Subject:

This instruction specifies AMSA's preferred method for the measurement of metallic hull thickness as required at each 10-year renewal survey.

Definitions:

Corrosion margin means the difference, in millimetres, between the original plate thickness and the minimum allowable thickness.

Excessive corrosion means corrosion that exceeds the allowable limit such that material must be replaced.

Excessive diminution means a reduction in overall plate thickness that exceeds the allowable limit such that material must be replaced.

IACS means the International Association of Classification Societies.

Minimum thickness means the minimum allowable thickness. If a plate or profile corrodes to less than this value, it will normally be required to be replaced.

Substantial corrosion means corrosion where less than 25% of the corrosion margin remains, but thickness is still greater than that for excessive corrosion.

Surveyor means an accredited marine surveyor (AMS).

UTM means Ultrasonic Thickness Measurement, used to determine the thickness of metallic plates and profiles.

General:

Safe Access

To enable the attending surveyor to carry out the survey, provisions for safe access are to be agreed between the owner and the surveyor.

Attention is drawn to applicable work health and safety (WHS) requirements, including confined space entry procedures and certification, which must be complied with.

Access to Structure

Where required, route planning should be considered prior to any confined space entry to ensure the safe conduct of the survey.

Sufficient lighting is to be provided to reveal corrosion, damage or other structural deterioration. Means are to be provided to enable the surveyor to safely survey the structure. Spaces are to be sufficiently cleaned and made safe for access and survey.

Cleaning and Preparation

All spaces are to be cleaned as necessary prior to survey. Spaces must be sufficiently clean and free from water, scale, dirt, oil residues and, for steel vessels, all loose scale is to be removed to reveal corrosion, distortion, fractures or other structural deterioration, as well as the condition of any protective coating.

Where steel structures are heavily scaled, de-scaling must be completed before survey as scale can affect both the conduct and accuracy of thickness measurements.

Deck coverings (for example, marine carpet) are to be lifted as required to allow adequate survey of deck areas.

Equipment

UTM equipment used must be suitable for the materials and thicknesses being tested and capable of calibration and verification in accordance with recognised Australian or international standards, such as **AS2083**.

All Vessels in Class with a Recognised Organisation

Thickness measurements for vessels in survey with a recognised organisation are to be undertaken in accordance with the requirements of that recognised organisation.

Vessels not in Class with a Recognised Organisation

Vessels < 24m Measured Length
UTM may be carried out by:

- the attending surveyor; or
- a competent person with appropriate experience or qualifications; or
- a third-party service provider holding appropriate industry qualifications or approved by a recognised organisation.

Where thickness measurements are undertaken by a third-party service provider, the measurements may be witnessed by the surveyor.

Where thickness measurements identify substantial corrosion, excessive diminution or structural defects, the owner must be advised. The extent of additional measurements shall be determined and repairs or renewals facilitated as required.

Vessels ≥ 24m Measured length
For vessels **24 m or greater in measured length**, UTM should be carried out by a third-party service provider approved by a recognised organisation or holding appropriate industry qualifications. UTM may only be carried out by a surveyor if they have demonstrable experience or qualifications appropriate to vessels of this size.

The surveyor is to be on board while thickness measurements are conducted to the extent considered necessary to control the process. Where a third-party service provider is engaged, measurements should be witnessed by the surveyor where practicable.

Where thickness measurements identify substantial corrosion, excessive diminution or structural defects, the owner must be advised. The extent of additional measurements shall be determined and repairs or renewals facilitated as required.

Execution of the thickness measurements on board
The surveyor should conduct or direct thickness measurement activities by selecting locations that ensure readings are representative of the general condition of the structure.

Before commencement, the surveyor is to:

- verify that the equipment is calibrated in accordance with recognised national or international standards;
- witness or perform calibration appropriate to the material and thickness; and
- be satisfied with the competence of the operator and adequacy of documentation.

Operators must have all required equipment and certificates available for inspection.

Selecting areas for thickness measurements
When selecting the position of thickness measurements, areas with local reinforcements, doublers or other obstructions on the deck and shell are to be avoided. Transverse sections shall be chosen where the largest reductions in thickness are suspected or as indicated by the deck plating measurement.

Transverse sections should avoid:

- The ends of superstructure.
- Strengthening in way of cargo hatch corners.

The surveyor must oversee UTM operators to stay updated on measurement results and identify any defects, such as significant corrosion, cracks, indents, buckling, or instances where doubler plates have been utilized for repairs

Additional thickness measurements should be undertaken where general wastage is evident. Measurements must be sufficient to determine the overall condition and extent of deterioration.

Reducing the extent of thickness measurements

The surveyor may consider reducing the extent of thickness measurements where protective coatings are found to be in good condition with only minor spot rusting, as defined in **IACS UR Z10.1**.

For the first 10-year renewal survey of a steel vessel, thickness measurement may be waived where a thorough visual survey identifies no evidence of corrosion or pitting.

Any areas that cannot be visually inspected (for example, sealed decks or inaccessible compartments) must be subject to thickness measurement.

Taking Measurements

The extent of measurements must allow the surveyor to:

- assess the amount of corrosion present;
- identify areas requiring repair or renewal; and
- determine representative mean thickness values.

Where a vessel is not in Class, and Class or IACS guidance is not applied, the minimum extent of testing is outlined below.

MINIMUM EXTENT OF TESTING – Steel Vessels not in Class	
10 Year	**20+ Year** **(in addition to 10-year items)**
Any exposed plating throughout the main deck • Shell plating in way of the waterline. • Shell plating below the waterline. • Suspect areas where the coatings appear defective.	• 2 transverse sections of deck and shell plating within 0.5L amidships*. • Suspect areas including: Areas where the coatings are found to be other than in good condition. Shell and tank top plating immediately adjacent to tank top margins.

** A transverse section is to include all longitudinal structure. For transversely framed vessels, a transverse section includes adjacent frames and their end connections in way of transverse sections. Thickness measurements are to be taken at locations selected to provide the best representative sampling of areas likely to be exposed to the most corrosion.*

Number of Readings

Where Class or IACS guidance is not followed, readings are to be taken in a grid pattern with spacing not exceeding frame spacing, up to a maximum of 600 mm.

Where excessive corrosion is indicated:

- spacing is to be reduced to 300 mm for vessels under 12 m; and
- 400 mm for vessels 12 m or greater.

Further readings are to be taken as necessary to determine the full extent of deterioration.

Conduct of Survey – Aluminium vessels:

Vessels Not in Class with a recognized Organisation

General plate wastage / corrosion is not commonly found in vessels constructed of aluminium, with pitting being the main source of corrosion. Many of the major classification societies do not have specific requirements for hull thickness testing at renewal surveys.

Aluminium vessels are to undergo a thorough visual inspection at each renewal survey. Attention must be paid to areas where plating may be exposed to ferrous material such as rust from piping and sea-chest strainers, or loose fastenings.

Where no corrosion or pitting is identified, thickness measurement may be waived.

Any areas that cannot be visually inspected must be subject to thickness measurement.

Where general corrosion or wastage is identified, thickness measurements are to be carried out in accordance with the steel vessel requirements.

Reporting:

At the first 10 yearly survey for steel vessels or for all 10 yearly surveys for aluminium vessels, if the thickness measurements have been waived as permitted above, this shall be recorded on the survey report.

In all other cases the surveyor must submit the thickness measurement reports as part of the 10 and 20+ year renewal surveys

Where thickness measurements are undertaken by an approved service supplier, reports must be endorsed by the surveyor and submitted as part of the renewal survey.

Thickness measurement reports must include, as a minimum:

- vessel name and UVI;
- date of measurement;
- sketches of areas measured;
- identification of each reading location;
- original plate thickness;
- allowable diminution;
- measured thickness;
- recorded diminution; and
- details of any plating or structural members requiring repair.

Diminution - acceptance criteria:

Steel Vessels

Steel Vessels Designed to LR SSC Rules

For SSC vessels the maximum allowable diminution specified in the LR Thickness measurement and close up survey guidance, Part 1 Thickness Measurement Process Ver.7.5 Chapter 5 should be applied.

Steel Vessels Designed to Other Classification Society Rules

The maximum diminution criteria specified within the appropriate classification society rules are to be applied.

USL Code Vessels and other standards called up in NSCV C3

The acceptance criteria shall be as below:

Permissible Diminution Levels – Steel USL Code Vessels *Note the percentage reduction is based on the installed plating thickness not the minimum calculated plate thickness*	
Envelope	**% Diminution**
Plating	30%
Miscellaneous & Internal Structure	**% Diminution**
Longitudinals	25%
Plain plating	30%
Corrugated plating	25%
Stiffeners	25%
Salt Water Double Bottom Tank frames or diaphragms	25%
Cargo hold shell frames and end brackets	25%
Cargo hold hatch cover / coaming plating	30%
Cargo hold hatch cover / coaming stiffeners	25%
Salt Water Double Bottom Tank Floors	25%
Web frame plating	25%
Web frame face plates	30%
Web frame secondary structure	30%
Other miscellaneous plating	30%
Other miscellaneous longitudinals or stiffeners	25%
Plating of seachests	30%
Shell plating in way of overboard discharges	30%

Aluminium Vessels

In general, pitting corrosion is more commonly found in aluminium vessel structures than general corrosion / wastage of plates. Pitting corrosion is to be addressed as per the section on Pitting Corrosion.

The acceptance criteria for general corrosion / wastage is as follows:

Aluminium Vessels to LR SSC Rules
For aluminium vessel originally designed in accordance with LR SSC Rules the corrosion and wear allowances for aluminium alloys shall be as per LR SSC Rules Part 1 Chapter 3 Section 5.5.2

Aluminium Vessels to DNV / DNVGL Rules
For aluminium vessels originally designed in accordance with DNV / DNVGL rules for HSLC, the corrosion and wear tolerances for aluminium alloys shall be as per DNV-GL Class Guideline Allowable thickness diminution for hull structure DNVGL-CG-0182.

Aluminium Vessels to Other Classification Society Rules
The maximum diminution criteria specified within the appropriate classification society rules are to be applied.

USL Code and other standards called up in NSCV C3
The acceptance criteria shall be as below:

Permissible Diminution Levels – Aluminium Vessels *Note the percentage reduction is based on the installed plating thickness not the minimum calculated plate thickness*	
Shell Envelope	**% Diminution**
Plating	20%
Miscellaneous & Internal Structure	**% Diminution**
Plating and stiffeners	20%
Shell frames and brackets	20%

Other corrosion - acceptance criteria:

Pitting Corrosion

Pitting Corrosion Not Requiring Repair

For plates with widely scattered pitting intensity less than 5%, the minimum remaining thickness in individual pits shall be the greater of:

- 70% of the original plate thickness
- 3.0mm

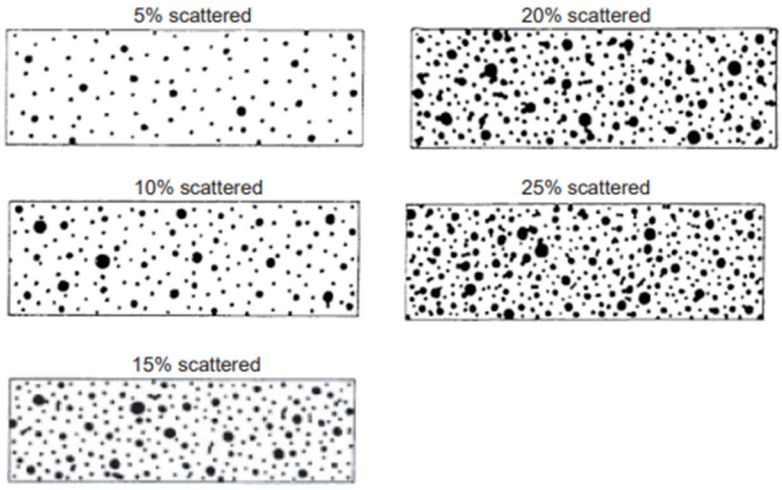
In such cases the pits can be cleaned, and steel must be coated to prevent further corrosion.

Pitting corrosion requiring repair but not replacement

For scattered pitting, based on IACS Common Structural Rules, i.e. intensity < 20% and where the remaining thickness in pitting is not less than 70% of the original plate thickness or 3.0mm whichever is greater, the following may apply:

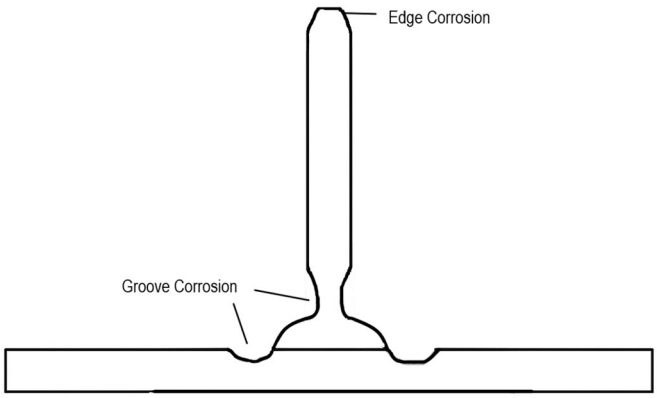
Welding, may be performed out of the water or afloat, in accordance with the following:

- pitting shall be thoroughly cleaned, ground and dried prior to welding
- low hydrogen electrodes approved for the material in question shall be used for steel repairs and approved welding wire / consumables for aluminium repairs. Weld to start outside pitting and direction reversed for each layer.



Pitting intensity Diagram (taken from IMO Resolution A.1049(27))

Groove and edge corrosion



Groove Corrosion

Groove corrosion is typically local material loss adjacent to weld joints along abutting stiffeners and at stiffener or plate butts or seams.

Grooves are to be smooth, without sharp edges or notches and welding is intact without cracking etc and with acceptable remaining throat thickness

The maximum extent of grooving shall be 15% of the height of the stiffener and the acceptable minimum thickness of stiffeners shall be at least 75% of the original thickness, based on IACS Common Structural Rules.

Edge Corrosion

Edge corrosion is defined as local corrosion at the free edges of plates, stiffeners, primary support members and around openings such as manholes, lightening holes etc.

Edges are to be smooth and without sharp edges or notches.

The maximum extent of edge corrosion shall be 25% of the height of a flatbar stiffener or 25% of the flange length of an inverted angle or built up stiffener and the acceptable minimum thickness at the edge shall be 30% of the original thickness, based on IACS Common Structural Rules.

Repair of areas of excessive corrosion:

Where corrosion exceeds acceptance criteria, repairs are to be undertaken by insert or replacement in accordance with *IACS Recommendation 47 - Shipbuilding and Repair Quality Standard Part B Repair Quality Standard for Existing Ships*.

An ad-hoc survey code and plan approval is required prior to repair.

Contact: dcvsurvey@amsa.gov.au.

References:

AS 2083 Calibration blocks and their methods of use in ultrasonic testing

IACS Recommendation Z7 Hull Classification Surveys

IACS Recommendation Z7.1 Hull Surveys for General Cargo Dry Ships. 6 Procedures for Thickness Measurements

IACS Recommendation 47 Shipbuilding and Repair Quality Standard

IACS Unified Recommendation UR Z10.1 Hull Survey of Oil Tankers

IACS Common Structural Rules for Bulk Carriers and Oil Tankers

Lloyds Register SSC Rules

DNV – GL Rules for High Speed and Light Craft and Naval Vessels

DNV-GL Class Guideline Allowable thickness diminution for hull structure DNVGL-CG-0182