GUIDANCE NOTES ON

MAINTENANCE AND REPAIR OF PROTECTIVE COATINGS

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Foreword

A protective coating is the most efficient way to preserve steel structural strength. However, coatings will deteriorate over time during service. In order to maximize service life with reduced life-cycle cost, it is critical to maintain and repair the coating at an early stage, before accelerated corrosion due to coating deterioration occurs. It is a regulatory requirement for ships to comply with the IMO Performance Standards of Protective Coatings (IMO PSPC) for the goal, as a minimum, of 15 years of useful coating life in "GOOD" condition. These Guidance Notes provide guidelines of coating maintenance and restoration of ballast tanks and cargo oil tanks in order to reach the PSPC goal as a minimum.

IMO Performance Standards of Protective Coatings (IMO resolutions MSC.215(82) and MSC.288(87), hereinafter referred to as "IMO PSPC") set out coating standards for new construction of seawater ballast tanks and crude oil tanks. The coatings applied in accordance with those PSPC standards are expected to have a target useful coating life of 15 years, over which time the coating system is intended to remain in "GOOD" condition. However, the actual useful life will vary, depending on numerous variables including actual conditions encountered in service.

The existing ABS *Guidance Notes on the Application and Inspection of Marine Coating Systems* published in January 2017 were developed to help the shipyard's implementation of adopted IMO PSPCs for dedicated seawater ballast tanks and crude oil tanks during new constructions. These newly developed ABS *Guidance Notes on Maintenance and Repair of Protective Coatings* cover recommendations on maintenance and repairs of the PSPC coatings in service, which help the ABS Surveyors, the shipyards, and ship operators assess the coating in-service maintenance and repairs. ABS Nautical Systems has been integrated with ship's Hull Manager to assist ship operators to assess and monitor the in-service coating conditions to meet the requirement of the ABS **HIMP** Notation issued. This guidance is in line with Hull Manager of ABS Nautical Systems.

The purpose of these Guidance Notes is to assist Surveyors, shipowners, ship managers, shipyards, flag Administrations, and other interested parties in maintaining the PSPC-related certification for compliance with PSPCs in relation to coating condition assessment, maintenance, and repair of protective coatings of seawater ballast tanks and crude oil cargo tanks.

These Guidance Notes become effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of these Guidance Notes is the most current.

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GUIDANCE NOTES ON

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CONTENTS

SECTION 1 General

1 Background

Two coating performance standards for protective coatings (PSPC) have been mandated from SOLAS regulations II-1/3-2 & 3.11 for dedicated seawater ballast tanks (IMO resolution MSC.215(82)) and cargo oil tanks of crude oil tankers (IMO resolution MSC.288(87)). Those IMO resolutions set PSPCs as new construction requirements of ships. The coatings applied in accordance with those PSPC standards have a target useful coating life of 15 years, over which time the coating system is intended to remain in "GOOD" condition. However, the actual useful life will vary, depending on the ability of the coating system to reach its target useful life of 15 years, which depends on numerous variables including the type of coating system selected, the design of the structures, coating application, coating in-service maintenance, and actual conditions encountered in service. All these aspects contribute to the performance of the coating system.

A protective coating is the most efficient way to protect steels and preserve structural strength. However, the coating can deteriorate over time during service. In order to maximize service life with reduced life-cycle cost, it is critical to maintain and repair the coating at an early stage, before accelerated corrosion due to coating deterioration occurs. It is also important for the coatings to comply with the IMO Performance Standards of Protective Coatings (IMO PSPC) for the goal, as a minimum, of 15 years of useful coating life in "GOOD" condition. These Guidance Notes provide guidelines of coating maintenance and restoration of ballast tanks and cargo oil tanks in order to reach the PSPC goal.

These Guidance Notes have been developed based on IMO recommendations from MSC.1/Circ.1330, MSC.1/Circ.1399, and the best information currently available. Consideration has been taken that maintenance may take place when the vessel is at sea, while repair usually takes place in dry dock or during scheduled repair periods (afloat at yard).

The ABS *Guidance Notes on the Application and Inspection of Marine Coating Systems* published in January 2017 were developed to help the shipyard's implementation of adopted IMO PSPCs for dedicated seawater ballast tanks and crude oil tanks during new constructions. These *Guidance Notes on Maintenance and Repair of Protective Coatings* cover recommendations on maintenance and repairs of the PSPC coatings in service.

These Guidance Notes assist in assessing coating conditions, which are reflected in ABS Nautical Systems Hull Manager to aid ship operators to assess and monitor in-service coating conditions of tanks for compliance with the ABS **HIMP** Notation. These Guidance Notes focus on the tank's coating maintenance and restoration, and provide updated information for ABS Nautical Systems Hull Manager.

3 Scope and Application

These Guidance Notes address maintenance and repair procedures for PSPC coatings of seawater ballast tanks and crude oil cargo tanks. Corrosion prevention systems other than coatings are not covered by these Guidance Notes.

Maintenance and repair of the protective coating system should be included in the vessel's overall maintenance and repair scheme and should be recorded in the Coating Technical File (CTF) as per IMO resolutions MSC.215(82) and MSC.288(87). The effectiveness of the protective coating system, which may include the use of anodes, should be monitored by the Administration or an organization recognized by the Administration during the life of a vessel.

SECTION 2 Definitions

1 Maintenance

Maintenance means minor coating restoration work regularly performed by a vessel's crew using normal shipboard means and tools to maintain "GOOD" or "FAIR" coating conditions. Maintenance delays or slows down the coating deterioration and effects short-term steel protection.

3 Repair

Repair means coating restoration work of a longer-term nature, usually performed during a vessel's drydocking or scheduled repair period (ship idle) to restore the "FAIR" or "POOR" coating condition to "GOOD" condition. This will usually require specialized shipyard arrangement and preparation, manpower, and equipment such as staging, blasting equipment, operators, and ventilation/dehumidifiers for surface preparation and coating application.

5 Coating Conditions

The condition of the coating is assigned and categorized as "GOOD", "FAIR", or "POOR", based on visual inspection and estimated percentage of areas with coating failures and rusty. Refer to IMO resolution A.744(18) and IACS Recommendation 87 for the coating condition definitions, photographs, and uniform/ localized assessment scales. The coating condition definitions from IMO MSC.1/Circ.1330 and IMO MSC.1/Circ.1399 are in line with those from IACS Recommendation No. 87.

- **GOOD:** Spot rusting without visible failures of the coating is be less than 3% of the area under consideration. Rusting at edges or welds is less than 20% of edges or weld lines in the area under consideration.
- **FAIR:** Breakdown of coating or rust penetration is less than 20% of the area under consideration. Hard rust scale is less than 10% of the area under consideration. Rusting at edges or welds is less than 50% of edges or weld lines in the area under consideration.
- **POOR:** Breakdown of coating or rust penetration is equal to or more than 20% or hard rust scale is equal to or more than 10% of the area under consideration or local breakdown concentrated at edges or welds is equal to or more than 50% of edges or weld lines in the area under consideration.

Section 2, Table 1 summarizes the coating conditions. Section 2, Table 2 provides ABS inspection grading criteria of coating conditions for the ABS Hull Inspection and Maintenance Program (HIMP).

TABLE 1
"GOOD", "FAIR", and "POOR" Coating Conditions

Considered Area	*Coating Condition*		
	GOOD	*FAIR*	*POOR*
Area under consideration (1)	Spot rusting without visible coating failures is < 3% of the area.	Breakdown of coating or rust penetration is ≥ 3% but < 20% of the area. Hard rust scale is < 10% of the area.	Breakdown of coating or rust penetration is ≥ 20% of the area. Hard rust scale is ≥ 10% of the area.
Edges/welds (2)	Rusting in the area is < 20% of edges or weld lines.	Rusting in the area is ≥ 20% but < 50% of edges or weld lines.	Rusting in the area is > 50% of edges or weld lines

Notes:

1 % is the percentage calculated on basis of the area under consideration or of the "critical structural area". Spot rusting is rusting in spots without visible failure of coating.

2 % is the percentage calculated on basis of edges or weld lines in the area under consideration or of the "critical structural area".

TABLE 2
Inspection Grading Criteria for the ABS Hull Inspection and Maintenance Program (HIMP)

Regulations	*ABS HIMP Program*			
Coating Condition	*Grading Point*	*Condition Description*	*Risk Level*	*Color Code*
Good	0	Excellent coating with negligible indication of coating failure	Very Low	
	1	Minor spot rusting	Low	
	2	• Spot rusting without visible coating failure is < 3% of the area under consideration. • Rusting is < 20% of edges or weld lines.	Low – Medium	
Fair	3	• Breakdown of coating or rust penetration is ≥ 3% but < 10% of the area. • Hard rust scale is < 5% of the area. • Rusting in the area is ≥ 20% but < 35% of edges or weld lines.	Medium	
	4	• Breakdown of coating or rust penetration is ≥ 10% but < 20% of the area. • Hard rust scale is ≥ 5% but < 10% of the area. • Rusting in the area is >35% but < 50% of edges or weld lines.	Medium – High	
Poor	5	• Breakdown of coating or rust penetration is ≥ 20% but < 30% of the area. • Hard rust scale is ≥ 10% but < 20% of the area. • Rusting in the area is ≥ 50% but < 75% of edges or weld lines.	High	
	6	• Breakdown of coating or rust penetration is ≥ 30% of the area. • Hard rust scale is ≥ 20% of the area. • Rusting in the area is ≥ 75% of edges or weld lines.	Very High	

7 Areas under Consideration and Critical Structural Areas

Areas under consideration are areas subdivided into sections small enough to be readily examined and evaluated by the Surveyor. However, the areas subdivided should not be so small as to be structurally insignificant or too numerous to report on practically. The coating condition in each area should be reported using current practice and terminology (frame numbers, longitudinal numbers and/or strakes numbers, etc.). See Section 3 for details.

Critical structural areas, per SOLAS Ch. II-1 Part A-1/Reg. 3-6/4.2, are defined as “locations which have been identified from calculations to require monitoring (might be found in the Coating Technical File (CTF) from new building stage), 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”. See Subsection 3/9 for details.

SECTION 3 Areas under Consideration

1 General

Recognizing that different areas in the tank experience different corrosion and erosion environments and thus different rates of coating breakdown, areas under consideration should be areas subdivided into sections small enough to be readily examined and evaluated by the Surveyor. However, the areas subdivided should not be so small as to be structurally insignificant or too numerous to practically report on. The coating condition in each area should be reported using current practice and terminology (frame numbers, longitudinal numbers and/or strakes numbers, etc.). Each area is then rated "GOOD", "FAIR", or "POOR" and the tank rating should not be higher than the rating of its "area under consideration" or its "critical structural areas" having the lowest rating. Examples of coating conditions with respect to areas under consideration of ballast tanks are given in IACS Recommendation 87, appendix I.

Special attention should be given to coatings in "critical structural areas" sensitive to cracking, buckling, corrosion, or erosion. "Critical structural areas", per SOLAS Ch. II-1 Part A-1/Reg. 3-6/4.2, 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". Each critical structural area is also rated "GOOD", "FAIR", or "POOR".

The specific details of the coated areas in each tank can be found from the CTF.

3 Coated Areas of Crude Oil Cargo Tanks in Oil Tankers

3.1 Minimum Areas Coated

The following are the minimum areas to be coated, as defined in IMO Resolution MSC.288(87). See Section 3, Figure 1, below.

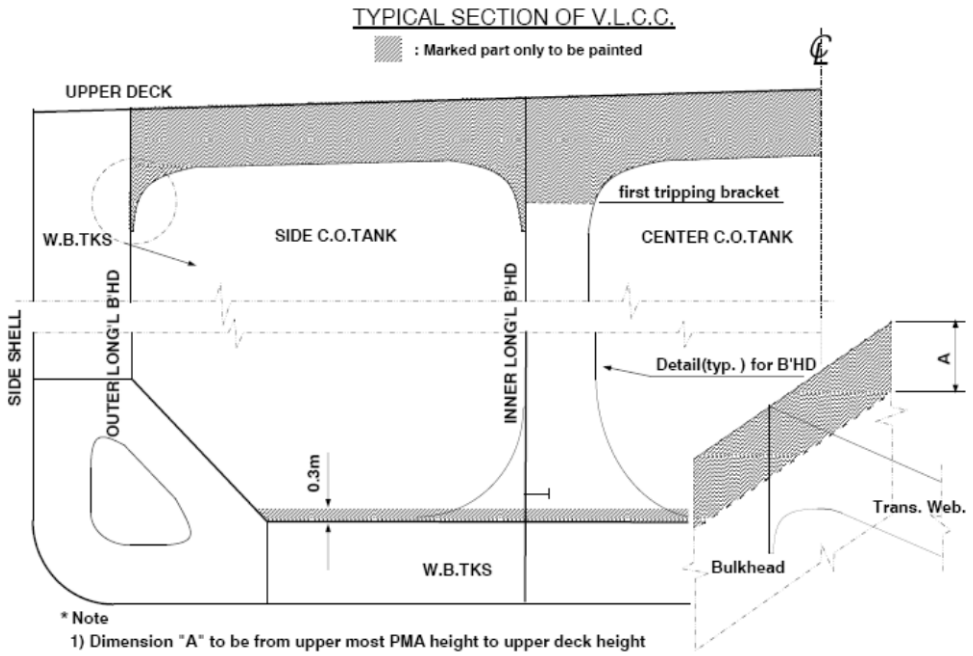
i) Deckhead with complete internal structure, including brackets connecting to longitudinal and transverse bulkheads. In tanks with ring frame girder construction, the underdeck transverse framing should be coated down to the level of the first tripping bracket below the upper faceplate.

ii) Longitudinal and transverse bulkheads should be coated to the uppermost means of access level. The uppermost means of access and its supporting brackets should be fully coated.

iii) On cargo tank bulkheads without an uppermost means of access, the coating should extend to 10% of the tank's height at centerline, but need not extend more than 3 m (10 ft) down from the deck.

iv) Flat inner bottom and all structure to height of 0.3 m (1 ft) above inner bottom should be coated.

FIGURE 1
Minimum Coated Areas of Typical VLCC Tanks



3.3 Deck Head with Upper Transverses and Longitudinal Bulkheads

Areas of under deck and bulkhead plating with attached structure in the upper coated areas are considered. One (1) area is for the deck head. One (1) area is for each longitudinal bulkhead upper part with any attached structure and access platforms or stringers. A total of three (3) areas are for the deck head. Transverse bulkhead upper parts are considered in 3/3.7 below.

3.5 Bottom Plating with Lower Transverse and Longitudinal Bulkheads

Areas of the tank bottom and transverse and longitudinal lower bulkheads (including hoppers) with attached structure (if any) in the lower coated areas are considered. A total of one (1) area is for the tank lower parts.

3.7 Transverse Bulkheads (Upper Forward and Aft)

Areas of transverse bulkheads and attached stiffeners and access outfittings in upper forward and aft transverse bulkheads are considered. A total of two (2) areas are for upper parts of transverse bulkheads.

3.9 Swash Bulkheads

The upper and lower parts of all swash bulkheads located in cargo tanks, together with any frames, brackets, and access outfittings in way are considered. A total of two (2) areas are for swash bulkheads.

3.11 Stringers

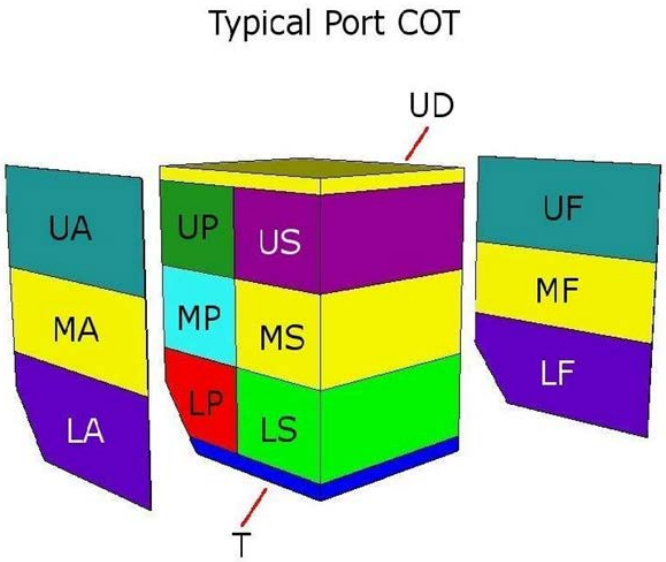
Stringers located outside the prescribed upper and lower coating areas (see Section 3, Figure 1) are not required to be coated. However, in the case that shipowners have voluntarily coated the upper surfaces of such stringers, these coated surfaces should be included in reports solely for the shipowner's benefit and choice of any action.

5 Coated Areas of Ballast Tanks in Oil Tankers

5.1 Typical Zones

The compartment is typically split into 14 zones. See Section 3, Figure 2.

FIGURE 2
Typical Zones for a Tank



Zone 1:	Under deck (UD)	Zone 8:	Upper aft (UA)
Zone 2:	Bottom (T)	Zone 9:	Lower port (LP)
Zone 3:	Lower forward (LF)	Zone 10:	Lower starboard (LS)
Zone 4:	Lower aft (LA)	Zone 11:	Middle port (MP)
Zone 5:	Middle forward (MF)	Zone 12:	Middle starboard (MS)
Zone 6:	Middle aft (MA)	Zone 13:	Upper port (UP)
Zone 7:	Upper forward (UF)	Zone 14:	Upper starboard (US)

5.3 Single Hull Tanker – Wing Ballast Tanks

5.3.1 Deck and Bottom

Areas of deck and bottom plating with attached structure are considered. One (1) area is for the deck and one (1) area is for the bottom. A total of two (2) areas are considered here. See Areas 1 and 2 illustrated in Section 3, Figure 3.

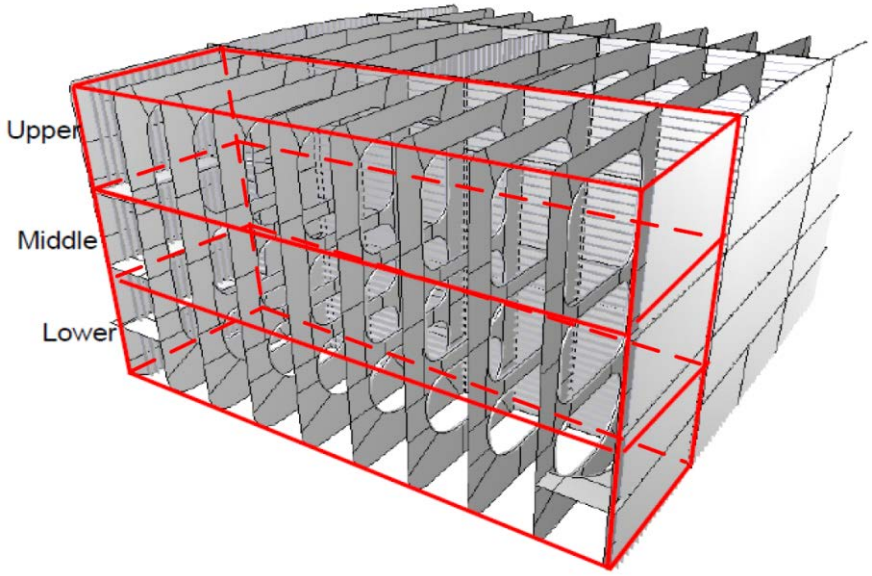
5.3.2 Side Shell and Longitudinal Bulkheads

Areas of side shell and longitudinal bulkhead plating and attached structure, in the lower, middle, and upper third are considered. Web frames are divided in half as attached structure of the longitudinal bulkhead and side shell. Three (3) areas are for the side shell and three (3) areas are for the longitudinal bulkhead. A total of six (6) areas are considered here. See Areas 3 through 8 illustrated in Section 3, Figure 3.

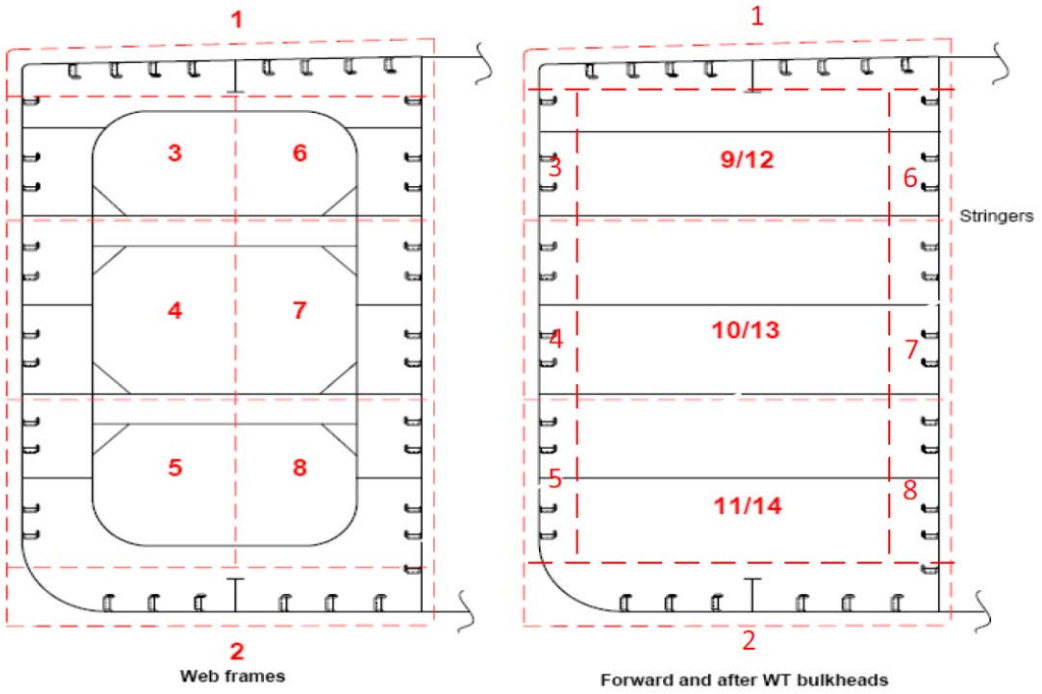
5.3.3 Transverse Bulkheads (Forward and Aft)

Areas of transverse bulkhead plating and attached stiffeners, in the lower, middle, and upper third are considered. Three (3) areas are for the forward transverse bulkhead and three (3) areas are for the aft transverse bulkhead. A total six (6) areas are considered here. See Areas 9 through 14 illustrated in Section 3, Figure 3.

FIGURE 3
Areas under Consideration for a Wing Ballast Tanks of a Single Hull Tanker



(a)



1	Main deck plating and attached structure
2	Bottom plating in way of bilge and attached structure
3,4,5	Upper, middle, and lower parts of shell plating and attached structure
6,7,8	Upper, middle, and lower parts of longitudinal bulkhead and attached structure
9,10,11	Forward Transverse Bulkhead upper, middle, and lower parts
12,13,14	Aft Transverse Bulkhead upper, middle, and lower parts

(b)

5.5 Double Hull Tanker – Double Bottom Ballast Tank

Areas of tank boundaries and attached structure in the lower and upper half of the tank are considered. A total of two (2) areas are for each double bottom ballast tank. See Areas 15 and 16 illustrated in Section 3, Figure 4.

5.7 Double Hull tanker – Double Hull Side Ballast Tank

5.7.1 Deck and Bottom

Areas of deck and bottom plating with attached structure are considered. One (1) area is for the deck and one (1) area is for the bottom. A total of two (2) areas are considered here. See Areas 1 and 2 illustrated in Section 3, Figure 4.

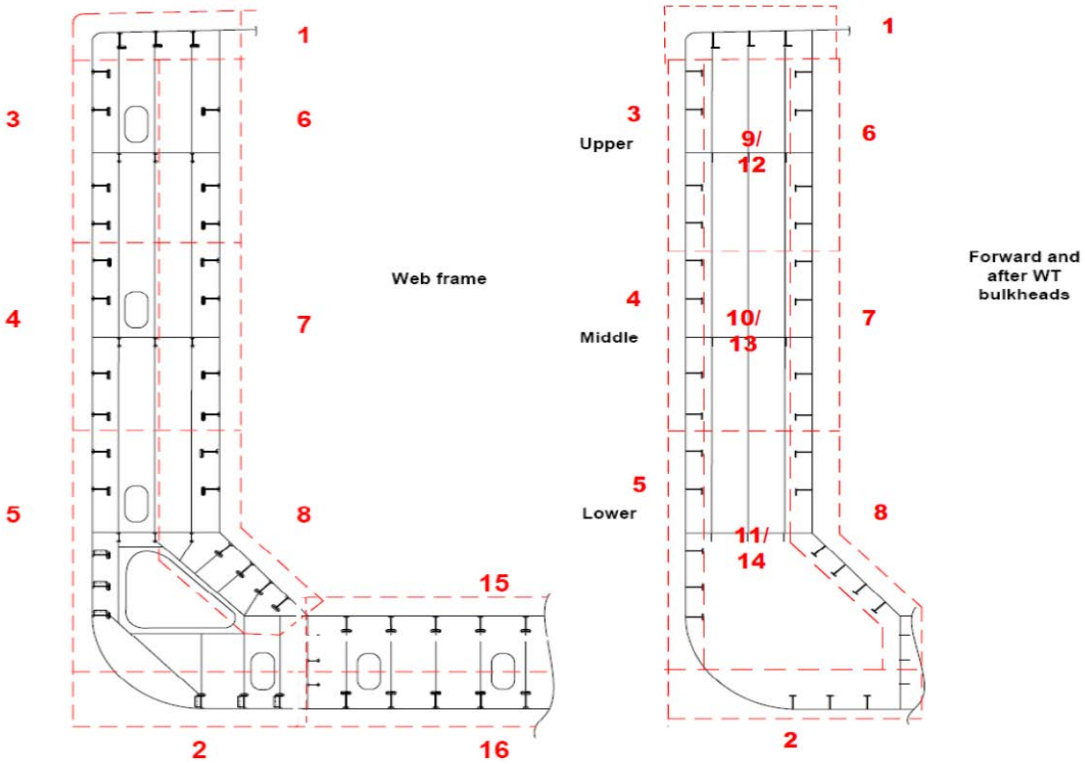
5.7.2 Side Shell and Longitudinal Bulkheads

Areas of side shell and longitudinal bulkhead plating with attached structure, in the lower, middle, and upper third are considered. Web frames are divided in half as attached structure of the longitudinal bulkheads and side shell. Three (3) areas are for the side shell and three (3) areas are for the longitudinal bulkhead. See Areas 3 through 8 illustrated in Section 3, Figure 4.

5.7.3 Transverse Bulkheads (Forward and Aft)

Areas of transverse bulkhead plating and attached stiffeners, in the lower, middle, and upper third are considered. Three (3) areas are for the forward transverse bulkhead and three (3) areas are for the aft transverse bulkhead. See Areas 9 through 14 illustrated in Section 3, Figure 4.

FIGURE 4
Areas under Consideration for Ballast Tanks of a Double Hull Tanker



1	Main deck plating and attached structures
2	Bottom plating in way of bilge and attached structures
3,4,5	Upper, middle, and lower shell plating and attached structures
6,7,8	Upper, middle, and lower longitudinal bulkhead and attached structures
9,10,11	Forward Transverse Bulkhead upper, middle and lower parts
12,13,14	Aft Transverse Bulkhead upper, middle and lower parts
15, 16	Upper and lower half parts of double bottom ballast tank

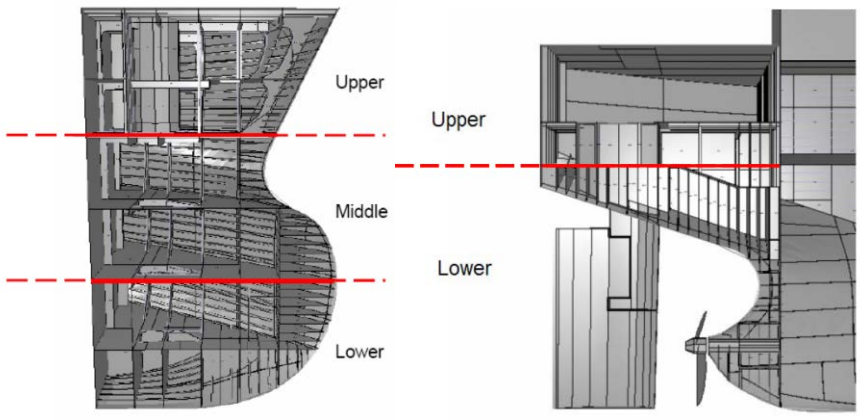
5.9 Fore Peak Tanks

Three (3) areas of tank boundaries and attached structure in the upper, middle, and lower third of the tank are considered. Section 3, Figure 5(a) illustrates areas of a fore peak tank.

5.11 After Peak Tanks

Two (2) areas of tank boundaries and attached structure in the lower and upper half of tank are considered. Section 3, Figure 5(b) illustrates areas of an after peak tank.

FIGURE 5
Areas under Consideration for a Fore Peak Tank and an Aft Peak Tank



(a) **(b)**

7 Coated Areas of Ballast Tanks in Vessels other than Oil Tankers

7.1 General

Areas under consideration for ballast tanks and double-side skin spaces in vessels other than oil tankers, which are based on representative tank configuration, are as follows: topside tanks, hopper tanks, double bottom tanks, side tanks, fore peak tanks, and after peak tanks. See Section 3, Figures 6 and 7 below.

Each area includes plating and attached structural members.

A tank configuration which is a combination of two or more tanks may be addressed separately in accordance with its unit shape of tank configuration (e.g., a tank which has a combination of a hopper tank and a double bottom tank or a tank which has a combination of a wing tank, a side tank and a hopper tank).

Fore peak tanks or after peak tanks, which consist of ballast tanks and void spaces, should be separately considered. Note that void spaces are not considered under these Guidance Notes.

If the vertical height of a ballast tank other than double bottom tanks, fore peak tank, and after peak tank, is more than 15 m (49 ft), it should be divided into three areas under consideration as shown in Section 3, Table 1 below.

TABLE 1
Areas for Ballast Tanks other than Double Bottom

Maximum Vertical Height (h) of Tank	*Areas under Consideration (Vertical)*
$h \leq 15$ m (49 ft)	Two areas (lower and upper)
$h > 15$ m (49 ft)	Three areas (lower, middle and upper)

When determining the boundary between those areas of the vertical surface, other than dividing the vertical surface equally, conspicuous structural member(s) such as stringers and/or horizontal girders on bulkheads or side shell may be used and recorded as the boundary.

7.3 Topside Tanks

7.3.1 Deck, Vertical Strake, and Bottom

Areas of deck, vertical strake, and bottom plating with attached structure are considered. One (1) area is for the deck and vertical strake with attached structure and one (1) area is for the bottom/sloping plating with attached structures. See Areas 1 and 2 illustrated in Section 3, Figure 6.

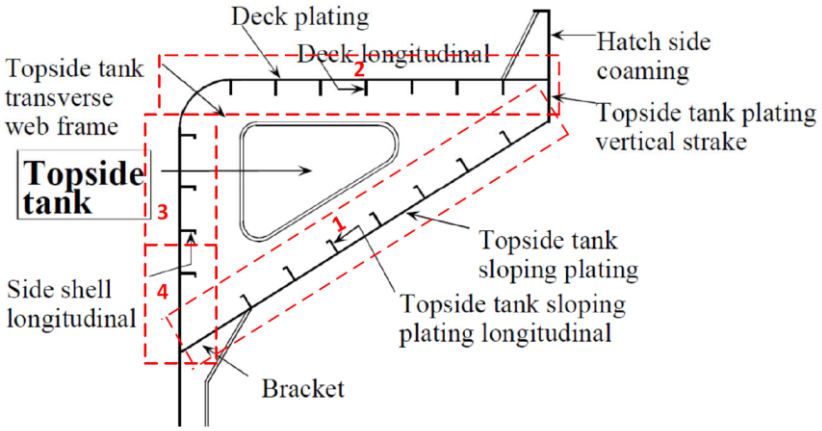
7.3.2 Side Shell

Areas of side shell with attached structure, in the lower and upper or in the lower, middle, and upper areas, depending on the vertical height, are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for the side shell. See Areas 3 and 4 illustrated in Section 3, Figure 6.

7.3.3 Transverse Bulkheads (Forward and Aft)

Areas of transverse bulkhead and attached stiffeners, in the lower and upper or in the lower, middle, and upper areas, depending on the vertical height, are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for forward and aft transverse bulkheads.

FIGURE 6
Topside Tanks



7.5 Hopper Tanks

7.5.1 Hopper, Side Girder, and Bottom

Areas of hopper, side girder, and bottom plating with attached structure are considered. One (1) area is for the bottom and side girder with attached structure and one (1) area is for the hopper. See Areas 1 and 2 illustrated in Section 3, Figure 7

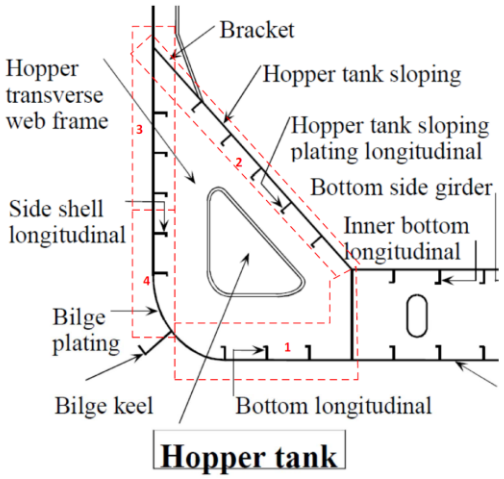
7.5.2 Side Shell

Area of side shell plating, including bilge plating, with attached structure, in the lower and upper or in the lower, middle, and upper areas are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for the side shell. See Areas 3 and 4 illustrated in Section 3, Figure 7.

7.5.3 Transverse Bulkheads (Forward and Aft)

Areas of transverse bulkhead and attached stiffeners, in the lower and upper or in the lower, middle, and upper areas are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for forward and aft transverse bulkheads.

FIGURE 7
Hopper Tanks



7.7 Double Bottom Tanks

Two (2) areas of tank boundaries and attached structure in the lower and upper half of tank are considered. See Areas 15 and 16 illustrated in Section 3, Figure 4.

7.9 Side Tanks

7.9.1 Deck and Bottom

Areas of deck and bottom plating with attached structure are considered. One (1) area is for the deck and one (1) area is for the bottom.

7.9.2 Side Shell and Longitudinal Bulkheads

Areas of side shell and longitudinal bulkhead plating with attached structure, in the lower and upper or in the lower, middle, and upper areas are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for the side shell.

7.9.3 Transverse Bulkheads (Forward and Aft)

Areas of transverse bulkhead plating and attached stiffeners in the lower and upper or in the lower, middle, and upper areas are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for forward and aft transverse bulkheads.

7.11 Fore Peak Tanks

Areas of tank boundaries and attached structure, in the upper and lower or in the upper, middle, and lower areas are considered. Two (2) or three (3) areas (depending on if the vertical height is more than 15 m (49 ft)) are for fore peak tanks. See Section 3, Figure 5(a).

7.13 After Peak Tanks

Two (2) areas of tank boundaries and attached structure, in the upper and lower areas are considered. See Section 3, Figure 5(b).

9 Critical Structural Areas

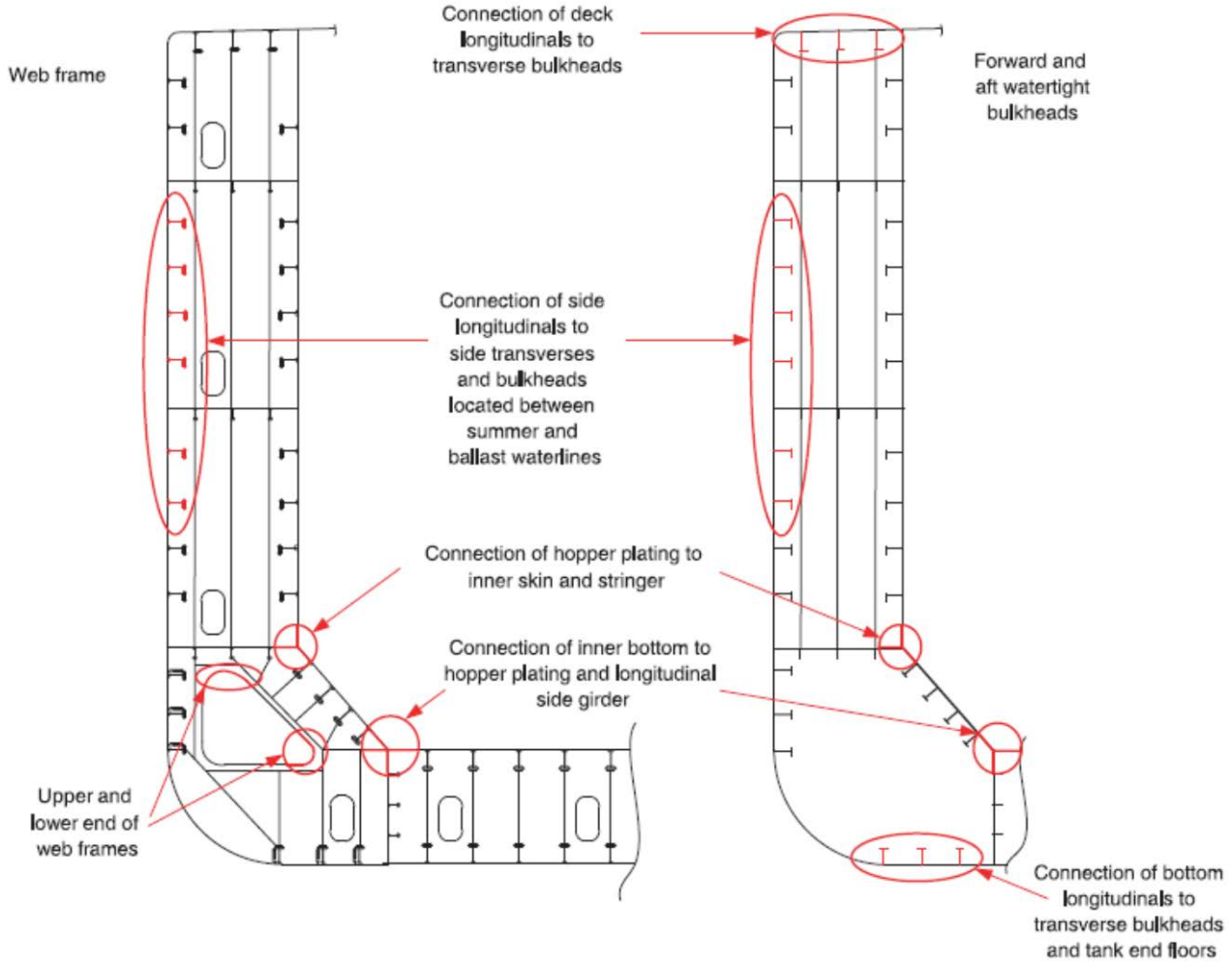
9.1 General

Critical structural areas are defined in Subsection 2/7 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), which are sensitive to cracking, buckling, corrosion or erosion".

9.3 Critical Areas in a Double Hull Tanker

Section 3, Figure 8 illustrates an example of typical critical areas in a double hull tanker.

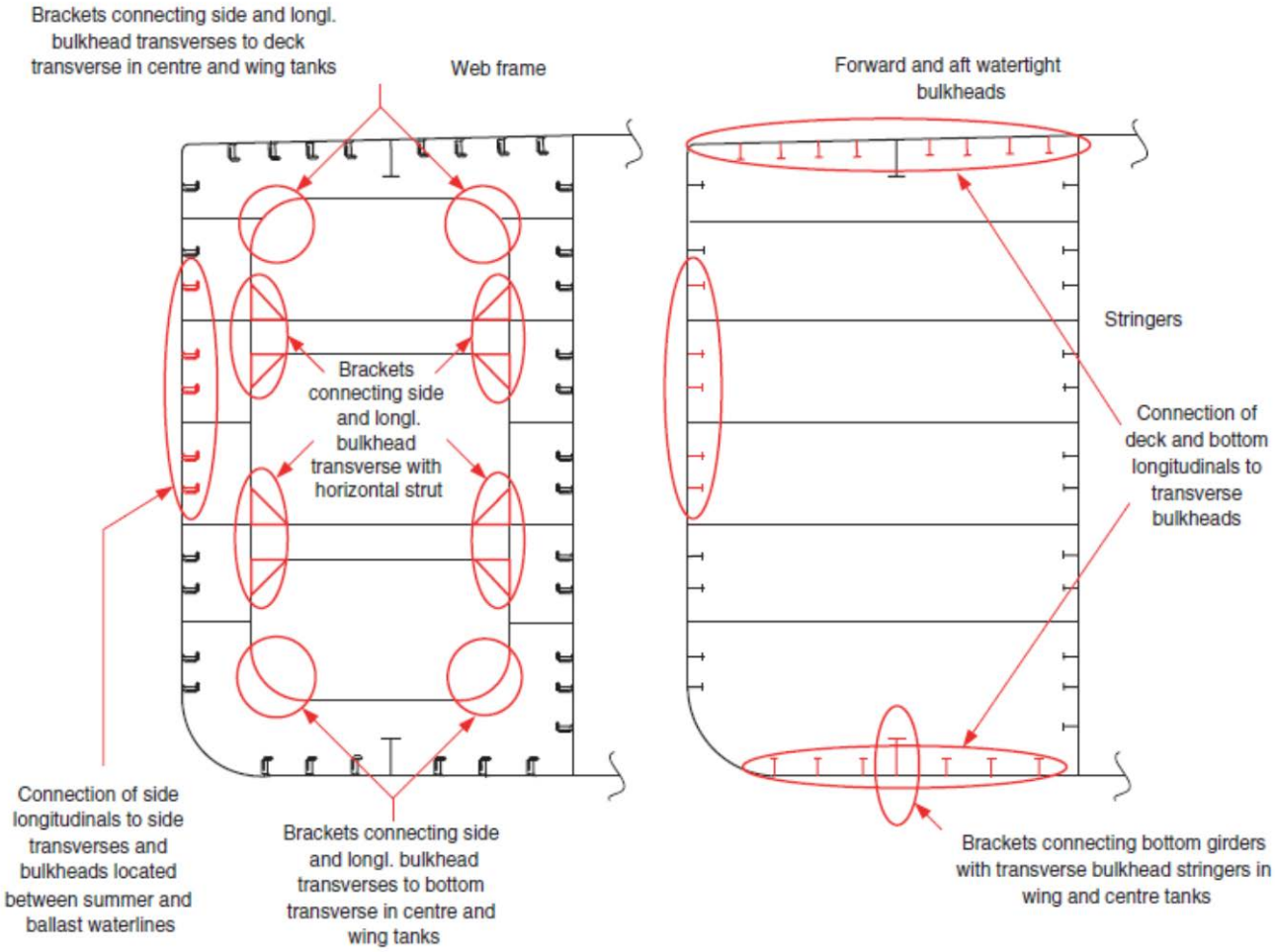
FIGURE 8
Typical Critical Areas in a Double Hull Tanker



9.5 Critical Areas in a Single Hull Tanker

Section 3, Figure 9 illustrates an example of typical critical areas in a single hull tanker.

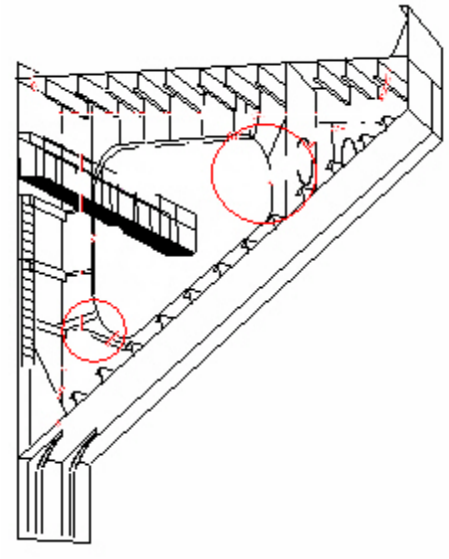
FIGURE 9
Typical Critical Areas in a Single Hull Tanker



9.7 Typical Critical Areas in a Topside Tank

Section 3, Figure 10 illustrates an example of typical critical areas in a topside tank.

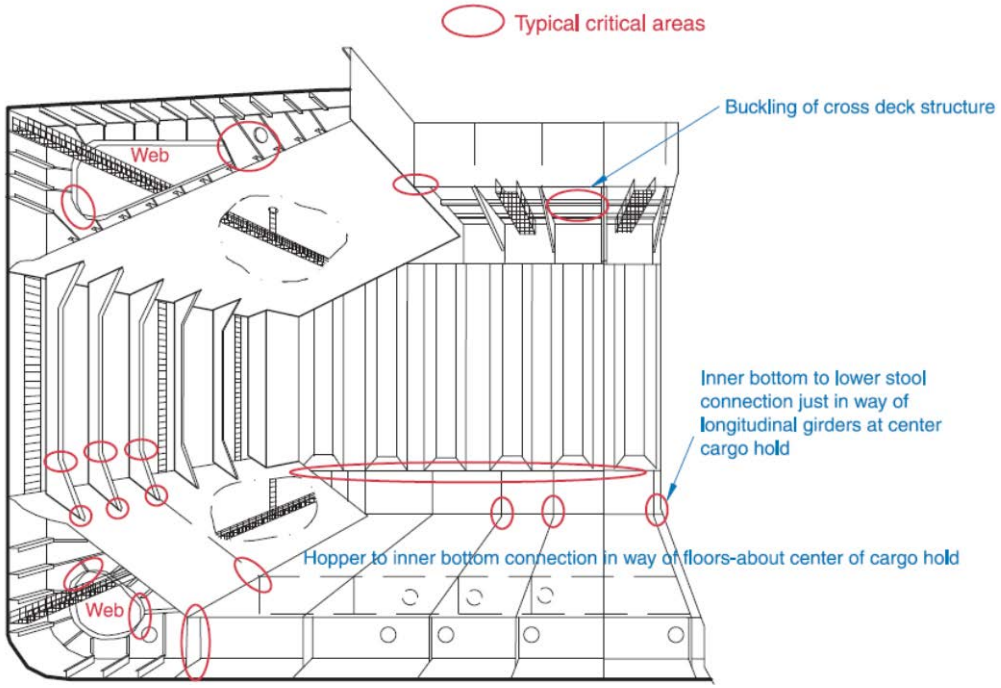
FIGURE 10
Typical Critical Areas in a Topside Tank



9.9 Typical Critical Areas in a Cargo Hold

Section 3, Figure 11 illustrates an example of typical critical areas in a cargo hold.

FIGURE 11
Typical Critical Areas in a Cargo Hold



SECTION 4 Survey Recommendation

1 Scope

The coating system in cargo tanks of all crude oil tankers of 5,000 tonnes deadweight or greater should be examined in connection with renewal and intermediate surveys, and any incidents with damage to the coated areas of cargo oil tanks during the service of the vessel.

The coating system in ballast tanks of all steel vessels above 500 gross tonnage should be examined in connection with renewal surveys and intermediate surveys.

The condition of the coating in tanks should be evaluated and recorded as “GOOD”, “FAIR”, or “POOR” based on visual inspection and estimated percentage of areas with coating failure and rusty surfaces (see Section 4, Table 1).

3 Cargo Tank Entry

In order to undertake a survey of cargo oil tanks, entry into the cargo oil tanks is required. Crude oil cargo tanks are considered an enclosed space, and therefore, all the recommendations contained in ISGOTT (International Safety Guide for Oil Tankers and Terminals) regarding enclosed space entry and gas freeing should be strictly followed. For gas freeing and venting, reference is made to ISGOTT for procedures and equipment for this purpose. Due attention should also be paid to the Recommendations for entering enclosed spaces aboard ships (IMO Resolution A.864(20), as amended).

5 In-service Condition Monitoring

When coating condition monitoring is carried out and a report is required, the report should include the following information, where applicable:

- Vessel name
- Tank number
- Inspection date
- Name of inspector and inspecting body
- Year coated; Year last coated, either delivery date or latest repair
- Coating name/type, manufacturer and product identification used
- Last repaired
- Surface area; designation and size
- Coating condition (GOOD, FAIR, or POOR)
- Pitting corrosion – Yes/No
- Amount of rust scale and coating breakdown (in m^2 (ft^2) or % of areas under consideration)
- Access arrangement condition
- Sounding pipe condition
- Vent pipe condition

- Ballast pipes condition, in the case of ballast tanks
- Other comments (such as structural damage, mechanical damage, location, and extent)
- Bellmouth condition and erosion underneath
- Conditions of coatings of Permanent Means of Access (PMA)

A copy of the latest standardized report should be maintained on board for use of the owner.

7 Frequency of Inspections

The coating system in ballast tanks should be examined in connection with:

- Intermediate Surveys for tankers exceeding 5 years of age
- Special Surveys for all tankers

It is recommended that all ballast tanks, especially for vessels over six years of age, are inspected at least annually by the crew.

The condition of the coating in ballast tanks is assigned and categorized as “GOOD”, “FAIR”, or “POOR”, based on visual inspection and estimated percentage of areas with coating failure and rusty surfaces.

The frequency of inspections for ballast tanks of single and double skin bulk carriers (according to Section 7-3-2 of the ABS *Rules for Survey After Construction (Part 7)* and IACS UR Z10.2 and Z10.5) is shown in Section 4, Table 1.

TABLE 1
Survey Frequency for Ballast Tanks and Combined Cargo/Ballast Tanks in the Various Previous Survey Conditions for Single and Double Skin Bulk Carriers

Ballast Tanks or Combined Cargo/Ballast Tanks Inspection during Periodical Survey																	
Coating Condition	GOOD	S			I		S			I		S			I		S
	FAIR	S			I		S			I		S	A*	A*	I	A*	S
	POOR	S	A	A	I	A	S	A	A	I	A	S	A	A	I	A	S
Vessel Age		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

S: Special Survey: An overall survey of all tanks and spaces is to be carried out. A ballast tank or a combined cargo/ballast tank is to be examined at subsequent annual intervals where the hard protective coating is found to be in POOR condition.

I: Intermediate Survey: For vessels with 5-10 years, overall survey of a minimum of three (3) representative ballast tanks, including fore and aft peak tanks, are to be surveyed. Where a hard protective coating is found in POOR condition, the examination is to be extended to other ballast tanks of the same type. For vessels >10 years, overall survey of all ballast tanks is to be carried out no matter what coating condition. The tanks in question are to be internally examined at each subsequent Annual Survey. Thickness measurements are to be carried out as considered necessary by the Surveyor.

A: Annual Survey for Vessels over 5 Years of Age: Ballast tanks or combined cargo/ballast tanks other than double bottom tanks, where a hard protective coating was found in POOR condition at previous surveys. Double bottom tanks with hard coatings in POOR condition and with substantial corrosion.

A*: Annual Survey for Vessels over 15 Years of Age: minimum 3 ballast tanks or combined cargo/ballast tanks other than double bottom tanks (one forward, one amidships, one aft) within the cargo hold area and fore and aft peak tanks, where FAIR coating conditions were identified at previous surveys.

The frequency of inspections for ballast tanks for tankers and chemical carriers (according to Section 7-3-2 of the ABS *Rules for Survey After Construction (Part 7)* and IACS UR Z10.1, Z10.3, and Z10.4) is shown in Section 4, Table 2.

TABLE 2
Survey Frequency for Ballast Tanks for Double and Non-Double Hull Tankers ESP and Chemical Carriers ESP

Ballast Tanks or Combined Cargo/Ballast Tanks Inspection during Periodical Survey																	
Coating Condition	GOOD	S			I		S			I		S			I*		S
	FAIR	S	A	A	I	A	S	A	A	I	A	S	A	A	I	A	S
	POOR	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vessel Age		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

S: Special Survey: An overall survey of all tanks and spaces is to be carried out. A ballast tank or a combined cargo/ballast tank is to be examined at subsequent annual intervals where the hard protective coating is found to be in less than GOOD condition.

I: Intermediate Survey: For vessels with 5-10 years of age, all ballast tanks and combined cargo/ballast tanks are to be examined. The tank is to be examined at subsequent annual intervals where the hard protective coating is found to be in less than good condition. For vessels over 10 years, overall survey requirements of the previous Special Periodical Survey is needed.

A: Annual Survey for Vessels over 5 Years of Age: Ballast tanks or combined cargo/ballast tanks, where a hard protective coating was found to be in less than GOOD condition at previous surveys.

The frequency of overall and close-up inspections for cargo holds of single and double skin bulk carriers (according to Section 7-3-2 of the ABS *Rules for Survey After Construction (Part 7)* and IACS UR Z10.2 and Z10.5) is listed in Section 4, Table 3. The typical coated areas of a cargo hold are shown in Section 4, Figure 1.

TABLE 3
Survey Frequency of Cargo Holds in Bulk Carriers

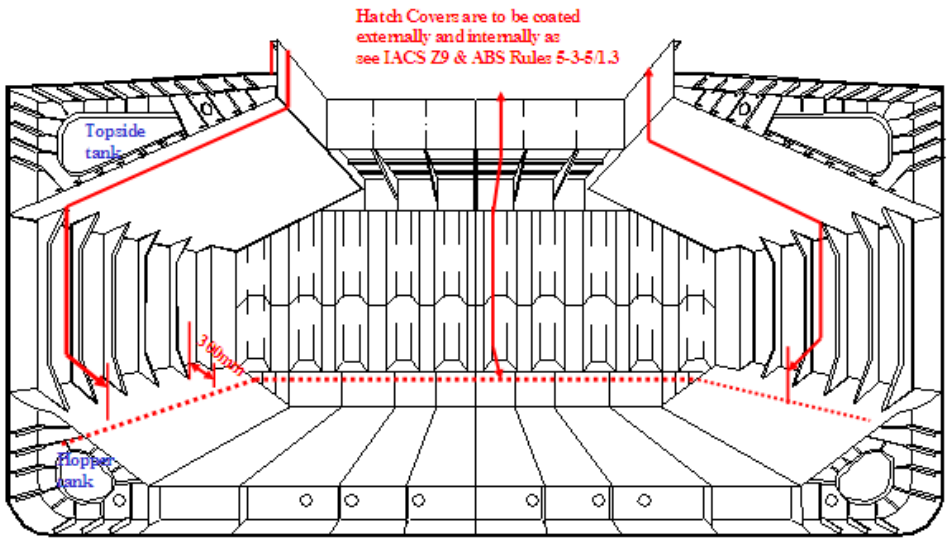
Cargo Hold Inspection of Bulk Carriers during Periodical Survey																	
Any Coating Condition	S		I			S	A	A	I	A	S	A	A	I	A	S	
Vessel Age	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	

S: Special Survey

I: Intermediate Survey

A: Annual Survey

FIGURE 1
Single Side Skin Bulk Carrier – Typical Areas in Way of Cargo Holds Required to be Coated



SECTION 5 Assessment Scales of Coating Conditions

1 General

Assessment of the condition of coated surfaces provides a means to characterize performance of coating systems. It can also provide information for decisions on when coating maintenance is required and the selection of effective coating maintenance procedures.

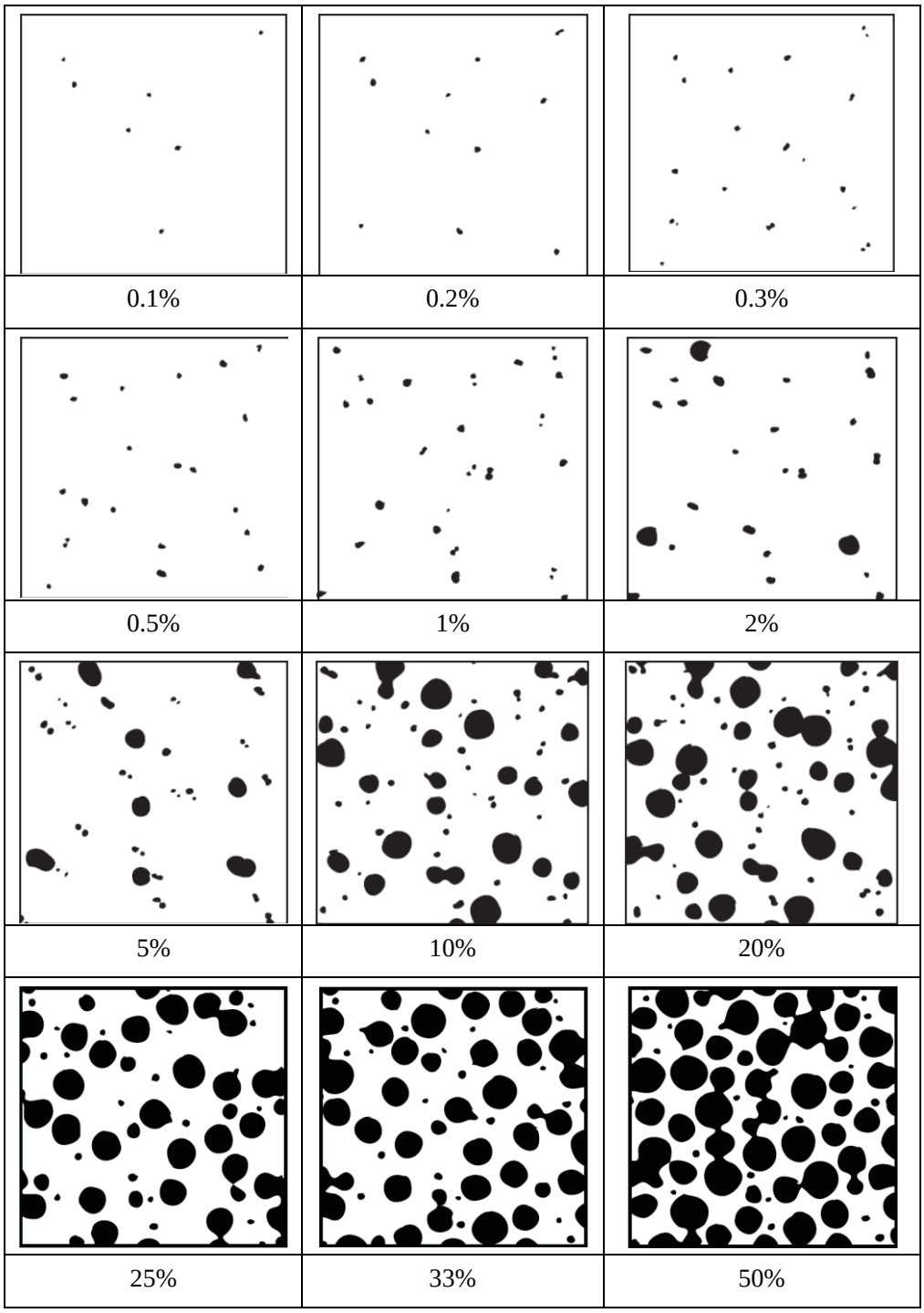
Coating failures may occur on flat areas, edges, and welds. On flat areas, the coating failure pattern can be scattered coating failures or localized coating failures. The coating failures on the edges and welds can be linear coating failures. This Section provides assessment scales for all of those failure patterns. Examples of coating failures are provided to help assess the coating condition of the area under consideration in accordance with the grading definitions.

It should be noted that the areas to be included in the assessment scale are those of actual corrosion and not areas of rust staining.

3 Scattered Coating Failures Assessment Scale

Diagrams for scattered coating failures are illustrated in Section 5, Figure 1.

FIGURE 1
Diagrams of Scattered Coating Breakdown for the Areas under Consideration



5 Localized and Scattered Coating Failures Assessment Scale

Diagrams for localized and scattered coating failures are illustrated in Section 5, Figure 2. Section 5, Figure 3 provides an additional set of coating assessment scales from IACS Recommendation 87.

FIGURE 2
Diagrams for Localized and Scattered Coating Failures in Corners

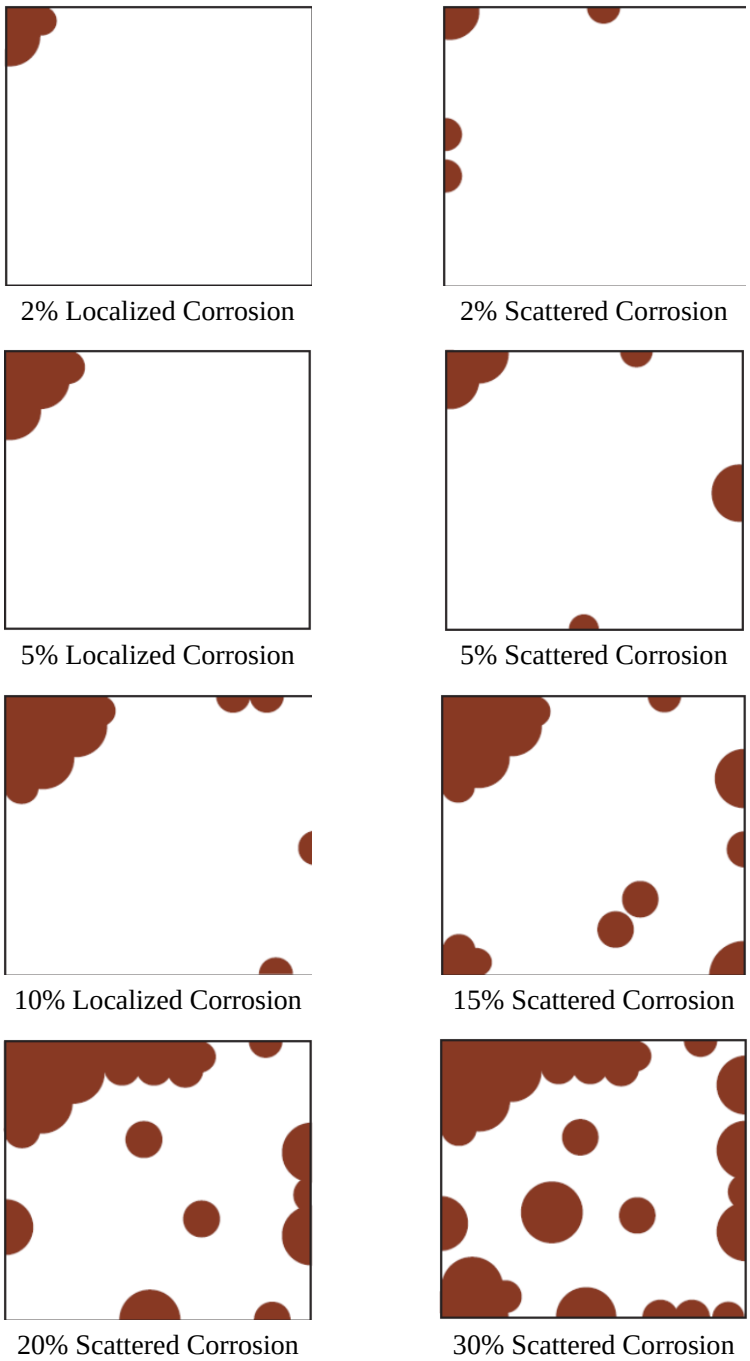
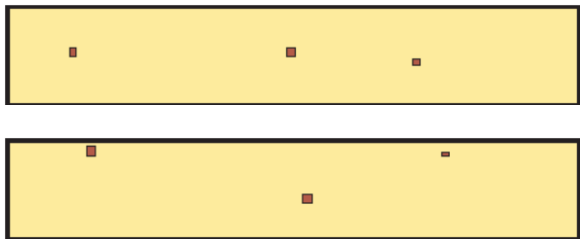


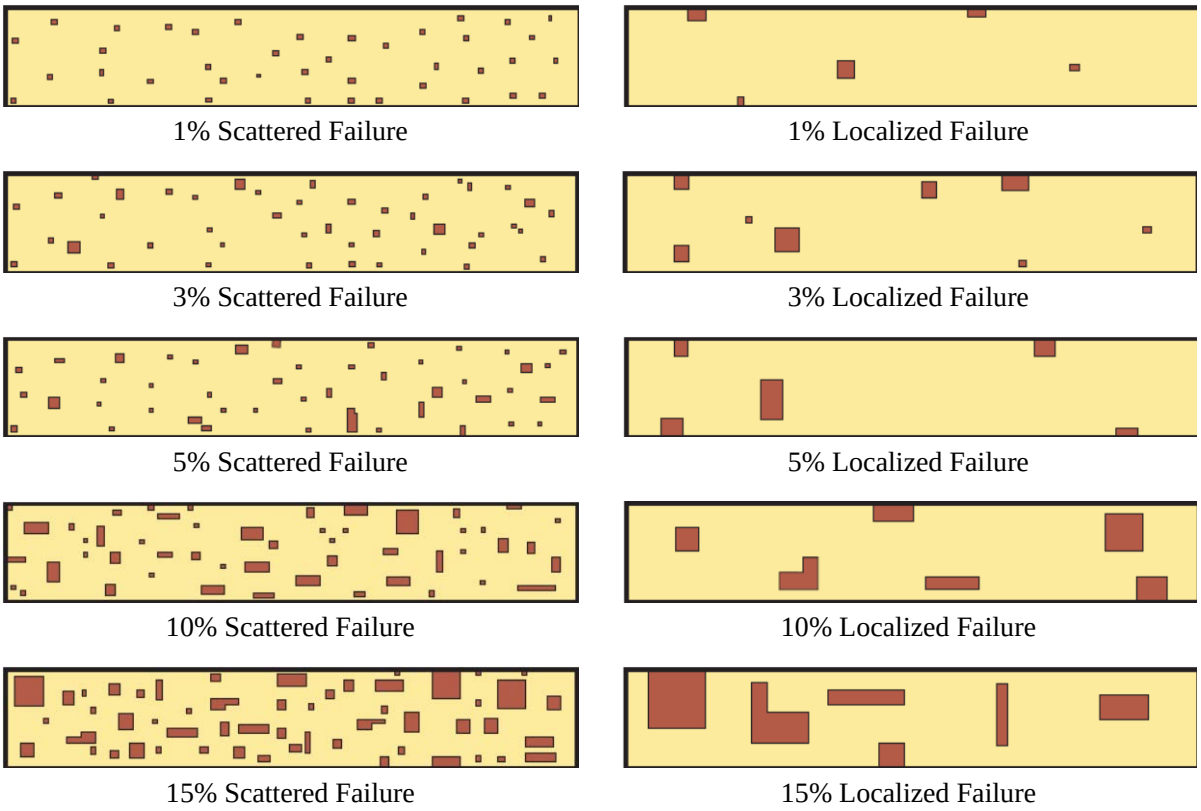
FIGURE 3
Assessment Scale of Failures (IACS Rec. 87)



0.1% Failure

0.3% Failure

Scattered Failures | **Localized Failures**



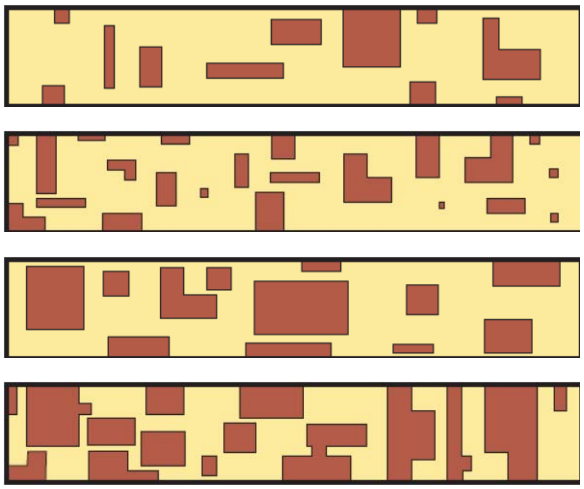
1% Scattered Failure | 1% Localized Failure

3% Scattered Failure | 3% Localized Failure

5% Scattered Failure | 5% Localized Failure

10% Scattered Failure | 10% Localized Failure

15% Scattered Failure | 15% Localized Failure



20% Failure

25% Failure

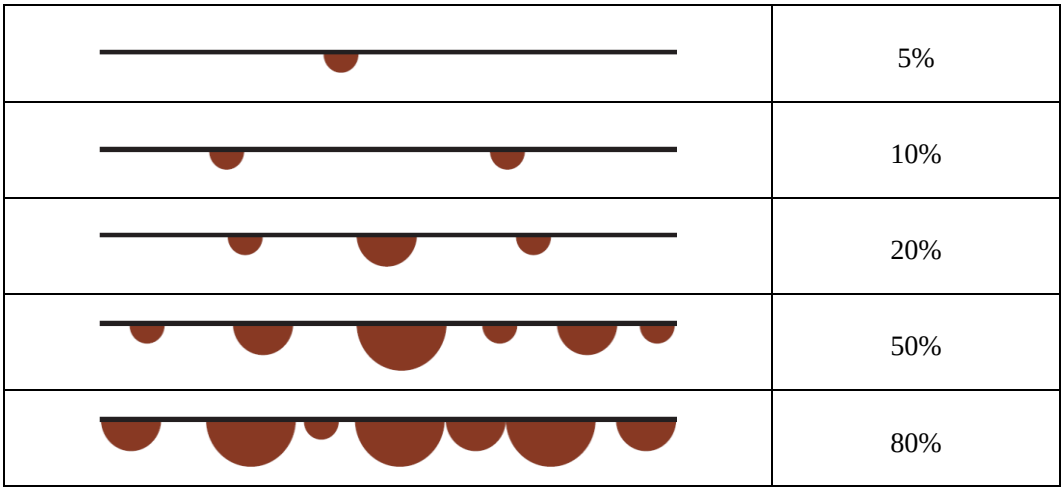
33% Failure

50% Failure

7 Linear Coating Failure Assessment Scale

Coating failure and steel corrosion have a linear failure mode which can be assessed based on the diagrams provided in Section 5, Figure 4. These coating failure assessment scales are designed for use along stiffener edges and on welds. The corrosion may extend to both sides of the arbitrary line.

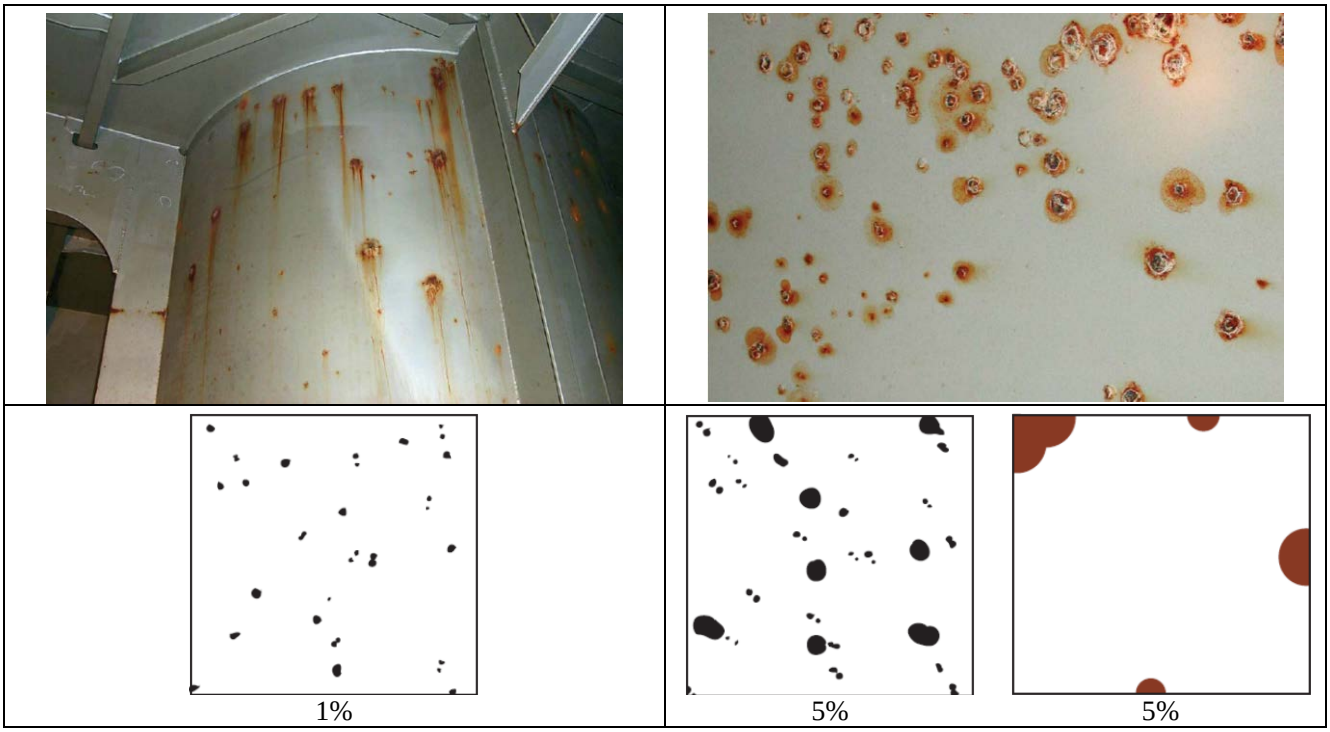
FIGURE 4
Linear Extent Diagrams

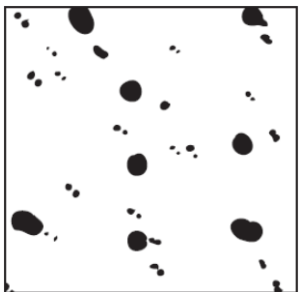


9 Examples of Coating Breakdown Failures

9.1 Breakdown on Flat Areas

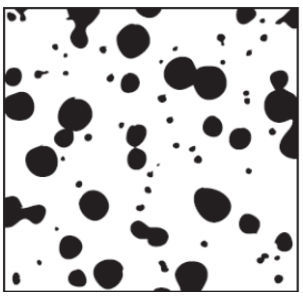
FIGURE 5
Coating Breakdown on Flat Area



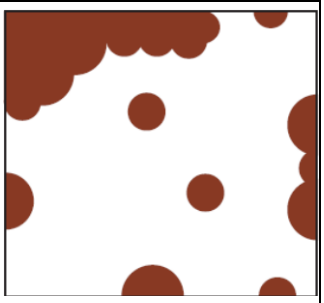


5%

10%



20%

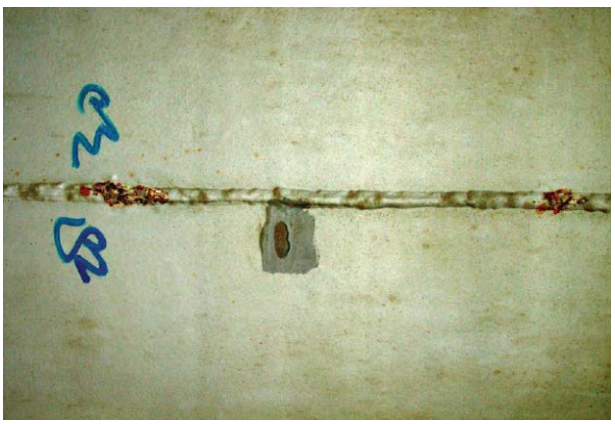


20%

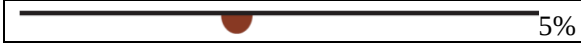
9.3 Breakdown on Welds and Edges

FIGURE 6
Coating Breakdown on Welds and Edges

Edges and welds < 5%



Edges and welds < 10%



5%

10%

Edges and welds < 20%

20%

Edges and welds > 50%

80%

Edges and welds > 50%

Corrosion of flat areas: 5%
Edges and welds: 30%

Flat areas: 0%
Edges and welds: 15%

Flat areas: < 1%
Edges and welds: 20%

Flat areas: 2%
Edges and welds: 30%

SECTION 6 Coating Maintenance

1 General

Maintenance can delay or slow down the deterioration of coatings. It can also provide short-term steel protection. Maintenance means minor coating restoration work regularly performed by a vessel's crew using normal shipboard means and tools to maintain "GOOD" or "FAIR" coating conditions.

3 Process Considerations

The following considerations should be taken into account when coating maintenance is undertaken:

- Safety, including tank entry requirements
- Tank surface cleaning
- Fresh water cleaning for salt contamination
- Rust scale removal
- Pitting corrosion repair
- Temperature and condensation issues
- Ventilation
- Compatibility of coating systems

Appendix 1 provides further instruction for these considerations.

5 Recommended Process

Maintenance process:

i) For oil tanks, tank washing and oil film/mud removal and venting

ii) Fresh water rinsing

iii) Drying

iv) Surface preparation, de-scaling

v) Protection of anodes from coating, as necessary

vi) Coating applications

Section 6, Table 1 provides the recommendations to maintain the coating conditions.

TABLE 1
Recommended Maintenance

Purpose	*Surface Preparation*	*Coating System*	
		Coating Type	*Dry Film Thickness (DFT)*
Maintain affected areas: GOOD to GOOD or FAIR to FAIR	• Removal of mud, oil, grease, etc. Suitable oil tank cleaning is needed • Fresh water washing to remove salts • Drying and ventilation/dehumidifier • Repair of pitted areas if any in accordance with the Class steel requirement • St 3 or equivalent or better of surface preparation • Check ambient conditions before coating is applied and apply coating according to manufacturer's recommendation	• Epoxy-based system • The maintenance coating specified in CTF or the same coating system as was originally employed or according to manufacturer's recommendation	According to manufacturer's recommendation

SECTION 7 Coating Repair

1 General

Repair means coating restoration work of a longer-term nature, usually performed during a vessel's drydocking or scheduled repair period (vessel idle) to restore the "FAIR" or "POOR" coating condition to "GOOD" condition. This will usually require specialized manpower and equipment, such as sand blasting equipment, operators, and dehumidifiers.

3 Process Considerations

The following major considerations should be taken into account when coating repairs are undertaken:

- Safety, including tank entry requirements for oil tanks
- Oil tank cleaning
- Staging, as needed
- Degreasing if any oil residue, fresh water cleaning of salt contamination
- Rust scale removal
- Pitting corrosion repair
- Temperature and condensation issues
- Ventilation/dehumidification, as needed
- Compatibility of coating systems and coating resistant to cathodic protection systems
- Stripe coating with consideration of no accessible areas
- Qualified and certified coating inspector

Appendix 1 provides further instruction for these considerations.

5 Repair Process

It should be noted that more control over the coating repair process can be achieved when in dock, and thus the overall cost effectiveness of repairs must establish whether the required service life will be achievable.

The repair process can be as follows:

i) Tank washing and oil film/mud removal for oil tanks; mud out ("slurry up" and pump out all mud) for ballast tanks

ii) Fresh water rinsing

iii) Drying

iv) De-scaling by hand scraping off loose scale. Ballast tank de-scaling may consider the use of magnesium. Surface preparation method chosen depends on the amount of coating failure and the service life intended.

v) Anode protection from being coated

vi) Coating applications

It is essential that all personnel, including contractor(s), involved in the repairs are fully qualified to carry out the required work. It is also necessary that while on board, the team is fully conversant with appropriate ship operation, safety, and evacuation requirements.

Coating repairs should be inspected by qualified inspectors certified to NACE Coating Inspector Level 2, FROSIO Inspector Level III, or equivalent as verified by the Administration.

It is recommended that the process, specification, coating application parameters, standards, and time schedule are discussed and agreed upon by the parties involved and presented to ABS (on behalf of the Administration) for review. ABS may, if it so requires, participate in the agreement process.

7 Recommended Repair

Section 7, Table 1 provides the recommendation for medium and long-term repair to restore "GOOD" coating condition of PSPC seawater ballast tanks.

Section 7, Table 2 provides the recommended short, medium, and long-term repairs for crude cargo oil tanks.

TABLE 1
Recommended Medium and Long-term Repairs of PSPC Ballast Tank Coatings

Purpose	*Surface Preparation*	*Coating System*		
		Service Target	*Coating System*	*Dry Film Thickness (DFT)*
Repair affected areas to GOOD: FAIR to GOOD or POOR to GOOD	• Removal of mud, oil, grease, etc. • Fresh water rinsing • Drying • De-scaling • St 3 or Sa 2½ for FAIR condition • Sa 2½ for POOR condition • Intact coating next to damaged area should be feathered • Total water soluble salts 80 mg/m^2 (1.14×10^{-7} psi) NaCl max. or manufacturer's recommendation, whichever more stringent • Climatic control	Medium term – 10 years of target life, not recommended for vessels less than 5 years of age	• Approved PSPC-SWBT Coating system • The coating system same as or compatible with or equivalent to the one originally applied, according to manufacturer's recommendation	250 µm (10 mil) NDFT with minimum 2 spray coats and 2 stripe coats
		Long term – More than 10 years of target life		320 µm (12.6 mil) NDFT with minimum 2 spray coats and 2 stripe coats

TABLE 2
Recommended Short-term Repair of PSPC Crude Oil Tank Coatings

Purpose	*Surface Preparation*	*Coating System*		
		Service Target	*Coating System*	*Dry Film Thickness (DFT)*
Repair affected areas to GOOD: FAIR to GOOD or POOR to GOOD	• Removal of mud, oil residues, grease, etc. thorough tank cleaning • Drying • St 3 or Sa 2 • Intact coating next to damaged area should be feathered • Total water soluble salts 80 mg/m^2 (1.14×10^{-7} psi) NaCl max. or manufacturer's recommendation, whichever more stringent • Climatic control • Pit repair to the Class requirement	Short term repair – Not recommended for tankers less than 1.5 years (18 months) of age	• Approved PSPC-COT Coating system • The coating system same as or compatible with or equivalent to the one originally applied, according to manufacturer's recommendation	250 µm (10 mil) NDFT with minimum two spray coats and two stripe coats
	• Same as above except for min. cleanliness Sa 2 to Sa 2½ is required	Medium term repair – Not recommended for tankers less than 10 years of age		280 µm (11 mil) NDFT with minimum two spray coats and two stripe coats
	• Same as above except for min. cleanliness Sa 2½ is required	Long term repair – Required for tankers less than 5 years of age		320 µm (12.6 mil) NDFT with minimum two spray coats and two stripe coats

Note: For partial or small spot area repairs, it is well understood that these recommendations might not be possible, but suitable preparation for the coating system being used should be according to the coating manufacturer's recommendation.

SECTION 8 Coating Technical File (CTF)

1 General

Maintenance and repairs should be carried out in accordance with the procedures and recommendations provided in the Coating Technical File (CTF) from the new construction. If the repair procedures provided in the CTF do not meet the actual repair process, new repair procedures should be proposed by the shipyard and agreed by the coating manufacturer and the shipowner.

3 CTF Maintenance

The CTF can be maintained in ABS Nautical Systems. See Appendix 2 for more information on ABS Nautical Systems.

3.1 Maintenance

For maintenance, the CTF should contain at least the following:

i) Copy of Technical Data Sheet, which includes, as a minimum:

- Product name and identification mark and/or number
- Composition of the coating system and components and colors of coatings
- Minimum and maximum dry film thickness (DFT)
- Application methods, tools, and/or machines
- Condition of surface to be coated (de-rusting grade, cleanness, profile, etc.)
- Environmental limitations (temperature and humidity)

ii) Coating maintenance activity data, including:

- Actual space and area [in square meters (square feet)] of coating applied
- Method of surface preparation (degreasing, fresh water washing, drying, de-scaling, etc.)
- Ambient condition (temperatures and humidity) during coating maintenance and coating application time and method (stripe coating – brush or roller)

3.3 Repairs

For repairs, the CTF should contain at least the following:

i) Copy of Statement of Compliance or Type Approval Certificate

ii) Copy of Technical Data Sheet, including:

- Product name and identification mark and/or number
- Composition of the coating system and components and colors of coatings
- Minimum and maximum dry film thickness (DFT)
- Application methods, tools, and/or machines
- Condition of surface to be coated (de-rusting grade, cleanness, profile, etc.)
- Environmental limitations (temperature and humidity)

iii) Shipyard coating repair records, including:

- Actual space and area [in square meters (square feet)] of coating applied
- Method of surface preparation (degreasing, fresh water washing, drying, de-scaling, etc.)
- Coating system and methods of coating applications
- Time of coating, thickness, number of layers, etc.
- Ambient condition (temperature and humidity) during coating applications

iv) Coating log issued by the coating inspector, stating that the coating was applied in accordance with the specifications to the satisfaction of the coating supplier representative and specifying deviations from the specifications (example of daily log and non-conformity report]see annex 2 to resolution MSC.215(82)]

v) Shipyard's verified inspection reports, including:

- Completion date of inspection
- Result of inspection
- Remarks (if given)
- Inspector signature
- Procedures for in-service maintenance and repair of coating system, if different than original coating system

APPENDIX 1 Considerations for Coating Maintenance and Repair

1 General

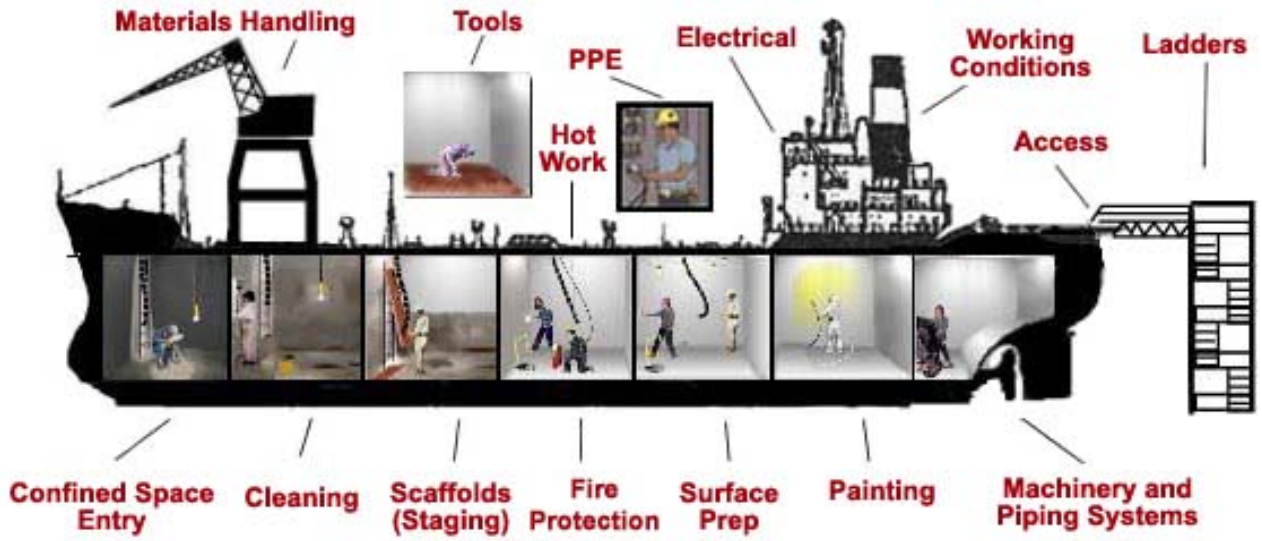
The following considerations should be taken into account when coating maintenance or repairs are undertaken.

3 Safety

Refer to the IMO Recommendations for entering enclosed spaces aboard ships (resolution A.864(20), as amended) and the International Safety Guide for Oil Tankers and Terminals **(**ISGOTT**)**, as applicable. All of the vessel's safety and tank entry procedures and policies are to be adhered to.

When a vessel is out of service undergoing shipyard repairs, local regulations apply regarding safety and the shipyard is responsible for their implementation.

FIGURE 1
Ship Repair Safety



(www.osha.gov)

5 Staging

Staging should be arranged to allow good access to all surfaces. Staging should be arranged according to prevailing safety regulations. Staging poles and working platforms should be placed in a distance from the surface to provide suitable work space for all subsequent operations, and special care should be taken to secure access to corrugated bulkheads.

FIGURE 2
Scaffolds and Staging

(www.osha.gov)

7 Tank Cleaning and Steel Surface Cleaning

The goal of tank cleaning is to provide surfaces free of oil residues and soluble salt contamination on areas to be repaired. Inadequate tank and steel surface cleaning will leave a few microns of oil film and/or residual soluble salts on the surface, which can seriously affect coating adhesion and lead to delamination or blistering.

Successful oil tank cleaning requires longer-term planning, even for previous voyages so that concentrated Crude Oil Washing (COW) is carried out at the port(s) of discharge for the relevant cargo tanks. Special attention should be given to tanks and areas to be cleaned and treated.

Subsequent to COW of the relevant tanks, water washing, which may include the use of suitable tank cleaning detergent and the use of fresh water, will be required. If deadweight and draft limitations of a preceding voyage allow collecting substantial quantities of fresh water from rivers or other sources, this will make for a much more successful water washing as it will limit the salt contamination of tank surfaces and facilitate hand washing during surface preparation.

Special care must be taken when solvents and detergents are used and disposed of so as to protect the environment. The gases released by these solvents are oftentimes poisonous, explosive, and toxic, and should be removed as quickly as possible from the tank atmosphere by venting and gas freeing equipment. Procedures as recommended in ISGOTT should be established.

The shipowner's office must be contacted to confirm availability and reserve capacity for oily tank washings disposal ashore at subsequent ports. Similar good communication and cooperation will also be required even for programmed coating repairs.

For seawater ballast tanks, it should be verified that tanks and areas to be cleaned have no visible oil/grease/mud. Thorough fresh water cleaning is necessary for removing soluble salts.

9 Salt Contamination

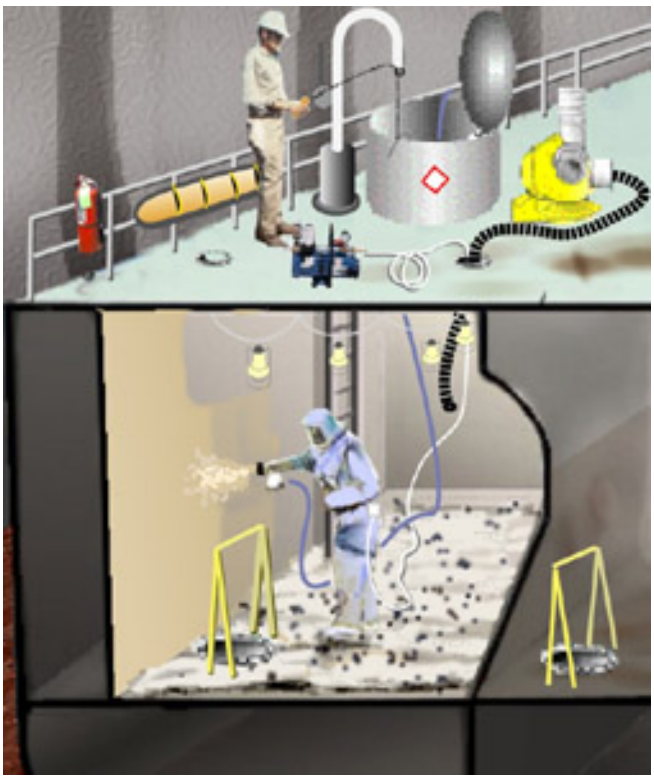
Salt contamination will cause accelerated deterioration of the coating if not removed prior to coating application. A recommended procedure to reduce salt contamination is to remove oil and grease first, if any, and then descale loose rust followed by thorough fresh water rinsing, preferably at elevated temperatures and high pressure. This should be the starting point in any surface preparation process. In the case of major repairs or full recoating, soluble salt content limit should be agreed between the parties concerned and noted in the CTF. Soluble salt content test after washing and before coating should be in accordance with standard ISO 8502-9 or other equivalent method. The surface is to be rewashed if necessary.

11 Rust Scale

Applying coating to rust scale will cause premature coating failure. 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. If the hard scale cannot be removed, the service life expectancy of the treatment is 1 to 2 years, regardless of the coating used.

Descaling is a necessary step for coating repair. Descaling can be done by hand scraping off loose scale. The use of magnesium may be considered for ballast tank descaling. The surface preparation method chosen depends on the amount of coating failure and the service life intended.

FIGURE 3
Surface Preparation



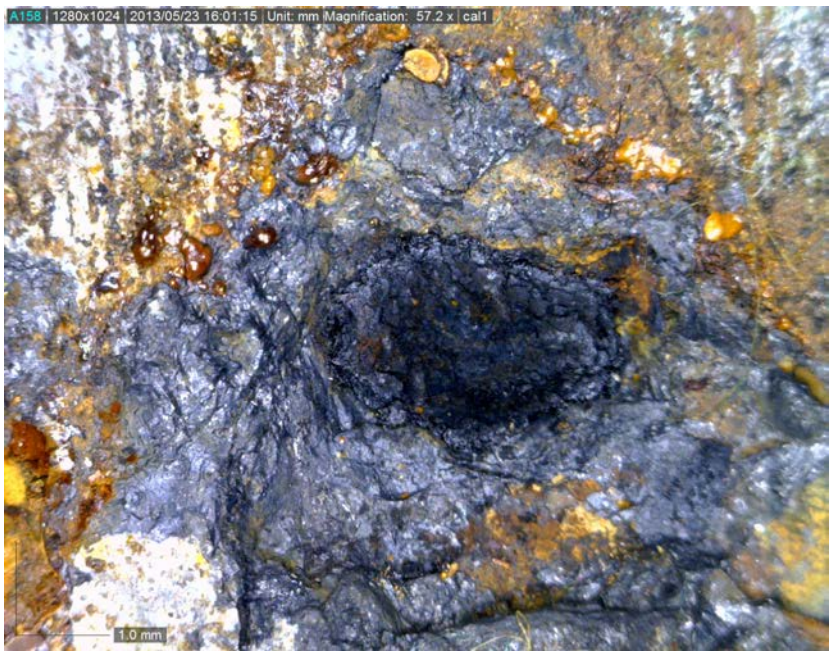
(www.osha.gov)

13 Pitting

Pitting corrosion (Appendix 1, Figure 4 as an example) is a major problem on board vessels on areas that have been exposed to seawater for some time. If it has been accepted that the pits need not be welded up, a coating should be applied in order to prevent further accelerated damage.

Soluble salts will be present within the pits, and it is essential that these are removed or the coating will fail because corrosion will soon start inside over-coated pits. Various methods of salt removal from pits have been proposed, (for example, waterjetting followed by blast cleaning or slurry blasting or wet blasting). Whichever method is chosen, any residues from the washing processes should be removed. Otherwise, the soluble salt will precipitate out of the water upon drying.

FIGURE 4
Typical Pitting Corrosion



15 Temperature, Humidity, and Condensation

Temperature is a critical parameter to consider. When repairs are carried out in a shipyard, proper surface temperature control can more readily be achieved in the areas requiring coating.

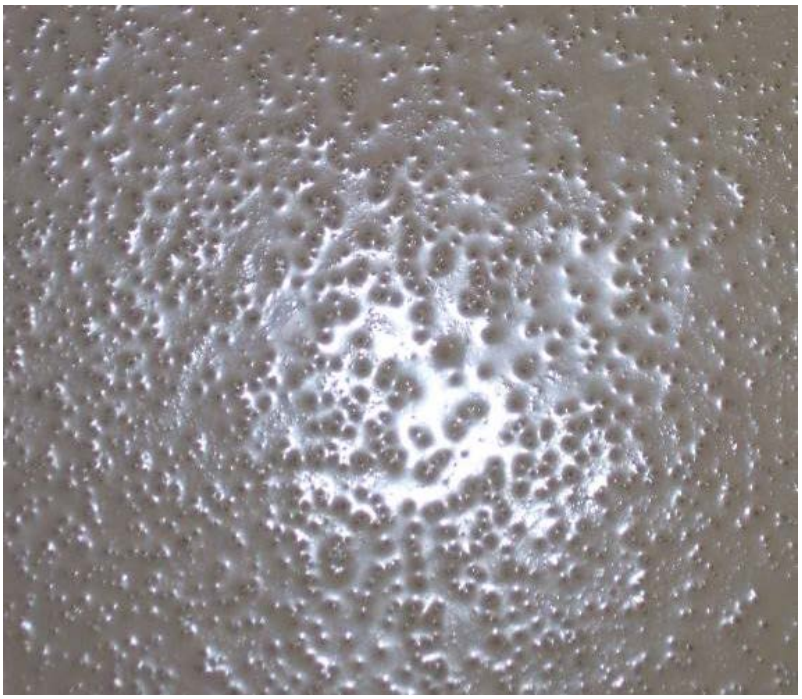
It is an absolute necessity that the contractors have a good understanding about limitations of relative humidity and steel surface temperature in relation to dew point, which not only relate to steel surface condensation, but also affect appropriate coating curing. In addition to the temperature range recommended by the coating manufacturer, it is important to know that, in coating industrial practice, surface preparation and coating application should not be performed when the relative humidity is higher than 85% or the steel surface temperature is less than 3°C (5°F) above the dew point. Too high relative humidity may also affect coating curing process. Too low steel surface temperature can slow down coating curing and cause coating cracking from internal stress developed by slow solvent release on later stage (Appendix 1, Figure 5). Too high surface temperature may force solvent escape from the coating and cause pinhole coating defects (Appendix 1, Figure 6).

When possible, control of the relative humidity during actual application of coating would increase the longevity of the coating and its adherence to the structure. Dehumidification is usually only an option during repairs alongside at an organized repair facility.

Dehumidification of the tank or space to be coated effectively prevents re-rusting of the steel after surface preparation and allows paint application on a dry steel substrate. This will not only provide proper conditions for the paint application, but it will also reduce delays and thus improve productivity. There are two different types of dehumidification (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. Dehumidification to 40% to 50% relative humidity is recommended.

FIGURE 5
Coating Cracking

FIGURE 6
Coating Pinhole Defects



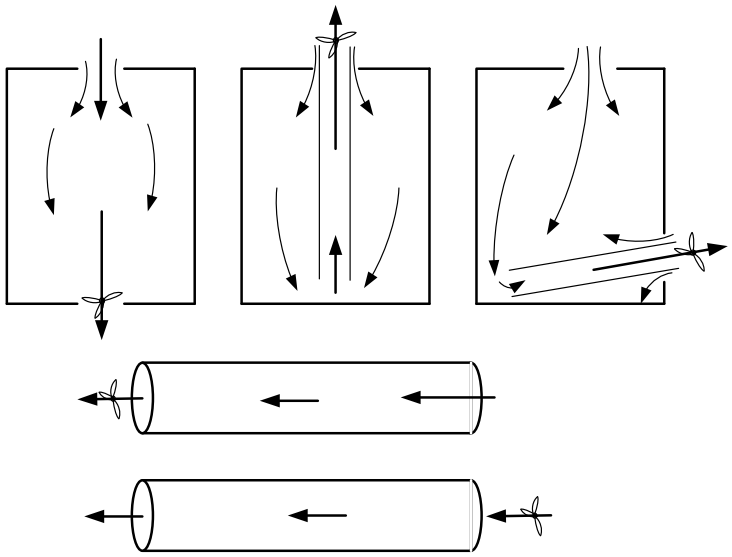
17 Ventilation

Ventilation is required for health and safety. In addition, for coatings containing solvents, the quality of a coating system is greatly affected by the amount and type of residual solvent in the coating film when the coating dries or cures. Ventilation can assist solvent release from the paint during curing. The use of solvent-free coating systems eliminates solvent release from the paint, but ventilation is still required during surface preparation, coating application, and curing.

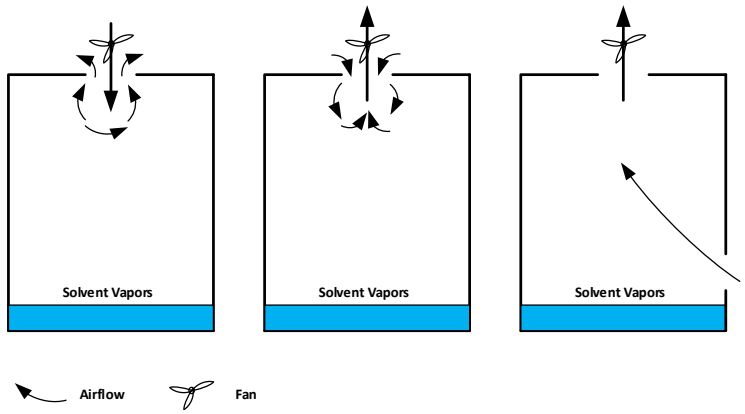
Ventilation is a vital factor for the safety and quality of the coating application and must be carried out continuously during surface preparation, paint application, drying, and curing. As a guideline for good ventilation, after application, the confined space should be ventilated 4-5 times its space volume per hour.

Solvent is heavier than air. Ventilation arrangements must provide maximum efficiency to extract from the lowest and furthest corners for fast and efficient removal of solvents (Appendix 1, Figure 7). For complex structures, the ventilation should be distributed over all compartments and confined spaces in order to facilitate good ventilation in all areas. In the case of waterborne paints, water vapor released from the paint rises to the upper areas of the tank. Therefore, it is recommended to position an extra exhaust outlet at the top of the tank.

FIGURE 7
Ventilation Arrangement



(a) Practices recommended



(b) Practices not recommended

19 Coating Systems and Coating Applications

Compatibility of coating systems is of utmost importance for a good end result.

Unless the original coating system is totally removed, a coating system compatible with the original system should be used in accordance with the paint manufacturer's recommendations. In addition, the coating system requires a Statement of Compliance or Type Approval Certificate according to the performance standards for protective coatings for cargo oil tanks or seawater ballast tanks. Demonstration of compatibility should not require separate approval of the combined coating system consisting of the old coating and new coating.

Method of coating application should be differentiated with respect to areas and structure design in order to obtain the specified Dry Film Thickness (DFT) on all areas. Edges, corners, weld seams, and other areas that are difficult to coat require special treatment. Edge rounding and weld grinding before "stripe coating" is needed. Stripe coats should be applied as a coherent film showing good film formation and no visible defects, such as pores, holidays, or de-wetted areas. All areas which are not able to be covered by spray application should be properly stripe coated by the application method employed. See Appendix 1, Figure 8.

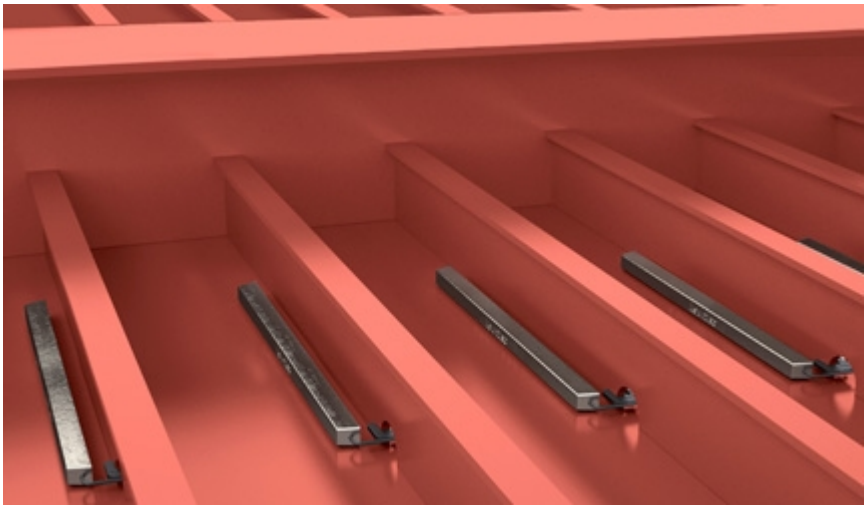
It is recommended to apply a stripe coat before or after each main coat. This should be done using a color that contrasts with each main coat, as this makes it easier to see that the stripe coat is satisfactory.

FIGURE 8
Stripe Coating

21 Cathodic Protection

Sacrificial anodes, as a supplemental anti-corrosion method of protective coatings, are commonly used in ballast tanks and crude oil tanks. The sacrificial anodes are normally replaced during a vessel's drydocking period. It is essential that all anodes are protected from coating during tank coating's maintenance and repairs. See Appendix 1, Figure 9. Coatings used in the tanks are subject to resistance to damage from the cathodic protection system.

FIGURE 9
Anodes in Ballast Tanks



APPENDIX 2 ABS Nautical Systems Hull Manager

1 Enabling Comprehensive Asset Management

During repair campaigns or at drydock, the consequences of lack of structural maintenance become apparent and drive unexpected costs. A robust hull integrity management approach can mitigate this risk and extend asset life and uptime.

ABS Nautical Systems Hull Manager fully integrates structural integrity management into the maintenance, purchasing and repair planning or drydock process, assisting with comprehensive maintenance strategies. Leveraging fleet and ship-specific models, NS Hull Manager delivers the industry's most comprehensive predictive and preventative asset lifecycle management tool. NS Hull Manager provides the same visibility of a vessel's structural condition previously only available for machinery.

When deployed with the NS Fleet Management Software, NS Hull Manager elevates a planned maintenance program to a complete asset management program.

3 NS Hull Manager Capabilities

3.1 One-click Access to Structural Health

Intuitive dashboards provide simple and efficient access to the structural condition of each compartment on the vessel through icons and color coding that are easy to understand.

3.3 Inspection Scheduling

The inspection scheduler gives both office and crew full visibility of all hull inspections – planned, ongoing or completed – to enable more efficient documentation of asset conditions at the fleet or vessel level.

3.5 Anomaly Reporting

NS Hull Manager supports a more efficient and accurate process to manage repair of structural anomalies. Anomaly thresholds, based on client requirements for substandard structural conditions, are generated automatically and can be further documented by attaching relevant files, including pictures, reference drawings, and previous inspection results. The integrated planning and resolution tool allows users to evaluate anomalies to determine what needs to be repaired immediately and what can be deferred for later action.

3.7 NS Software Integration

NS Hull Manager integrates with NS Maintenance, Purchasing, and Drydock Managers to deliver the industry's most comprehensive asset lifecycle management tool.

5 3D Visualization

The 3D capability enables users to map thickness measurements and anomalous conditions directly on a 3D model of the as-built asset. Estimate and calculations tools make planning and budgeting of steel replacement more precise. Operators benefit from a reduction of risk exposure and unplanned downtime.

- *Creating and Visualizing Gauging Results* – Mapping and color coded visualization of substantially corroded areas simplify the assessment process and assists with an automated creation of repair plans.
- *Tracking of Gaugings and Trending Forward of Asset Condition* – Use of the 3D module and historical data allows users to quickly visualize current and predict future condition for development of optimal repair strategies.

- *Decision Support* – Support for critical strategic decisions regarding asset life extension, disposition and repair, sell or scrap strategies.
- *Rapid Assessment of Hull Structure* – Extraction of as-gauged model information can be used to reassess corroded areas to optimize repair solutions and rapidly develop repair specifications. Repair options can be assessed and optimized by use of the NS Hull Manager Finite Element Analysis as an add-on or a service.

5.1 Enhanced Tools for Planning and Management of Asset Structural Condition, Maintenance, and Repair

- Supports both historical and current structural condition, inspection and repair data
- More accurate by use of virtual 3D model based off latest as built structural drawings
- Provides better interpretation of inspections for more efficient reporting of asset conditions
- Offers more effective and accurate process for repair of structural deficiencies reducing costs
- Integrated with ABS NS Fleet Management System

5.3 Key Features

- Web enabled from office to asset
- Follows real-world management lifecycle of inspection, planning, scheduling and structural condition monitoring
- Prepares gauging plans and tracks results
- Offers 3D visualization of structural condition, predictive analysis and repair planning analysis

APPENDIX 3 References

1. IACS Recommendation 87, Guidelines for Coating Maintenance and Repairs for Ballast Tanks and Combined Cargo/Ballast Tanks on Oil Tankers, revision 2, 2015.
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3. ISGOTT (International Safety Guide for Oil Tankers and Terminals), 5th edition 2006.
4. IMO MSC.1/Circ.1330, Guidelines for Maintenance and Repair of Protective Coatings
5. IMO MSC.1/Circ.1399, Guidelines on Procedures for In-service Maintenance and Repair of Coating Systems for Cargo Oil Tanks of Crude Oil Tankers
6. IMO Resolution MSC.215(82), Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in All Types of Ships and Double-side Skin Spaces of Bulk Carriers
7. IMO Resolution MSC.288(87), Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers
8. US Occupational Safety and Health Administration (OSHA) – www.osha.gov
9. ABS Guide for Hull Inspection and Maintenance Program, 2016
10. ABS Guidance Notes on the Application and Inspection of Marine Coatings, 2017
11. ABS Inspection Grading Criteria for the ABS Hull Inspection and Maintenance Program, 2017