UK P&I CLUB

Safinah

RISK FOCUS: PAINT

Protecting your asset against the environment

UK P&I CLUB
IS MANAGED
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Guarding the value of your asset from corrosion

The primary role of a coating is to protect the asset from the environment it has to work in, in order to provide as long a service life as possible. Not only does corrosion affect service life, it has a real and detrimental effect on costs to the asset owner in terms of service time, down time, performance levels and ultimately, asset value.

41%

Studies show 41% of coating failures are due to poor specification

100x

Repairing coatings offshore can be up to 100 times the cost of the initial coating

25bn

Worldwide, $25 billion per annum is spent on marine coatings

$2tr

Each year, $2 trillion is spent tackling corrosion

90secs

One tonne of steel rusts every 90 seconds

3%

Faulty paint is the cause of 3% of failures

The coating on a vessel is only a fraction of the thickness of the structural steel, and certainly much less than the cost of the steel, but without paint the asset value would rapidly decrease and working life would be short.

Thickness of coating compared to that of the structural steel

Coating lifetime

The length of service obtained from a coating depends on three main factors:

a. How well the coating was applied initially,

b. The environment the coating is in, and

c. Whether routine maintenance is carried out.

If the environment is not too aggressive and routine maintenance is carried out, then the coating may reasonably be expected to last 15 years and beyond.

In fact, for vessels above 500 gross tonnage, the coatings in ballast tanks are under IMO Performance Standards for Protective Coatings (PSPC) rules, a standard designed to achieve a target coating lifetime of 15 years. More on Water ballast tanks later.

If, on the other hand, there is poor maintenance and the environment is very aggressive, which might be the case in cargo tanks, coating lifetime may be as short as five years.

Coating failure

Prevention is better than cure.

Coating failure or breakdown can occur for a variety of reasons, including structural design, coating specification, poor surface preparation, poor application and poor maintenance. Nothing can be done on structural design, and unless the reader is thinking of buying a new ship, nothing can be done initially on good surface preparation or paint application.

However, putting in place and maintaining routine maintenance is a must.

Initial maintenance may involve little more than regular inspections, but once coating damage or coating breakdown is detected, it should be repaired to prevent corrosion from spreading.

Importance of surface preparation

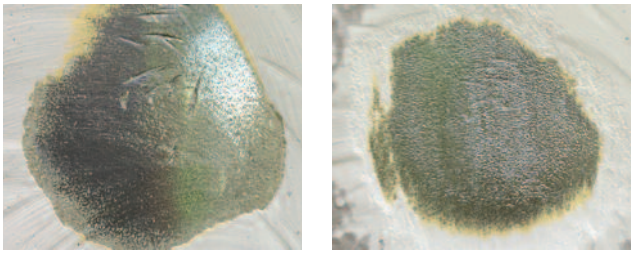
Good surface preparation is the foundation for any repair. This involves making sure that the prepared surface is clean and has a surface profile. Any contaminants left on the surface e.g. loose rust, oil, grease, dirt, salts, chemicals or dust prior to coating will lead to poor coating performance.

This stage is possibly the most important part of the coating process.

Poor surface preparation can mean either no surface preparation has taken place at all, or that what was attempted was insufficient either in terms of producing a profile for the paint to adhere to, or failure to properly clean the surface before paint application.

Of particular concern when repair is carried out on board is the use of power tools and the tendency to polish the surface, removing the steel profile.

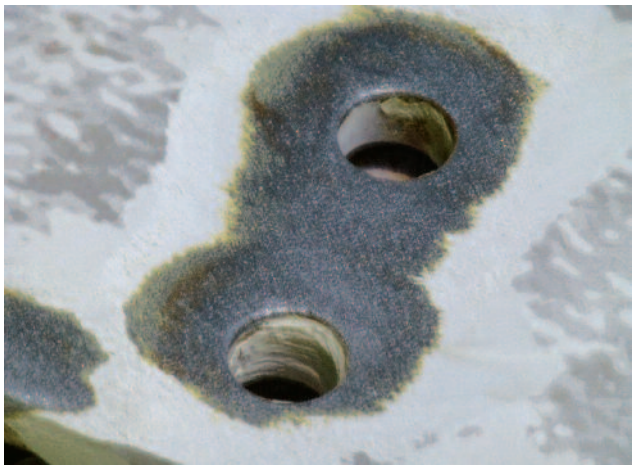
An example of the 'finish' obtained using a conventional hand held tool is shown below. Note the shine on the metal surface on the left compared to the profiled surface on the right.



Poor surface preparation is one of the single largest causes of paint failure and could leave your vessel in poor condition, with random and extensive delamination and corrosion.

If poor surface preparation is combined with over application, the result could well be large scale detachment.

Polished mechanical tooling



Repair area with profiled surface ready for painting

Measuring the dry film thickness (dft)

Case study: Coating delamination

Safinah was requested to investigate the cause of paint detachment from a new build vessel.

A review of the paperwork showed that the method of surface preparation involved disk grinding the surface before application of the primer coat.

Examination of the under-surface of the delaminating coating showed two distinct features:

a. The absence of grinding marks i.e. the surface had not been ground as per instruction, and

b. the presence of embedded particulate material i.e. paint had been applied over a dirty surface.

Both of the above indicate very little/no surface preparation had taken place.

Technical note:

The fact that the particulate material was embedded into the underside of the coating clearly indicates that the wet paint was applied on top of the material. If the particulate material had been loosely adhering to the paint under-surface, this would indicate that the material had found its way in between the delaminating paint and the underlying substrate after detachment had occurred.

Importance of paint application

Over and under application

Two common causes of coating failure are related to coating thickness. Both over and under application of the protective coating have the potential to cause problems: It is therefore important that the paint manufacturer's guidelines are adhered to with regard to the recommended paint dry film thickness (dft).

Over application of the tank coating at new build can result in paint failure if insufficient time is allowed for the coating to cure properly before loading the first cargo.

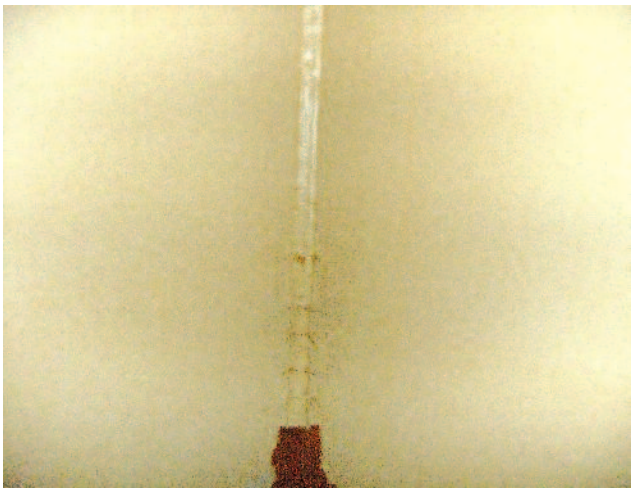
If over application is known to have occurred, seek advice. Delay loading your first cargo until you are sure the coating has cured properly. Once the damage has been caused, if it is too extensive for patch repairs, then the coating will need to be replaced.

This is a case where more is not always better.

Another problem that can be related to high dry film thickness is development of cracking. This can happen due to the build-up of stress in the coating, which can be exacerbated by thermal cycling, especially if the cargo has to be heated.

Cracking is a problem that is particularly associated with welds and corners – where there is a change in geometry.

Once the paint has cracked, underfilm corrosion can occur which then results in paint detachment.



Cracking in paint over weld

Under application of the protective coating can, and does, lead to early coating failure with scattered corrosion in areas of under film thickness.

The main tools used to apply paint on board ship are brush and roller.

Scattered corrosion

It is very easy to under apply paint when using either of these tools as the tendency is to spread out the paint too thinly. Even though the required number of coats of paint may well have been applied (as per paint manufacturer's technical data sheet), the repair is likely to be under the recommended scheme film thickness.

This under application means that the repair patch is not able to perform properly as a corrosion barrier. As a consequence, the repair can break down. Note that many of the repair patches shown below show corrosion.

Case Study: Under application of paint

Safinah was approached to carry out a survey of the level of corrosion in an almost one year old water ballast tank. The owner had had two other independent inspections carried out – both had concluded that the extent of breakdown (~1%) was within that allowed by the warranty and therefore could not be claimed for. (Note: greater than 3% rust after one year is a fairly standard warranty kick in point).

It was discussed and agreed that there was little point in repeating a standalone inspection for a third time. However, it was thought that an inspection along with examination of the ship build contract, the paint specification and associated documentation could be beneficial.

The document review identified that 90% of the coated area must be 250microns or greater and the remaining 10% must have a dry film thickness of at least 225microns.

Analysis of the dft readings following the inspection clearly showed a number of areas where the coating thickness fell below the specification minimum.

In fact, 35% of the dft readings were less than 200microns.

A technical claim could therefore be made against the yard.

Technical notes:

a. the water ballast tank scheme consisted of a single coat where control of dft is more difficult compared to a more standard two coat scheme. Despite the inherent difficulty of applying such a scheme, the yard had agreed to this.

b. A two coat scheme is standard under PSPC rules.

Maintenance and repair

Some coating breakdown will occur during normal operation and minor repairs do need to be carried out whilst at sea.

Repair should take place at the earliest opportunity.

Depending on the cause and extent of coating failure it may be possible to repair the damage by making patch repairs.

There are two situations, however, where this just is not realistic: if the coating has been over applied i.e. out of specification (and so should have been rejected), or if the surface has not been properly prepared.

In the case of the former, it is possible that over application may result in detachment in other areas over time. In the case of the latter the newly applied paint may suffer from the same adhesion problems as the old paint.

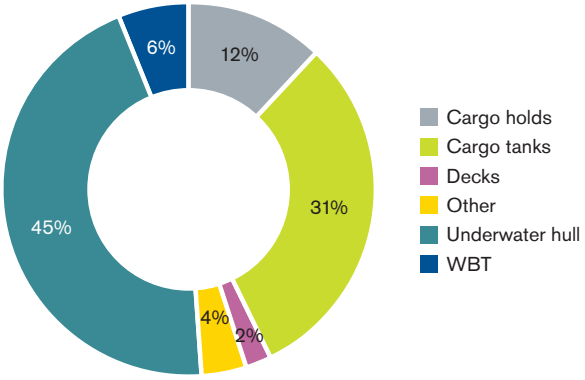
If poor surface preparation is the cause of paint detachment, then the only solution is to remove the paint and start all over again. It pays to get it right first time!

VESSEL AREAS

Contracts by vessel area

Analysis of the marine sector contracts held by Safinah over the last two years indicates the following activity breakdown by vessel area.

Contracts by vessel area %



Whilst this is just a snap shot, it is clear from the above that the biggest area of activity with respect to vessel area, is that of the underwater hull, followed by cargo tanks and then cargo holds.

The top three ranking is perhaps not so surprising considering that coating problems in these areas can directly affect revenue generation.

Vessel areas

The cargo carrying spaces on board a vessel primarily require corrosion protection.

Cargo tanks

For chemical and product tankers that require carriage of high purity cargos, however, another reason for coating the tanks is to preserve the purity of the cargo by preventing contamination from the steel substrate. Uncoated mild steel tanks will corrode when aqueous and water containing cargoes are carried. These tanks would then be unsuitable for carrying higher purity cargoes such as methanol etc.

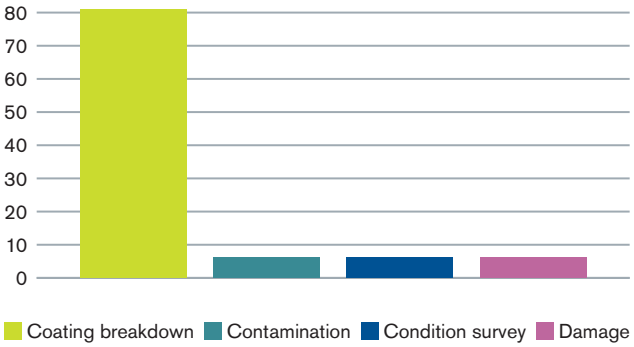
A good tank lining also speeds up the cleaning process during cargo sequencing.

It is well recognised that as the coating comes towards the end of its lifetime, cargoes move towards the 'dirty' end of the spectrum where coating condition is not an issue. However, these cargoes are not as valuable as the high purity ones, so the tanks need to be kept in as good a condition as possible to maintain this higher revenue.

Poor quality coatings could also result in cargo vetting agents rejecting the tanks for carriage of cargo with potentially huge financial penalties.

Analysis of contracts relating to cargo tank area

Cargo tanks – contract types %



Perhaps not surprisingly, the greatest issue relating to cargo tanks is coating breakdown.

The analysis can be considered to be quite simplistic, as there might be several different causes of breakdown. Nevertheless, regardless of how it has come about, it is clear that coating breakdown is the biggest cause of claims in relation to cargo tanks.

Case Study: Not all rust is as it appears

Safinah were asked to inspect and report on the level of rust present in the cargo tank of a one year old vessel. The photo supplied appeared to show a heavily corroded tank top:

On closer inspection, however, the rust was found to be a surface layer of corroded steel grit. Light abrasion removed the rust to reveal a sound coating underneath.

Corrosion was due to the grit, caught in the pipework during construction, which had subsequently fallen onto the tank top. Far from needing to recoat the cargo tanks, the recommendation was to remove the rust staining and apply a single coat of paint.

Technical note:

Abrading the surface of the paint will leave a roughened surface which is more difficult to clean, and therefore may lead to cargo inspectors deeming the tanks not suitable for certain cargoes, hence the need for a single coat over the top.

Cargo resistance lists

Paint used in product and chemical tankers (tank linings) have associated cargo resistance lists produced by the paint manufacturer that document which cargoes can be safely carried and under what conditions.

Sequencing of cargoes can also be an issue. If this is the case, the cargo resistance list will indicate which cargoes this restriction applies to.

If a material does not appear on the list, it is possible that it is exempt from carriage. In this instance, the paint company concerned should be contacted for clarification.

In addition, certain (more aggressive) cargoes cannot be carried for a certain time period following application of the paint. Carriage of other less harmful cargoes is permitted during this time period.

This period is required for the coating to 'cure', and become more resistant to an aggressive cargo. Trying to circumvent the required period may result in paint failure as the coating may not be resistant enough to prevent attack from a more aggressive cargo.

The length of this initial time period should be identified by discussion with the paint company concerned. After this initial period, it is safe to carry more aggressive cargoes.

Carrying a high purity cargo in the first months after application may not damage the coating, but the coating could damage (contaminate) the cargo!

Post cure

To help obtain better cargo resistance, some tank coatings require a post cure.

This happens when the coating is exposed to a specified temperature for a specified time, usually (but not always) straight after application, before the carriage of any cargo.

Post cure promotes a greater degree of reaction in the coating, which creates a greater cross link density in the coating, which in turn leads to a more resistant coating.

Not all coatings require such a post cure.

Exposing coatings to a post cure if one is not required is not beneficial, and may in fact invalidate the paint warranty.

Conversely, if a coating specifies a post cure, this is what must be done. If not, the coating will remain under cured and therefore less resistant to aggressive cargoes and therefore more prone to damage.

If a post cure is specified but is not carried out, the area should not be accepted.

It is a false assumption that carriage of a heated first cargo will effect satisfactory post cure. It may not.

Cargo holds

For a bulk carrier, the cargo holds are the revenue generating spaces.

The main performance characteristic for cargo hold coatings, aside from corrosion resistance, is its ability to withstand mechanical damage.

Mechanical damage may occur at any stage from loading the cargo, to cargo settlement to unloading.

Much of what is written above about cargo tank linings also applies to cargo hold linings: particularly the need to restrict certain cargoes in the early life of the coating,

Unlike cargo tank linings, however, it is unlikely that there is a cargo resistance list to refer to relating to safe carriage of materials, although the paint company may well recommend avoiding hard angular cargoes initially.

One specific risk of which there is general poor awareness, is the carriage of bulk coals, especially in the early stages of the coating lifetime.

There are two specific problems, both related to softening of the hold coating:

a. Some coals contain solvent, which can be absorbed by the coating.

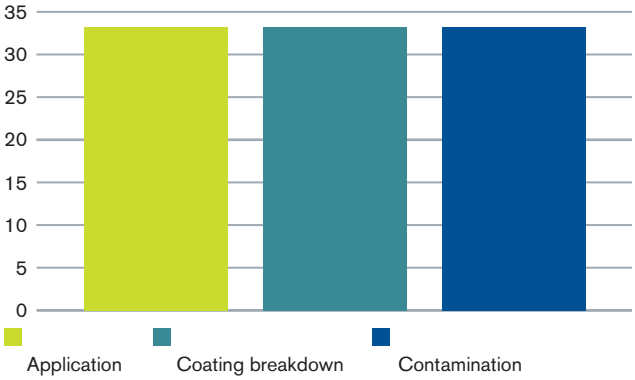
b. Coals can exotherm, producing heat.

Once the coating has softened, there is a greater probability of coating damage as the cargo settles and drags the coating down with it.

Analysis of contracts relating to cargo holds

From the problems seen, there is an even split between coating breakdown, application and contamination issues.

Cargo holds – contract types %



Water ballast tanks and coating technical file

As mentioned previously, the painting of water ballast tanks must comply with the requirements of IMO Performance Standards for Protective Coatings (PSPC).

This means two things:

a. The coating has to be PSPC compliant, and

b. A coating technical file should exist on board the vessel.

If considering buying a second-hand vessel over 500GT where:

a. The building contract was placed on or after 1st July 2008

b. The keel was laid on or after 1st January 2009

c. Delivery was on or after 1st July 2012

Then look for the coating technical file.

The coating file is an important document, which contains not only the relevant coating history but also information on surface preparation. This document will help with making future decisions about maintenance and repair.

Hull: Underwater

It is well known that significant performance penalties will be incurred if the underwater area of the hull is not coated to prevent fouling.

As fouling progresses, the friction of the hull through the water increases, resulting in a need for more power to maintain the same speed or a reduction in speed. Both cost the charterer or owner more money.

The first fouling to occur is slime, which is then followed by weed fouling and finally, by hard shell fouling.

It was thought originally that slime fouling only had a 2-4% fuel penalty. However, there is a much greater recognition that slime fouling alone can generate a fuel penalty of up to 15-20%, whilst hard shell fouling can give a fuel penalty of up to, and over, 40%.

Prevention is better than cure.

Types of fouling control

To date, there are three main types of antifouling available on the market:

a. Conventional biocidal antifoulings

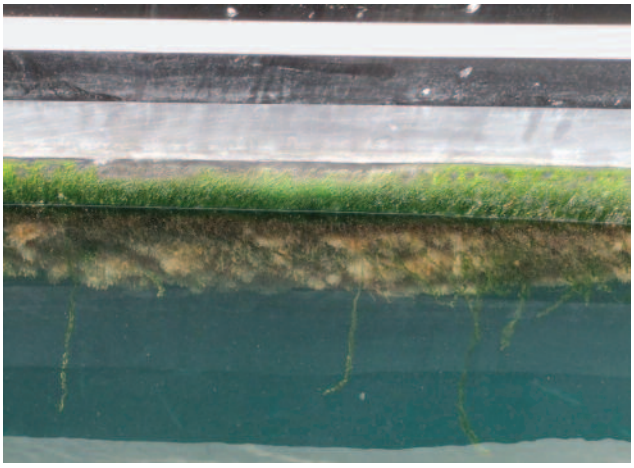
This category breaks down into several different sub categories including:

- Control depletion polymer (CDP, or ablative), Copper, Zinc or Silyl acrylate self polishing copolymers (SPC), and hybrids of these.
- Such coatings rely on the film surface being continually refreshed to expose active biocide/s to prevent fouling.
- These coatings have different lifetimes, which generally range from 12 to 60 months.

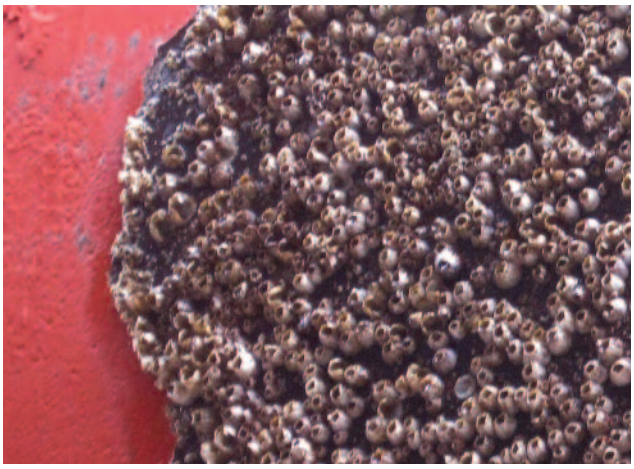
b. Hard, surface cleanable coatings

These do not 'prevent' fouling – but the hardness of the coating is claimed to allow the surface to be regularly scrubbed to remove fouling.

Slime fouling



Weed fouling



Hard calciferous fouling

c. Foul release coatings

The coating has an extremely smooth, low energy elastomeric surface, which makes it difficult for fouling to adhere.

In theory, motion of the vessel through the water will release attached fouling. These coatings are based on silicone chemistry with various additives such as silicone oil, fluoropolymer, etc. Foul release coatings generally do not contain biocides, however, recently, at least one manufacturer has introduced a biocide containing product.

Antifouling selection

It is important that the correct type of antifouling is selected in view of the vessel's operational needs and coating lifetime requirement.

No single antifouling can meet all the operational conditions for a particular vessel. In addition, some of the systems currently on the market are better than others in specific operating conditions.

A vessel with low activity, slow steaming and a risk of extended static periods will have a different antifouling requirement to a vessel which has high activity, is fast steaming, is only static for short periods of time and has a predictable operational profile.

In addition, different areas of the hull are likely to experience different operating conditions, which are also likely to affect, if not the type of antifouling, the thickness of the applied antifouling.

CDPs are typically specified for up to a 30 month service period, whilst hybrid SPC-CDP type coatings and pure SPCs are specified up to 60 months.

There is, of course, a cost associated with each type of antifouling, and all paint companies that offer antifoulings will generally offer three levels of anti fouling protection: 'standard', 'premium' and 'ultra'.

Antifouling coating selection might also be affected by where hull cleaning can take place, whether part of the vessel's trading pattern takes it into fresh water, etc. Thus, where the ship trades, as well as how it trades, needs to be carefully considered.

Antifouling pros and cons

The following is not intended to form a comprehensive study of the attributes and drawbacks of the various antifoulings, but to present a very short overview. A much more detailed study is required to convey all the various aspects of the different antifoulings available on the market.

Whilst each technology type, when used within the limits of its capabilities, provides a good solution, there are also potential draw backs. Some of the issues related to antifouling technology are given below:

Conventional antifouling

Rosin in the CDP type products gives rise to problems with coating integrity as is softened by water absorption and may be damaged more easily than the SPCs on cleaning. This is slightly less of an issue with hybrid coatings, which contain less rosin.

With CDP type coating, biocide release is not linear over the coating lifetime but has a high emission of biocide initially which tails off with time. In addition, due to the mode of action, this coating type has an inherent fuel penalty built in.

A specific draw back with SPCs is the lack of performance in fresh and or brackish water.

Hard cleanable coating

This coating will foul and regular cleaning is required. If regular cleaning is not possible, heavy fouling will occur, increasing the drag on the vessel. This is what your vessel could look like after only 2-3 months, with both weed and barnacle fouling.

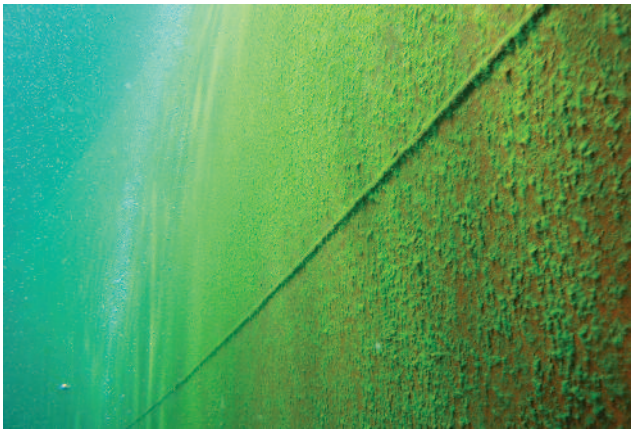
Although the hard coating can be cleaned with less apparent damage, the surface will suffer from micro-abrasion during the cleaning process, which will result in a rougher surface compared to the coating straight after application.

Successive cleaning regimes over time will increase this micro roughness, especially if the surface is not polished after scrubbing. This will, in turn, lead to increased fuel costs.

Foul release

The early biocide free version of foul release coatings suffered from slime fouling. Weed and barnacle fouling was also a problem with slow steaming vessels. Faster steaming removed the problems with weed and barnacle fouling, and whilst it helped to keep the slime down, it did not remove the slime completely.

A large fleet owner chose to use market leading foul release technology on its vessels, but due to the presence of slime and the associated increased fuel penalty, the owner decided to remove the foul release coatings and return to biocidal antifoulings. So if a vessel is slow moving, the biocide free version of this technology is probably not appropriate for use.



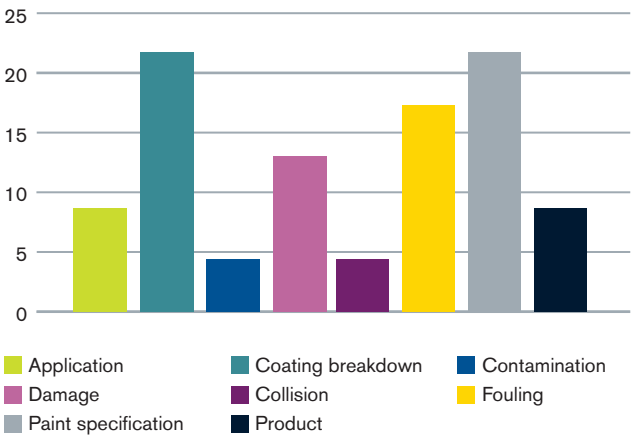
In addition, as the coating is soft, cleaning has to be effected by soft brushes or other non-contact methods, which can take more time and is more expensive than with other more conventional cleaning techniques.

Analysis of contracts relating to underwater hull area

Root cause analysis of contracts involving the underwater hull area is, at first glance, perhaps more surprising than might have been anticipated.

It is clear from the results below that as well as antifouling, there are several other issues relating to this area of the vessel, which are of concern.

Underwater hull – contract types %



Purchase of a second hand vessel or charter

It is important to realise that the existing antifouling coating would have been selected to work with the trading route / trading pattern of the vessel.

From an antifouling perspective, the biggest risk on buying a second hand vessel, or chartering a vessel, is that the new trading pattern / trading route is different from the vessel's current pattern and route, and as such, the applied antifouling is less suitable. If this is the case, there is a greater risk of problems occurring relating to antifouling performance.

Hull: Above water

This area is mainly an area of aesthetic concern. Coating problems in this area, in general, are twofold and relate to:

a. Coating detachment following application outside of the overcoating interval, and

b. Mechanical damage to the coating system.

Decks

These are usually protected by a non-skid coating. The paint contains particulate material, which creates a rough surface. It is important to realise that just because the surface is rough it is still possible to slip, especially if oil has been spilt onto it.

SUMMARY

Paint is important in asset protection. It can have a profound effect on both running costs and revenue generation.

To preserve coating life, there are three clear steps:

a. Select the correct coating scheme

b. Ensure good surface preparation

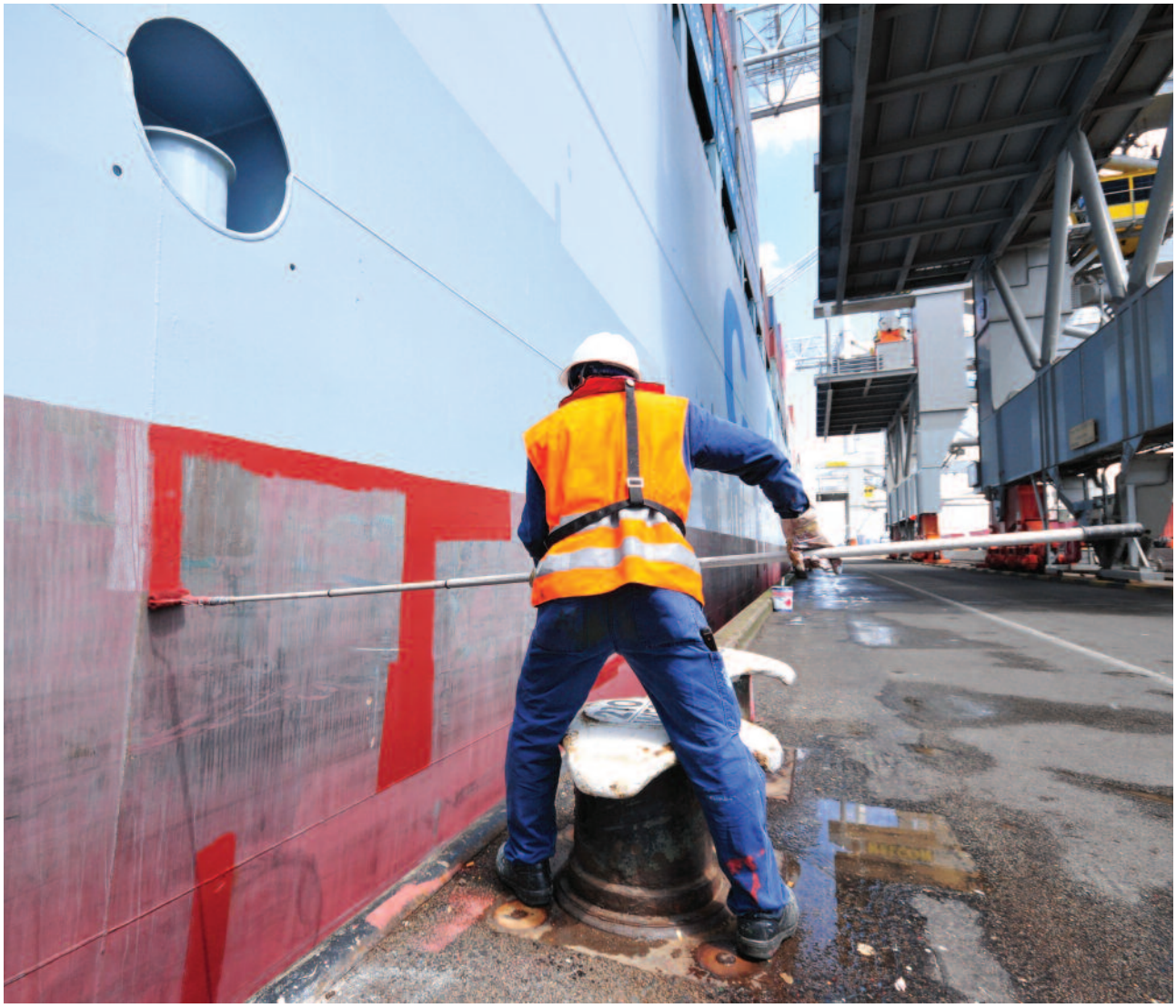
c. Ensure paint application conforms to the paint specification

Concentrate on the key areas that cause the most pain with regard to coatings:

a. Underwater hull

b. WBTs

c. Cargo tanks and cargo holds



Safinah

Safinah has a worldwide reputation for creating innovative and effective solutions to all aspects of coating issues, reducing client costs, adding value, improving quality and delivering results.

The in-house team has an unparalleled understanding of all aspects of coatings in the marine, protective, yacht and chemical industries, which enables Safinah to provide authoritative, expert advice on the whole chain of activities supporting your business needs and goals.

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GLOBAL NETWORK

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