Polski Rejestr Statków

RULES

PUBLICATION No. 109/P

COATING MAINTENANCE AND REPAIRS
FOR BALLAST TANKS AND COMBINED CARGO/BALLAST TANKS
ON OIL TANKERS

2017
February

Publications P (Additional Rule Requirements) issued by Polski Rejestr Statków complete or extend the Rules and are mandatory where applicable

GDAŃSK

Publication No. 109/P – Coating Maintenance and Repairs for Ballast Tanks and Combined Cargo/Ballast Tanks on Tankers – February 2017, was approved by PRS Board on 30 January 2017 and enters into force on 1 February 2017.

The present Publication replaces *Publication No. 109/P – Application and Interpretation of Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers – July 2015*.

PRS/OP, 01/2017

CONTENTS

1 GENERAL

1.1 These Rules apply to ships classed with the Polski Rejestr Statków (called PRS hereafter).

1.2 These Rules shall be applied by PRS to oil tankers subject to the requirements of *Publication No. 87/P – Application of the Performance Standard for Protective Coatings under Requirements Concerning the Construction of Sea-going Bulk Carriers and Sea-going Double Hull Oil Tankers*.

1.3 Reference Documents

Standards

(1) ISO 8502-9:1998 *Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 9: Field method for the conductometric determination of water-soluble salts.*

(2) ISO 4628-2:2016 *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 2: Assessment of degree of blistering.*

(3) ISO 4628-3:2016 *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting.*

(4) ISO 4628-4:2016 *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 4: Assessment of degree of cracking.*

(5) ISO 4628-5:2016 *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 5: Assessment of degree of flaking.*

(6) ISO 8501-1:2007 *Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.*

Other Documents

(I) IACS Recommendation 87 *Guidelines for Coating Maintenance & Repairs for Ballast tanks and Combined Cargo/Ballast tanks on Tankers Rev. 2 May 2015.*

(II) *Publication No. 36/P – Hull Survey of Oil Tankers.*

(III) *Publication No. 58/P – Hull Survey of Double Hull Oil Tankers.*

(IV) IMO Resolution A.1049(27): *International code on the enhanced programme of inspections during surveys of bulk carriers and oil tankers, 2011 (2011 ESP Code).*

(V) IMO Resolution A.1050(27): *Revised recommendations for entering enclosed spaces aboard ships.*

(VI) *Publication No. 28/I – Guidelines for Safe Entry to Confined Spaces*.

1.4 Application

1.4.1 These Rules focus on survey, maintenance and repair procedures of coatings.

1.4.2 Chapter 2 is primarily intended for PRS surveyors in assessing the coating condition.
Chapter 3 is primarily intended for Owners, Yards and Flag Administrations in connection with inspection, maintenance and/or repair schemes.

1.4.3 These Rules deal with ballast tanks and combined cargo/ballast tanks herein referred to as "ballast tanks" on tankers in service. They only cover maintenance and repair of coatings. Corrosion prevention systems other than coating are not covered, nor is the design, installation and maintenance of anodes.

1.4.4 The intention with maintenance and repair in this context is to either:

.1 maintain GOOD coating condition; or

.2 restore GOOD coating condition, if the coating is found in FAIR or POOR condition.

1.4.5 These Rules have been developed using the best information currently available, and considering that maintenance and repair may take place:

- **.1** in dry dock;
- **.2** afloat at yard;
- **.3** on voyage (riding crew).

1.4.6 They are intended only as guidance in support of the sound judgement of surveyors. Should there be any doubt with regard to interpretation or validity in connection with the use of these Rules, clarification should be obtained from the PRS.

1.5 Class survey requirements

1.5.1 The coating system in ballast tanks is to be examined in connection with:

- **.1** intermediate Surveys for tankers exceeding 5 years of age;
- **.2** special Surveys for all tankers.

1.5.2 The condition of the coating in ballast tanks is assigned and categorised as GOOD, FAIR or POOR, based on visual inspection and estimated percentage of areas with coating failure and rusty surfaces according to table 2 in paragraph 2.1.2.

1.5.3 The ballast tank will be subject to Annual Survey when, during an Intermediate or Special Survey, as applicable, it is found with:

- **.1** no protective coating from the time of construction; or
- **.2** a soft coating; or
- **.3** Substantial Corrosion; or
- **.4** protective coating in less than GOOD condition and the protective coating is not repaired to the satisfaction of the Surveyor; or
- **.5** a common plane boundary with a cargo tank with any means of heating, regardless of whether the heating system is in use and regardless of the condition of the coating (only single hull oil tanker as defined in PRS' . *Publication No. 36/P*[(II)])

1.5.4 Thickness measurements to the same extent as the previous Special Survey are mandatory requirements of Intermediate Surveys for tankers exceeding 10 years of age.

However, the surveyor may request thickness measurements as a result of his examination of the ballast tanks, if he considers it necessary, on a tanker of any age.

If the results of these thickness measurements indicate that Substantial Corrosion is present, the extent of thickness measurements is to be increased.

1.5.5 Areas of Substantial Corrosion identified at previous Special, Intermediate or Annual Surveys are to have thickness measurements taken at Annual Surveys regardless of the coating condition. Substantial Corrosion is an extent of corrosion such that assessment of corrosion pattern indicates wastage in excess of 75% of allowable margins, but within acceptable limits.

When wastage exceeds acceptable limit, repair such as renewal of the hull structural members is to be carried out.

1.5.6 Further details on the scope and extent of annual surveys are provided in:

- **.1** PRS' *Publication No. 36/P*[(II)] and *Publication No. 58/P*[(III)];
- **.2** the PRS' *Instructions to surveyors*.

1.5.7 A record of Substantial Corrosion should still be made even if the owner elects to coat the area and arrest further corrosion.

1.5.8 For areas in ballast tanks where coatings are found to be in a GOOD condition, the extent of thickness measurements may be specially considered by the PRS.

1.5.9 Special Surveys are to be carried out at 5 years intervals to renew the Class Certificate. Intermediate Survey is to be held at or between either the 2nd or 3rd Annual Survey. Annual Surveys are to be held within 3 months before or after anniversary date.

Table 1 shows the sample difference in frequency of internal inspections for ballast tanks in GOOD and less than GOOD condition.

Table 1 indicates also that the interval between a survey at which the coating is found in GOOD condition and the next following survey is 2 or 3 years, i.e. an average value of 30 months.

Table 1
Sample difference in frequency of inspections for ballast tanks

Coating Condition	Surveys (Internal Inspection)															
Good	S			I		S			I		S			I		S
Fair or Poor	S	A	A	I	A	S	A	A	I	A	S	A	A	I	A	S
Years	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

S: Special Survey
I: Intermediate Survey
A: Annual Survey

2 COATING CONDITIONS

2.1 Definitions

2.1.1 The present definitions of coating conditions GOOD, FAIR and POOR in *IMO Resolution A.1049(27)*[(IV)] and *Publication No. 36/P*[(II)] and *Publication No. 58/P*[(III)] are as follows:

.1 GOOD: condition with only minor spot rusting.

.2 FAIR: condition with local breakdown of coating at edges of stiffeners and weld connections and/or light rusting over 20% or more of areas under consideration, but less than as defined for POOR condition.

.3 POOR: condition with general breakdown of coating over 20% or more of areas or hard scale at 10% or more of areas under consideration.

2.1.2 In this *Publication*, it is found necessary to offer a clarification of these definitions in order to achieve unified assessment of coating conditions as follows, also specified in table 2:

.1 **GOOD:** Condition with spot rusting on less than 3% of the area under consideration without visible failure of the coating. Rusting at edges or welds, must be on less than 20 % of edges or weld lines in the area under consideration.

.2 **FAIR:** Condition with breakdown of coating or rust penetration on less than 20 % of the area under consideration. Hard rust scale must be less than 10 % of the area under consideration. Rusting at edges or welds must be on less than 50 % of edges or weld lines in the area under consideration.

.3 **POOR:** Condition with breakdown of coating or rust penetration on more than 20% or hard rust scale on more than 10% of the area under consideration or local breakdown concentrated at edges or welds on more than 50 % of edges or weld lines in the area under consideration.

Table 2
Clarification of GOOD, FAIR and POOR coating conditions

	GOOD [c)]	FAIR	POOR
Breakdown of coating or area rusted [a)]	< 3%	3 – 20%	> 20%
Area of hard rust scale [a)]	–	< 10%	≥ 10%
Local breakdown of coating or rust on edges or weld lines [b)]	< 20%	20 – 50%	> 50%

Notes:

a) % is the percentage of the area under consideration or of the "critical structural area"

b) % is the percentage of edges or weld lines in the area under consideration or of the "critical structural area"

c) spot rusting i.e. rusting in spot without visible failure of coating.

These clarifications are further exemplified via photos along with narrative descriptions of the condition, uniform and localised assessment scales, in the enclosed Appendix 8 while a "Library of pictures" is provided in Appendix 9.

2.2 Areas under consideration

2.2.1 The term "areas under consideration" found in the definitions of coating condition FAIR and POOR in *IMO Resolution A.1049(27)*[(IV)] and in *Publication No. 36/P*[(II)] and *Publication No. 58/P*[(III)] is clarified in the following:

- **.1** Recognizing that different areas in the tank experience different coating breakdown and corrosion patterns, the intent is to subdivide the planar boundaries of the tank for evaluation of coating, into areas small enough to be readily examined and evaluated by the Surveyor, but not so small as to be structurally insignificant or too numerous to practically report on.
- **.2** Coating condition in each area should be reported using current practice and terminology (frame nos., longitudinal nos. and/or strakes nos. etc.).
- **.3** Each area is then rated (GOOD, FAIR or POOR) and the tank rating is then to be not higher than the rating of its "area under consideration" having the lowest rating.

Examples of how to report coating conditions with respect to areas under consideration are given in Appendix 10.

2.2.2 Special attention should be given to coating in Critical Structural Areas which are defined as "locations which have been identified from calculations to require monitoring or from the service history of the subject ship or from similar or sister ships (if available) to be sensitive to cracking, buckling or corrosion which would impair the structural integrity of the ship" as specified in Appendix 5.

2.2.3 Each Critical Structural Area is rated (GOOD, FAIR or POOR) applying table 2 indicated in paragraph 2.1.2 and the rating of each "area under consideration" is then to be not higher than the rating of its Critical Structural Area (if present) having the lowest rating.

2.2.4 The "area under consideration" with the poorest coating condition will determine whether examination of ballast tanks is required at subsequent Annual Surveys. Hence, it is not intended to "average" the coating condition for all "areas under consideration" within a tank, to determine an "average" coating condition for the entire tank.

2.2.5 Definitions of "areas under consideration" are as follows:

.1 Single hull tanker – wing ballast tanks – Figure 1:

- (a) deck and bottom – areas of deck and bottom plating with attached structure (one (1) area to consider for deck and one (1) area to consider for bottom);
- (b) side shell and longitudinal bulkheads – areas of side shell and longitudinal bulkheads with attached structure, in lower, middle and upper third (three (3) areas to consider for side shell and three (3) areas to consider for longitudinal bulkhead);
- (c) transverse bulkheads (forward and aft) – areas of transverse bulkhead and attached stiffeners, in lower, middle and upper third (three (3) areas to consider for forward transverse bulkhead and three (3) areas to consider for aft transverse bulkhead);

.2 Double hull tanker:

- (a) double bottom ballast tank – areas of tank boundaries and attached structure, in lower and upper half of tank (two (2) areas to consider);
- (b) double hull side tank:
  - – deck and bottom – areas of deck and bottom plating with attached structure (one (1) area to consider for deck and one (1) area to consider for bottom);

- side shell and longitudinal bulkheads – areas of side shell and longitudinal bulkheads with attached structure, in lower, middle and upper third (three (3) areas to consider for side shell and three (3) areas to consider for longitudinal bulkhead);
- transverse bulkheads (forward and aft) – areas of transverse bulkhead and attached stiffeners, in lower, middle and upper third (three (3) areas to consider for forward transverse bulkhead and three (3) areas to consider for aft transverse bulkhead).

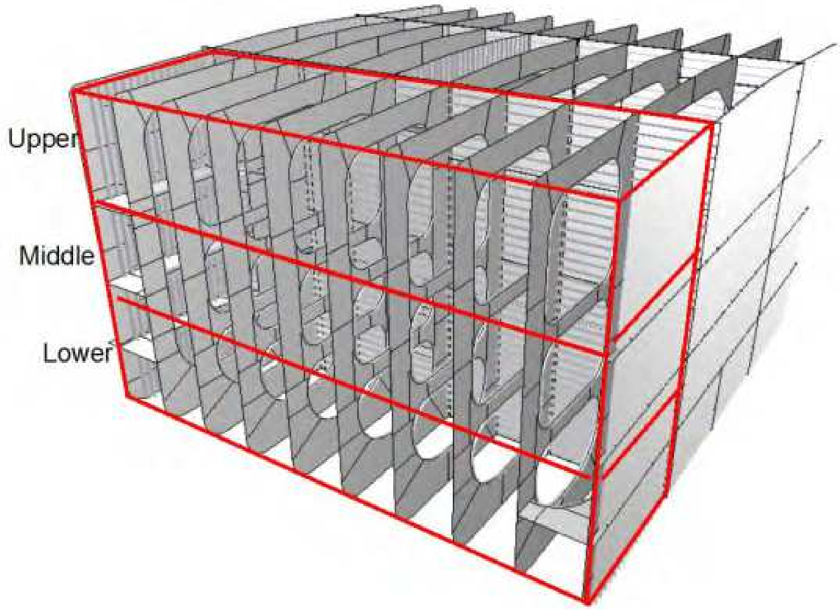


Figure 1. "Areas under consideration" indicated for a Wing Ballast Tank, from one side, i.e., deck, side shell and transverse bulkheads forward.

.3 Fore peak tanks – Figure 2

(a) areas of tank boundaries and attached structure, in upper, middle and lower third of tank (three (3) areas to consider).

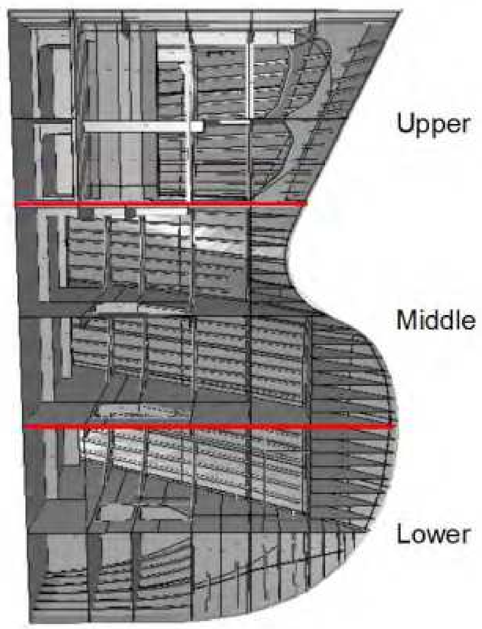


Figure 2. "Areas under consideration" indicated for a Fore Peak Ballast Tank

.4 Fore peak tanks – Figure 3

(a) areas of tank boundaries and attached structure, in upper, middle and lower third of tank (three (3) areas to consider).

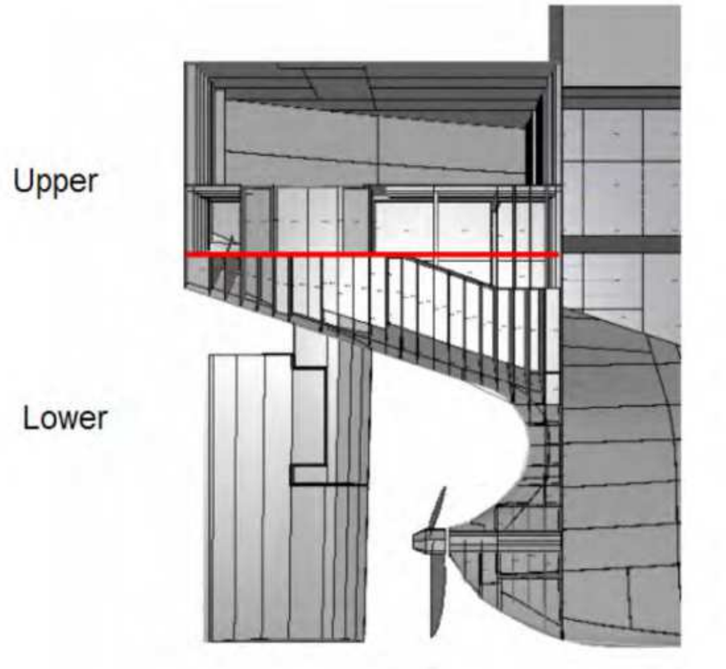


Figure 3. "Areas under consideration" indicated for an Aft Peak Tank

3 COATING MAINTENANCE AND REPAIRS

3.1 Process considerations

3.1.1 Major considerations are:

.1 Safety
.2 Salt contamination
.3 Rust scale
.4 Pitting corrosion
.5 Temperature
.6 Ventilation
.7 Condensation
.8 Dehumidification
.9 Compatibility of coating systems
.10 Design/Surface area Coating Technical File (CTF).

3.1.1.1 ***Safety*** referring to requirements of *IMO Resolution A.1050(27)*[(V)] and *PRS' Publication No. 28/I*[(VI)]. It is an absolute requirement that all of the ship's safety and tank entry procedures and policies are adhered to.

In addition, it is strongly recommended that all travel coating squad members are trained in safe usage of all the equipment and tools to be used for the project on board, before being sent to the ship.

3.1.1.2 ***Salt contamination*** is an ever present problem onboard ships and will cause severe problems if not removed prior to coating application.

A recommended procedure to reduce salt contamination is to remove loose rust scale followed by good fresh water rinsing, at elevated temperatures and high pressure, if possible.

Test the salt content after washing and before coating using ISO 8502-9[(1)] and re-wash if necessary until the salt level is less than 30 mg/m2. This should be the starting point in any surface preparation process in ballast tanks onboard ships.

Coatings described as "salt tolerant" are available, however, the user is advised to determine from the manufacturer details of the required preparations, limitations of use and guarantees of performance and, regardless of that, it is recommended to reduce the salt level to not more than 30mg/m^2 prior to coating application.

3.1.1.3 ***Rust scale*** that is not removed prior to coating application will cause early failure. The loose top-scale is easy to remove, however the inner (black) hard scale is much more adherent.

When over-coated it will soon detach between the steel and the scale and come off, typically with the coating adhering very well to the outside of it.

If the hard scale cannot be removed the service life expectancy of the treatment is 1 to 2 years regardless of the coating used.

3.1.1.4 ***Pitting corrosion*** is a major problem onboard ships on plates that have been exposed to seawater for some time. If it has been accepted that the pits need not be welded up, in order to prevent further accelerated damage, a coating should be applied.

Chloride salts will be present within the pits and it is essential that these are removed otherwise corrosion will soon start inside over-coated pits, affecting the service life.

Various methods of salt removal from pits have been proposed e.g. water-jetting followed by blast cleaning possibly also exposure to high humidity and repeating of water-jetting.

Whichever methods are chosen any residues from the washing processes must be removed otherwise the chlorides will precipitate out of the water on drying.

When Microbiologically Influenced Corrosion (MIC) is involved the pits are of a much wider nature, typically "shiny" clean inside with sharp edges to unaffected surrounding steel and often with a foul smell, like rotten egg, being evident when breaking up the scale cap.

A MIC attack can proceed very deep, very fast.

3.1.1.5 ***Temperature*** is a critical parameter to consider. If it is too cold in the water it will be hard to keep the inside tank surfaces free from condensation and to cure the coating in a timely manner.

Plan, if possible, the maintenance operation for periods, or locations, of warmer water.

Areas above the water level can be heated, although it is a fairly difficult task.

3.1.1.6 ***Ventilation*** is a vital factor. This is one item that clearly supports both the quality of the application and the safety of the operation.

Arrange the ventilation that it extracts from the lowest and furthest corners to ensure the fast and efficient removal of dangerous solvents.

The use of so called "solvent free" coating systems does not mean that ventilation is not required.

3.1.1.7 ***Condensation*** is always a risk onboard ships. It is an absolute necessity that the travel coating squad have a good understanding about relative humidity and it's relation to substrate temperature and dew point.

To paint over a surface that is at, or below, the dew point, or that will be at or below the dew point while the coating is wet, will not perform.

3.1.1.8 ***Dehumidification*** is the best insurance for good productivity and performance that money can buy. There are two different types i.e. desiccant and refrigeration. Both work well, the desiccant-type being ideal in moderate and cold climates, and the refrigeration type in warmer climates.

The use of dehumidifiers prevents condensation and dew point problems, ensures proper cure of the coating, reduces flash-back rusting, prevents grit blasting from "turning" and assists productivity.

3.1.1.9 ***Compatibility of coating systems*** is of utmost importance for good end result. To ensure compatibility of coating systems, using the same coating system as was originally employed is recommended and, if this is not possible, the paint manufacturer recommendations have to be followed.

3.1.1.10 ***Design/Surface areas*** should be differentiated with respect to coating application as degree of access varies. Edges, corners, weld seams and other areas that are difficult to coat needs special treatment.

Stripe coating is used to produce a satisfactory coating and to obtain specified DFT on such areas. It is recommended applying a stripe coat in advance of every coat of the main coating system and preferably using a round (cylindrical) brush.

This should be done using a colour that contrasts with the following main coat, as this makes it easier to see that the stripe coat is satisfactory.

Stripe coats should be used after pre-treatment in order to obtain the best possible result.

3.2 Principles for maintenance and repairs

3.2.1 Ballast tanks

3.2.1.1 Maintenance and repair process:

.1 mud out ("slurry up" and pump out all mud);
.2 de-scaling (hand scrape off loose scale – the use of magnesium descaling can be considered);
.3 phosphating of pitted parts (safety hazards to be controlled);
.4 fresh (potable) water rinsing;
.5 drying;
.6 surface preparation*
.7 anode protection
.8 coating.

3.2.2 Contractors

3.2.2.1 There are many contractors offering voyage repairs onboard ships recommending various tools and processes.

3.2.2.2 It is imperative that the process, specification, coating application parameters, standards and time schedule are discussed and agreed upon by the parties involved.

3.2.2.3 It is essential that the Contractor providing the service can prove that all personnel are fully qualified to carry out the required work. It is also necessary that whilst on-board the team are also fully conversant with appropriate ship operation, safety and evacuation requirements.

3.2.3 In-service condition monitoring

3.2.3.1 A successful maintenance and repair procedure starts with good information.

3.2.3.2 It is therefore a pre-requisite that the owner initiate, as a minimum, an annual inspection of all tanks and spaces by the ship's crew, sometimes assisted by additional inspectors.

3.2.3.3 Standardised reports should be used and submitted to the responsible superintendent that answers the following questions:

.1 ship's name;
.2 tank number;
.3 inspection date;
.4 inspection by whom;
.5 year coated;
.6 coating name/type;
.7 last repaired;
.8 surface area;
.9 amount of blistering ISO 4628-2(2) (see Appendix D. Pictorial ISO standards);
.10 amount of rusting ISO 4628-3(3) (see Appendix D. Pictorial ISO standards);
.11 amount of cracking ISO 4628-4(4) (see Appendix D. Pictorial ISO standards);
.12 amount of flaking ISO 4628-5(5) (see Appendix D. Pictorial ISO standards);
.13 amount of pitting corrosion;

* Surface preparation method chosen depends on the amount of failure and the service life intent.

.14 amount of light rust scale;
.15 amount of heavy rust scale;
.16 extensive steel loss – if relevant, location;
.17 rating (GOOD/FAIR/POOR as indicated in chapter 2);
.18 welds rusty – amount;
.19 edges rusty – amount;
.20 sounding pipe condition;
.21 vent pipe condition;
.22 ballast pipes condition;
.23 surfaces under ballast suction piece;
.24 amount of mud;
.25 any structural damage;
.26 other comments;
.27 crew maintenance (specified in paragraph 3.2.3.6);
.28 mechanical damage, location and extent.

3.2.3.4 The rating used is to give the Owner's technical staff an objective report of the condition so that the urgency of the repairs can be established and the most cost effective solution found.

The suitable rating system for this purpose is GOOD/FAIR/POOR as indicated in chapter 2.

With this information available the Owner's technical staff can plan ahead and find the most cost effective solution(s).

3.2.3.5 It should be realised that more control over the coating process can be achieved in dock and hence the overall cost effectiveness of voyage maintenance and repair must establish whether the required service life will be achievable.

3.2.3.6 ***Crew maintenance*** – valuable information can be gained from well trained and informed crew members (most paint companies can provide on-board maintenance training) undertaking the tank condition inspections.

It is recommended that the crew should identify the course of action necessary when defects have been detected.

This exercise if carried out in a consistent manner will provide shore based staff with a good opportunity to judge the extent and urgency of any necessary repairs and respond accordingly.

3.2.4 Recommended maintenance

3.2.4.1 The table 3 and table 4 describes the recommended short, medium and long term maintenance (e.g. 5, 10 and 15 years target lifetime respectively) to either maintain or to restore GOOD coating conditions.

Table 3
Recommended short term maintenance

Target Lifetime	Areas under consideration evaluated to	Pre-treatment [a), b)]	Coating system	Dry Film Thickness (DFT)
Short term maintenance (5 years)	GOOD	– Removal of mud, oil, grease, etc. – Fresh-water hosing – Drying – Power tool cleaning/ wire brushing – Climatic control	"Hard coating" compatible with original coating or equivalent. Recommended "hard coatings" are: – Pure or modified epoxy – Solvent less epoxy – Solvent free epoxy[c)]	– 1 diluted touch-up/stripe coat – 1 × 100 µm 1st coat
	FAIR	– Removal of mud, oil, grease, etc. – Fresh-water hosing – Surface treatment of damaged area by blast cleaning to grade Sa 2 [d)] or equivalent [e)] – Drying – Climatic control		– 1 diluted touch-up/stripe coat – 1 × 100 µm diluted 1st coat [f)] –1 × 100 µm 2nd coat – DFT correction

Target Lifetime	Areas under consideration evaluated to	Pre-treatment [a), b)]	Coating system	Dry Film Thickness (DFT)
	POOR	– Removal of mud, oil, grease, etc. – Fresh-water hosing – Surface treatment of **all** areas under consideration to grade Sa 2 [d)] or equivalent [e)] – Drying – Climatic control	– Epoxy mastic or surface tolerant	

Notes:
a) For up to 5 years target lifetime, different pre-treatment methods using water may be employed.
b) Small areas of coating damage may be treated individually without disturbing intact coating.
c) Solvent free epoxy (100% volume solid).
d) ISO 8501-1 [(6)].
e) equivalent grade e.g. by water-jetting (with or without abrasive).
f) is depending on coating system, % volume solids content, etc.

Table 4
Recommended medium and long term maintenance

Target Lifetime	Areas under consideration evaluated to	Pre-treatment [a)]	Coating system	Dry Film Thickness (DFT)
Medium term maintenance (10 years) and Long term maintenance (15 years)	GOOD	– Removal of mud, oil, grease, etc. – Fresh-water hosing – Drying – Power tool cleaning / wire brushing – Climatic control	"Hard coating" compatible with original coating or equivalent. Recommended "hard coatings" are: – Pure or modified epoxy – Solvent less epoxy – Solvent free epoxy[b)] – Epoxy mastic or surface tolerant	– 1 diluted touch-up/stripe coat – 1 × 100 µm 1st coat
	FAIR	– Removal of mud, oil, grease, etc. – Fresh-water hosing – Surface treatment of damaged area by blast cleaning to grade Sa 2½ [c)] – Drying – Climatic control		Medium term maintenance – 1 diluted touch-up/stripe coat – 1 × 150 µm diluted 1st coat [d)] – 1 diluted 2nd stripe coat – 1 × 150 µm 2nd coat – Dry Film Thickness (DFT) correction Long term maintenance – 1 diluted touch-up/stripe coat – 1 × 150 µm diluted 1st coat [d)] – 1 diluted 2nd stripe coat – 1 × 100 µm 2nd coat – 1 diluted 3rd stripe coat – 1 × 100 µm 3rd coat – DFT correction
	POOR	– Removal of mud, oil, grease, etc. – Fresh-water hosing – Surface treatment of all areas under consideration to grade Sa 2 ½ [c)] – Drying – Climatic control		

Notes:
a) High-pressure water-jetting is not recommended for target lifetime beyond 5 years
b) Solvent free epoxy (100% volume solid)
c) ISO 8501-1 [(6)]
d) is depending on coating system, % volume solids content, etc.

APPENDIX

1 FAILURES

1.1 Coating failures

1.1.1 The coating failures considered in *this Publication* is the coating degradations within the intended coating service life.

1.1.2 The main types are identified in the following items:

.1 cracking;
.2 flaking;
.3 blistering.

1.1.2.1 ***Cracking*** is a break-down in which the cracks penetrate at least one layer and which may be expected to result ultimately in complete failure.

Such cracks may result from:

(a) over thicknesses of paint,
(b) plastic structural deformations exceeding the elongation properties of the paint film,
(c) localised fatigue stress, due to non appropriate design.

Coating cracking

1.1.2.2 ***Flaking (loss of adhesion)*** consists in the lifting of the paint from the underlying surface in the form of flakes or scales.

The causes of a loss of adhesion may be the following ones:

(a) unsatisfactory surface preparation,
(b) incompatibility with underlayer,
(c) contamination between layers,
(d) excessive curing time between layers.

Coating flaking

1.1.2.3 ***Blistering*** appears as a bubble formation scattered on the surface of a paint film, with a diameter ranging from 3-4 mm to 20-30 mm. Blisters contain liquid, vapour or gas.

Blistering is a localised loss of adhesion and lifting of the film, coming generally from osmosis due to one of the following causes:

(a) solvent retention,

(b) improper coating application,

(c) soluble salt contamination under the paint film, due to an insufficient cleaning of the surface.

It is to be noted that in most cases there is no corrosion in an unbroken blister and many years of protection can be obtained if these blisters are left untouched.

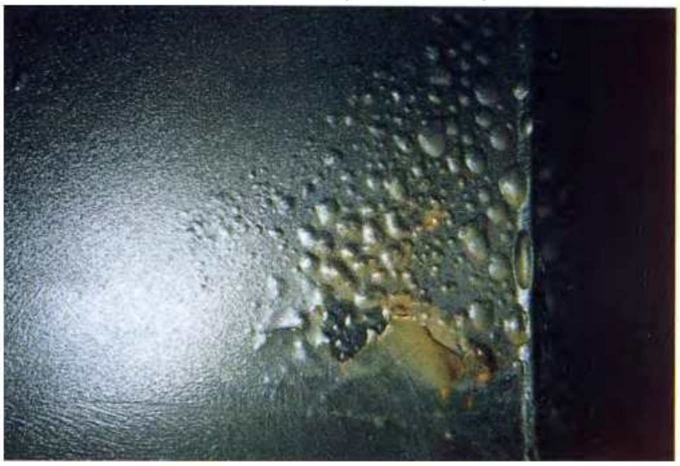
1.1.2.3.1 Due to a heavy overlap coating and poor workmanship, blisters have often been observed.

Coating blistering

Blister around opening (8 years)

1.1.2.3.2 Blisters have sometimes been observed on flat part and often been observed on areas which have difficulties to work on such as back of face plate of extrusions.

Coating blistering



Blister on flat part (5 years)

1.2 Corrosion

1.2.1 There are many forms of corrosion. The typical corrosion pattern which may be observed in a sea water ballast tank are described in the following items:

.1 general corrosion (uniform corrosion);

.2 pitting corrosion (localised corrosion);

.3 crevice corrosion;

.4 erosion corrosion;

.5 bacterial corrosion;
.6 stress corrosion.

1.2.1.1 ***General corrosion*** appears as non-protective, friable rust which can uniformly occur on tank internal surfaces that are uncoated.

The rust scale continually breaks off, exposing fresh metal to corrosive attack.

The anodic and cathodic areas on the same piece of steel change with time, so those areas that were once anodes become cathodes and vice versa.

This process allows the formation of a relatively uniform corrosion of steel.

General corrosion

1.2.1.2 ***Pitting corrosion*** is one of the most common forms that can be noted in ballast tanks. It is a localised corrosion that occurs on bottom plating, other horizontal surfaces and at structural details that trap water, particularly the aft bays of tank bottoms.

For coated surfaces the attack produces deep and relatively small diameter pits that can lead to hull penetration.

Pitting of uncoated tanks, as it progresses, forms shallow but very wide scabby patches (e.g. 300 mm diameter); the appearance resembles a condition of general corrosion. It is caused by the action of a localised corrosion cell on a steel surface due to the breaking of the coating (if present), to the presence of contaminants or impurities on the steel (e.g. mill scale) or to impurities present in the steel.

Pitting corrosion

1.2.1.3 ***Crevice corrosion*** is also localised corrosion that appears as pitting. The most common case occurs in cracks and generally on steel surfaces covered by scales and deposits.

Typical examples are ship welding seams, pipe supports and bolts.

The phenomenon is due to the fact that a small area of steel (i.e. the crevice, the crack or the area covered by debris) lacks oxygen and becomes the anode of a corrosion cell, while the remaining free surface, abundantly oxygenated, becomes the cathode. Since the anodic area is very small compared to the cathodic one, the corrosion process is extremely fast.

1.2.1.4 ***Corrosion due to erosion*** occurs when abrasives (i.e. sand or mud) held in the sea water impinges, with a certain velocity, an existing corrosion cell. The abrasives remove the accumulation of corrosion products keeping the metal clean and the corrosion active.

Crude oil washing or hot and cold seawater washing can be considered as a particular erosion corrosion form. The greasy or waxy layer that, covers the steel surfaces, act as a corrosion inhibitor is removed, together with corrosion product, by the washing process keeping the steel clean and the corrosion active.

1.2.1.5 ***Bacterial corrosion***, called Microbiologically Influenced Corrosion (MIC) appears as scattered and/or localised pitting. MIC is a form of corrosion originated by the presence of microscopic one-celled living organism including bacteria, fungi and algae.

The corrosive bacteria live in water layer on the bottom of cargo oil tanks as well as in the sediment of water ballast tank bottom.

1.2.1.5.1 Sulphate Reducing Bacteria (SRB) and Acid Producing Bacteria (APB) are the two most important and well known groups of microorganisms, which cause corrosion. SRB and APB live together with other species of bacteria in colonies on the steel surfaces helping each other to grow.

1.2.1.5.2 SRB's are anaerobic in nature and obtain their needs of sulphur by a complex chemical reaction. During this reaction, the organism assimilates a small amount of sulphur, while the majority is released into the immediate environment as sulphide ions, which are hydrolysed as free H_2S. In this way, SRB give rise to a corrosive process that supports the anodic dissolution of the steel. When bacteria have started to produce sulphide, the environmental condition becomes more favourable for growth, resulting in a population explosion.

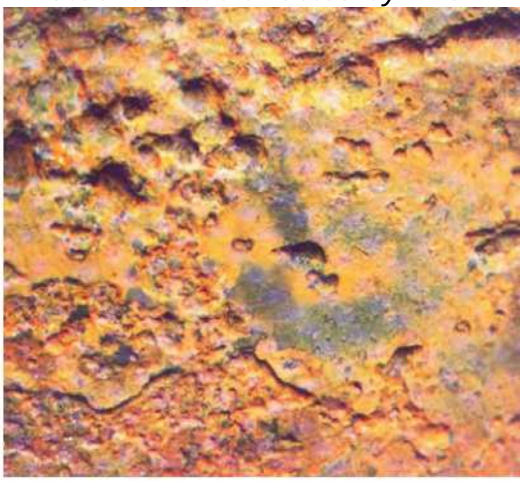
1.2.1.5.3 APB's use the small quantity of oxygen of the water to metabolise hydrocarbons and produce organic acids such as propionic acid, acetic acid and other higher molecular acids.

1.2.1.5.4 Since the APB's "consume" the residual oxygen present in the sediment, they produce, under the colonies, a suitable and ideal environment for the SRB's.

1.2.1.5.5 When active, the corrosion process originated by these bacteria can be extremely fast and can cause corrosion pits with a rate up to 1,5 – 3 mm per year, which is about five times higher than normally expected.

1.2.1.5.6 Colonies of bacteria may appear like slimy black deposits on the steel surfaces.

Steel surface affected by MIC



1.2.1.6 ***Steel subject to stress*** or fatigue can be affected by fractures, even small. These areas act as a crevice and, due to low aeration, will corrode as already described.

Furthermore, a fracture can also cause micro cracking on the protective coating, giving rise to a very active corrosion cell.

2 CORROSION PREVENTION

2.1 Protective coating (paints)

2.1.1 Coatings can protect metals from corrosion by providing a barrier between the metal and the electrolyte, preventing or inhibiting the corrosion process or in some cases by a particular form of cathodic protection.

2.1.2 The selection of the coating system, as well as the selection of its application procedure is extremely important since it affects the performance of the coating itself and consequently the life of the steel structure.

2.1.2.1 The following photos show the ballast tanks of two ships with the same age of 13 years.

During the construction, both ships were coated with an epoxy system, but the application procedure of the ship of the first photo was correctly done, while that one of the ship shown in the second photo was clearly poor.

The photos are a clear example of the importance of the implementation of correct application procedure (surface preparation and paint system application) and coating selection.

Correct application, condition after 13 years	*Poor application, condition after 13 years*
	

2.1.2.2 If the protective coating is properly applied and a suitable maintenance program is performed, it can control the corrosion process of ballast tank surfaces for the complete life of the ship (see the following photos).

Ballast tank after 16 years	*Ballast tank after 28 years*
	

2.1.3 Paint systems

2.1.3.1 A paint system is formed by one or more coats of paint, each of which is applied at a specified film thickness.

This sequence of coats, called paint system, provides corrosion control by means of one or more of the following mechanisms:

(a) barrier protection (namely providing an insulating barrier between electrolyte and metal),
(b) chemical inhibition of corrosion reaction,
(c) cathodic protection when a coat of zinc rich primer, acting as sacrificial anode, is applied.

2.1.3.2 Paint system is the logic and organic sequence of successive coats.

It can be represented in a schematic generic form as ***Primer - Undercoats – Finishing***:

(a) ***Primer*** is the first coat of the paint system. It has very important function such as, for example, to assure the adhesion of the whole system and to provide the required anticorrosive protection. It must be applied after a proper surface preparation, before which its quality could decay. Primer has to be overcoated according to the overcoating time and instructions recommended by the paint manufacturer.
(b) ***Undercoats*** are used to connect the primer with the finishing coat and to increase the total thickness of the system, as requested by the material to be protected and the location (e.g. bottom, topside etc.).
(c) ***Finishing*** provides specific characteristics to the area where it is applied: aesthetic appearance for topside and other exposed areas, anti-fouling protection for the underwater etc.

2.1.3.3 On ballast tanks in order to optimise corrosion prevention, the same paint is generally applied in more coats, providing more properties at the same time.

It is useful, first of all, to clarify some terms of recent use:

(a) ***Hard coatings*** are coatings which chemically converts during its curing process, normally used for new constructions or non-convertible air drying coating which may be used for the maintenance purposes. Hard coating can be either inorganic or organic. All conventional paints are included in this definition, e.g. epoxy, polyurethane, zinc silicate, vinyl, etc.
(b) ***Semi-hard coatings*** are coatings that, after drying, remain flexible and hard enough to be touched and walked upon without damaging them and that are not affected by water erosion during de-ballasting operations.
(c) ***Soft coatings*** are coatings that do not dry, but remain permanently soft. Soft coatings are not recommended. Where Soft Coatings have been applied, safe access is to be provided for the surveyor to verify the effectiveness of the coating and to carry out an assessment of the conditions of internal structures which may include spot removal of the coating. When safe access cannot be provided, the soft coating is to be removed.

2.1.4 Paint systems for ballast tanks

2.1.4.1 There are a lot of paint systems available for the protection of ballast tank surfaces.

Each paint system proposed by the paint manufacturer has its number of coats and its specific film thickness.

A schematic description of the various paint systems would be too vague and generic.

For information only, the following table gives the basic characteristics of the paint systems until now more widely used for ballast tanks.

Table 5
Paint systems for ballast tanks

Paint system	Characteristics
PURE or MODIFIED EPOXY	Two-components Light colour
SOLVENT LESS EPOXY	Two-components Light colour

Paint system	Characteristics
SOLVENT FREE EPOXY (100% volume solids)	Two-components Light colour
EPOXY MASTIC and SURFACE TOLERANT	Two-components Light colour

2.2 Cathodic protection

2.2.1 Cathodic protection is a system of corrosion control by means of which a sufficient amount of direct current passing onto a metallic surface, converts the entire anodic surface to a cathodic area.

Cathodic protection is effective only when the metallic surface is immersed.

2.2.2 A cathodic protection system can be carried out by means of impressed current equipment or by sacrificial anodes.

2.2.3 In ballast tanks the impressed current system is not permitted, due to the large amount of hydrogen gas produced by the process.

Therefore only a system of sacrificial anodes (zinc or aluminium) is used.

2.2.4 Anodes generate the necessary direct current so that they are corroded by their natural potential difference, protecting the surrounding steel.

2.2.5 Pitguard anodes are suitable for arresting Sulphate Reducing Bacterial (SRB) attack.

2.3 Design

2.3.1 Corrosion prevention already starts during the design stage of the ship.

A suitable structural design may control the corrosion by eliminating one or more components necessary for the corrosion reaction or by permitting an easier application of other methods of corrosion control and prevention.

A good design must avoid:

(a) contact of dissimilar metals,
(b) stagnation and water traps,
(c) crevices (e.g. skip/chain/intermittent welds or irregular welding seams), that apart from the already described reasons, are difficult to protect with coating,
(d) irregular and sharp surfaces, because they are difficult to coat with the correct film thickness,
(e) difficult-to-reach-areas, since they can prevent the correct application of the coating.

2.3.2 In connection with repair, it is recommended to pay close attention to obtain a design favourable from a corrosion prevention point of view.

3 SURFACE PREPARATION METHODS

3.1 The main methods of surface preparation options are:

.1 hand chipping;
.2 power tool cleaning; needle-gun, chipping-gun, rotary grinders, wire brushes, etc.;
.3 water-jetting;
.4 ultra-high-pressure water-jetting;
.5 slurry blasting;
.6 water-jetting with grit injection;
.7 ultra-high-pressure water-jetting with grit injection;
.8 dry ice blasting;
.9 sodium-bicarbonate (Baking Soda) blasting;
.10 blast cleaning;
.11 magnesium de-scaling;
.12 sponge-jet blasting.

3.1.1 ***Hand chipping*** is a fairly slow and labour intensive method that does not require much technical ability of the operator. It does not yield a clean substrate and coatings in seawater ballast spaces applied over hand chipped surfaces normally fail within 2 years.

The so called "surface tolerant" primers will perform better, typically up to two years, whereas conventional primers will fail much earlier.

3.1.2 ***Power tool cleaning*** is a surface preparation method that can yield a very clean substrate. It is much more labour intensive than blast cleaning.

Many tools such as rotary disc grinders and wire brushes, etc., will not clean inside crevices or shallow pits.

Care is to be taken when using these tools e.g.:

(a) wire brushes which does not give a high surface profile,

(b) needle gun cleaning peens the surface and is not ideal.

3.1.2.1 The typical service period that a good coating will provide on power tool cleaned surfaces ranges from 2 to 5 years.

3.1.2.2 The cleaner, and higher the surface profile (roughness) the greater the expected performance.

3.1.2.3 As for the hand chipped surfaces a coating that is designed for a more compromised substrate will typically perform better than one that is less tolerant. Typically a well suited method for small spot repairs.

3.1.3 ***Water-jetting (WJ)*** is defined as having a water pressure in excess of 100 MPa is a relatively new process.

The energy output and with it the cleaning ratio and success is highly dependent on the nozzle pressure, water volume and the design of nozzle.

In general however, water-jetting will only remove loose rust, loose scale and loose paint at an acceptable production rate. It will not remove mill-scale or "black rust" (magnetite-scale).

Painting over such scale will bring the performance expectation down to that of hand chipping. The process does not provide a surface profile to promote coating adhesion and relies on the original abrasive blasted or corroded surface condition.

Where there is no scale and a clean substrate is produced, although there will always be some re-rusting, the service life expectancy can be in excess of 5 years. Surface tolerant coatings are the best option for these surfaces. Warning is given here regarding so called "moisture tolerant" coatings.

3.1.3.1 As the industry has not yet advanced to a point where it can accurately define or measure moisture content on a substrate, Owners could be subject to high risk if reliant on "moisture tolerant coatings".

3.1.3.2 It is also to be noted that the use of water miscible components in the coating to assist with the dissolution (displacement) of the surface water is common in so called moisture tolerant coatings.

Such species will however act as solutes in an osmotic couple with water and can be the direct cause of blisters.

3.1.3.3 Moisture curing coating types e.g. polyurethanes etc., can use some or all of the surface water in its curing reaction.

The same problem applies however since the amount of surface water cannot be measured and the stoichiometry of the reaction will not be ideal, any excess water may therefore cause exactly the same problems as for a non-moisture cured system.

3.1.3.4 Water treatments below 6.8 MPa are not surface preparation methods but cleaning methods.

Low-pressure washing, having water pressure below 6.8 MPa while ***high-pressure water cleaning (HPWC)*** are termed the treatments having pressures from 6.8 to 68 MPa.

3.1.4 ***Ultra-high-pressure water-jetting (UHP-WJ)*** is defined as having a pressure in excess of 150 MPa. Normally, such tools operate at 200 MPa or more. UHP-WJ produce better and faster cleaning than the water-jetting method does.

The service life expectancy span for UHP-WJ can be 2 to 10 years depending on the cleanliness achieved, the amount of re-rusting and moisture control during painting. The same comments about coatings apply as for water-jetting.

3.1.5 ***Slurry blasting*** is using a modified dry grit blasting system with water as the propellant instead of air.

There are no advantages (apart from a reduced dust and salt level) with this system compared to normal blast cleaning, but it has quite a few draw-backs, which is why it has not been used onboard ships to any significant degree.

The service life expectancy will depend on the amount of re-rusting which is usually significant and varies from 3 to 5 years. This method does remove scale. The same comments about coatings apply as for water-jetting.

3.1.6 ***Water-jetting with grit injection*** has been used with success on some projects at sea. It produces a surface cleanliness about the same as slurry blasting but leaves much less wet grit to be removed.

Re-rusting is a major problem and coating performance is dependent on how that matter is dealt with. Service life expectancy and coating comments will be the same as for the slurry blasting.

3.1.7 ***Ultra-high-pressure water-jetting with grit injection*** is interesting in that the production rate is reported to be very high, the grit consumption quite low and the rerusting easily removed with water only using the same pump. It removes scale but is difficult to use in hard to reach areas.

Properly operated this method could yield the same performance expectation as grit blasting; e.g. in excess of 10 years. Coating comments, same as for water-jetting.

3.1.8 ***Dry-ice blasting*** is suggested from time to time. It clean at a similar rate as sodium bicarbonate blasting does.

The equipment is expensive and produces cold surfaces that are subject to condensation onboard ships.

Dry-ice blasting does not remove millscale or hard rust scale. This method has not been used to any significant degree onboard ships. If used, adequate ventilation must be arranged to offset any carbon dioxide build-up during melting of the dry ice.

3.1.9 ***Sodium-bicarbonate blasting*** ("baking-soda blasting") is another method that is proposed from time to time. It is interesting as the residue is water miscible and can be pumped out.

The process must be followed by water rinsing as residual "baking-soda" will otherwise act as a solute to water in an osmotic couple that may cause blisters.

Flashback rusting will always be a problem and the service life expectancy is therefore in the water-jetting region. Sodium-bicarbonate blasting does not remove mill-scale or hard rust scale.

3.1.10 ***Blast cleaning*** for corrosion prevention systems is still the most cost effective method to yield a good substrate for the coating. The service life expectancy is in excess of 10 years.

It is noted that there are several different types of grit, e.g. copper slag, garnet, etc.: not all of them are suitable for use in all cases and care is therefore to be taken in selecting the most appropriate type for the case under consideration.

3.1.10.1 When used as a repair process, great care is needed to minimise the amount of damage to the sound coating close to the areas being repaired.

Invariably there will be some damage to the sound coatings, resulting in rust spots appearing.

3.1.10.2 It is to be noted that there are a number of different grit blasting units i.e. open air, vacuum, etc.

There is also a large selection of unit sizes available e.g. back-pack, minipot, 200 litre pot, "hopper" size, etc. The type used would depend on the project to be undertaken.

3.1.11 ***Magnesium de-scaling*** is sometimes used for ballast tank de-scaling and coating. Hydrogen gas formation is a major risk factor when using this method.

It is also vital to wash the tank down immediately after the seawater used for the de-scaling has been pumped out or a detrimental white powder (calcium/magnesium carbonate) is formed on the surface of the steel. This method has had varying success and the service life expectancy will be regarded as in the water-jetting region of 2 to 5 years.

3.1.12 ***Sponge-jet blasting*** is a method that uses grit abrasives with a "sponged" surface. The method requires recycling which will involve an abrasive washing system.

The interest is that adjacent areas may not be damaged by ricochets from blasting, hence it may be a useful means of preparing block joint surfaces within painted ballast spaces.

4 PICTORIAL ISO STANDARDS

ISO 4628 Paint and varnishes – Evaluation of degradation of paint coatings – Designation of intensity, quantity and size of common types of defect.

ISO 4628-1 General principles and rating schemes

Table 6
Intensity of deterioration

Rating	Intensity of change
0	unchanged, i.e. no perceptible change
1	very slight, i.e. just perceptible change
2	slight, i.e. clearly perceptible change
3	moderate, i.e. very clearly perceptible change
4	considerable, i.e. pronounced change
5	sever, i.e. intense change

Table 7
Quantity of defects

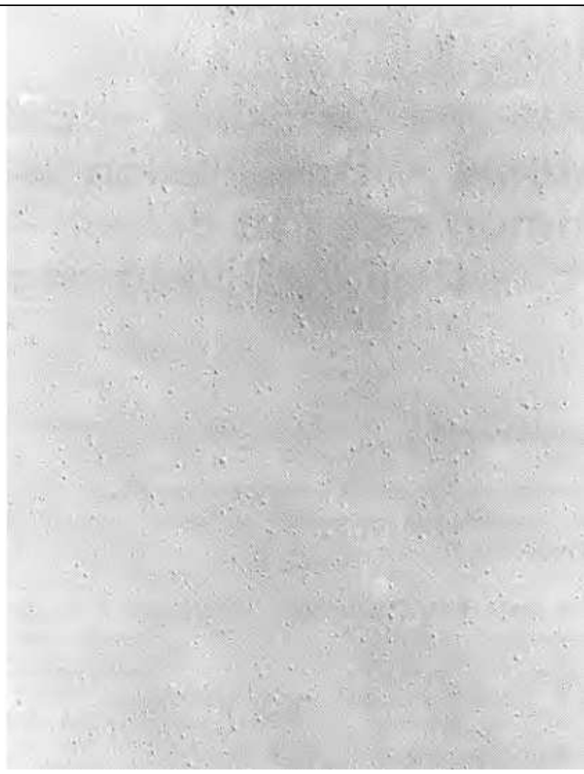
Rating	Quantity of defects (relative to a test area of 1 to 2 dm^2)
0	none, i.e. no detectable defect
1	very few, i.e. some just significant defects
2	few, i.e. small but significant amounts of defects
3	moderate, i.e. medium amount of defects
4	considerable, i.e. serious amount of defects
5	dense, i.e. dense pattern of defects

Table 8
Size of defects

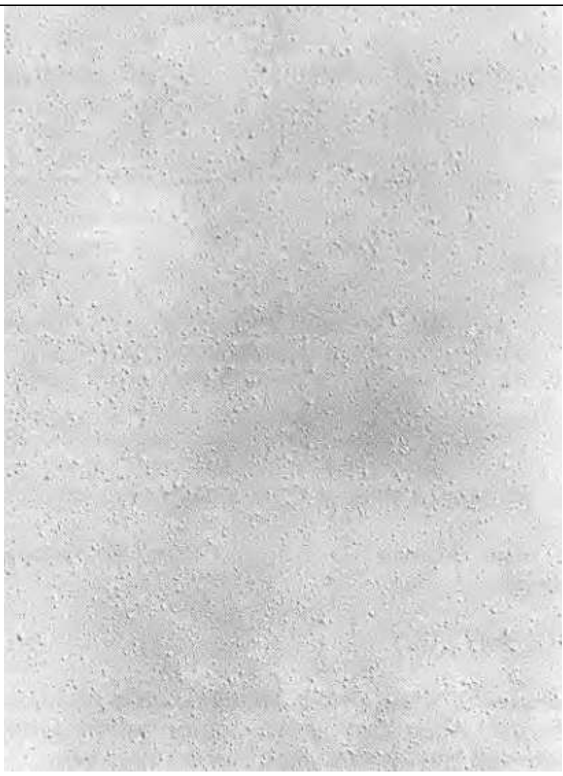
Rating	Size of defects
0	not visible under x 10 magnification
1	only visible under magnification up to × 10
2	just visible with normal corrected vision
3	clearly visible with normal corrected vision (up to 0,5 mm)
4	range 0,5 to 5 mm
5	larger than 5 mm

ISO 4628-2 Designation of degree of blistering

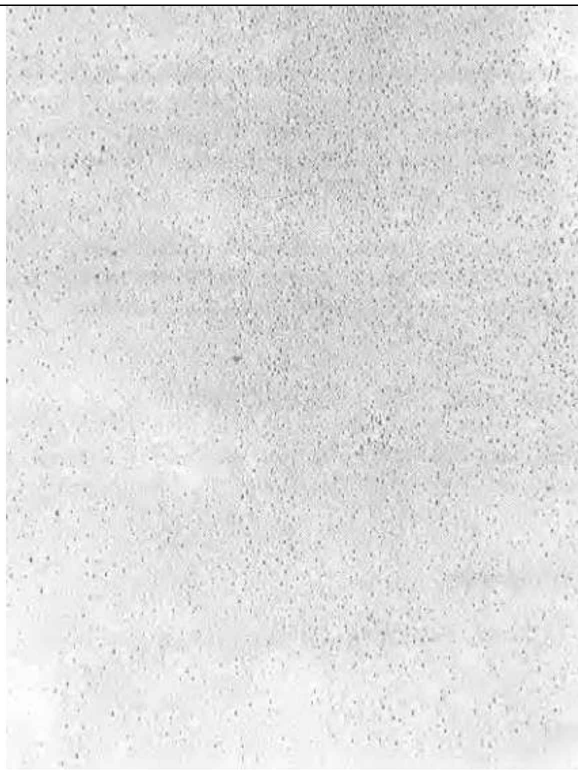
Density 2



Density 3

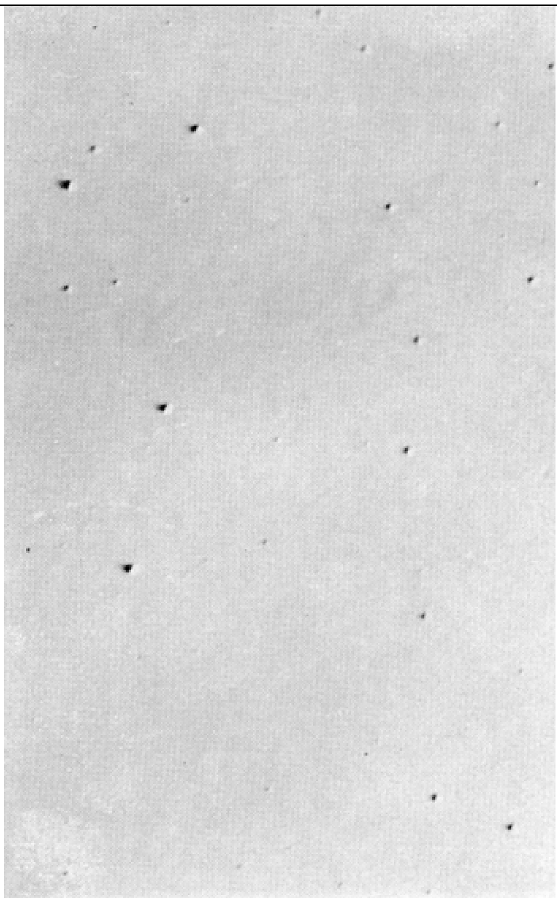


Density 4



Density 5

Figure 1. Degree of blistering. Blisters of size 2



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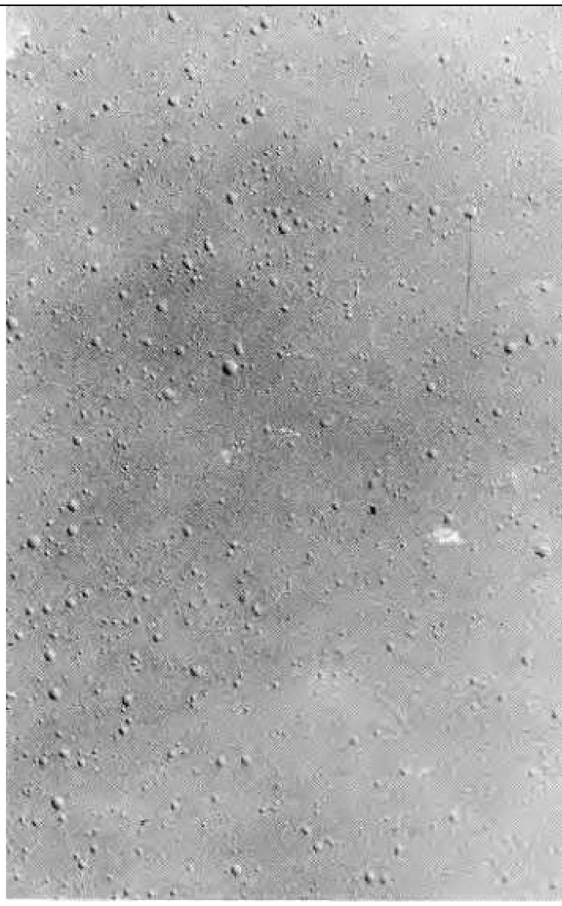

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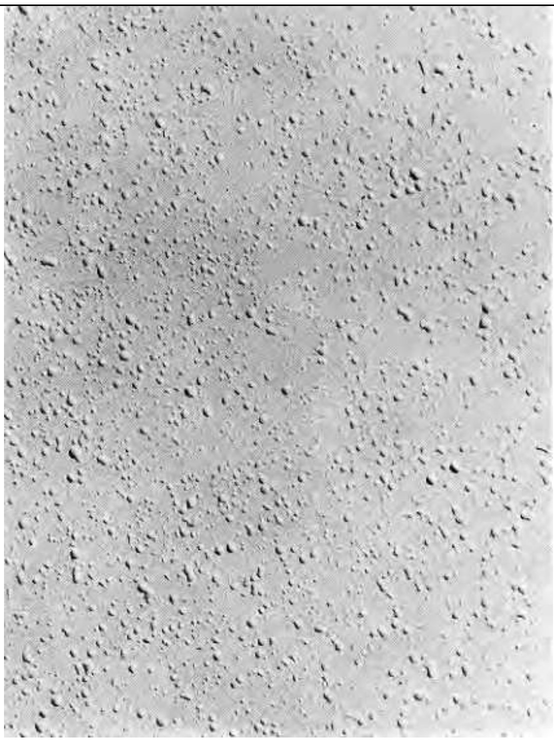
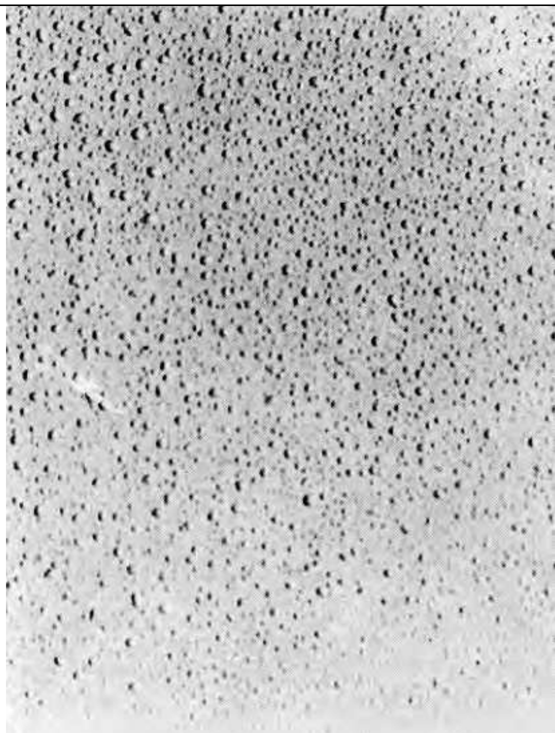
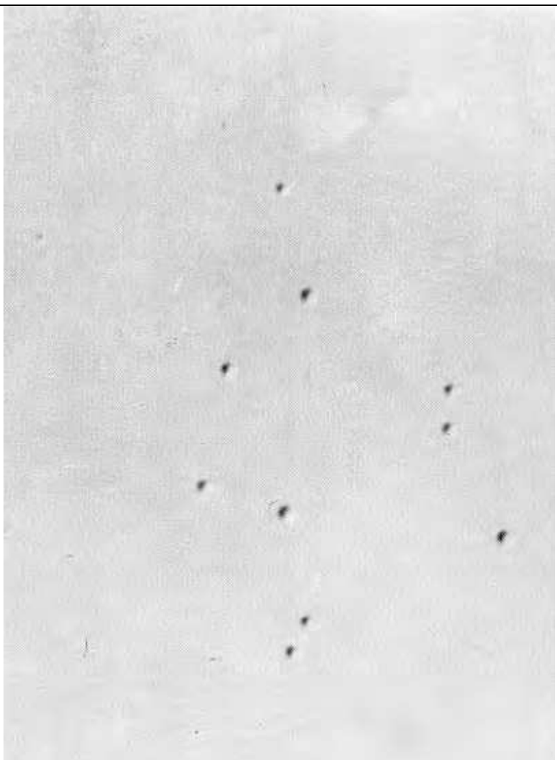


Density 4

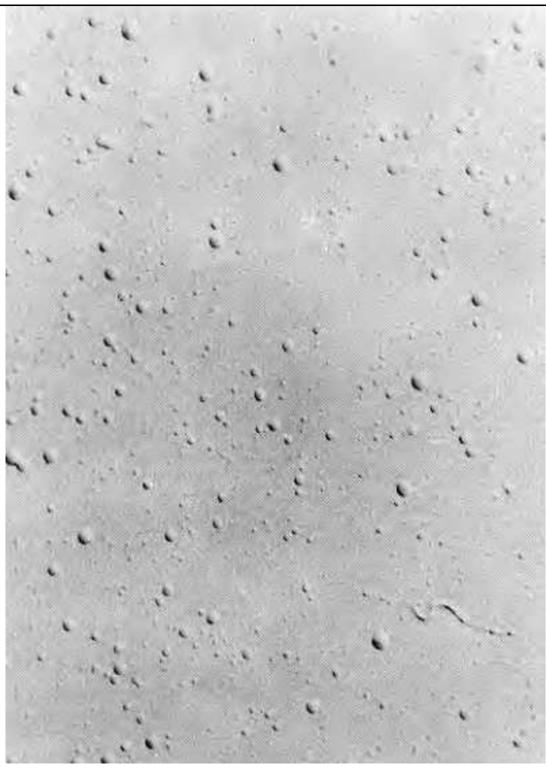


Density 5

Figure 2. Degree of blistering. Blisters of size 3



Density 2



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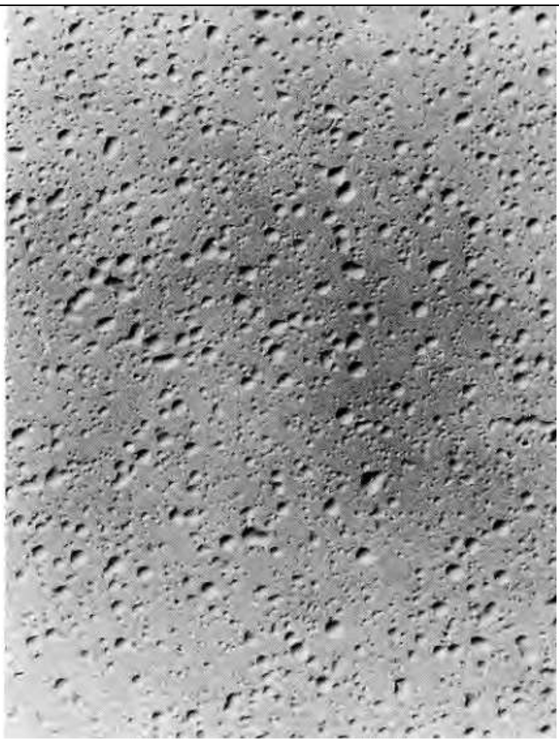

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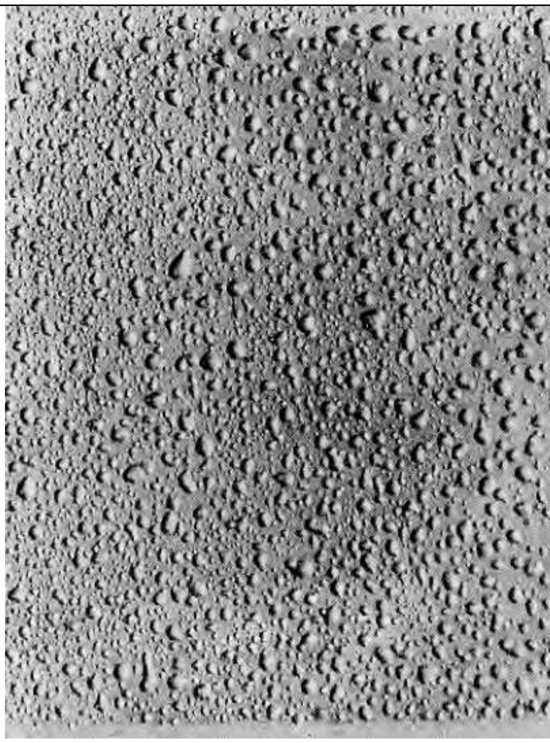
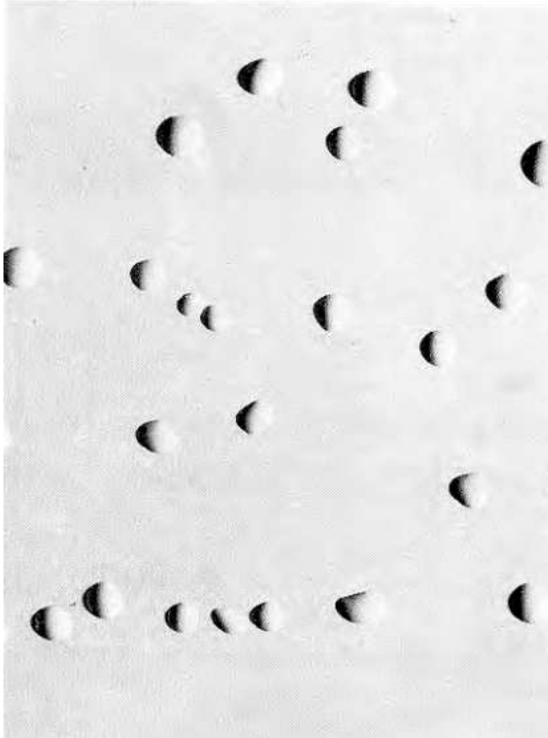


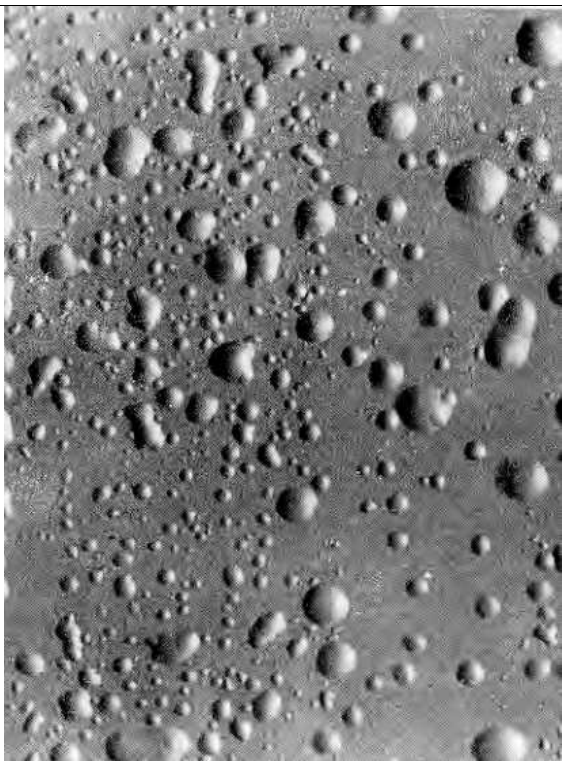
Density 5

Figure 3. Degree of blistering. Blisters of size 4

Density 2



Density 3



Density 4

Density 5

Figure 4. Degree of blistering. Blisters of size 5

ISO 4628-3 Designation of degree of rusting

Table 9
Degree of rusting and 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

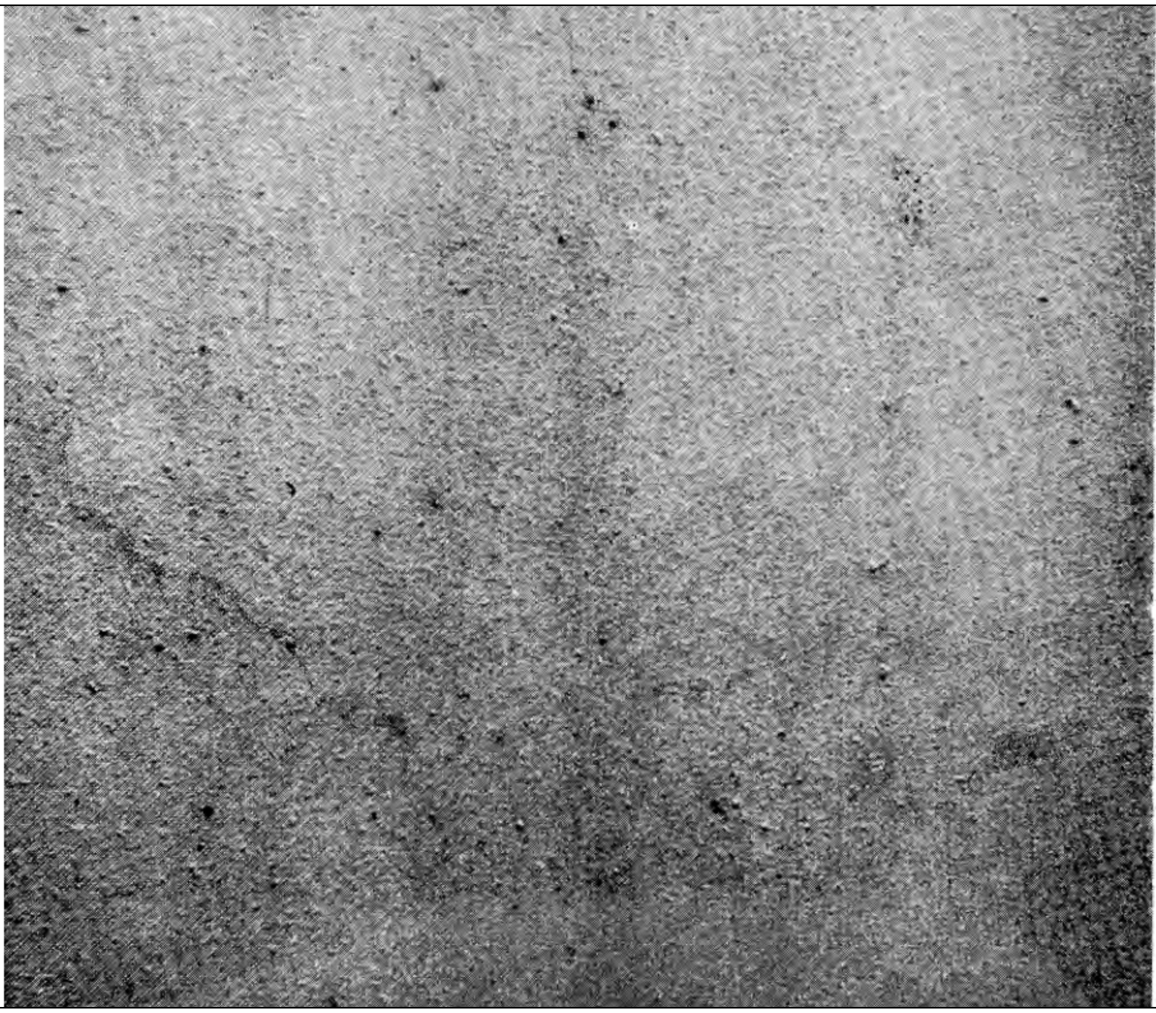


Figure 5. Degree of rusting. Ri 1

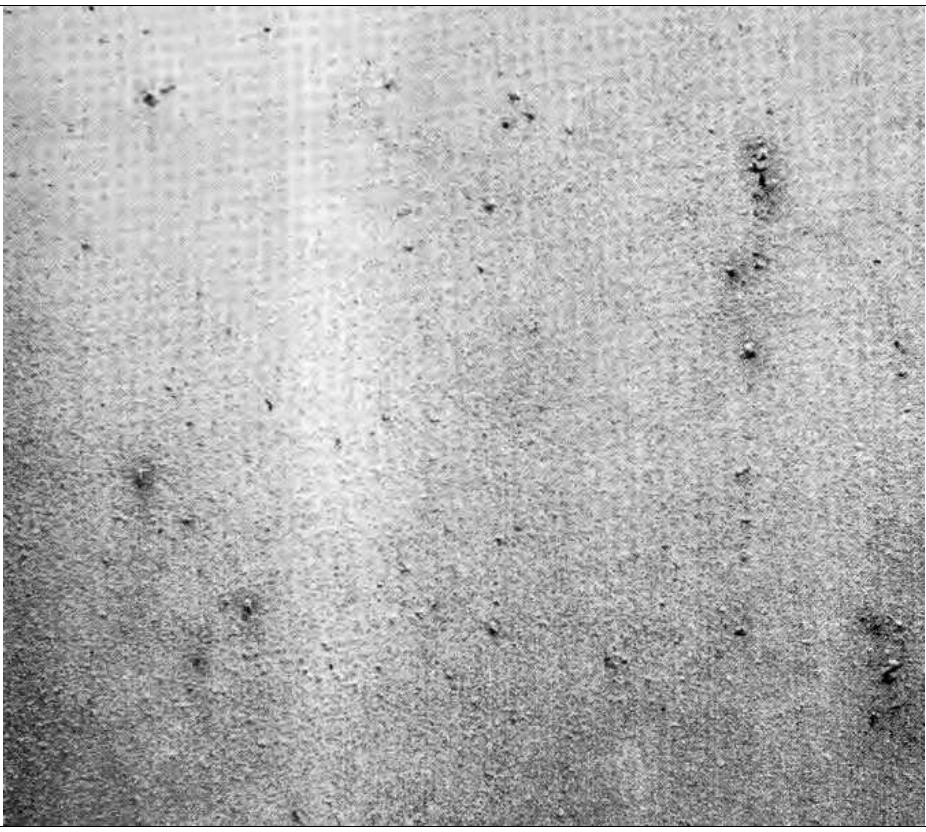


Figure 6. Degree of rusting. Ri 2

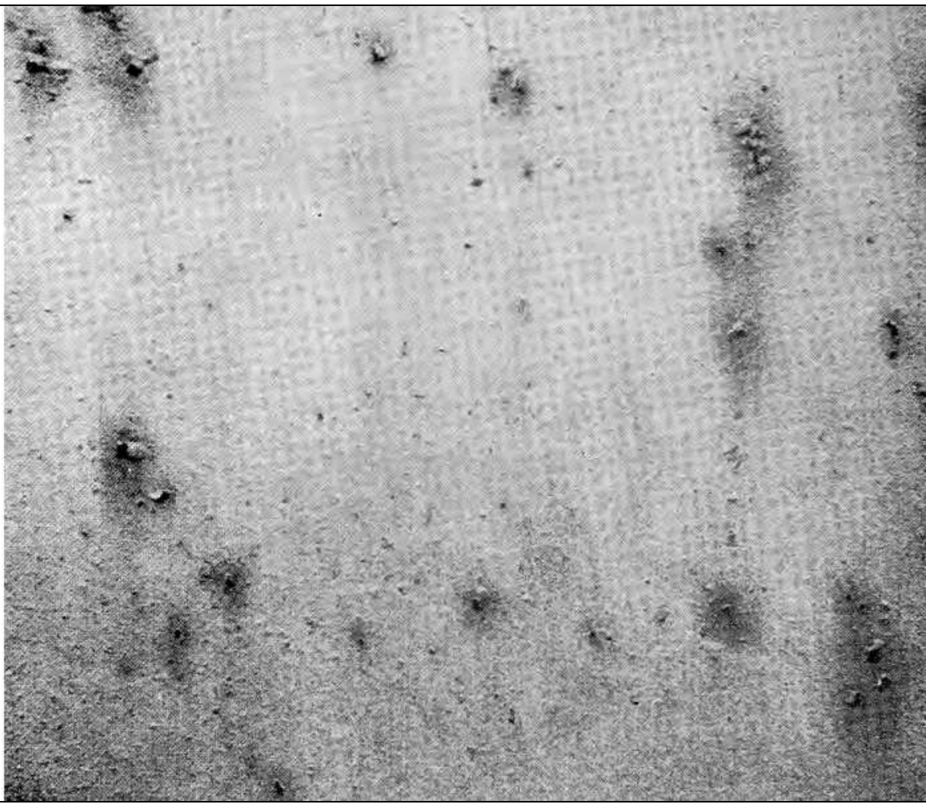


Figure 7. Degree of rusting. Ri 3

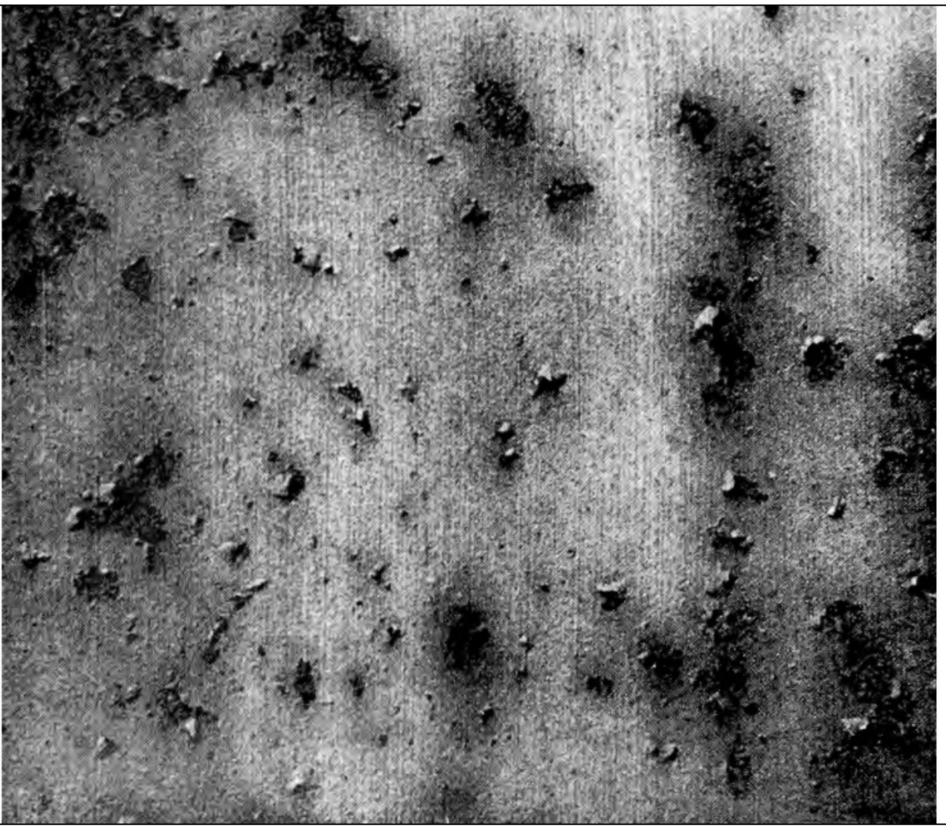


Figure 8. Degree of rusting. Ri 4

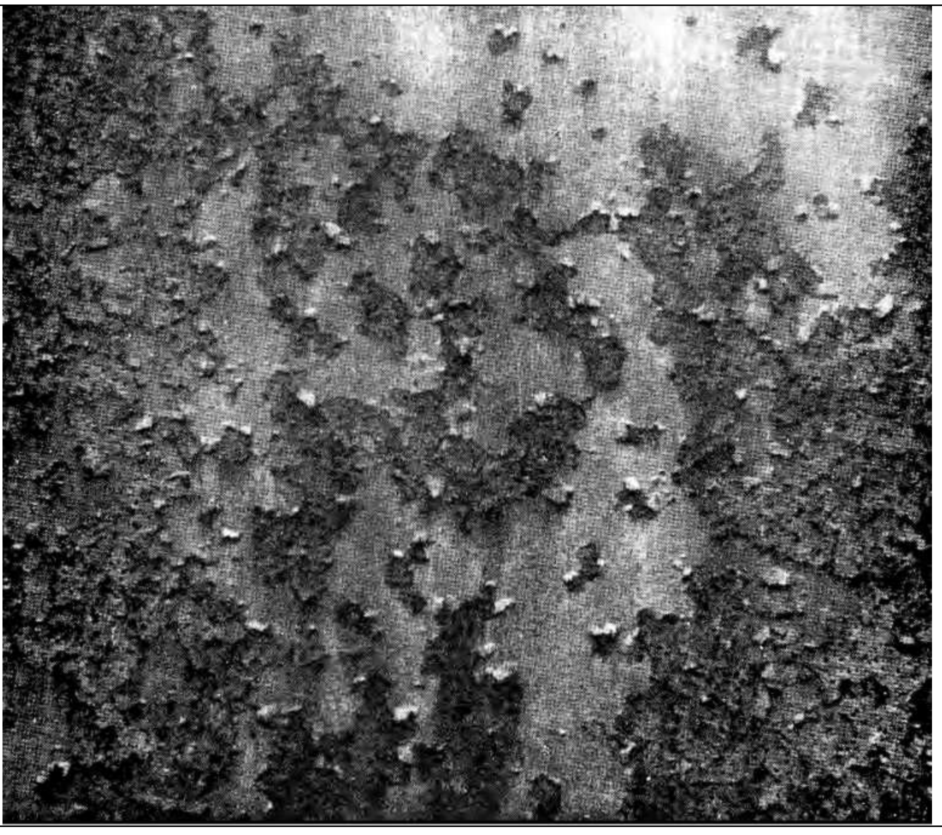


Figure 9. Degree of rusting. Ri 5

ISO 4628-4 Designation of degree of cracking

Table 10
Rating scheme for the designation of the size of cracks

Rating	Size of cracks
0	not visible under × 10 magnification
1	only visible under magnification up to × 10
2	just visible with normal corrected vision
3	clearly visible with normal corrected vision
4	large cracks generally up to 1 mm wide
5	very large cracks generally more than 1 mm wide

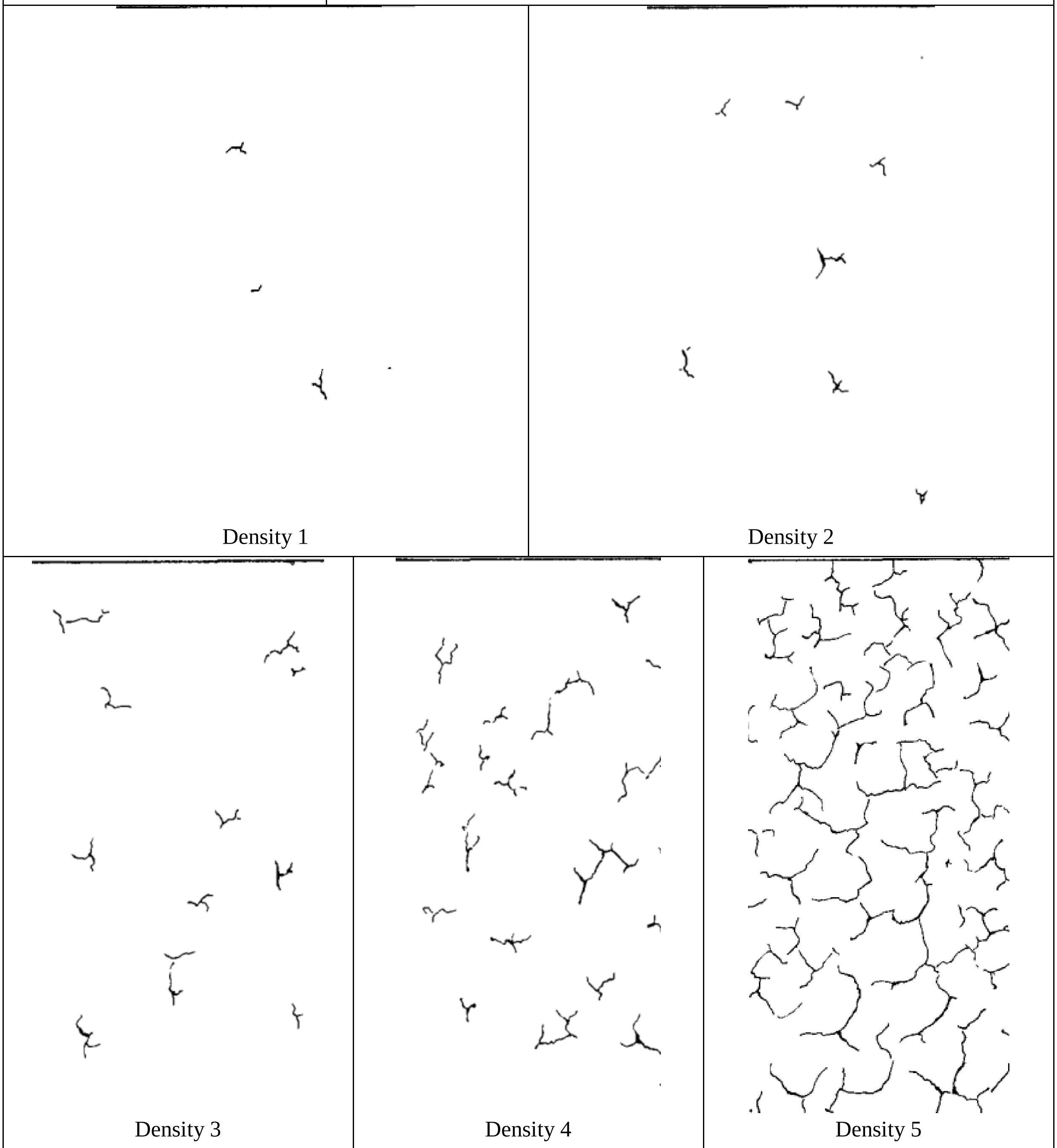


Figure 10. Cracking without preferential direction

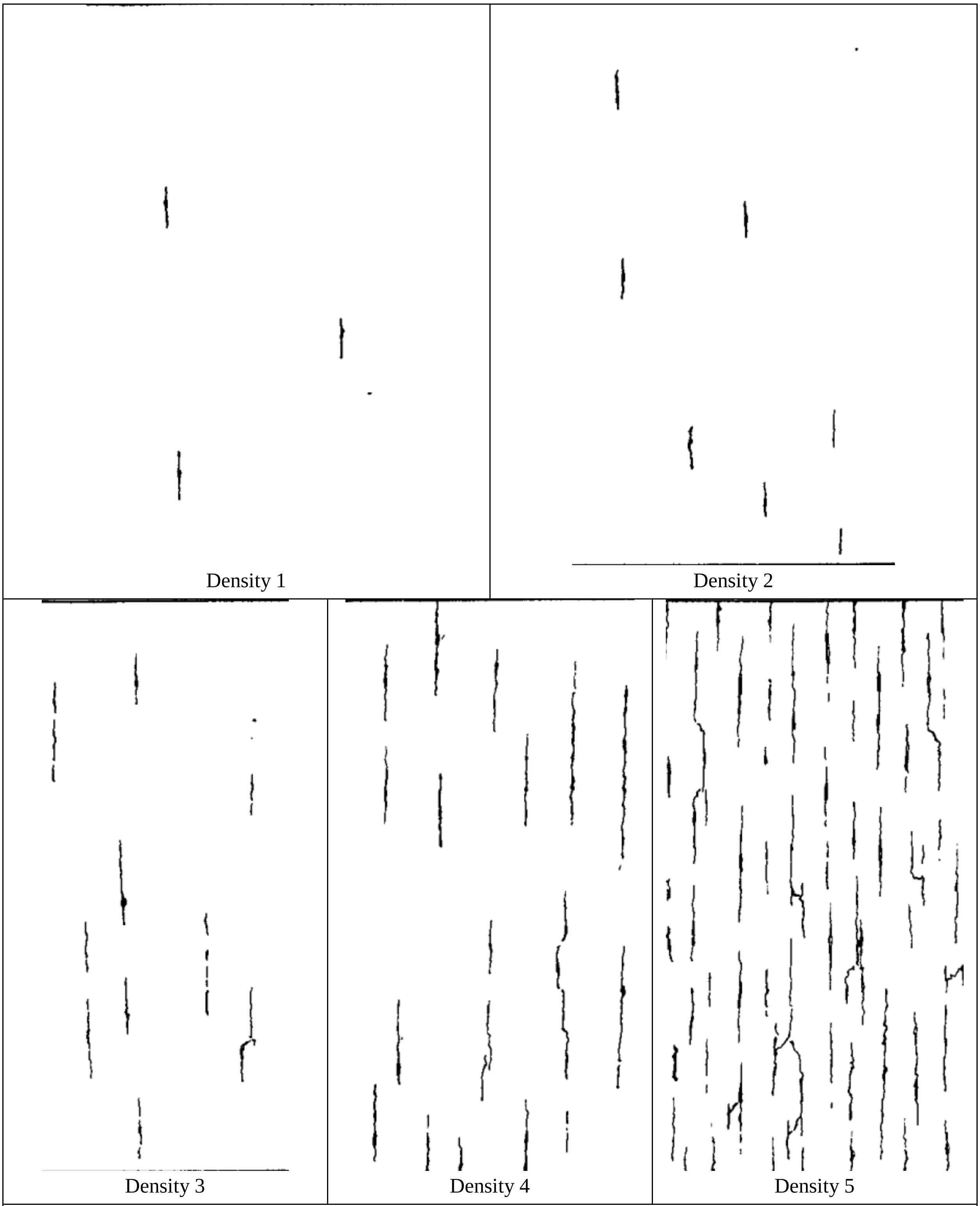


Figure 11. Cracking with one preferential direction (e.g. due to brush marks or wood grain)

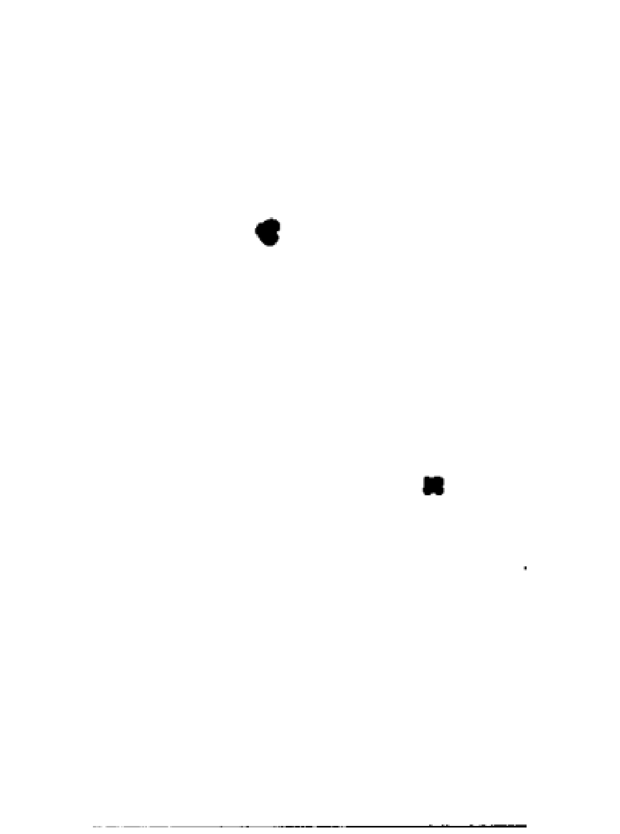
ISO 4628-5 Designation of degree of flaking

Table 11
Scale for the designation of the quantity of flaking

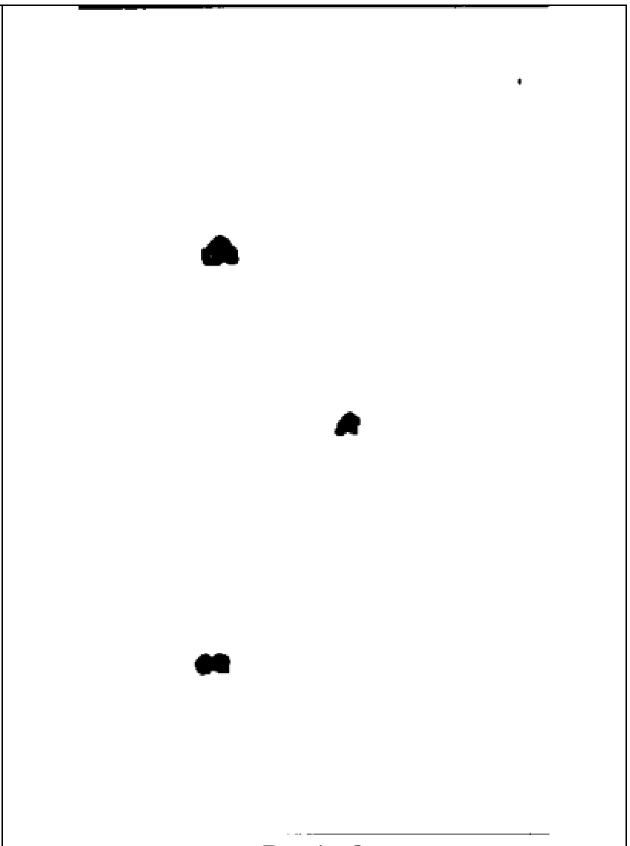
Class	Flaked area %
0	0
1	0.1
2	0.3
3	1
4	3
5	15

Table 12
Scale for the designation of the quantity of flaking

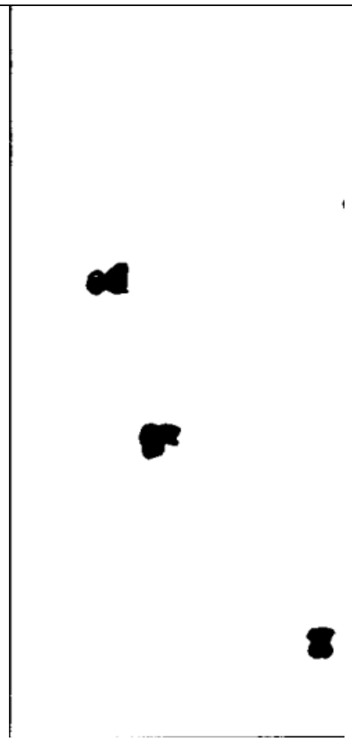
Rating	Size of flaking (largest dimension)
0	not visible under x 10 magnification
1	up to 1 mm
2	up to 3 mm
3	up to 10 mm
4	up to 30 mm
5	larger than 30 mm



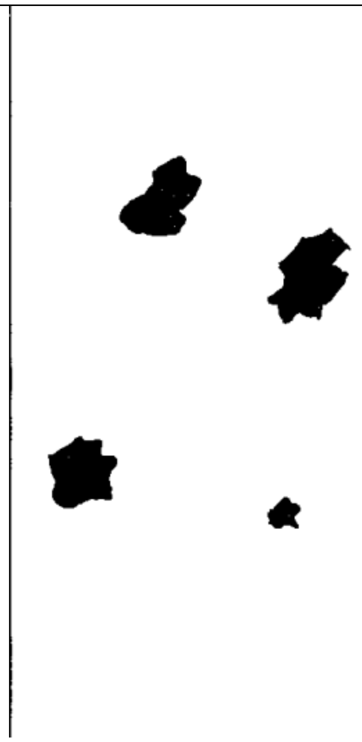
Density 1



Density 2



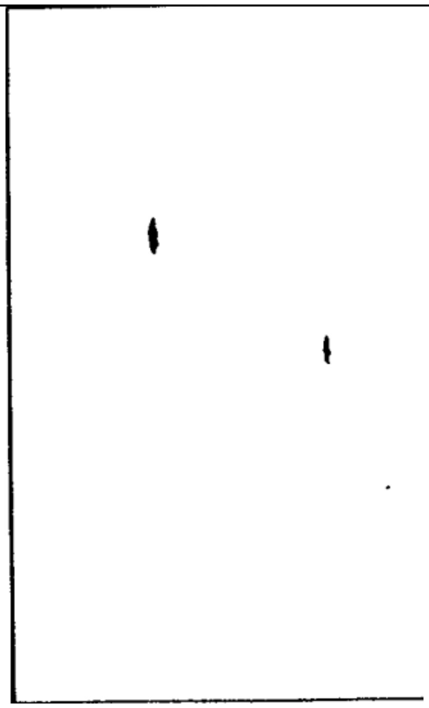
Density 3



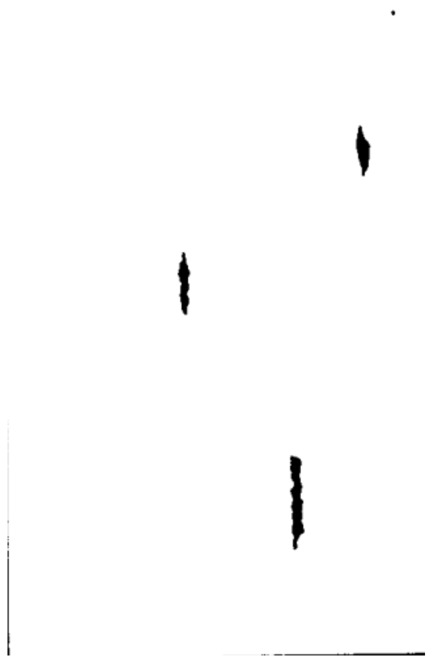
Density 4

Density 5

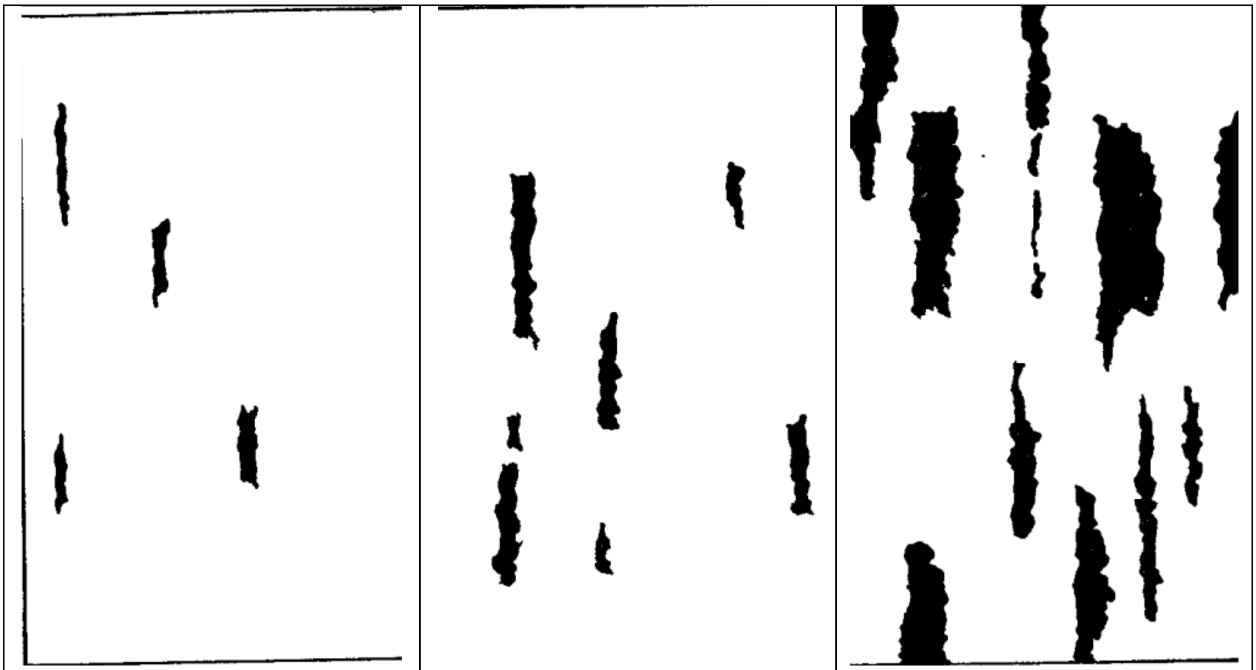
Figure 12. Flaking without any preferential direction



Density 1



Density 2



Density 3	Density 4	Density 5

Figure 13. Flaking with one preferential direction

5 DEFINITIONS AND DESCRIPTION OF TERMS

.1 Abrasive – The agent used for abrasive blast cleaning; for example, garnet, grit, shot etc.

.2 Absorption – The process of soaking up, or assimilation of one substance by another.

.3 Adhesion – The bonding strength; the attraction of a coating to the substrate.

.4 Administration/Flag Administrations – Government of the state whose flag the ship is entitled to fly.

.5 Adsorption – The process of attraction to a surface; attachment; the retention of foreign molecules on the surface of a substance.

.6 Ageing – Progressive degradation of a coating in the long run.

.7 Air entrapment – The inclusion of air bubbles in liquid paint or a paint film.

.8 Air spraying – An application method by which paint is atomised by compressed air and transported to the surface.

.9 Airless spraying – An application method by which the paint is forced to a great pressure (up to 350 kPa) and is atomised by forcing it through a tiny nozzle.

.10 Ambient temperature – The room temperature or temperature of surroundings.

.11 Amphoteric – Capable of reacting chemically either as/with an acid or as/with a base. and/or Suspect Areas.

.12 Anode – The corroding part of an electrochemical corrosion cell such as sacrificial anode or impressed current anode. The electrode at which corrosion occurs.

.13 Anticorrosive – Generic term defining paint used to protect metals from corrosion.

.14 Ballast tank – A tank which is being used solely for water ballast or a tank which is used for both cargo and ballast will be treated as a ballast tank when Substantial Corrosion has been found in that tank.

.15 Batch – The amount of paint produced in a single production process and identified by a number assigned by manufacturer.

.16 Binder – The component of a coating that holds the paint together and fixed to the substrate. Common such binders are epoxies, vinyl, urethane, etc.

.17 Blast cleaning – Cleaning with propelled abrasive.

.18 Bleeding – The appearance of a coloured substance on a newly painted surface from a previously painted substrate. The soluble substances causing this defect are, for example, bituminous paint, specific organic pigments, etc.

.19 Blistering – Bubbling in coating films normally caused by osmosis.

.20 Block Holding Primer (BHP) – Primer applied at block stage to reduce the amount of *insitu* secondary surface preparation. Not a pre-construction primer.

.21 Blushing – Development of a milky appearance on a coating surface during drying process caused by humidity and/or from the precipitation of one or more solid components of the paint.

.22 Body – Improper term to indicate the high percentage of volume solid of a paint.

.23 Breakdown of coating – Defects in the coatings like rust penetration, blistering, flaking and cracking.

.24 Brittle failure – Cracking and/or other failure normally encountered with hard, low ductility glassy objects and films.

.25 Brittleness – Degree of resistance to cracking or breaking by bending. Lack of resistance to cracking or breaking when bent.

.26 Bubbling – Coating defect, temporary or permanent, in which small bubbles of air or solvent or both are present in the applied film.

.27 Cargo area – That part of the ship that contains cargo tanks, slop tanks and cargo/ballast pump rooms, cofferdams, ballast tanks and void spaces adjacent to cargo tanks and also deck areas throughout the entire length and breadth of the part of the ship over the above mentioned spaces.

.28 Cathode – The electrode at which corrosion does not usually occur.

.29 Cathodic protection – Corrosion prevention by sacrificial anodes or impressed current.

.30 Chalking – Formation of powder on a coated surface as a result of weathering.

.31 Chipping – Cleanliness method of steel by removing paint, rust and mill scale, or other material by mechanical tools.

.32 Clean surface – One free of contamination (including non-visible contamination such as soluble salts).

.33 Close-up inspection – An inspection where details of structural components are within the close visual inspection range of the surveyors, i.e. normally within reach of hand.

.34 Close-up survey – A survey where the details of structural components are within the close visual inspection range of the Surveyor, i.e. normally within reach of hand.

.35 Clotted – Irreversible gelatinisation of a paint that becomes unusable.

.36 Coat of paint – One layer of dry paint, resulting from a single wet application.

.37 Coating material – Compound generally liquid, mastic or powder, forming a solid, filling protective and/or decorative coating.

.38 Coating system – A number of coats separately applied, in a predetermined order, at suitable intervals to allow for drying and curing, resulting in a completed job.

.39 Coating, lining – Term used to define various products that are applied on steel to protect it from corrosion and/or to decorate it.

.40 Coatings – Surface coverings; paints; barriers.

.41 Cohesion – Property of holding together of a single material.

.42 Compatibility – Attitude of a paint to be applied on another already dry coating.

.43 Conductivity – The inverse of the resistance (Ohm × cm). In *these Publication*: conductivity, i.e. specific electrical conductance, of an electrolyte, as salt and water mixtures (seawater).

.44 Corrosion prevention/protection system – A system designed for protecting the metal substrate from corrosion. For the purpose of *these Publication*, a corrosion prevention / protection system is:

(a) a hard coating, or

(b) a hard coating supplemented by anodes.

.45 Corrosion rate – The rate usually in mm/year, at which the corrosion process proceeds. The corrosion rate is always to be calculated from metal loss on the surface, even when occurring on both sides of a steel plate. Corrosion rate shall not be confused with "steel thickness reduction rate".

.46 Corrosion – Decay; oxidation; deterioration due to interaction with environment.
.47 Cracking of coating – Defect with fracture in the coating in at least one coat, often down to the substrate. Related expression is checking, which is surface cracking and crocodilling.
.48 Critical Structural Areas – Are locations which have been identified from calculations to require monitoring or from the service history of the subject ship or from similar or sister ships (if available) to be sensitive to cracking, buckling or corrosion which would impair the structural integrity of the ship.
.49 Cross application – System of application by airless spraying and by brush consisting of crossing the various coats at right angles.
.50 Cross Hatch Test – A method for testing adhesion of a coating, performed by a parallel series of crosshatch cuts near each other.
.51 Cross-spray – Spraying first in one direction and second at right angles.
.52 Curing agent – Hardener, promoter.
.53 Curing time – Time required by a coating to reach its complete properties and mechanical characteristic.
.54 Curing – Setting up, hardening.
.55 Curtaining – Special form of sagging by which the film appears locally with high thickness and with flakes similar to drape curtains.
.56 Dew point – Temperature at which moisture condenses.
.57 DFT – Dry film thickness.
.58 Diluent – A liquid which lowers viscosity and increases the bulk but is not necessarily.
.59 a solvent for the solid ingredients; a thinner.
.60 Discing – Surface preparation method carried out with an abrasive disc assembled on a pneumatic or electric tool.
.61 Discoloration – Colour change of a coating after application, normally caused by exposure to sunlight or chemical atmospheres.
.62 Double Hull Oil Tanker – For the purpose of *these Publication* a Double Hull Oil Tanker is a ship which is constructed primarily for the carriage of oil in bulk, which has the cargo tanks protected by a double hull which extends for the entire length of the cargo area, consisting of double sides and double bottom spaces for the carriage of water ballast or void spaces. For other classification purposes, the definition provided in *Publication No. 58/P*[(III)] is to be used.
.63 Dry Film Thickness (DFT) – The thickness of the paint film, after drying and curing.
.64 Dry spray – Over spray or bounce back; sand finish due to spray particles being partially dried before reaching the surface.
.65 Dry to handle – Time interval between application and ability to pick up without damage.
.66 Dry to recoat – Time interval between application and ability to receive next coat satisfactorily.
.67 Dry to touch – Time interval between application and tack-free time.
.68 Dryers – Substances that incorporated in relatively small percentages in the paint accelerate the drying process.
.69 Drying time – Time interval between application and final cure.
.70 Drying – Process by which coatings change from a liquid to solid state due to evaporation of the solvent, physical/chemical reactions of the binder or a combination of these factors.
.71 Dulling or Tarnishing – Loss of gloss of a coating.
.72 Edging – Striping.
.73 Elasticity – Term improperly used to indicate the flexibility of the coating, corresponding to a permanent plastic deformation.
.74 Electrochemical cell – See electrolytic corrosion.
.75 Electrolytic corrosion – Corrosion occurring in an electrolyte, i.e. an electrically conductive liquid such as salt water. Anodes and cathodes formed on the steel surface, together with an electrolyte and the metallic pathway through the metal, constitute electrochemical cells.
.76 Enamel – A finish coat of paint that shows a smooth, gloss surface after drying.
.77 Epoxy amine – Amine cured epoxy resin.

.78 Epoxy resins – Film formers (binders) usually made from bisphenol-A and epichlorohydrin, resins containing the oxyrane ring.
.79 Erosion – Gradual and irregular destruction of coating surface caused by a mechanical or also by a chemical-physical action.
.80 Explosion limits – A range of the ratio of solvent vapour to air in which the mixture will explode if ignited. Below the lower explosion limit (LEL) or above the higher explosion limit (HEL) the mixture is too lean or too rich to explode. The critical ratio runs from about one to 7 percent of solvent vapour by volume at atmospheric pressure.
.81 Extender – Inert substance, for certain characteristics similar to pigments, but without or of low hiding power, used as a paint component for technical needs or for economic reasons (filling).
.82 Feather edge – Tapered edge.
.83 Ferrous – Iron containing.
.84 Film integrity – Degree of continuity of film.
.85 Film thickness – The thickness of a coating layer or a multilayer coating system. Minimum and maximum values are the only relevant numbers when dealing with corrosion protection.
.86 Film – A layer of coating material applied on a surface. The film just applied, before evaporation of the solvents is called “wet film”; the dry paint film, after solvent evaporation, “dry film”.
.87 Fingers (airless) – Broken spray pattern, finger like.
.88 Finish – Term used to define indifferently the final coat in a paint system or the general aspect of a painted surface after drying.
.89 Flaking – Detachment of a coating from the surface, in the form of flakes.
.90 Flash off – Starting stage of drying process, during which most of the solvents evaporate from the coating.
.91 Flash Point – The lowest temperature at which a liquid gives off sufficient vapour to form an ignitable mixture with the air near the surface of the liquid.
.92 Flexibility – The degree at which a coating is able to conform to movement or deformation of it's supporting surface without cracking or flaking.
.93 Flooding-floating – Differentiated separation of pigments on a coating surface.
.94 Flow – Degree to which a wet paint film can level out after application so as to eliminate brush marks and produce a smooth uniform finish.
.95 Forced drying – Acceleration of drying by increasing the temperature above ambient temperature accommodated by forced air circulation.
.96 Galvanic corrosion – Corrosion of dissimilar metals in electrical contact.
.97 Galvanising – Anticorrosive system which consists in dipping a steel structure, into melted zinc at a temperature of approximately 450°C.
.98 Galvanized steel – Zinc plated steel applied in a molten bath of zinc.
.99 Gelling – Partial or complete transformation of a paint into a mass similar to a gelatine.
.100 General corrosion – Evenly distributed corrosion attack on steel surface.
.101 Generic – Belonging to a particular family.
.102 Glazing – Coat intentionally applied with a small thickness.
.103 Gloss – Aptitude of a surface to reflect the light in certain conditions.
.104 Grit – An abrasive obtained from slag and various other materials.
.105 Hard coating – A coating which chemically converts during its curing process, normally used for new constructions or non-convertible air drying coating which may be used for the maintenance purposes. Hard coating can be either inorganic or organic. All conventional paints are included in this definition, e.g. epoxy, polyurethane, zinc silicate, vinyl, etc.
.106 Hard rust scale – Sever general corrosion accumulated in layers adhering tightly to the steel surface.
.107 Hardener, curing agent, catalyst – Component of a two-pack paint that mixed with a binder creates a chemical reaction forming a harder and resistant film.

.108 Hardness – Resistance of a dry coating to scratching or to superficial deformation due to pressure.

.109 Hiding power – The ability of a coating material to hide, after drying, the colour of surface underneath.

.110 Hold point – A stage in the production process where the work is stopped for an inspection to take place.

.111 Holiday – Pinhole; skip; discontinuity; voids.

.112 Hot spraying – Spray application of a coating that has been heated to reduce its viscosity in special equipment.

.113 Humidity – Measure of moisture content; relative humidity is the ratio of the quantity of water vapour in the air to the greatest amount possible at the given temperature. Saturated air is said to have a humidity of 100%.

.114 Hydroxyl – Chemical radical, OH, basic nature.

.115 Hygroscopic – Having a tendency to absorb water.

.116 Immersion – Referring to an environment which is continually submerged in a liquid, often water.

.117 Impressed current – Cathodic protection system in which the current is supplied at the anode from an external source.

.118 Induction time – The period of time between mixing of two component products and the moment they can be used.

.119 Inert – Not reactive.

.120 Inhibitive pigment – One which retards a corrosion process.

.121 Inhibitor – An agent added to retard corrosion.

.122 Inorganic coating – Those employing inorganic binders or vehicles.

.123 Inorganic – Material containing primarily ionic bonds and elements other than C and H.

.124 In-situ – In *these Publication* meaning work at the final hull stage; Plate stage - to - Panel stage - to - Block stage - to - Super-block stage - to -*In-situ* stage.

.125 Inspection hold point – Point in the production process where work will stop to enable inspection to take place.

.126 Inter-coat contamination – Presence of foreign matter between successive coats.

.127 Job-specification – Detailed working procedure outlining each step in the surface preparation and coating processes, including inspection hold points, thickness ranges, etc.

.128 Lead free – Contains by weight less than 0.5% lead for industrial products and less than 0.06% lead in consumer products.

.129 Light colour – Light colour in these guidelines means a colour that reflects light to an extent that a simple flash light (hand torch) will make inspection easy and fast. Normally light grey, buff, off-white, swimming pool blue/green, etc. easily distinguishable from rust.

.130 Linings – Internal barriers; linings may be coated or sheet type.

.131 Local breakdown of coating – Various kinds of more or less concentrated or spot-wise defects in the coatings like rust penetration, blistering, flaking and cracking.

.132 Maintenance painting:

(a) repair painting; any painting after the initial paint job; in a broader sense it includes painting of items installed on maintenance,

(b) all painting except that done solely for aesthetics.

.133 Masking – Covering areas not painted.

.134 Mastic – A heavy bodied coating of high build.

.135 Material Safety Data Sheet – Document published by paint manufacturer in which components of the paints and all the safety requirements are given.

.136 Mechanical cleaning – Power tool cleaning, by means of grinding disc, wire brush or similar.

.137 Mill scale – Oxide layer formed on steel by hot rolling.

.138 Miscible – Capable of mixing or blending uniformly.

.139 Mist coat – Thin tack coat; thin adhesive coat. Common practice to wet an inorganic zinc layer, and permit air escape, before full build when top coating.

.140 Moisture vapour transmission (MVT) – Moisture vapour transmission rate through a membrane.

.141 MSDS – Material Safety Data Sheet

.142 Non-ferrous – A term used to designate metals or alloys that do not contain iron, example, brass, aluminium, magnesium, copper, etc.

.143 Oil Tanker – for the purpose of *these Publication* an Oil Tanker is a ship which is constructed primarily to carry oil in bulk and includes ship types such as combination carriers (Ore/Oil ships etc.). For other classification purposes, the definition provided in *Publication No. 36/P*[(II)] is to be used.

.144 Orange peel – Appearance similar to orange peel, that can be seen on a film applied by airless spraying due to incomplete levelling.

.145 Organic – Containing carbon.

.146 Osmosis – Transfer of liquid through a paint film or other membrane as the result of a solute/solvent couple.

.147 Osmotic blistering – Formation of blisters containing liquid through osmosis.

.148 Overall inspection – An inspection intended to report on the overall condition of the hull structure and determine the extent of additional close-up inspections.

.149 Overall survey – A survey intended to report on the overall condition of the hull structure and determine the extent of additional close-up surveys.

.150 Owner – Owner or Owners representative.

.151 Paint system – The complete number and type of coats comprising a paint job. In a broader sense, surface preparation, pre-treatments, dry film thickness, and manner of application are included in the definition of a paint system.

.152 Peeling – Disbonding of particles of a coating from substrate in the form of strips, due to loss of adhesion.

.153 Peen – To draw, bend or flatten by or as if by hammering with a peen (wedge-shaped end of the head of a hammer).

.154 Peened – As if hammered by a rounded tool or shot.

.155 Permeability – Quality or state of being permeable.

.156 pH value – Measure of acidity or alkalinity; pH 7 is neutral; the pH value of acids ranges from 1 to 7, and of alkalis (bases) from 7 to 14 in water solution.

.157 Pigments – Insoluble coloured particles dispersed in a coating material in order to define appearance, structure and functionality of the final film.

.158 Pinholes – Presence of small holes in a coating that are formed during application or drying.

.159 Pitting – Cavity in a metallic surface, due to localised corrosion.

.160 Plasticizer – A paint ingredient which imparts flexibility.

.161 Polymerization – Formation of large molecules from small ones.

.162 Pot-life – Time interval after mixing during which liquid material is usable with no difficulty.

.163 Power tool preparation – Surface preparation method carried out by mechanical tools, pneumatic or electric such as abrasive discs, wire brush, sandpaper etc.

.164 Preventive maintenance painting – Spot repair painting; touch-up or full coats of paint before rusting starts.

.165 Prime coat – First coat.

.166 Primer – General term used to define the first coat of a paint system applied to provide adhesion and/or corrosion protection.

.167 Product Data Sheet – Document published by paint manufacturer in which the characteristic of the product, the method to use, the instructions for application and storage are indicated.

.168 Profile depth – Average distance between tops of peaks and bottom of valleys on the surface.

.169 Profile-surface – Surface contour as viewed from edge.

.170 Prompt and thorough repair – A permanent repair completed at the time of survey to the satisfaction of the Surveyor, therein removing the need for the imposition of any associated condition of classification.

.171 Protective coating – Usually epoxy coating or equivalent. Other coating systems may be considered acceptable as alternatives provided that they are applied and maintained in compliance with the manufacturer's specification.

.172 Protective life, useful life – Interval of time during which a paint system protects substrate from deterioration.

.173 Recoat time – Time interval required between application of successive coats.

.174 Repainting – Repetition of a complete painting operation including surface preparation.

.175 Representative tanks – Those tanks which are expected to reflect the condition of other tanks of similar type and service and with similar corrosion protection systems. When selecting representative tanks account is to be taken of the service and repair history onboard and identifiable Critical Areas.

.176 Resin – The film former, binder.

.177 Roller application – Hand application of a coat of paint using an absorbing roller on a surface.

.178 Sacrificial anode – Anode made from less noble metal than steel in the galvanic series, (usually zinc or aluminium). When immersed, the anode protects the steel by coming into solution.

.179 Sags – Runs.

.180 Salt fog test – A cabinet designed to accelerate the corrosion process in evaluating coatings; combines 100% humidity with a 5% salt concentration at 100°F in an enclosed cabinet, as in ASTM-B117.

.181 Sandblast – Blast cleaning using sand as an abrasive.

.182 Sandpapering – Generic term identifying various methods used to smooth or in some cases to roughen a coating surface. In particular, sandpapering is a smoothing carried out with abrasive paper.

.183 Saponification – The alkaline hydrolysis of fats/oils whereby a soap is formed; typical reaction between alkyds and galvanized metals resulting in peeling or from cathodic protection.

.184 Scattered breakdown of coating – Various kinds of evenly distributed defects in the coatings like rust penetration, blistering, flaking and cracking.

.185 Semi-hard coating – Coating that, after drying, remain flexible and hard enough to be touched and walked upon without damaging them and that are not affected by water erosion during de-ballasting operations.

.186 Service life, protective life – Interval of time during which a paint system protects substrate from deterioration.

.187 Settling – Accumulation of pigments and fillers in the bottom of a paint container.

.188 Shop primer – An inexpensive, rust inhibiting primer designed to protect steel from general weathering immediately after plate fabrication and before final coating processes.

.189 Shot blasting – Blast cleaning using steel shot as the abrasive.

.190 Shrinkage – Decrease in volume on drying.

.191 Skinning – Solidification process of the superficial part of paint in the can due to oxidation, evaporation, coagulation etc.

.192 Soft coating – Defined as coatings that does not dry, but remain permanently soft.

.193 Solid content – Non-volatile part of a paint, see also solids by volume.

.194 Solids volume – Formulated percent of total paint volume occupied by non-volatile parts of the coating.

.195 Solubility – Degree to which a substance may be dissolved.

.196 Solution – A liquid in which a substance is dissolved.

.197 Solvent entrapment – The encapsulation of solvent within a cured paint film.

.198 Solvent – A liquid in which another substance may be dissolved.

.199 Solvent-Free – Paint without volatile binder (100% volume solid).
.200 Solvent-Less – Paint containing a small percentage, generally 10-15%, of volatile binder.
.201 Spaces – Separate compartments including holds and tanks.
.202 Specification – A set of instructions detailing the plan for coating of a project; a list of criteria for a coating.
.203 Spontaneous degradation – Coating degradation that is controlled and directed internally; self-acting, developing without apparent external influence, force, cause, or treatment.
.204 Spot repair – Preventative maintenance; repainting of small areas.
.205 Spot rusting – Rusting in spot without visible failure of coating.
.206 Spreading rate – Surface in square metres covered by one litre of paint at a specified thickness.
.207 Stripe coating – Painting method used before a general coat on positions (weld, back, edge, corner etc.) where it is not easy to achieve the final thickness with the simple airless spray application.
.208 Striping – Edge, weld, scallop painting prior to priming.
.209 Substantial Corrosion – An extent of corrosion such that assessment of corrosion pattern indicates wastage in excess of 75% of allowable margins, but within acceptable limits.
.210 Substrate – Surface to be painted; in this context carbon steel, stainless steel, galvanized steel and all surfaces that can affect the corrosion rate or can corrode.
.211 Surface tension – Cohesive force on liquid surface.
.212 Suspect Areas – Locations showing Substantial Corrosion and/or are considered by the Surveyor to be prone to rapid wastage.
.213 Sweat-in time – Time for a two component material to start the reaction that allows the two components to become soluble in each other; Induction time.
.214 Sweating – Condensing moisture on a substrate.
.215 Swelling – Increasing in volume.
.216 Tg (Glass transition temperature) – The temperature at which a coating is transformed from the rubbery to the glassy state.; e.g. becomes a brittle hard film; the temperature under which the coating becomes rubbery and able to deform.
.217 Thermo-Hygrometric condition – The environmental conditions that are present during surface preparation and paint application.
.218 Thermosetting – Becomes rigid under heat due to chemical cross linking and cannot be remelted.
.219 Thinners – Volatile organic liquids for reducing viscosity; diluents.
.220 Thinning ratio – Percentage of solvents to add to a paint, to make it suitable for a defined application system.
.221 Thixotropic – False-bodied; a gel which liquefies with agitation but gels again on standing.
.222 Thixotropy – Characteristic of a coating material to reach a viscosity reduction when shaken, stirred or other mechanical operations and that readily recovers its original viscosity when allowed to stand.
.223 Touch drying – Drying is the stage of film formation in which, when exercising a light pressure with the finger, no sign remains and it is not sticky.
.224 Touch-up painting – Spot repair painting usually conducted a few months after initial painting; manual painting to correct thickness deficiencies.
.225 Touch-up – Operation of repair of spot damage coated surface.
.226 Transverse Section – Includes all longitudinal members such as plating, longitudinals and girders at the deck, side, bottom, inner bottom and longitudinal bulkheads.
.227 Turn – To oxidize.
.228 Two-Pack paints – Paints stored in two separate containers and that have to be mixed in the correct proportion before application.
.229 Useful life, protective life – Interval of time during which a paint system protects substrate from deterioration.

.230 Varnish, lacquer – Non-pigmented coating material.

.231 Vehicle – The liquid portion of paint in which the pigment is dispersed. It is made up of resin and solvent.

.232 Viscosity – A measure of fluidity of a liquid.

.233 Volume solids – Non-volatile part of a coating compound, which after drying forms the coating.

.234 Walk-on-time – Time at which a coating is dried/cured enough so that it can be walked upon without being damaged.

.235 Weld joints – Beads of weld joining two members.

.236 Weld slag – Amorphous deposit formed during welding.

.237 Weld spatter, weld splatter – Beads of metal left adjoining a weld.

.238 Weld splatter, weld spatter – Beads of metal left adjoining a weld.

.239 Wet Film Thickness – The thickness of paint film just applied and before evaporation of the volatile part.

.240 Wet-on-Wet – Paint technique consisting of the application of a coat on a previous one not yet dry. The result is of one film that dries as a whole. The process requires specific paints.

.241 Wetting strength – The maximum distance or penetration the vehicle is capable of delivering the paint or coating assembly in a vertical or horizontal direction on a specific substrate.

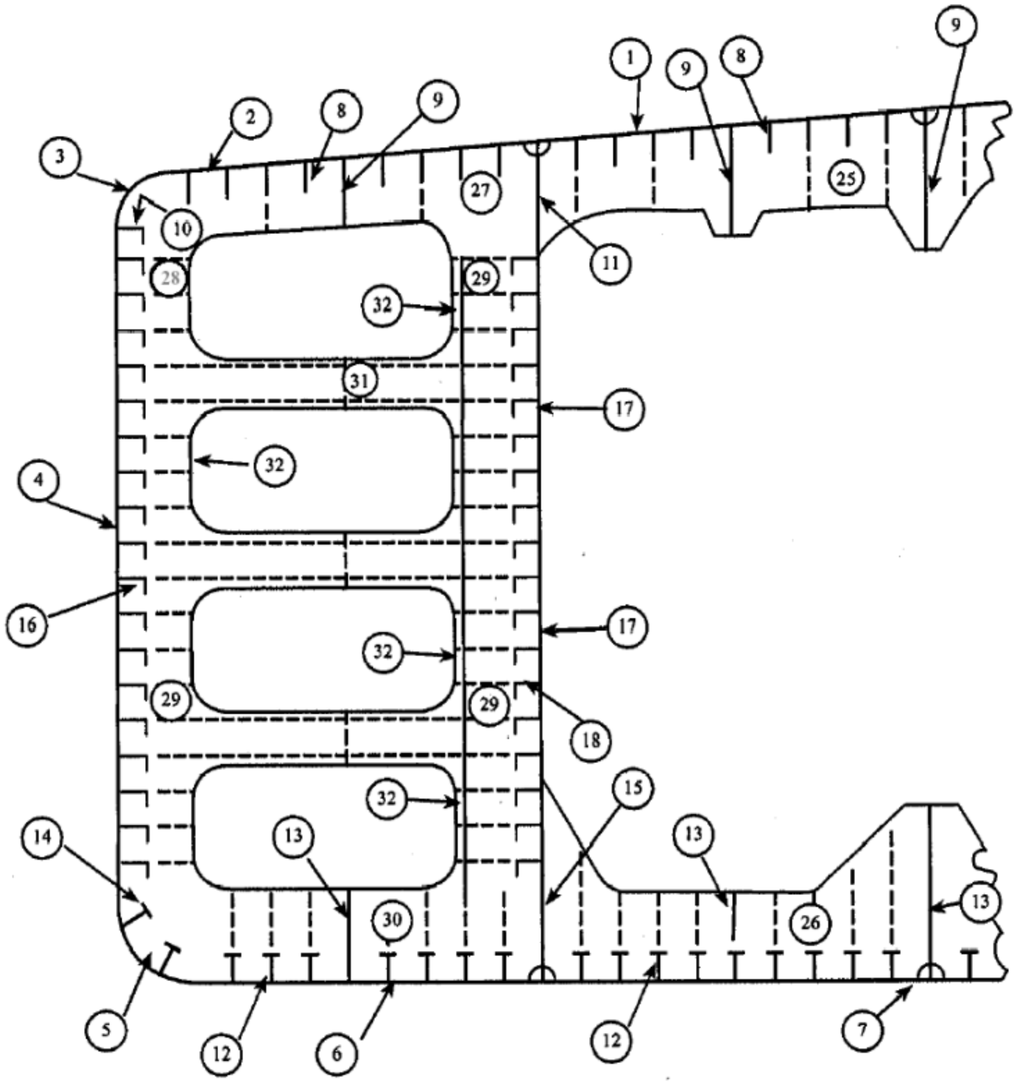
.242 Wetting time – The time required for a vehicle to reach the end point of a distance and penetration on a metal.

.243 Wrinkling – Coating defect due to a non-homogeneous solidification of the paint film with wrinkling of the surface coat.

.244 Zinc rich coating – Products containing > 86% (by weight) metallic zinc in the dry film.

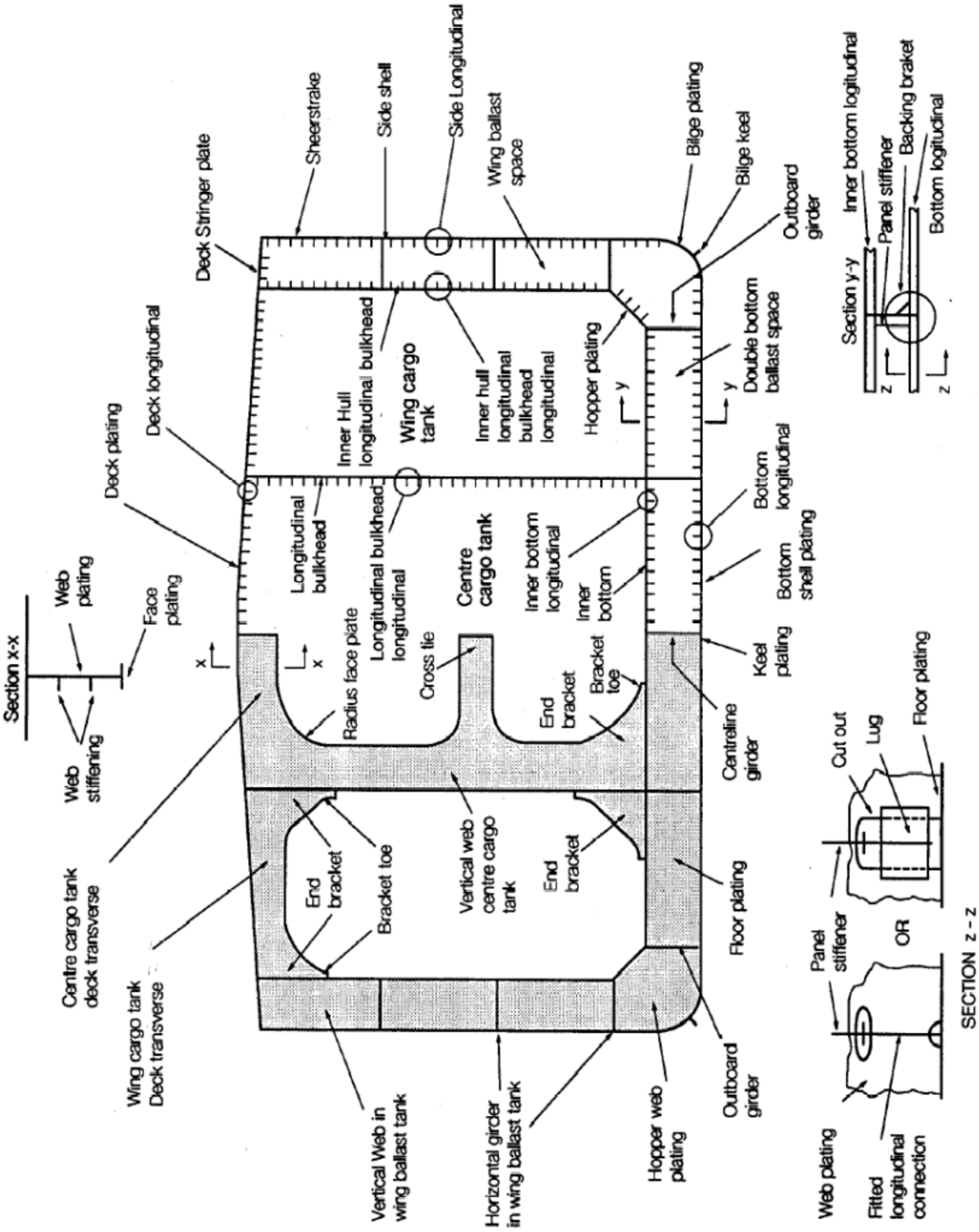
.245 Zinc silicate – Inorganic zinc coating.

.246 Typical nomenclature for single hull – Typical transverse section of single hull tanker



1	Strength deck plating	14	Bilge longitudinals
2	Stringer plate	15	Longitudinal bulkhead lower strake
3	Sheer strake	16	Side shell longitudinals
4	Side shell plating	17	Longitudinal bulkhead plating
5	Bilge plating	18	Longitudinal bulkhead longitudinals
6	Bottom shell plating	25	Deck transverse centre tank
7	Keel plate	26	Bottom transverse centre tank
8	Deck longitudinals	27	Deck transverse wing tank
9	Deck girders	28	Side shell vertical web
10	Sheer strake longitudinal	29	Longitudinal bulkhead vertical web
11	Longitudinal bulkhead top strake	30	Bottom transverse wing tank
12	Bottom longitudinals	31	Cross ties
13	Bottom girders	32	Transverse web face plate

.247 Typical nomenclature for double hull – Typical transverse section of double hull tanker



6 PERTINENT STANDARD

Standard	Subject	Standard	Subject
ASTM 56	flash-point	BS 2634	surface roughness comparator
ASTM 711	drying times of coatings	BS 2691	thickness measurements
ASTM 1005	thickness measurements	BS 3900 part C5	thickness measurements
ASTM 1259	binder/pigment/volatile/solids content	BS 3900 part C5	wet film thickness
		BS 3900 Part E4	elongation, cupping of coated plates (Erichsen test)
ASTM 1310	flash-point		
ASTM 1640	drying times of coatings	BS 3900 Part E1	elongation, bending over mandrel
ASTM 1953	drying times of coatings	BS 3900 Part E3	impact resistance
ASTM 2240	hardness	BS 3900 Part E7	impact resistance

Standard	Subject
ASTM 262	binder/pigment/volatile/solids content
ASTM 2832	binder/pigment/volatile/solids content
ASTM 3278	fiash-point
ASTM D93	fiash-point
ASTM D522	elongation, bending over mandrel
ASTM D610	degree rusting
ASTM D658	abrasion resistance
ASTM D659	degree chalking
ASTM D660	degree checking
ASTM D661	degree cracking
ASTM D662	degree erosion
ASTM D714	degree blistering
ASTM D772	degree flaking
ASTM D821	abrasion resistance
ASTM D968	abrasion resistance
ASTM D1141	synthetic seawater
ASTM D1186	dry thickness, ferrous
ASTM D1200	viscosity
ASTM D1212	wet thickness reading
ASTM D1397	abrasion resistance
ASTM D1400	dry thickness, non-ferrous
ASTM D1653	water vapor transmission
ASTM D1737	elongation, bending
ASTM D2134	hardness
ASTM D2197	adhesion, scrape test
ASTM D2370	tensile elongation, free film
ASTM D2485	heat resistance testing
ASTM D2485	resistance to high temperature
ASTM D2697	binder/pigment/volatile/solids content
ASTM D2794	impact resistance
ASTM D3732	drying times of coatings
ASTM G8	cathodic disbondment
ASTM G14	impact resistance
ASTM G53	cyclic test
ASTM MD570	water absorption of plastics and free coating films over mandrel
ASTM MD3258	porosity of films
ASTM MD3276	guidance for inspectors
ASTM MD3359	adhesion by tape test
ASTM MD3363	hardness by pencil test
ASTM ME376	eddy current gauge
ISO 8503-1	roughness definition
ISO 8503-2	roughness comparator
ISO 8503-3	roughness, Fucus microscope
ISO 8503-4	roughness, Stylus instrument
NACE No.7	water jetting/blasting standards
NACE TM 170-70	degrees of surface preparation
NACE RP0178	weld and steel standards
NACE RP0274	holiday/pinhole detection
SIS 055900	degrees of surface preparation
SIS 162201	hardness

Standard	Subject
BS 3900 Part G7	heat resistance testing
BS 4164	hardness
BS 4164	heat resistance testing
BS 4232	degrees of surface preparation
BS 4692	heat resistance testing
BS 5493	wet film thickness
BS 6374	holiday / pinhole detection
DIN 1342	viscosity
DIN 2691	thickness measurements
DIN 51550	viscosity
DIN 51755	flash-point
DIN 51758	flash-point
DIN 53156	elongation, cupping of coated plates (Erichsen test)
DIN 53177	viscosity
DIN 53213	flash-point
DIN 55928	degrees of surface preparation
ISO 1517	drying times of coatings
ISO 2808	thickness measurements
ISO 2812-2	immersion/freeze/dry test
ISO 3233	binder/pigment/volatile/solids content
ISO 4828-4	paint and varnishes-evaluation of degradation of paint coatings
ISO 6270	condense chamber test
ISO 7253	salt spray testing
ISO 8501-1	surface preparation
ISO 8501-3	steel surface imperfections
ISO 8502-1	soluble iron
ISO 8501-3	steel preparation
ISO 8502-2	labtest – chlorides
ISO 8502-3	dust assessment
ISO 8502-4	condensation probability
ISO 8502-6	field extraction – chlorides
ISO 8502-9	field conductimetric determination of water soluble salts
ISO 8503-1	surface roughness spec.
ISO 8503-2	surface roughness comparator
ISO 8503-3	surface roughness microsc.
ISO 8503-4	surface profile, Stylus instrument
ISO 8504-1	surface preparation methods
ISO 8504-2	abrasive blast cleaning
ISO 8504-3	power & hand tool cleaning
ISO 8502-10	titrimetric determination of water soluble salts
SIS 184153	drying times of coatings
SIS 184160	thickness measurements
SSPC PA2	thickness gauge calibration
SSPC SP 1	substrate degreasing
SSPC VIS 1	degrees of surface preparation, blasted steel
SSPC VIS 3	degrees of surface preparation, power tooled steel
SSPC-VIS4(1)	water jetting/blasting standards

7 TABLES COMPARING COMMONLY USED STANDARDS

Table 13
Comparison of blasting standards

Standard	Highest degree = white metal	Good degree = near white metal
ISO 8501-1	Sa 3	Sa 2 ½
SIS 055900	Sa 3	Sa 2 ½
DIN 55928	Sa 3	Sa 2 ½
BS 4232	First Quality	Second Quality
NACE TM170-70	No. 1	No. 2
SSPC	SP 5	SP 10

Table 14
Comparison of power tool standards

Standard	Highest degree	High degree	Lower degree
ISO 8501-1	NA	St 3	St 2
SIS 055900	NA	St 3	St 2
DIN 55928	NA	St 3	St 2
SSPC	SP 11	SP 3	SP 2

Table 15
Correlation between ISO and ASTM rating systems for blisters

Density		Size	
ASTM	ISO	ASTM	ISO
None	0		
(less than few)	1	(smaller than 8)	1
Few	2	8	2
Medium	3	6	3
Medium – Dense	4	4	4
Dense	5	2	5

Table 16
Correlation between ISO and European rust scales

ISO rust scale	European rust scale
Ri 0	Re 0
Ri 1	Re 1
Ri 2	Re 2
Ri 3	Re 3
Ri 4	Re 5
Ri 5	Re 7

Table 17
Approximate correlation between ISO and ASTM rust scales

ISO rust scale	ASTM rust scale
Ri 0	10
Ri 1	9
Ri 2	7
Ri 3	6
Ri 4	4
Ri 5	1 to 2

8 EXAMPLES OF ASSESSMENT OF COATING CONDITIONS

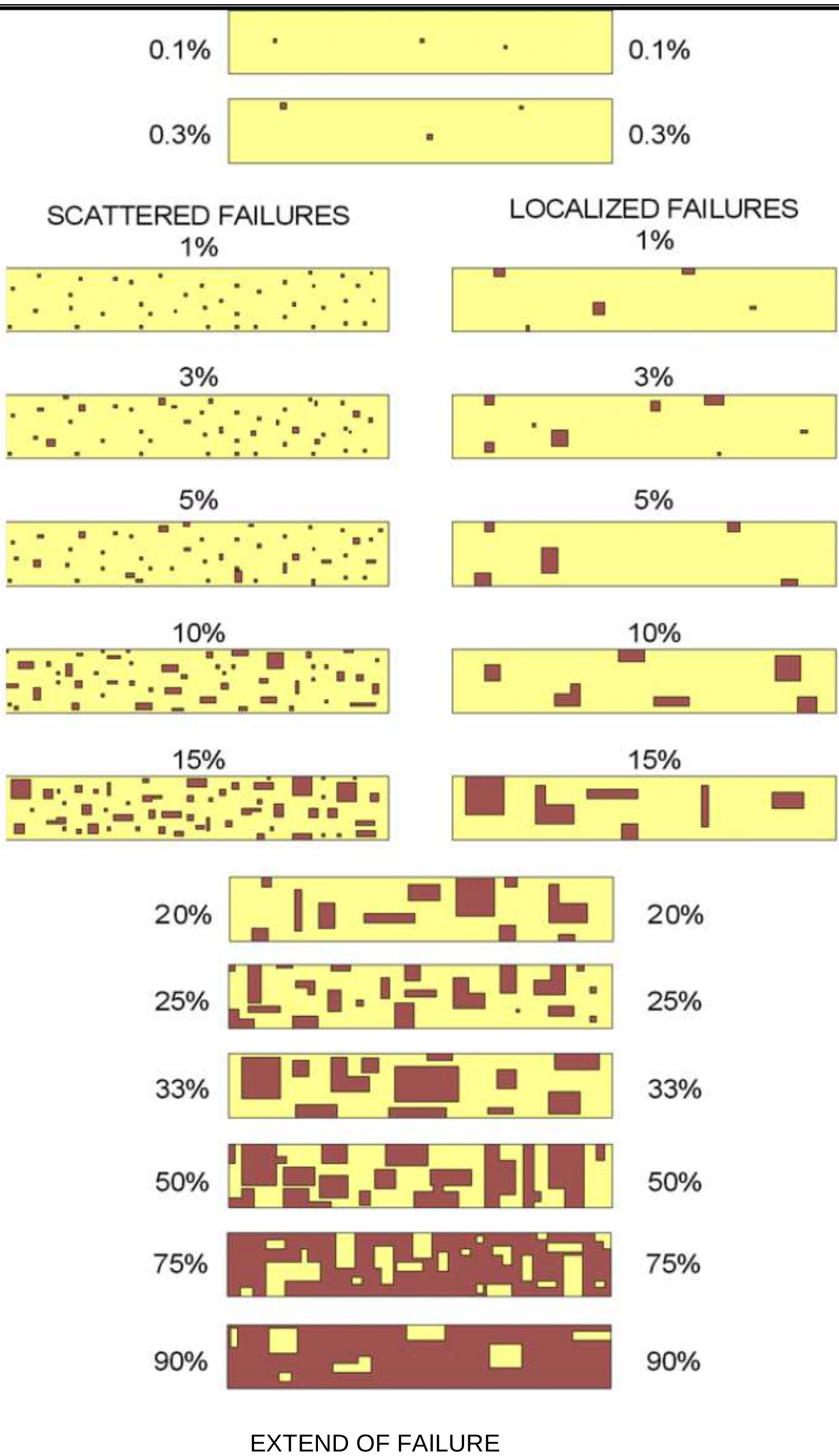
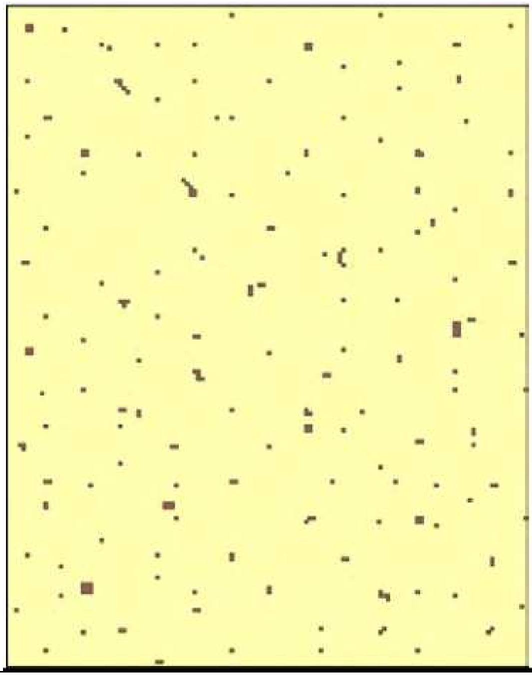


Figure 14. Assessment scale for breakdown

Notes: Condition: **GOOD**
spot rusting: scattered 1%
spot rusting on edges or weld lines: localised less than 5%

Assessment scale:



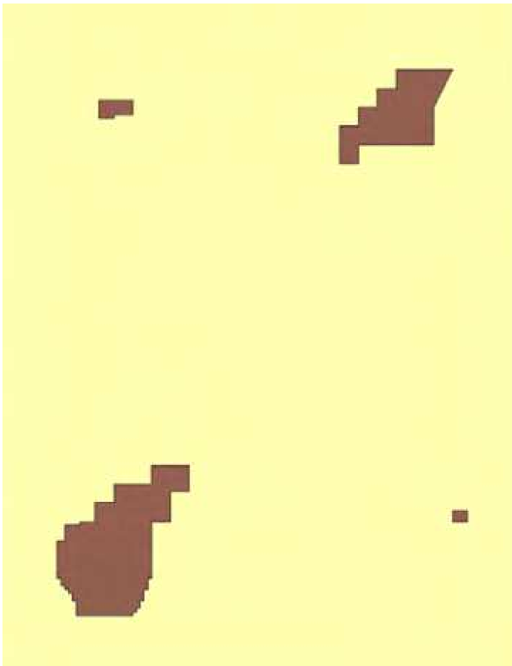
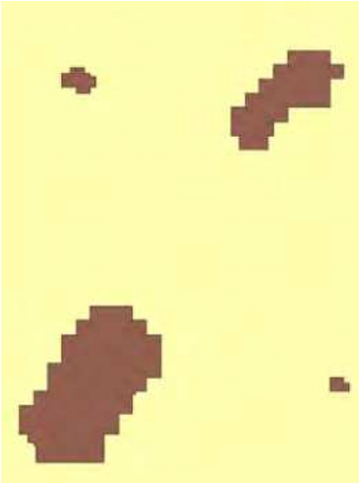


Figure 15. Coating condition evaluation

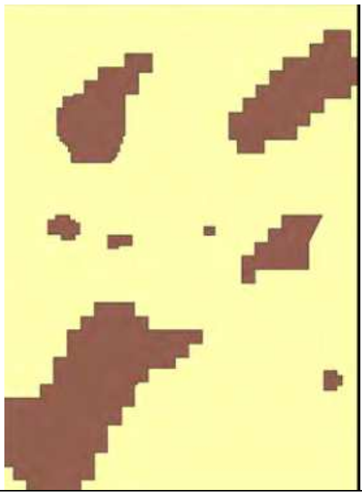
Notes: Condition: **FAIR**
Breakdown of coating/area rusted: localised 15-20%
Area of hard rust scale: less than 10% of the area rusted
Local breakdown of coating or rust on edges or weld lines: 30-40%
Remarks: FAIR for longitudinal close to bottom; remaining surface **GOOD**

Assessment scale:

10%
LOCALIZED CORROSION



20%
CORROSION



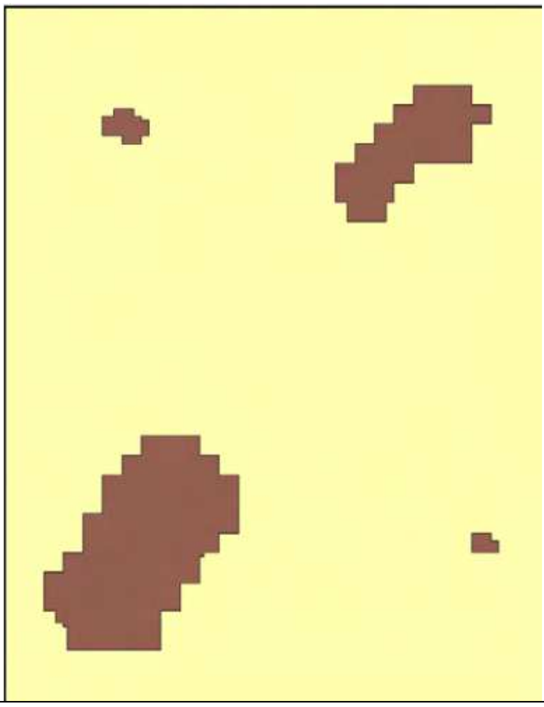
33%
CORROSION

Figure 15. Coating condition evaluation

Notes: Condition: **POOR**
Breakdown of coating/area rusted: approx. 30%
Area of hard rust scale: more than 10% of the area rusted
Local breakdown of coating or rust on edges or weld lines: 30-40%

Assessment scale:

10%
LOCALIZED CORROSION



33%
CORROSION

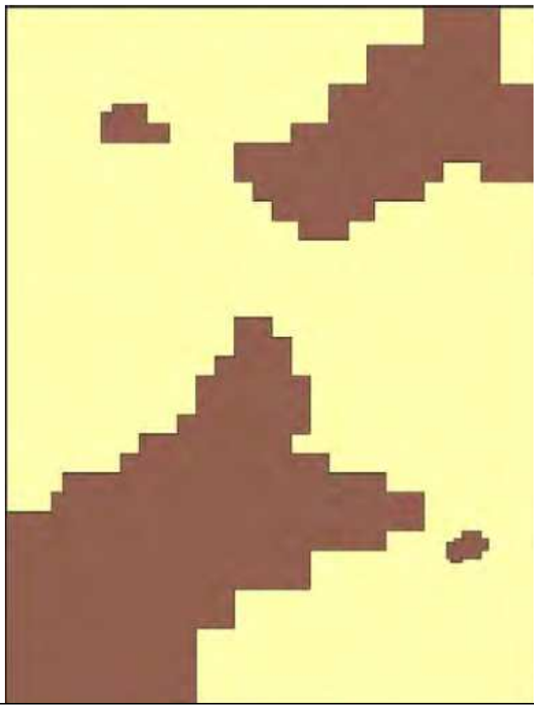


Figure 16. Coating condition evaluation

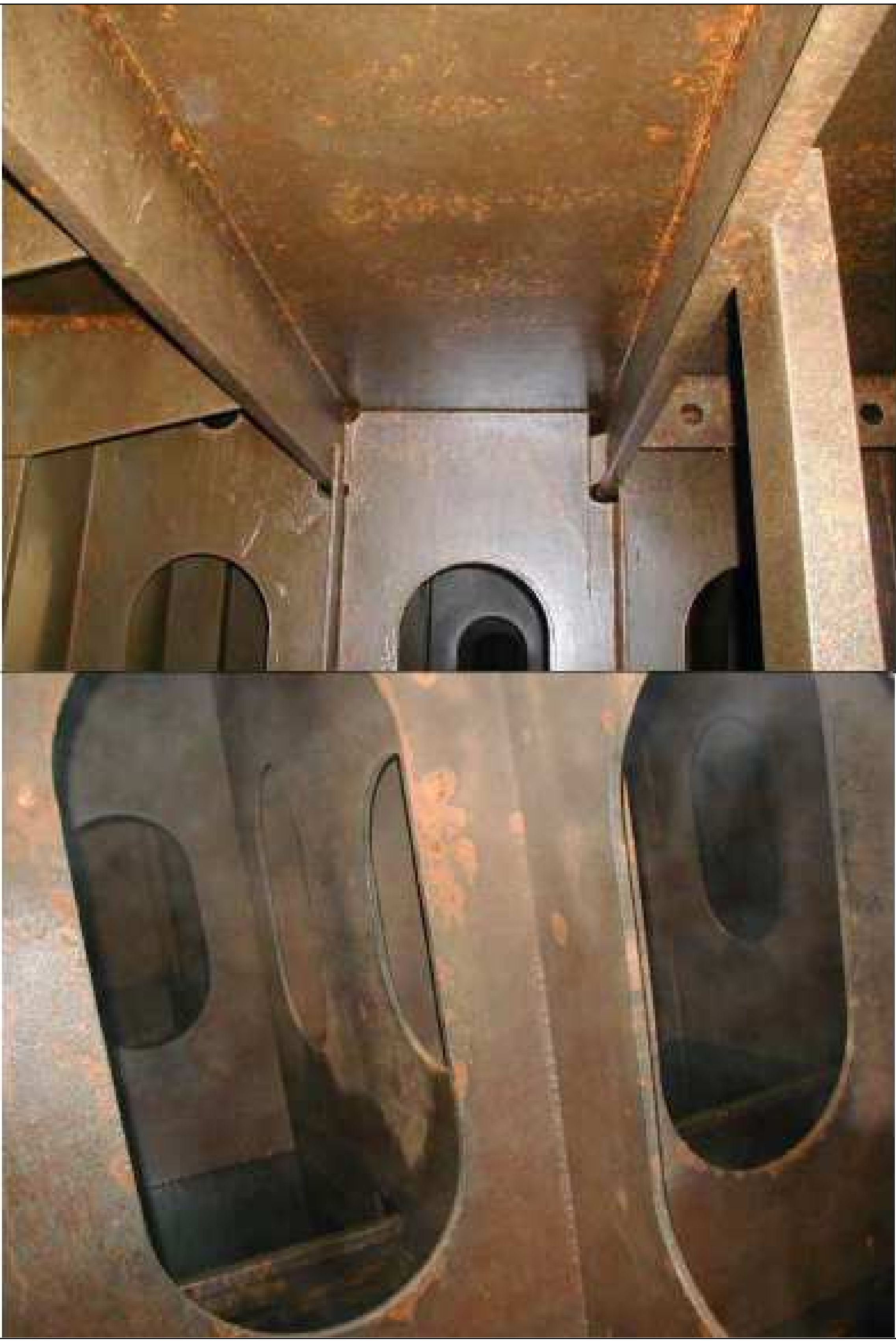
9 LIBRARY OF PICTURES

GOOD COATING CONDITION

GOOD COATING CONDITION

GOOD COATING CONDITION

GOOD COATING CONDITION



GOOD COATING CONDITION

TRANSITION GOOD TO FAIR COATING CONDITION: THIS IS A GOOD CONDITION


FAIR COATING CONDITION

FAIR COATING CONDITION

FAIR COATING CONDITION

FAIR COATING CONDITION

FAIR COATING CONDITION

TRANSITION FAIR TO POOR COATING CONDITION:
THIS IS A FAIR CONDITION

TRANSITION FAIR TO POOR COATING CONDITION:
THIS IS A FAIR CONDITION

TRANSITION FAIR TO POOR COATING CONDITION: THIS IS A FAIR CONDITION

TRANSITION FAIR TO POOR COATING CONDITION: THIS IS A FAIR CONDITION


TRANSITION FAIR TO POOR COATING CONDITION:
THIS IS A POOR CONDITION

TRANSITION FAIR TO POOR COATING CONDITION:
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TRANSITION FAIR TO POOR COATING CONDITION: THIS IS A POOR CONDITION

TRANSITION FAIR TO POOR COATING CONDITION: THIS IS A POOR CONDITION


POOR COATING CONDITION

POOR COATING CONDITION

POOR COATING CONDITION

POOR COATING CONDITION

POOR COATING CONDITION

10 EXAMPLES OF HOW TO REPORT COATING CONDITIONS WITH RESPECT TO AREAS UNDER CONSIDERATION

10.1 The example below illustrates how the surveyors may report coating condition in the Executive Hull Summary, table 3 and table 4 indicated in paragraph 3.2.4.of *these Publication*.

10.1.1 Example 1: **Single Hull Tanker**

No. 3 Wing Ballast Tank (P)				Tank Protection[a)]	**C**
Structure[b)]	**Coating Condition**[c)]			**Remarks**[d)]	
	Areas under consideration				
	Upper	Middle	Lower		
Fore Transverse Bulkhead	**F**	**G**	**G**		
Aft Transverse Bulkhead	**F**	**G**	**G**		
Side Shell	**F**	**F**	**F**		
Longitudinal Bulkhead	**F**	**G**	**G**		
Deck	**F**				
Bottom	**F**				
OVERALL TANK RATING	**FAIR**			To be examined at next annual survey	

Notes:
a) **C:** Coating, **A**: Anodes, **NP**: No protection
b) The structure includes plating and attached structural members
c) **G**: Good, **F**: Fair and **P**: Poor in accordance with table 2, indicated in paragraph 2.1.2
d) Other than **Good** condition, locations and structure members are to be reported.
For instance, a case of **Fair** condition: "Fair coating member: upper deck plating Fr No. 45 to Fr No. 85"

10.1.2 Example 2: **Double Hull Tanker**

No. 1 Double Bottom Tank			Tank Protection[a)]	**C, A**
Structure[b)]	**Coating Condition**[c)]		**Remarks**[d)]	
	Areas under consideration			
	Lower	Upper		
Double Bottom Tank	**P**	**F**		
OVERALL TANK RATING	**POOR**		To be examined at next annual survey	

No. 1 Double Hull Side Tank Port				Tank Protection[a)]	**C, A**
Double Hull Side Tank	Areas under consideration			**Remarks**[d)]	
	Upper	Middle	Lower		
Fore Transverse Bulkhead	**F**	**G**	**G**		
Aft Transverse Bulkhead	**F**	**G**	**G**		
Side Shell	**F**	**F**	**F**		
Longitudinal Bulkhead	**G**	**G**	**G**		
Deck	**G**				
Bottom	**G**				
OVERALL TANK RATING	**FAIR**			To be examined at next annual survey	

Notes:
a) **C:** Coating, **A**: Anodes, **NP**: No protection.
b) The structure includes plating and attached structural members.
c) **G**: Good, **F**: Fair and **P**: Poor in accordance with table 2, indicated in paragraph 2.1.2.

d) Other than **Good** condition, locations and structure members are to be reported.
For instance, a case of **Fair** condition: "Fair coating member: upper deck plating Fr No. 45 to Fr No. 85"

10.1.3 Example 3: **Fore Peak Tank**

Fore Peak				Tank Protection[a)]	**C**
Structure[b)]	**Coating Condition**[c)]			**Remarks**[d)]	
	Areas under consideration				
	Upper	Middle	Lower		
Fore Peak Tank	**G**	**G**	**P**		
OVERALL TANK RATING	**POOR**			To be examined at next annual survey	

Notes:
a) **C:** Coating, **A**: Anodes, **NP**: No protection
b) The structure includes plating and attached structural members
c) **G**: Good, **F**: Fair and **P**: Poor in accordance with table 2, indicated in paragraph 2.1.2
d) Other than **Good** condition, locations and structure members are to be reported.
For instance, a case of **Fair** condition: "Fair coating member: upper deck plating Fr No. 45 to Fr No. 85"

List of amendments effective as of 1 February 2017

Item	*Title/Subject*	*Source*
all items	All chapters replaced with new text.	IACS Rec. 87, Rev.2 May 2015
