Beware the challenges of surveying steel hull inland waterways craft – and other considerations

By Geoff Waddington

Geoff Waddington, IIMS President, speaks out passionately in light of a number of issues that are causing him (and colleagues) concern relating to the survey of inland waterways craft, steel narrowboats and barges in the UK. His advice, however, is good practice for surveyors working around the world.

I admit that I have only limited experience of inland waterways craft. My career in the marine industry started over fifty years ago on ships. Over the last forty years of surveying both large and small craft, I have been involved with the new construction of a wide beam barge, fitting out of a narrowboat, insurance investigations involving narrowboats and small, steel inland waterways craft, and of course many GRP motor cruisers designed for both use on inland waterways and RCD CE CAT B vessels, which were in use on inland waterways.

During the last few insurance investigations into claims against surveyors of inland waterways craft it has become apparent that there is a wide range of standards being applied by surveyors during their assessments of surveyed vessels. This has resulted in claims against IIMS members, meaning it has become necessary to readvise surveyors, insurers and lawyers in regard to 'what is the acceptable level of corrosion and resultant diminution of metal hull plate-work'. When asked, surveyors opinions varied wildly for the acceptable level of wastage due to the corrosion of steel plate as far as diminution and pitting are concerned. For example, in regard to 6mm plate, opinions vary between accepting a limit of 20%, (approximate 4.8mm) to 50%, (3mm), to the lowest limit of 70%, (2mm). In fact, both the MCA and Classification Societies have percentage rules, which in general are 20% dependent on longitudinal position and these rules apply to all craft whether sea going or inland waterways.

Talking to surveyors of inland waterways craft, as I have done, there appears to be a good deal of 'That's OK', and 'That's the way it's always been'. I have yet to see a survey report in dispute, as far as an inland waterways vessel was concerned, where the vessel surveyed was clean and presented in a condition where the hull plate work can be thoroughly inspected and almost never has there been any access to inspect the outer bottom. A hull fouled by freshwater mussels, weed and slime cannot in any circumstances be properly inspected, examined or even assessed. However, this seems to be routine practice for some. I was advised that the reasons are that owners and purchasers will not accept the cost of lifting and pressure washing the craft for survey - and due to the extensive use of cheap environmentally unfriendly bituminous paint, the potential cost of re-painting the hull prior to relaunch due to the "Blacking" being washed off by the pressure washer. I wonder if these owners would be happy to drive a vehicle without a current MOT or a house without survey and the mandatory certification.

Some of these issues also appear to be the result of the lack of suitable facilities for the removal of craft from the water. Some vessels involved in claims were removed on trollies, which were too low to allow access underneath. Another instance was that the vessel to be inspected was too heavy for the capacity of the hoist, so it was only lifted just an inch or two above the water (presumably because of concerns over gear failure). Conducting surveys in these conditions is an impossible challenge and a surveyor is setting themselves up to fail. Perhaps some surveyors should invest in diving equipment, or duck underneath and save the cost of lifting the vessel from the water altogether!

It occurred to me that a surveyor might just as well stay in their vehicle and conduct the survey through the window. Unsurprisingly, I subsequently found out that this phenomenon already exists and is known in the USA as a **drive by boat survey**.

Internally ballast is often paving slabs. One Dutch barge I was asked to repair had bilges full of gravel. On removal of the gravel, she was found to be corroded through from the inside. Fixed internal panelling and flooring also means that often the internal construction cannot be inspected with flat bilges precluding the removal of bilge water by bilge pumps and contained sub-division leading to trapped internal water. And here is the hub of the point I am making. If you cannot conduct a survey properly and, therefore, professionally, either don't do it at all, or at least ensure that the instructing client is aware that there were circumstances that made a thorough inspection impossible at time of survey and consequently the integrity of the hull structure could not be determined.

The question has also been raised as to whether the rules of construction applied to inland waterways craft and this was also unknown territory. I have determined that by analysing the existing rules and reading between the lines, so to speak, all vessels (sea going and inland waterways), should comply with the rules applied by the Classification Societies, CE Compliance (RCD ISO 12215) and the MCA. These are the standards to which the vessels should have been originally constructed to and this should be determined by the surveyor to enable assessment of suitability and of any subsequent deterioration.
The Canal Boat Builders' Association (CBA) Code of Practice for steel inland waterways craft and narrowboat construction includes vessels up to 20 feet constructed of 3mm steel plate. All vessels to be constructed to RCD Cat D (IAW ISO 12215).
Under RCD preferred Classification Society rules are those that are principally intended for use with pleasure craft, e.g.:

Germanisher Lloyd Pleasure Craft Rules (2004)

American Bureau of Shipping Guide for Offshore Racing Yacht (1994)

American Bureau of Shipping Guide for Motor Pleasure Yachts (2000)

As I have to increasingly deal with members of the IIMS who have fallen foul of these issues, we should be careful in the instructions that we give to members and in particular to student members and those seeking to learn through the IIMS Professional Qualification modules.

The information required to make a safe judgment on the acceptable parameters for conducting a survey of a steel inland waterways craft is available to all, if you are willing to look for it. Below is what I consider a well written preconceived piece by a current IIMS student, Mr Mathew Willis, who readily admits that he is not a surveyor, but someone who would wish to become a surveyor.

Levels of diminution requiring replacement/repair are variously considered to be a loss of approximately 15-25% of the original plate thickness. Many insurance companies specify a minimum of 4mm plate thickness, but this is not particularly helpful as some vessels are initially built with thinner plate than 4mm. Additionally whilst reduction of 5mm plate to a mean of 4mm thickness is a loss of 20%, reduction of 8mm plate to 4mm is a loss of 50% thickness and therefore should be considered much more serious in respect of the scantling calculations that originally led to the specification of 8mm plate. The surveyor must use all the information gleaned from the vessel's original build specification concerning plate thicknesses as well as his visual observations and experience as a surveyor before making a final decision in his report. For the purposes of this survey a loss of 20% of original thickness will be deemed the point at which steel plate is replaced.

After hauling, the hull should be pressure washed and cleaned of any marine growth. The first part of the survey should involve a thorough visual inspection of the hull plating including welds and superstructure plating to assess general condition, evidence of buckling or distortion and identification of areas that might warrant more in-depth attention with the hammer and UTS gauge. If coating of the steel is not removed, then the surveyor should also make a detailed assessment of the condition of the coating and its adhesion to the steel plate and observe at what stage of its 'life cycle' it appears to be at.

A UTS survey is only as good as the coverage that is achieved and whilst it is inevitable that some areas will be beyond access, the surveyor should ask the owner/operator to enable access to as many internal areas as possible so that surveyor can check internal plate and frame condition. If necessary, the owner should be requested to remove pronounced rusting or flaking corrosion internally and externally in advance to improve the reliability of the survey results.

Unfortunately, the worst corrosion is likely to occur on the internal areas that are least accessible and which will have suffered the most from lack of maintenance and painting hence the likelihood of corrosion. To reflect this the surveyor's terms and conditions will need to include a disclaimer covering areas that cannot be inspected to the surveyor's satisfaction.

Whilst many meters (including the Cygnus 4) claim that coatings make no difference to the readings obtained, in practice grinding back to smooth metal will generally produce more reliable results. This needs to be explained to the commissioning client and the potential risks arising out of not having the coating removed should also be reflected in the disclaimers in the surveyor's terms and conditions.

For the purposes of the UTS survey the surveyor will also require a chipping hammer which can be used for chipping away small areas of coating if diminution is suspected. On sound steel this will cause no lasting damage to the steel, but it may well uncover rotten plate not detected by the UTS meter and in extremis it might actually make a hole in the hull if it is significantly corroded, which is better discovered out of the water than afloat.

Following a thorough visual inspection, the hull and superstructure on this vessel should be divided up into 1m x 1m squares which can be delineated using chalk line markings to enable the surveyor to follow a structured approach to the survey by testing one area at a time, ensuring that complete coverage is achieved. The number of tests per metre square is open to some interpretation but a minimum of 9 per m2 is recommended. These should be equally spaced within the square whilst ensuring that any pitting corrosion detected is measured at its deepest point. (This may also require the use of a pitting gauge.) Additional readings should be taken at areas of maximum stress concentration such as plates that have been fabricated

into bends, bilges, chines and deck edges and especially in the area approximately on and extending 400mm below the waterline which is generally a focus area for corrosion on all vessel types.

In response to the question regarding 'Over-plating' or 'Doubling' I personally recall in the 1980's the MOD requiring that all welders on hull structure (myself included), had to be code B qualified to a hull insert inclined overhead procedure and that doubling plates were to be considered an emergency repair process only. In the 1990's as a ship repair manager Lloyd's surveyors would only allow doublers as temporary repairs, which were required to be replaced with inserts at the next scheduled docking. However, this was all in relation to sea going craft. For inland waterways wind and waterline over-plating appears to be quite common and if completed properly with window welding to ensure attachment to the underlying structure, should be considered a suitable repair, however future surveys should take into consideration that one never knows what is going on under the over-plating. Please also see a link below to an IIMS article from 2017 on this subject at **https://bit.ly/3tUTwWF**.

The exception would be floating **house boats** (definition: *a boat which is or can be moored for use as a dwelling*), often on drying berths, the principal concern here is keeping water out and staying afloat rather than structural strength. But again, this must be made perfectly clear in the report, because the danger is that the vessel could be sold to someone who intends to re-engine the craft and turn it back into a navigable vessel, it is not unknown for owners to take their vessels across channel to cruise the continental waterways.

I want to share and re-emphasise some extracts from my President's column, published in the December issue of the IIMS Report Magazine.

"Going back to inland waterways craft, I had reason to research the standards and rules which should be applied to the inspection and operation of these vessels. I was amazed to find that many surveyors of inland waterways craft had little knowledge of the rules and that they applied their own standards and formed their own opinions".

"I recently read an account of an incident involving the accidental deaths of two unfortunate small craft occupants due to Carbon Monoxide poisoning. This was not an isolated incident and there have been many more instances of this silent invisible killer on both commercial and pleasure vessels. The incident highlighted the need for surveyors to act in the absence of current mandatory requirements. Until legislation is passed, and manufacturers, Certifying Authorities and installation engineers are required by law to ensure that CO detectors are fitted to vessels it remains down to the individual vessel owners and operators to do so. This means that potentially the only professional and responsible people who attend on board a vessel are marine surveyors, who should assess the risk during their attendances for survey, be it pre-purchase, insurance, valuation, or indeed any other reason for them to be on board, whether it is a requirement of their attendance instructions or not".

"It is a wakeup call to all surveyors to remember that they have a duty of care and include some statement along the lines of '*Although not part of this particular level of survey or our instructions we must bring to your attention that*' and include any advice that the surveyor can offer to improve the safety of the vessel. In some of the accident reports although no blame is apportioned it was obvious that at least one of the vessels had been quite recently surveyed. The loss of life in the most recent cases had been the result of, in one instance, a diesel heater, another a butane-fuelled gas cooker, two instances with petrol inboard engines, and one a petrol generator. Diesel inboard engines are also a source of Carbon Monoxide as are solid fuel heaters.

My conclusion is that unless a vessel is an open sailing boat or rowing dinghy there will most probably be a requirement to assess whether CO detectors should be installed and if they are installed do they work? I found a vessel recently which had two CO detectors, one in each cabin area, one of which had the wires cut presumably to silence the alarm! When was the last time you checked the batteries in your home smoke alarm?

Over half of these incidents involved inland waterways craft. In 2014 the MCA and the Association of Inland Navigation Authorities produced the Inland Waters Small Passenger Boat Code, which is a Code of Practice for small commercial vessels operating in category A, B, C and D waters, and other inland waters, which specified Hydrocarbon detectors on vessels with gas consuming devices. Unfortunately, not all gas detectors detect Carbon Monoxide. Since then, as recently as 1st April 2019, there has become a BSS requirement for CO detectors on inland waterways craft, but at the time of writing no such mandatory requirements exist for other vessels".

SEA GOING PLEASURE VESSELS	INLAND WATERWAYS COMMERCIAL VESSELS	SEA GOING COMMERCIAL VESSELS
RCD CAT A		**MCA CAT 1 CAT 0**
OCEAN		MCA CAT 0 UNRESTRICTED SERVICE
WINDS EXCEEDING FORCE 8 SEAS ECEEDING 4 METERS		**MCA CAT 1** UP TO 150 MILES FROM A SAFE HAVEN
RCD CAT B OFFSHORE		**MCA CAT 2** UP TO 60 MILES FROM A SAFE HAVEN
WINDS UP TO AND INCLUDING FORCE 8 SEAS UP TO AND INCLUDING 4 METERS		
RCD CAT C INSHORE		**MCA CAT 3** UP TO 20 MILES FROM A SAFE HAVEN
WINDS UP TO AND INCLUDING FORCE 6	**MCA Navigation Safety Branch (NSB)**	**MCA CAT 4** UP TO 20 MILES FROM A SAFE HAVEN IN FAVOURABLE WEATHER AND DAYLIGHT
SEAS UP TO AND INCLUDING 2 METERS	**UK MCA MSN 1837 / MSN 1776** defines UK inland water Categories as follows: These categorisations apply specifically to the operation of Class IV, V and VI Passenger Ships and also determine which waters are not regarded as "sea" for the purposes of regulations made, or treated as made, under Section 85 of the Merchant Shipping Act.	**MCA CAT 5** TO SEA WITHIN 20MILES FROM A NOMINATED DEPARTURE POINT IN FAVOURABLE WEATHER AND DAYLIGHT
RCD CAT D SHELTERED WATERS	**CAT D** TIDAL RIVERS AND ESTUARIES	**MCA CAT 6** TO SEA WITHIN 3 MILES FROM A NOMINATED DEPARTURE POINT AND NEVER MORE THAN 3 MILES FROM LAND
WINDS UP TO AND INCLUDING FORCE 4 SEAS UP TO AND INCLUDING **0.5M**	WHERE THE SIGNIFICANT WAVE HEIGHT COULD NOT BE EXPECTED TO EXCEED **2.0 METERS** AT ANY TIME.	IN FAVOURABLE WEATHER AND DAYLIGHT
	CAT C TIDAL RIVERS AND ESTUARIES AND LARGE DEEP LAKES AND LOCHS WHERE THE SIGNIFICANT WAVE HEIGHT COULD NOT BE EXPECTED TO EXCEED 1.2 METERS AT ANY TIME.	
	CAT B WIDER RIVERS AND CANALS WHERE THE DEPTH OF WATER IS GENERALLY 1.5 METERS OR MORE	
	CAT A NARROW RIVERS AND CANALS	
	WHERE THE DEPTH OF WATER IS GENERALLY LESS THAN 1.5 METERS	

My Comment
The cross-over between RCD Cat D waters and MCA Cat D waters is inconsistent. There is a significant difference between 0.5 metre waves and 2.0 metre waves. There is consistency between Sea Going Pleasure Vessels and Sea Going Commercial Vessels; therefore, why do Inland Waterways Pleasure Vessels not have the same restrictions of areas of use as Inland Waterways Commercial Vessels?

Internet extract from Rugby Boats - see **https://bit.ly/39mzM4Y**:
The RCD is a grey area for quite a few people, and a complete mystery to the rest of us. It is effectively a CE mark for a boat. It is poorly policed in the UK and many boats sold on the market, both new and used, fail to comply with the regulations, particularly as in the case of boats classed as Category D (which includes all narrow boats) the builder self-declares without any requirement for an independent inspection.

For reference see the RYA website at **https://bit.ly/3Ct6m1p.**
"The Inland Waters Small Passenger Boat Code was produced jointly by the MCA and the Association of Inland Navigation Authorities (AINA) to provide a national framework, which local authorities could apply in full or in part as they see fit. The Inland Waters Small Passenger Boat Code covers equipment, build and manning and which elements of it are applied (if any) is up to the Local Authority; they can of course set totally different regulations if they feel that way inclined. However, the manning aspects of the Code have now been superseded by the relevant Boat Master's Licence (BML) regulations" - (see MSN 1853 at **https://bit.ly/3zqnC5x**.

My Comment
Contrary to popular belief the MCA continues to be setting the standards for Construction and Maintenance of inland waterways craft. As mentioned earlier a Code of Practice for Inland Waters Small Passenger Boats in cooperation with The Association of Inland Navigation Authorities and British Marine has been produced for inland boatbuilding. Unfortunately, all this means is that there are a number of rules and standards and also a number of associations involved - in fact over 60 different inland waterways authorities at my last count.

My Comment
I also note that the British Marine Inland Boatbuilding 'Code of Practice 2017-2' which incorporates and expands upon the Canal Boat Builders' Association (CBA) Code of Practice regarding steel inland waterways craft and narrowboat construction was, and still is, available only in DRAFT format. My question is 'Has this been finalised and ratified, and how is this to be enforced?'

Overall, the UK's approach to implementation of the Inland Waterway Directive has been to make use of the derogation in the Directive which allowed Member States with inland waterways unlinked by inland waterway to those of another Member State to which the Directive applies, to derogate from some, or all, of the technical requirements of the Directive, or to implement more stringent requirements in certain cases, such as additional provisions for passenger vessels. Reference see - **https://bit.ly/3hR8Izn**.

The UK MCA comments that considers that the NRMM Regulation (Non-Road Mobile Machinery) does apply irrespective of the requirements set out in the derogation to inland waterway vessels operating on Category A, B, C and D waterways.

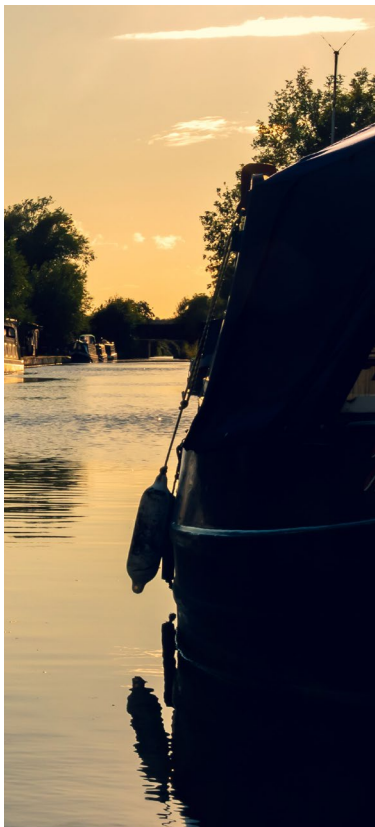
Yet, inland waterway vessels only operating on tidal Category C and D with an installed engine rating power of 130 kW, or above, are subject to the requirements of the Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008. As the NRMM (Non-Road Mobile Machinery) Regulation applies to engines fitted to inland waterway vessels with a net power of 19 kW and above, it will therefore apply to such vessels operating on tidal Category C and D waters which are below the threshold for compliance with the 2008 Regulations.

The MCA states, "The UK has over 4,000 miles of inland waterways. Construction requirements and levels of safety equipment that must be carried on vessels in the UK depend on the nature of the waters in which the vessel operates. *Reference (Hire Boat Code. Issue 1: Technical and Operational Standards')*. There are no national construction requirements for private pleasure vessels." References - (RCD & British Marine Inland Boatbuilding Code of Practice 2017 – 2). (MGN 489 Pleasure vessels are vessels used for sport or recreational purposes and do not operate for financial gain. A more extensive legal definition is provided by the Merchant Shipping (Vessels in Commercial Use for Sport or Pleasure) 1998 (SI 1998/2771), as amended).

My Comment
To conclude, I am sure that there is no simple answer to all of this, and I personally find some of it quite confusing. But I hope this has helped you to make a more informed judgment when undertaking these types of surveys.

The reason for producing this article is that we would like to advise our members of the correct rules to apply in an attempt to level the playing field and ultimately to keep the surveyor safe from litigation.

Geoff Waddington
IIMS President



Jeffrey Casciani-Wood HonFIIMS responds to Geoff Waddington's original article as follows:

Thank you for your screed, Geoff, I agree with everything you have written. The problem lies in the widespread ignorance of boat owners, boatyard staff and some marine surveyors about corrosion in general and that on canal boats in particular. Many seem to think that even a pre-purchase survey of the hull of such a boat consists only in taking UTS measurements of the side shell. That is not so.

Hull corrosion on such boats can be divided into two main types:

1. General corrosion resulting in plate thinning caused, *inter alia*, by the usual electro-chemical process using oxygen and moisture, mill scale, microbially induced corrosion (MIC), and physical damage.

2. Pitting corrosion caused by galvanism (common) or electrolysis (rare).

I will discuss them in order.

Mill scale corrosion is nowhere near as common as one would think. Its existence on a boat over five years of age is unlikely and steel for new constructions can be purchased, shot blasted and primed from the mill in which case it is non-existent. That is not to say that it can be ignored but, to put it into perspective, I have only seen this once in the fifty odd years I was a practising marine surveyor. MIC is very common. About 45% of the boats I have inspected had various forms of attack ranging from minor to almost total coverage. It has been known about in the marine industry from the days of the first iron-clad warships and the *gallionella ferruginea* species was identified and named as long ago as 1830. It is also named (but not discussed) in Barnaby's *Basic Naval Architecture*. I once attended a boat where there was another, well known marine surveyor present. The boat was covered in MIC which the other man put down to *"the quality of the steel"*. General electro-chemical corrosion is not common on the shell except in two main places:

1. The side shell in way of the fresh-water tank,

2. The bottom shell plate.

The interior of the fresh-water tank is a prime place for haematite corrosion. The tank is rarely, if ever, opened after the boat is built. I have never seen one open on a pre-purchase survey. The tank is regularly filled and emptied with water interspersed with fresh air. It is hardly surprising, therefore, that the interior structure corrodes rapidly affecting both the side and bottom shell in way, the tank top and the heel of the bulkhead forming the forward end of the accommodation. How many marine surveyors take UTS readings on the tank top I wonder? The heel of the bulkhead – often only 3 mm thick – is usually hidden behind linings and in accessible. How often is that plate measured for thickness? I know of two boats where the heel of the bulkhead was holed, and quite badly.

For totally specious and scientifically incorrect reasons, boat yards and owners often refuse to paint the bottom plate or to fit it with anodes - a situation which is aggravated by cradles, painting docks and slipways making it inaccessible in many cases. If it is possible to inspect the exterior of the plate it will almost without fail be covered with galvanic pitting, general corrosion and MIC. The outfitter of such boats rarely, if ever, fits access hatches in the cabin sole with the result that the floors and inside of the bottom plate ***cannot*** be inspected. Why do they not fit hatches? It is not difficult to do when the boat is being fitted out.

Your comments Geoff on not removing the coating to examine the shell are valid. I could quote cases to support my comments on the above paragraphs.

Photograph 1. Galvanic pitting on the unpainted bottom of a Dutch Barge

Marine surveyors should also have it banged into their heads that UTS measurements are an addendum to a hammer test and NOT the other way round. Whacking the side of a boat with a 2 lb shipwright's hammer (I still have mine from the days when I was servin' me time) will tell you far more than even closely spaced UTS measurements, which tell you ONLY the spot thickness and nothing else.

They should also know, and understand the implications, of the six caveats that apply to UTS measurements.

As far as minimum shell thicknesses are concerned, it is sometimes suggested that for pleasure vessels under 24 metres in the European Economic Area, ISO 12215-5 would be a suitable standard, even though it is hard to work with unless the marine survyor uses the Hullscant software. Alternatively, Dave Gerr's *Elements of Boat Strength* which uses the scantling number method and is very easy to dip into quickly could be used as an accepted standard as the book is widely recognised and acknowledged. Both of those authorities, however, only apply to new builds, not to boats with a long number of years in service. The scantling number approach suggested above is relatively straightforward for vessels prior to 1998 and for commercial vessels post 1998, but the marine surveyor must realise that minimum allowable thicknesses are dependent on many other factors such as speed, panel size and so on. The author considers anything more than 15% wastage to be the limit before repair work is required and, where possible, quotes the original plate thickness and the percentage loss. The real problem is when the vessel was poorly built and was too thin to start with. The vessel may then be a liability despite no corrosion. In practice, the decision whether or not to repair and to what extent is dependent entirely upon the marine surveyor's experience and that extremely rare and misnamed quality, common sense.

Perhaps the last word on this subject should be left to the Classification Societies. For classed ships built with scantlings in accordance with the IACS Common Structural Rules, *substantial* corrosion is an extent of corrosion such that the overall corrosion pattern indicates a gauged or measured thickness between t_{net} mm and t_{net} + 0.5 mm as indicated in the red section in Figure 1 below. The value of t_{net} is generally 80% of the original thickness. The given formula replaces the original definition where the metal was allowed to lose up to 75% of the allowable diminution before the corrosion was declared to be substantial.

Although the new formula, in the class rules, is strictly only applicable to oil tankers and bulk carriers built after April 2006, the small craft marine surveyor may, and, in the author's opinion, should, use the rule as a guideline. It is certainly technically more realistic than the insurance industry's arbitrary and unreliable 4 mm minimum thickness.

Excessive diminution is defined as wastage of individual plates or items of structure more than that permissible. At that point, the item must be renewed.

Except in areas in way of ballast tanks, neither of these conditions is likely to be found on the majority of small craft but the possibility should not be discounted as doubling is not allowed. The problem with both these definitions for the small craft marine surveyor is that they do not specify the area over which the individual measurements are presumed to apply, and it would appear that they make the unspoken assumption that an individual reading or set of readings represents the average remaining thickness of the plate. That assumption cannot be justified. Furthermore, neither do the definitions take any notice of any pitting bearing in mind that individual pit depths may often exceed the allowable diminution figure. Table 1 gives thicknesses that represent substantial corrosion according to the above rule. The readings are in mm.

Corrosion is often hidden by paint or it may lie in obscure or difficult to access areas. A pricker or screwdriver should be used to probe suspect areas where the paint coat shows discolouration, moisture, or bubbles.

Table 1

Thickness readings indicating substantial corrosion

Original Thickness	4	6	8	10	12
Corroded Thickness	3.7	5.3	6.9	8.5	10.1

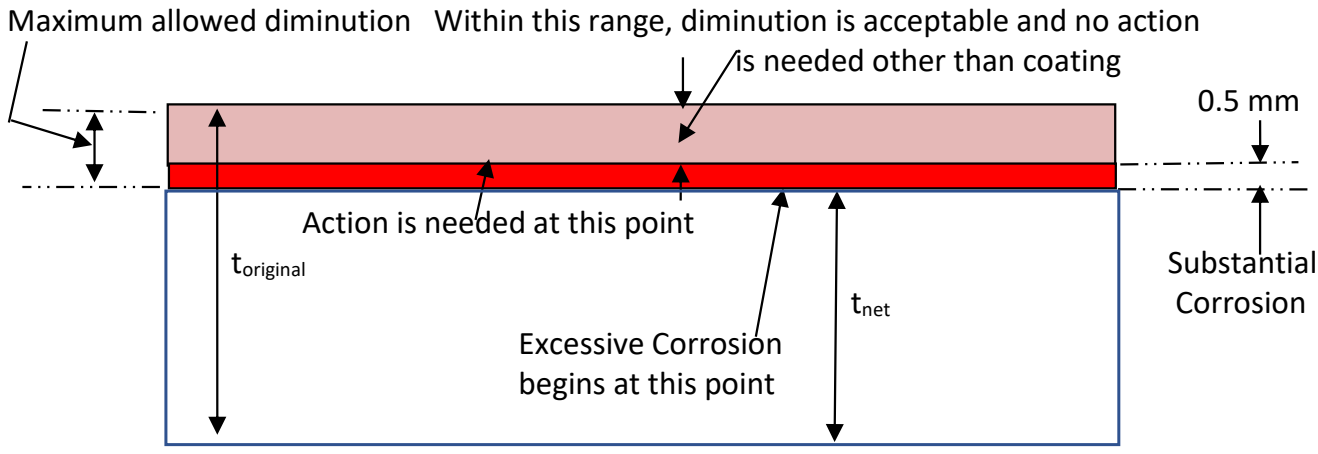


Figure 1. The Classification Society definition of substantial corrosion

In calculating corrosion allowances, the small craft marine surveyor should adopt the following points in his/her philosophy. The allowances are to be:

- no provision or reductions based on so-called superior coatings or extraordinary maintenance of existing coating systems, or the presence of any type of corrosion protection scheme.
- based on a minimum twenty-five-year service life with provision for out of water inspection and re-assessment at the very least every five years.
- based on absolute numbers not percentages, i.e., 1.00 mm not 15%.
- independent of local failure mode assessment, i.e., yielding, buckling or fatigue etc.
- based, wherever possible, on published or otherwise established verifiable data.
- with respect to stiffeners or webs, allowances should be based on loss of thickness not loss of section modulus.
- dependence on vessel size should be considered on a ship-by-ship basis.
- structural items within the same space and subject to the same or similar environmental factors and orientation, as far as possible, should have the same corrosion allowance.
- safety margins should not be included in any corrosion allowance.

The deckhead area of tanks must be dealt with separately from other areas of the tank structure and, for small craft, should be taken as the area above a horizontal line one metre below the top of the tank. Bilge plating should be regarded as the same as the bottom plating basically because there tends to be a collection of rubbish and crud in the bilge area making the plating similar more to the bottom shell than the hull side plating.

The assessment of the amount of pitting is a matter of judgement. In an ideal world every pit would be measured and recorded, but that, obviously, is impractical, time consuming and costly. However, a reasonable assessment should be made and used as the basis for any conclusions regarding the condition of the hull. Two significant figures can offer an assessment of the effect of pitting. They are the maximum and average pit depths. For the purposes of a normal hull survey, the collection of sample area pit depths can be used to determine those two figures to two significant figures. What determines a sample area depends upon survey constraints.

When faced with hull with extensive pitting, the marine surveyor may have to make an on-the-spot judgement as to its seriousness.

He can use the following formula as a guide:

$$A_P \times D_P \geq 0.10$$

where

A_P = fraction of area of the hull's wetted surface with pitting.
D_P = average depth of pits as a fraction of the plate thickness.

The problem of the pitting on shell plating is gauging its effect on the overall remaining thickness of the plate when taking UTS measurements. That can be resolved as follows:

The volume of metal lost by a pit is its plate surface entry area multiplied by its depth times a constant to allow for the fact that the pit is roughly conical in shape rather than cylindrical. Thus:

$$V_P = \tfrac{2}{3} \times \pi/4 \times d_s^2 \times d_e \quad mm^3$$

If, on a given plate, there are no pits covering an area a x b mm2, then the mean loss of metal over that area is

$$M_L = (n \times \pi/6 \times ds2 \times de)/(a \times b) \quad mm$$

where

M_L	=	mean metal loss	mm
V_P	=	volume of pit	mm^3
a, b	=	dimensions of area examined	mm^2
d_e	=	depth of pit	mm
d_s	=	diameter of pit's entry	mm
n	=	the number of pits in area a x b	-
π	=	22/7	-

If the metal loss is less than the difference between the original plate thickness and the net thickness plus 0.5 mm, then no action need be taken but the converse is also true. I recommend that, where possible, the affected area of plating should be cropped out and the metal renewed. Fitting a doubling plate, though commonly practised, can only be described as a bodge and poorly executed job.

Pitting is usually due to a poorly designed or incorrectly fitted cathodic protection scheme *i.e.*, badly placed anodes.

Many individual pits will be found deep enough to penetrate the net thickness of the metal. Where such are scattered, or isolated, they should be pooled or filled with welding. If numerous, then, regardless of the mean metal loss value, the affected area should be cropped, and the metal renewed. If it is decided to double plate an area, then the marine surveyor MUST keep in mind the **Law of Unintended Consequences**.

On a final comment before I move on, how many marine surveyors take and record the weardown on the tail end shaft or ask to see the shaft drawn for close up examination?

Items covered by a general condition survey

These actually, and rather surprisingly, since there are at least two published Codes of Practice covering the point – one by the IIMS and one by the YDSA – vary wildly from person to person but for the author the following is the minimum and is based on the IIMS and YDSA Codes and the known requirements of two leading marine insurance companies. A good survey report for either pre-purchase or insurance purposes on small craft should cover at least the following main parts of the boat and her machinery, rig and outfit as appropriate:

- *Measurement* of the boat's principal dimensions including the depth and freeboard.
- Hull structure, keel, planking, shell plating or skin including ultrasonic thickness measurements or gelcoat wetness measurements as appropriate, cement cover or skin as appropriate, all primary and secondary supporting structure, frames, beams, stringers, bulkheads, stiffeners *etc., etc.,* as far as is accessible.
- Stem and keel bolts.
- Ballast whether loose or fixed.
- Bilge keels and bilge keel bolts.
- Bottom coating.
- Topside coating.
- Anodes including their bonding if appropriate.
- Deck(s) and their supporting structures.
- Superstructure(s) and deck houses.
- Hatches, companionways, weather, or watertight doors.
- Harpins and rubbing strakes.
- Davits, fastenings, and falls.
- Boarding ladder(s).
- Swim platform.
- Deck equipment and fittings.
- Guard and grab rails.
- Ventilators.
- Windows, port lights and scuttles.
- Internal hull examination – compartment by compartment.
- Skin fittings and sea valves.
- Steering gear.
- Rudder(s) and hangings.
- Ground tackle and windlass including the ranging and measurement of the cables.
- Non-invasive or superficial inspection of the main engine(s) and transmission(s) and all other machinery including the stern gear including weardown, shafts, propellers, stern bushes, A, P or V brackets, rope cutters and trim tabs.
- Fuel tanks and fuel system.
- Mast(s), rigging and sails.
- Electrical system including batteries, fuses, circuit breakers, master switches, wiring, navigation lights, internal lighting, sockets etc.
- Nautical equipment.
- Gas system including a soundness test, lock off test and smoke test.
- Fresh water system.
- Sewage system.
- Firefighting equipment.
- Life-saving apparatus and safety equipment including bilge pump(s) and first aid kit.

The reader should be particularly aware that a non-invasive or superficial inspection of the machinery does not include opening up the crank case, removing and testing spark plugs or injectors, removing heads, pistons etc. taking crankshaft deflection readings and similar mechanical investigations as they are classed as a full engine survey. Nor does it include a running test of the machinery or checking of the boat's speed and/or fuel consumption as those items come under a sea trial. Some marine surveyors are able to offer a full engine survey service if they are suitably qualified both academically and practically by experience but will usually charge extra for carrying out such work. The marine surveyor should make the point clear when negotiating the survey contract. As far as the author knows, only two similar lists exist, both published by an insurance company.

None, as far as the author knows, have been published by an organisation representing underwriters. Ignoring the above list is the direct cause of many survey reports, in the author's view, not really being fit for the purpose intended, but a moot point that has never, to the author's knowledge, been tested in the Courts.

Items not generally covered by a general condition survey

Here, again, the items not covered vary considerably but an exclusion clause should be written into the report to cover at least the following items:

- Design.
- Scantlings.

Jeffrey Casciani-Wood