bitumen	x	X	X	X	X	X	X
	Chlor. Rubber	x	F[1,4]	P[1]	x	F[1,4]	F[1,4]	F[1,4]
	Coal Tar Epoxy	x	F [3,4]	G [3,4]	x	F [3,4]	F [3,4]	F [3,4]
	Epoxy Ester	x	P[1]	P[1]	G[2]	X	F[1.4]	P
	Ethyl Zinc Silicate	p[1]	G[4]	E	X	G[4]	G[4]	G[4]
	M.C. Urethane	x	E[2]	F[1,2]	F[1,4]	G[4]	G[2]	F[1,4]
	Polyamide Epoxy	x	G[4]	G[2]	P	F[4]	G[4]	F[4]
	Silicone Alkyd	x	P[1]	P[1]	E[2]	X	F[1,4]	P[1]
	Urethane (2 pack)	x	G[2]	F [2,3]	F[1,4]	E[2]	G[2]	F [3,4]
	Urethane Acrylic	x	G[1]	F	F[1,4]	G	E	F[1]
	Vinyl	x	F[1,4]	X	X	F[1,4]	F[1,4]	G[1]

Note: The above chart is a generalisation and provides a rough indication of paint compatibility. Paint formulations vary widely between different manufacturers. It is strongly recommended that you check with the manufacturer regarding the compatibility of the products in question.

PAINT PROPERTIES CHART

Product	Alkyd	Bitumen	Chlorid Rubber	Coal Tar Epoxy(2 pack)	Epoxy Ester
Resistance to UV light	Good	Chalks	Chalks	Chalks	Chalks badly
Resistance to Water Immersion	Poor	Fair in fresh water	Excellent	Excellent	Fair
Resistance to Mechanical damage	Fairly good	Fair	Fair	Good	Good
Resistance to oils and Cutting oils m	Fair	Not resistant	Not resistant permanently softened	Good	Excellent
Curing Agent	Oxygen	N/A	N/A	Usually polyamide isocyanate or amine adduct	Oxygen
Drying Mechanism	SE&OX	SE	SE	SE&CC	SE&OX
Intercoat Adhesion (coat on coat) - aged	Good with right tie coat	Excellent (solvertweld)	Excellent (sokntweld)	Poor	Good with right tic coat
Resistance Dry Continuous (cured	90°C	70°C	70°C	90°C	100°C
Chemical Resistance (2)	Poor	Poor	Excellent	Good	Good
Solvent Resistance (aged)	Fair	Poor	Poor	Good Pitch bleed through can occur	Good
Resistance to Vapour Permeation	Fairly high	High	Very high	Very high	High
Minimun Application Temperature	4°C	0°C	0°C	10°C (31	4°C
Colour Availability	Full range	Usually Black & dark brown	Full range	Usually Blk, dark brown, dark grey	Full range

Drying Mechanism:
SE= Solvent Evaporation
CC = Chemical Cure
OX= Oxidation

Notes:
[1] = Reaction with moisture necessary
[2] = Check with specific manufacturers
[3] = Isocyanate cure types down to (K

PAINT PROPERTIES CHART

Ethyl Silicate	Grease Coatings	Pure Epoxy (2 pack)	Pure Urethane (1 pack)	Silicone Alkyd	Solution Vinyl	Urethane (2 pack)	Urethane Acrylic
N/A	Good but very high din pickup	Chalks	Very high low chalking - aliphatic grade	Exceptional very low chalking	Chalks	Very high low chalking	Good
Excellent when sealed	Very good	Very good	Very good	Fair	Very good	Very good	Very good
Very good	Very poor	Excellent	Very good	Fairly good	Very good	Out standing	Very good
Excellent but may be absorbed	Non resistant	Excellent	Excellent	Excellent	Good	Excellent	Excellent
Zinc dust and moisture	N/A	Usually isocyanate polymide or amine adduct	Moisture from atmo sphere or substrate (min 35%)	Oxygen	N/A	Aliphatic or aromatic isocyanate	Topcoats= aliphatic isocyanate Primer= aromatic isocyanate
SE&CCd)	SE	SE&CC	SE(D	SE&OX	SE	SE&CC	SE&CC
Poor	Excellent	Good with right tie coat	Good with right tie coat	Good	Excellent	Good (not gloss on gloss)	Good (incl. gloss on gloss)
450°C	50°C	110°C	120°C (non-	120°C	80°C	120°C(non-thermo plastic)	120°C
Poor	Good	Excellent	Very good	Good	Very good	Very good	Good
Excellent	Good	Excellent	Very good	Good	Fair	Very good	Good
Low	Very high	Very high	Fair	High	High	Low	Low
5°C	4()C	Min 5°C (3)	<0°C	4°C	0°C	<0°C	<0°C
Grey only primer	Full range	Full range	Full range	Full range	Full range	Full range	Full range

Note:
The above chart provides a rough indication of paint properties. Paint formulations vary widely between different manufacturers. It is recommended that you check these properties with the manufacturer concerned.

Once the estimator has calculated his initial total cost the ”loss Factors" need to be considered.

Depth of Profile
As a general rule optimum surface amplitude is specified at 50 -75 microns. However, higher build materials, i.e. glassflake materials, require amplitude of 75 to 100 microns. Therefore, more material will be required to fill the troughs and cover the peaks, since dry film thickness measurements are usually taken over the peaks.

Irregularity of Shape
It is difficult to achieve uniform paint application on complex shapes and fabricated structures and, therefore, losses due to over-spray or excess paint build up in corners will inevitably need to be taken into consideration. This can usually increase the paint consumption rate to plus 30% or more, depending on substrate configuration.

Overspray
Even on relatively uncomplicated substrates, this can amount to 5%, even with efficient airless spraying.

Wind Loss
When applying paint in the open in high wind conditions, losses of 20 - 50% can be experienced.

General Losses
Exceeding potlife, pilferage, spillage etc/need to be considered in any paint consumption calculation.

Absorbent Surfaces
Wood surfaces, if not properly sealed, would tend to absorb paint into the substrate and a factor of 2% - 5% should be considered for such surfaces.

General
Even with well trained operatives, "on the job" inspection, good QA/QC procedures/the paint estimator should add a baseline factor of 25% to his original paint consumption calculation. All other factors listed above will then need to be taken into consideration.

PAINT ARITHMETIC

When assessing the cost of painting an estimator needs to take into account various factors before arriving at the true cost.

To calculate the total cost or cost per square meter of different paints with differing volume solids for achieving a D.F.T. of 375 microns over an area of 15,000 sq.m.

Paint A Epoxy, volume solids 62% - cost per litre £1.35

Paint B Epoxy, volume solids 55% - cost per litre £1.22

Paint C Epoxy, volume solids 50% - cost per litre £1.19

Calculations for Total Costs

Paint A

Volume = $\frac{15.000\text{x}375}{10\text{x}62}$ = 9.073 litres x Cost @ £1.35 = £12.248,55

Paint B

VLUME = $\frac{15.000\text{x}375}{10\text{x}55}$ = 10.227 litres x Cost @ £1.22 = £12.476,94

Paint C

Volume = $\frac{15.000\text{x}375}{10\text{x}50}$ = 11.250 litres x Cost @ £1.19 = £13.387,50

It can be clearly seen that the volume solids affect the material calculation and the costs. Although initially Paint C appears cost effective only after calculation does it becomes clear that Paint A is the more economic paint because of its higher V.S.%.

Peripheral factors such as poor quality control, delayed deliveries, poor technical support and service are subjective, however, they affect choice of supplier and materials to be used.

Appendix

When comparing solventless/solvent free, coatings, with normal solvent bound types/one will invariably find that the former is much more expensive than the latter. However,one must consider that for a given dry film thickness, the coverage rate will be much higher with the solventless/solvent free type. The following example illustrates this point.

Paint 1: Solventless materials VS. = 97.5% @ £4.80 per litre

Paint 2: Solvent free materials V.S.=100% @ £4.90 per litre

Paint 3: Solvent bound types V.S. = 50% @ £2.70 per litre

To obtain the coverage for 250 mikron D.F.T. use $\frac{\text{D.F.T.}}{\text{W.F.T.}} = \text{V.S.\%}$

The W.F.T. required for **Paint 1** = $\frac{250 \times 100}{97.5} = 256.41$

The W.F.T. required for **Paint 2**= $\frac{250 \times 100}{100} = 250$

The W.F.T. required for **Paint 3**= $\frac{250 \times 100}{50} = 500$

Therefore the volume required to cover 1 m^2

with **Paint 1**= $\frac{256.41 \times 100 \times 100}{10{,}000}$ ccs/mis = 256.41mls

with **Paint 2** = $\frac{250 \times 100 \times 100}{10{,}000}$ ccs/mis = 250 mis

with **Paint 3** = $\frac{500 \times 100 \times 100}{10{,}000}$ ccs/mis = 500 mis

Therefore the cost per m^2 using; **Paint 1** = £4.80 x .25641 = £1.23
Paint 2 = £4.90 x .250 =£1.22
Paint 3 = £2.70 x.500 =£1.35

In this hypothetical case/the use of solvent free materials (Paint 2),although more expensive in cost per litre, actually works out cheaper.

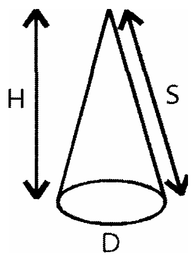
FORMULAE FOR SURFACE AREAS

Abbreviations

Length =L Width =W Height =H Radius =F Diameter =D

Area = A π =3,142 approx.

Cone
(Slant side = S, Base diameter = D)
Area of the curved surface of a cone is:



$$A = \frac{\pi \times D \times S}{2}$$

Cube (Side = L)
A cube has six identical square faces.Total surface area is six multiplied by the square of the length of one side.

$$A = 6 \times L^2$$

Cylindrical Tank
The surface area consists of the cylindrical

shell ($2 \times \pi \times R \times H$) plus the two flat ends2 x (πR^2).

$A = (2 \times \pi \times R \times H) + 2(\pi \times R^2)$

Domed end of Tank
(Height of dome =H)

$A = 2 \times \pi \times R \times H$

Ellipse (Major axis=D, Minor axis=d)

$$A = \frac{\pi \times D \times d}{4}$$

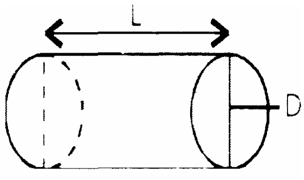
Appendix

I Beam
(Plate thickness = C)

$$A = 2 \times (2W + H - C) \times L$$

Pipe
The surface area of a pipe is calculated

by multiplying the diameter by π and then multiplying by the pipe length.



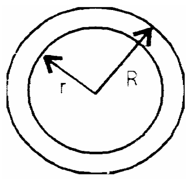
$$A = \pi \times D \times L$$

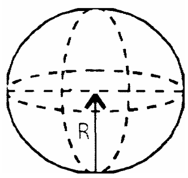
Ring
(Outer radius = R, Inner radius = r)

$$A = \pi \times R^2 - \pi \times r^2$$

Sphere
The surface area of a sphere is calculated by multiplying the square of radius (R)

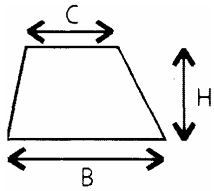
by π by 4.





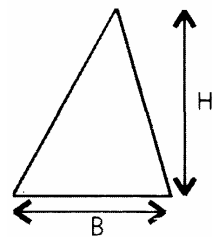
$$A = 4 \times \pi \times R^2$$

Trapezium
(Parallel sides length=B&C)



$$A = \frac{(B+C) \times H}{2}$$

Triangle
(Base length=B)



$$A = \frac{B \times H}{2}$$