

GUIDANCE NOTES

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China Classification Society

Guidelines for Application of Corrosion Limit and Renewal Criteria of Mobile Offshore Units

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CONTENTS

CHAPTER 1 GENERAL	1
Section 1 GENERAL PROVISIONS.....	1
Section 2 DEFINITION AND SYMBOLS.....	1
CHAPTER 2 CORROSION LIMIT AND RENEWAL CRITERIA	4
Section 1 GENERAL PROVISIONS.....	4
Section 2 CATEGORIES OF CORROSION.....	4
Section 3 CATEGORIES OF STRUCTURAL MEMBERS	6
Section 4 CORROSION LIMIT.....	7
Section 5 EVALUATION OF THICKNESS MEASUREMENT	7
Section 6 RENEWAL CRITERIA OF AVERAGE CORROSION OF LOCAL STRUCTURAL MEMBERS.....	8
Section 7 RENEWAL CRITERIA OF PITTING CORROSION, EDGE CORROSION AND GROOVE CORROSION.....	9
CHAPTER 3 REQUIREMENT FOR RENEWAL	11
Section 1 GENERAL PROVISIONS.....	11
Section 2 RENEWAL THICKNESS	11
Section 3 REQUIREMENTS FOR MATERIALS	11
Section 4 STRUCTURAL CORROSION PROTECTION.....	12
Appendix 1 ASSESSMENT METHODS OF BUCKLING OF STRUCTURES WITH PITTING CORROSION	13
Section 1 GENERAL PROVISIONS.....	13
Section 2 ASSESSMENT PARAMETERS OF CORROSION STATE	13
Section 3 ASSESSMENT CRITERIA OF BUCKLING OF PITTING CORROSION.....	16
Section 4 ADJUSTMENT COEFFICIENT FOR PITTING CORROSION OF NON-STIFFENED PANEL STRUCTURES	17
Section 5 ADJUSTMENT COEFFICIENT FOR PITTING CORROSION OF STIFFENED PANEL STRUCTURES	18
Section 6 BUCKLING TEST OF STRUCTURES WITH PITTING CORROSION.....	19

CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 General requirements

1.1.1.1 The purpose of the Guidelines is to provide renewal criteria and renewal requirements for the corrosion of mobile units in operation.

1.1.1.2 The Guidelines are only applicable to the steel mobile offshore units in operation that are classed based on the *Rules for Classification of Mobile Offshore Units* of China Classification Society (hereinafter referred to as CCS), unless otherwise specified.

1.1.2 References in the Guidelines

1.1.2.1 References to relevant documents in the Guidelines constitute requirements of the Guidelines. For undated references, their latest version applies.

1.1.3 Method of operational renewal

1.1.3.1 The Guidelines provide the following two renewal methods. The owner/designer can select either of them as the strategy of renewing operational plates at later stages:

- (1) Method of net thickness: determine the later-stage operational renewal criteria of the structure according to the net thickness of members to conduct renewal maintenance;
- (2) Method of percentages: use a certain percentage of the corrosion thickness of the member as the later-stage renewal criterion to conduct renewal maintenance.

Section 2 DEFINITION AND SYMBOLS

1.2.1 Definition

1.2.1.1 Suspect area

It refers to the locations showing substantial corrosion and/or are considered by the Surveyor to be prone to rapid wastage.

1.2.1.2 Substantial corrosion

It refers to an extent of corrosion such that assessment of corrosion pattern indicates wastage in excess of 75% of allowable margins, but within acceptable limits.

1.2.1.3 Coating condition

GOOD refers to the condition with only minor spot rusting;

FAIR refers to the condition with local breakdown at edges of stiffeners and weld connections and/or light rusting over 20% or more of areas under consideration, but less than as defined for POOR condition;

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

1.2.2 Symbols

1.2.2.1 See Table 1.2.2.1 for the symbols used in the Guidelines.

Definitions of symbols

Table 1.2.2.1

Symbol	Definition
A_0	Original cross-sectional area
A_i	Superficial area of a single corrosion pit
A_{min}	Minimum cross-sectional area
DOP	Density of pitting
C_x , C_y and C_τ	Reduction factor
d_{pit}	Diameter of corrosion pit
f	Allowable corrosion limit
h_{pit}	Depth of corrosion pit
L_a	Length of measured area in DOP statistics
L_b	Breadth of measured area in DOP statistics
N_{pit}	Total number of corrosion pits
R_{eH_P}	Minimum yield strength of plate
R_{eH}	Yield strength of material
t_{annual}	Allowable renewal thickness for annual surveys
t_{as_built}	As built thickness of member
t_{corr}	For corrosion addition, see 1.7.4, Chapter 1, PART TWO, <i>CCS Rules for Classification of Mobile Offshore Units</i> .
t_{lim_tk}	Ultimate corrosion thickness
t_{own}	Owner/builder specified additional wastage allowance
t_p	Net thickness of plate panel
t_{ren}	Renewal thickness
t_{repair}	Minimum requirement of thickness of renewal materials
t_{sub_tk}	Substantial corrosion thickness
t_m	Measured thickness
V_0	Volume of original plate
V_i	Volume of single corrosion pit
ΔV	Total volume of corrosion pits
σ'_{cx}	Ultimate buckling stress in the direction parallel to the longer side of the plate panel
σ'_{cy}	Ultimate buckling stress in the direction parallel to the shorter side of the plate

Symbol	Definition
	panel
τ'_c	Ultimate buckling shear stress
$\xi_{corr-\sigma}$, $\xi_{corr-\tau}$	Adjustment coefficient for ultimate buckling stress of pitting corrosion

CHAPTER 2 CORROSION LIMIT AND RENEWAL CRITERIA

Section 1 GENERAL PROVISIONS

2.1.1 General requirements

2.1.1.1 This Chapter requires the measured thickness of the unit structure to be used in corrosion assessment.

2.1.1.2 For surface-type units, in addition to meeting the requirements of the Sections 4 to 7 in this Chapter, structural assessment shall be conducted using measured thickness to control corrosion, if necessary.

2.1.2 Requirement of documents

2.1.2.1 The plans prepared on the unit shall include the as built thickness and renewal thickness of each member that are defined in this Chapter. All owner/builder specified additional wastage allowance shall also be indicated explicitly on drawings.

2.1.2.2 Refer to PART ONE of CCS *Rules for Classification of Mobile Offshore Units* for the list of the drawings and data that are kept in the unit.

2.1.3 Requirement of surveys

2.1.3.1 See Table 5.3.5.2, Chapter 5, PART ONE, CCS *Rules for Classification of Mobile Offshore Units* for the minimum requirement of unit survey for maintaining the class of the unit, including the minimum requirements for thickness measurement.

Section 2 CATEGORIES OF CORROSION

2.2.1 Average corrosion

2.2.1.1 Average corrosion is the uniform reduction of material thickness in a certain of area.

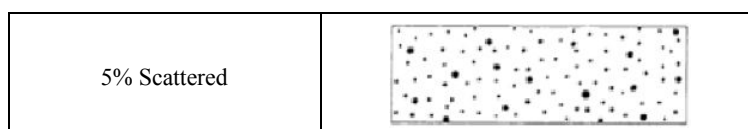
2.2.1.2 The renewal criteria for average corrosion are given in 2.6.2 of this Chapter.

2.2.2 Pitting corrosion

2.2.2.1 Pitting corrosion is the reduction of material thickness within a local area, either in a point like way or by small areas, and the thickness reduction is greater than the average corrosion thickness of the surrounding material.

2.2.2.2 See Figure 2.2.2.2 for the rating of the DOP.

2.2.2.3 See 2.7.2 of this Chapter for the renewal criteria of pitting corrosion.



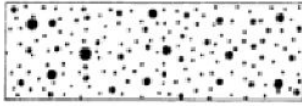
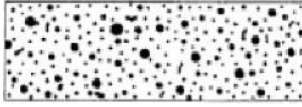
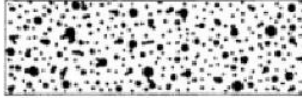
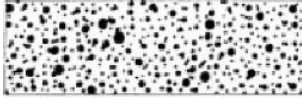
10% Scattered	
15% Scattered	
20% Scattered	
25% Scattered	

Figure 2.2.2.2 DOP Diagram

2.2.3 Edge corrosion

2.2.3.1 Edge corrosion is defined as local corrosion at the free edges of plates, stiffeners, primary support members and around openings. An example of edge corrosion is shown in Figure 2.2.3.1.

2.2.3.2 See 2.7.3 of this Chapter for the renewal criteria of edge corrosion.

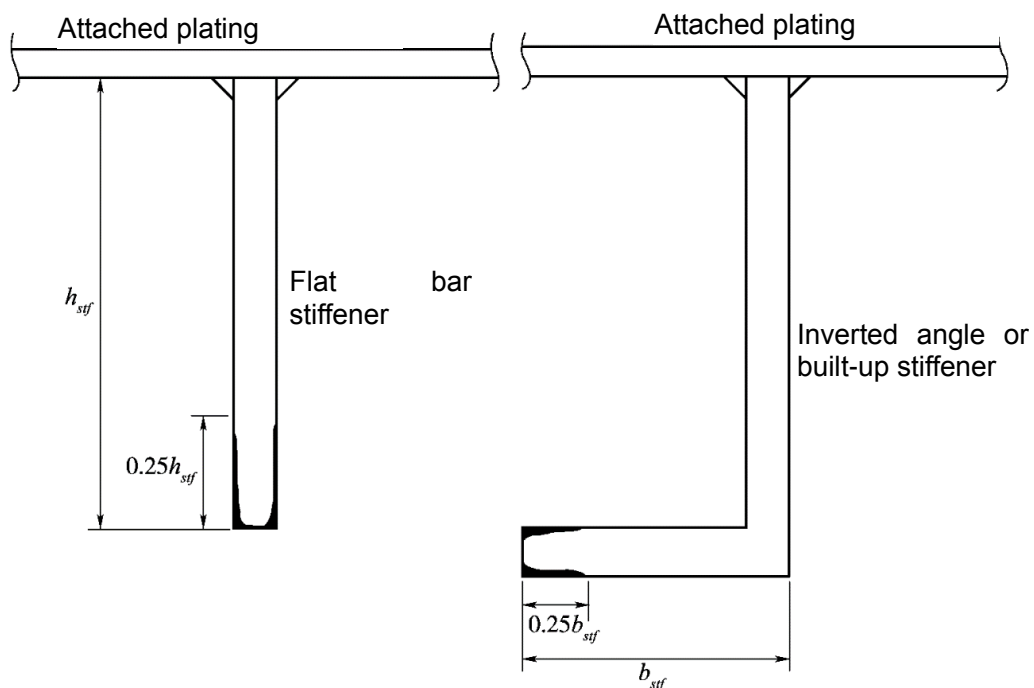


Figure 2.2.3.1 Edge Corrosion

2.2.4 Grooving corrosion

2.2.4.1 Grooving corrosion is typically local material loss adjacent to weld joints along abutting stiffeners and at the butts or seams of stiffeners or plates. An example of Grooving

corrosion is shown in Figure 2.2.4.1.

2.2.4.2 See 2.7.4 of this Chapter for the renewal criteria of Grooving corrosion.

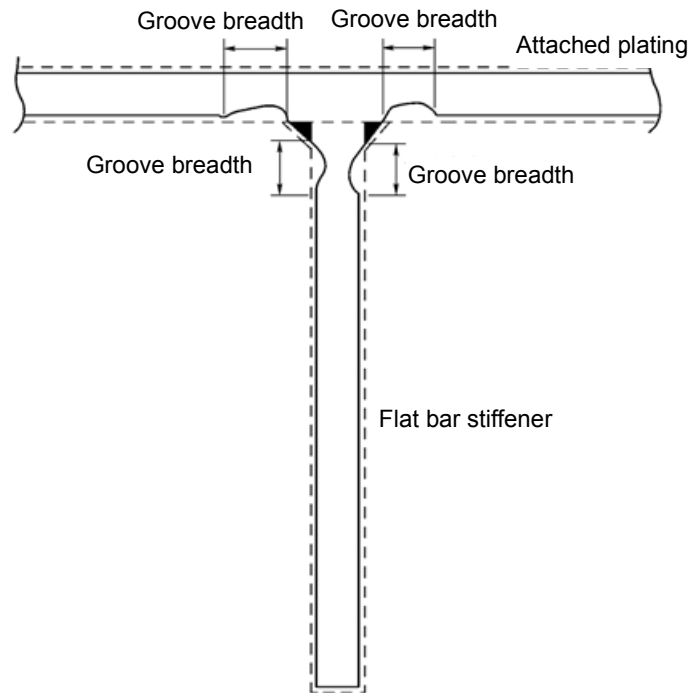


Figure 2.2.4.1 Grooving corrosion

SECTION 3 CATEGORIES OF STRUCTURAL MEMBERS

2.3.1 General requirements

2.3.1.1 All structural members of the unit may be divided into the following categories according to applied loading, stress level and associated stress pattern, critical load transfer and stress concentrations, and consequence of failure:

- (1) A secondary structural member is a member of minor importance, and its failure is unlikely to affect the overall integrity of the unit structure;
- (2) A primary structural member is a member essential to the overall integrity of the unit structure;
- (3) A special structural member is the primary structural member at the critical load transfer point and stress concentration.

2.3.1.2 The categories of the structural members in self-elevating units shall meet the requirements of 1.4.2.2, Section 4, CHAPTER 1, PART TWO, CCS *Rules for Classification of Mobile Offshore Units*.

2.3.1.3 The categories of the structural members of column-stabilized units shall meet the requirements of 1.4.2.3, Section 4, CHAPTER 1, PART TWO, CCS *Rules for Classification of Mobile Offshore Units*.

2.3.1.4 Categories of structural members of submersible units shall meet the requirements of 1.4.2.4, Section 4, CHAPTER 1, PART TWO, in CCS *Rules for Classification of Mobile Offshore Units*.

2.3.1.5 The categories of the structural members in surface-type units shall meet the

requirements of 1.4.2.5, Section 4, CHAPTER 1, PART TWO, in *CCS Rules for Classification of Mobile Offshore Units*.

Section 4 CORROSION LIMIT

2.4.1 Allowable corrosion limit

2.4.1.1 The allowable corrosion limits f of self-elevating units, column-stabilized units, submersible units and surface-type units shall be determined according to Table 2.4.1.1.

2.4.2 Remaining ultimate corrosion thickness

2.4.2.1 The remaining ultimate corrosion thickness t_{lim_tk} after deducting the allowable corrosion limit from the average corrosion of local structural members shall be calculated using the following equation:

$$t_{lim_tk} = t_{as_built} \times (1 - f)$$

Where: t_{as_built} — As-built thickness of structural member, mm;

f — Allowable corrosion limit, determined according to Table 2.4.1.1.

2.4.2.2 The ultimate corrosion thickness t_{lim_tk} shall meet the requirements of buckling strength in Section 4, CHAPTER 3, PART TWO, *CCS Rules for Classification of Mobile Offshore Units*.

Allowable corrosion limit of mobile offshore units Table 2.4.1.1

Type of unit	Category of structural member	Allowable corrosion limit
Self-elevating, column-stabilized, submersible and surface-type units	Special member	5%
	Primary structural member ^①	15%
	Secondary structural member ^①	25%
	Helicopter deck and support members	15%

Note: ① Exclude helicopter decks and their support members.

Section 5 EVALUATION OF THICKNESS MEASUREMENT

2.5.1 Requirement of thickness measurement

2.5.1.1 Where substantial corrosion is suspected in any area of the main structure in every annual, intermediate or special survey, thickness measurement shall be carried out.

2.5.1.2 The minimum requirements for thickness measurement in special surveys of various units shall comply with the provisions of Table 5.3.5.2 (1) ①, ②, ③ and ④, Section 3, CHAPTER 5, PART ONE, *CCS Rules for Classification of Mobile Offshore Units*.

2.5.1.3 If it is confirmed that there is any substantial corrosion in the structural member, the Surveyor shall increase thickness measurement to confirm the scope of the Substantial corrosion.

Additional thickness measurement shall be conducted according to the corrosion scope of the structural member that is confirmed according to Table 2.5.1.3.

Requirement for additional thickness measurement of structural member Table 2.5.1.3

Structural member	Scope of thickness measurement	Mode of thickness measurement
Plate	Suspect area and its adjacent plate	5 measurement point within 1 m ²
Section	Suspect area	3 measurement points on the same cross-sectional line of the web plate 3 measurement points on the same cross-sectional line of the wing plate

2.5.2 Allowable renewal thickness for annual survey

2.5.2.1 When the additional thickness measurement t_{tm} is between the renewal thickness t_{ren} (see Sections 6 and 7 of this Chapter) and the allowable renewal thickness t_{annual} in annual surveys, the measures of coating or conducting thickness measurement for the area of substantial corrosion every year may be adopted in lieu of renewal. Coating shall be maintained in “good” status.

2.5.2.2 The calculation equations of the two operational renewal methods corresponding to allowable renewal thickness t_{annual} in annual surveys are:

a. Method of net thickness: $t_{annual} = t_{as_built} - t_{own} - t_{corr} + 0.5$, mm

b. Method of percentage: $t_{annual} = t_{sub_tk}$, mm

Where: t_{as_built} — As build thickness of structural member, mm;

t_{own} — Owner/builder specified additional wastage allowance, if any, mm;

t_{corr} — Corrosion addition, mm;

t_{sub_tk} — Substantial corrosion thickness, $t_{sub_tk} = t_{as_built} \times (1 - 0.75f)$, mm.

Section 6 RENEWAL CRITERIA OF AVERAGE CORROSION OF LOCAL STRUCTURAL MEMBERS

2.6.1 General requirements

2.6.1.1 The renewal criteria in this Section are applicable to the unit’s structural members of average corrosion category.

2.6.2 Renewal criteria

2.6.2.1 If the measured thickness t_{tm} is smaller than the renewal thickness t_{ren} , the renewal

of the structural members is required.

2.6.2.2 The calculation equations of the two operational renewal methods corresponding to renewal thickness t_{ren} :

a. Method of net thickness: $t_{ren} = t_{as_built} - t_{own} - t_{corr}$ mm

b. Method of percentage: $t_{ren} = t_{lim_tk}$ mm

Where: t_{as_built} — As build thickness of structural member, mm;

t_{own} — Owner/builder specified additional wastage allowance, if any, mm;

t_{corr} — Corrosion addition, mm;

t_{lim_tk} — Ultimate corrosion thickness, mm.

Section 7 RENEWAL CRITERIA OF PITTING CORROSION, EDGE CORROSION AND GROOVING CORROSION

2.7.1 General requirements

2.7.1.1 If the measured thickness is smaller than the renewal criterion defined below respectively, it is required to conduct the renewal of structural members against pitting corrosion, grooving corrosion and edge corrosion.

2.7.2 Pitting corrosion

2.7.2.1 For the plates with the DOP lower than 20% (see Figure 2.2.2.2 for rating of the DOP), the measured thickness t_m of all structural members shall meet the smaller one of the following formula:

$$t_m \geq 0.7(t_{as_built} - t_{own}) \quad \text{mm}$$

$$t_m \geq t_{ren} - 1 \quad \text{mm}$$

Where: t_{as_built} — As build thickness of structural member, mm;

t_{own} — Owner/builder specified additional wastage allowance, if any, mm;

t_{ren} — Renewal thickness of average corrosion that is calculated according to Equation 2.6.2.2 a, mm.

2.7.2.2 The average measured thickness of any cross-section of the plate shall not be smaller than the renewal criteria of average corrosion defined in Equation 2.6.2.2a.

2.7.3 Edge corrosion

2.7.3.1 If the corroded breadth (or height) of the edge corrosion of the stiffener wing plate (or stiffener web plate) is less than 25% of the breadth of the stiffener wing plate (or the height of the stiffener web plate), the measured thickness t_m shall meet the smaller one of the following formula:

$$t_m \geq 0.7(t_{as_built} - t_{own}) \quad \text{mm}$$

$$t_m \geq t_{ren} - 1 \quad \text{mm}$$

Where: t_{as_built} — As build thickness of structural member, mm;
 t_{own} — Owner/builder specified additional wastage allowance, if any, mm;
 t_{ren} — Renewal thickness of average corrosion that is calculated based on Equation 2.6.2.2 a, mm.

2.7.3.2 The average measured thickness across the stiffener face plate or the stiffener web plate shall not be lower than the renewal criteria of average corrosion defined in Equation 2.6.2.2 a.

2.7.3.3 In the following two occasions, the edge thickness of the plates located at manholes, lightening holes and other openings are allowed to be smaller than the minimum renewal thickness defined in Equation 2.6.2.2 a:

(1) The reduction of the thickness is smaller than the minimum range (the radial direction of the opening) of the opening edge that is required in Equation 2.6.2.2 a. It shall not be larger than 20% of the minimum size of the opening, and not larger than 100 mm;

(2) After cutting and modification of the corroded area at the opening edge, the maximum increase of the opening size shall not be larger than 10%.

2.7.4 Grooving corrosion

2.7.4.1 If the breadth of grooving corrosion is larger than 15% of the height of web plate and not larger than 30 mm, as shown in Figure 2.2.4.1, the measured thickness t_m of the structure member shall meet the smaller one of the following formula:

$$t_m \geq 0.75(t_{as_built} - t_{own}) \quad \text{mm}$$

$$t_m \geq t_{ren} - 0.5 \quad \text{mm}$$

But not less than $t_m = 6 \quad \text{mm}$

Where: t_{as_built} — As build thickness of structural member, mm;
 t_{own} — Owner/builder specified additional wastage allowance, if any, mm;
 t_{ren} — Renewal thickness of average corrosion that is calculated according to Equation 2.6.2.2 a, mm.

2.7.4.2 For the structural members with the grooving corrosion scope larger than the requirements of 2.7.4.1, the evaluation shall be conducted according to the renewal criteria of average corrosion defined in Equation 2.6.2.2 a.

CHAPTER 3 REQUIREMENT FOR RENEWAL

Section 1 GENERAL PROVISIONS

3.1.1 General requirements

3.1.1.1 In case of any structural wastage or structural damage that exceeds the allowable limits (including large deformation, buckling, grooving, detachment or fracture, cracks) and affects, or that is deemed by the Surveyor to be going to affect, the integrity of the unit structure, watertightness or weathertightness, thorough repair shall be conducted immediately.

3.1.1.2 For the structure with DOP higher than 20% or other special considerations deemed as necessary by the Surveyor, the evaluation for corroded structures can be conducted by referring to Appendix 1 in the Guidelines in lieu of renewal.

3.1.1.3 If it is difficult to complete the repair of aforementioned defects on the ports/sea areas where the defects are found, with the consent of CCS, the unit may be allowed to proceed to a repair port with adequate repair capacity for completing the repairs. The unit may be required to carry out load reduction and/or temporary repair for the repair voyage.

Section 2 RENEWAL THICKNESS

3.2.1 General requirements

3.2.1.1 For the areas requiring renewal based on the renewal criteria in Sections 6 to 7, CHAPTER 2, the thickness of renewal materials shall not be less than t_{repair} , i.e.

$$t_{repair} = t_{as_built} - t_{own} \quad \text{mm}$$

Where: t_{as_built} — As built thickness of structural member, mm;

t_{own} — Owner/builder specified additional wastage allowance, if any, mm;

Section 3 REQUIREMENTS FOR MATERIALS

3.3.1 General requirements

3.3.1.1 The materials and welding of the units shall meet the requirements of CCS *Rules for Materials and Welding*.

3.3.1.2 The grades of the renewal materials shall generally not be lower than the grades of original structural members.

3.3.1.3 The materials that meet the material grades required by the standards acceptable to CCS and have the grades certified to be equivalent to the requirements of material grades used by original structural members may be used as the renewal materials after being approved by CCS.

3.3.1.4 The equivalence of the material grades shall at least include the following contents:

- (1) Heat treatment and delivery condition;
- (2) Chemical composition;
- (3) Mechanical properties;
- (4) Tolerance.

3.3.1.5 The corresponding procedures shall be conducted for the welding of renewal materials, and welders shall have corresponding qualifications.

3.3.2 Welding materials

3.3.2.1 The grades of the welding materials used for the structure shall meet the steel grade of the renewal steel materials.

Section 4 STRUCTURAL CORROSION PROTECTION

3.4.1 General requirements

3.4.1.1 The anti-corrosion measures of the internal and external surfaces of renewal materials shall not be lower than the anti-corrosion measures adopted of original structural members.

Appendix 1 ASSESSMENT METHODS OF BUCKLING OF STRUCTURES WITH PITTING CORROSION

Section 1 GENERAL PROVISIONS

1.1.1 General requirements

1.1.1.1 Pitting corrosion is common in operation survey of mobile offshore units, which will affect the extreme strength of the unit structure. This appendix proposes the evaluation parameters of pitting corrosion and the adjustment coefficient for the buckling stress of pitting corrosion limits, and provides the assessment criteria of buckling in the structure with pitting corrosion as well as the alternative criteria for the renewal of the structural with pitting corrosion.

1.1.1.2 Before assessment, the surface of the corroded structural members shall be thoroughly ground and cleaned to facilitate the determination of parameters of corrosion pits.

1.1.1.3 This appendix applies to the structures with DOP between 20% and 25% or other special considerations deemed as necessary by the Surveyor. The limit of corrosion depths shall meet the requirements of Table 2.4.1.1 in CHAPTER 2.

1.1.1.4 This Appendix requires to use the measured thickness of the unit structure for corrosion assessment.

Section 2 ASSESSMENT PARAMETERS OF CORROSION STATE

1.2.1 General requirements

1.2.1.1 For the assessment of pitting corrosion state, representative parameters may be adopted to describe the corrosion degree, considering comprehensively the effects of various factors. Typical assessment parameters of corrosion state shall include:

- (1) The shape of the corrosion pit;
- (2) The size of the corrosion pit;
- (3) The density of pitting (DOP);
- (4) The minimum cross-sectional area;
- (5) Total volume of corrosion pits.

1.2.2 Shape of corrosion pit

1.2.2.1 Common shapes of corrosion pits are shown in Figure A1.2.2.1.

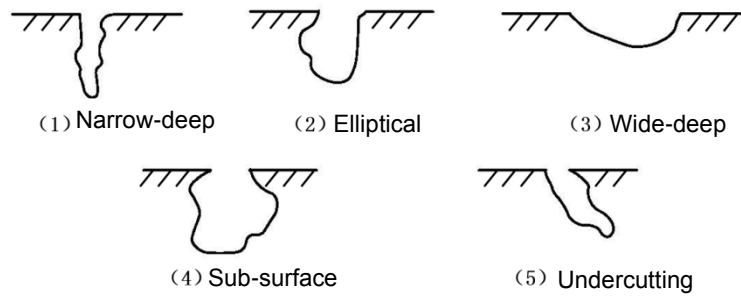


Figure A1.2.2.1 Schematic Diagram of Shapes of Corrosion Pits

1.2.2.2 Generally, the effects of shapes of corrosion pits on the ultimate structural strength may be considered negligible. In numerical modeling or test analysis, the shape of a corrosion pit can be simplified as a cylindrical shape for simpler calculation.

1.2.3 Size of corrosion pit

1.2.3.1 The main parameters of cylindrical corrosion pits are pit diameter and pit depth, as shown in Figure A1.2.3.1.

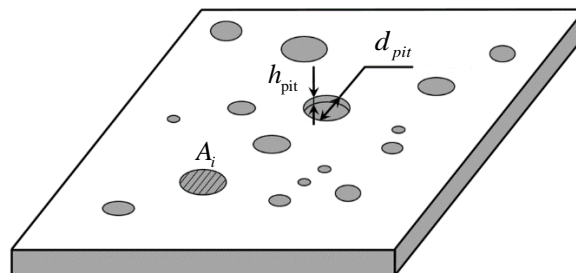


Figure A1.2.3.1 Schematic diagram of sizes of corrosion pits

Where: d_{pit} — Diameter of corrosion pit, mm;
 h_{pit} — Depth of corrosion pit, mm;
 A_i — Superficial area of a single corrosion pit, mm².

1.2.3.2 The diameter-depth ratio is the ratio of the diameter to the depth of the corrosion pit, which shall be between 4:1 and 10:1.

1.2.3.3 The depth of the corrosion pit may be measured by technical means of radiation, electromagnetics, acoustic wave, etc.

1.2.4 Density of pitting

1.2.4.1 The density of pitting (DOP) is defined as the ratio of the corrosion area to the superficial area of the original plate, i.e.:

$$DOP = \frac{1}{L_a L_b} \sum_{i=1}^{N_{pit}} A_i \times 100\%$$

Where: L_a — Length of the measured area, mm;
 L_b — Breadth of the measured area, mm;
 N_{pit} — Total number of corrosion pits.

1.2.4.2 Comparison of standard diagrams

The DOP of a structure may be rated by comparing the corrosion state with the DOP diagram in Figure 2.2.2.2, Section 2, CHAPTER 2, in the Guidelines.

1.2.4.3 Statistical method

Place a grid containing 3 mm to 6 mm meshes on the metal surface, count and record the quantities and sizes of the corrosion pits in each square mesh, which shall be conducted through systematically moving the grid until the whole surface has been counted. The DOP may be assessed after inductive statistics.

1.2.4.4 The increase of the DOP will cause significant decrease in the ultimate strength of the structure. When the DOP is used for the assessment of ultimate strength, the influence of the factors such as the structural sizes and the depths of corrosion pits shall be considered comprehensively.

1.2.5 Minimum cross-sectional area

1.2.5.1 Pitting corrosion leads to local thinning of a plate. The minimum cross-sectional area A_{min} may be used to evaluate the reduction of the ultimate strength that is caused by local corrosion. Such area is defined as the minimum value of the cross-sectional area of a plate, as shown in Figure A1.2.5.1.

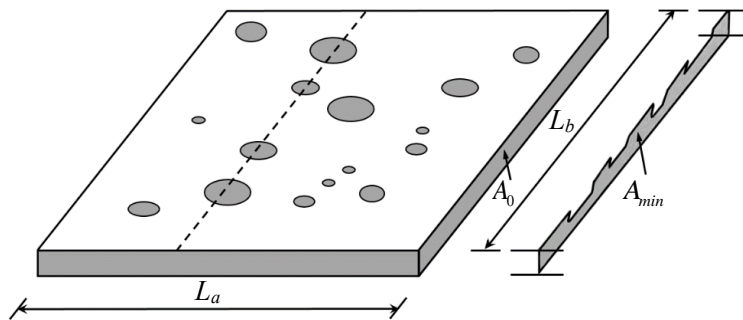


Figure A1.2.5.1 Minimum cross-sectional area

1.2.5.2 See 1.4.1 of this Appendix for the adjustment coefficient for ultimate buckling stress of pitting corrosion based on the minimum cross-sectional area.

1.2.6 Total volume of corrosion pits

1.2.6.1 The total volume of corrosion pits is the sum of all volumes of corrosion pits:

$$\Delta V = \sum_{i=1}^{N_{pit}} V_i$$

Where: ΔV — Total volume of corrosion pits, mm³;
 N_{pit} — Total number of corrosion pits;
 V_i — The volume of a single corrosion pit, mm³.

1.2.6.2 See 1.4.2 of this Appendix for the adjustment coefficient for ultimate buckling stress of pitting corrosion based on the volume of corrosion pits.

Section 3 ASSESSMENT CRITERIA OF BUCKLING OF PITTING CORROSION

1.3.1 Adjustment coefficient of pitting corrosion

1.3.1.1 The adjustment coefficients of pitting corrosion $\xi_{corr-\sigma}$ and $\xi_{corr-\tau}$ are the coefficients used for adjusting the ultimate buckling stress caused by pitting corrosion on stiffened panels and non-stiffened panels.

1.3.1.2 See Section 4 of this Appendix for the adjustment coefficient of the pitting corrosion of non-stiffened panels.

1.3.1.3 See Section 5 of this Appendix for the adjustment coefficient of the pitting corrosion of stiffened panels.

1.3.2 Buckling assessment criteria

1.3.2.1 For the stiffened and non-stiffened panels with pitting corrosion, except that the ultimate buckling stress of panels and the ultimate buckling stress of shear panels, other buckling assessment shall be implemented according to CCS *Technical Guidelines for Assessment of Buckling Strength of Offshore Engineering Structures*.

The ultimate buckling stress of panels, in N/mm²:

$$\sigma'_{cx} = \xi_{corr-\sigma} C_x R_{eH-P}$$

$$\sigma'_{cy} = \xi_{corr-\sigma} C_y R_{eH-P}$$

The ultimate buckling stress of shear panels, in N/mm²:

$$\tau'_c = \xi_{corr-\tau} C_\tau \frac{R_{eH-P}}{\sqrt{3}}$$

Where, σ'_{cx} — Ultimate buckling stress in the direction parallel to the longer side of the buckling plate panel, in N/mm²;

σ'_{cy} — Ultimate buckling stress in the direction parallel to the shorter side of the buckling plate panel, in N/mm²;

τ'_c — Ultimate buckling shear stress, in N/mm²;

C_x, C_y, C_τ — Reduction factor, referring to 3.5.3 of CCS *Guidelines for Buckling Strength Assessment of Offshore Engineering Structures*;

$\xi_{corr-\sigma}, \xi_{corr-\tau}$ — Adjustment coefficient for ultimate buckling stress of pitting

corrosion;

R_{eH_P} — Minimum yield strength of plates, N/mm².

Section 4 ADJUSTMENT COEFFICIENT OF PITTING CORROSION OF NON-STIFFENED PANEL STRUCTURES

1.4.1 Adjustment coefficient of pitting corrosion based on minimum cross-sectional area

1.4.1.1 Adjustment coefficient $\xi_{corr-\sigma}$ of pitting corrosion of plates with pitting corrosion under uni-axial longitudinal pressure:

$$\xi_{corr-\sigma} = \left(\frac{A_{\min}}{A_0} \right)^{0.73}$$

Where: A_0 — Original cross-sectional area of structures in non-corrosion state, mm²;
 A_{\min} — Minimum cross-sectional area, in mm²; see the definition in 1.2.5 of this Appendix.

1.4.2 Adjustment coefficient of pitting corrosion based on corroded area

1.4.2.1 Adjustment coefficient $\xi_{corr-\sigma}$ of pitting corrosion of plates with pitting corrosion under uni-axial longitudinal pressure:

$$\xi_{corr-\sigma} = -54.716 \left(\frac{\Delta V}{V_0} \right)^3 + 14.804 \left(\frac{\Delta V}{V_0} \right)^2 - 3.298 \left(\frac{\Delta V}{V_0} \right) + 1$$

$\Delta V / V_0 \leq 10\%$

Where: ΔV — Total volume of corrosion pits, mm³;
 V_0 — Original plate area of structures in non-corrosion state, mm³;

1.4.2.2 Adjustment coefficient $\xi_{corr-\tau}$ of pitting corrosion of plates with pitting corrosion under shear:

$$\xi_{corr-\tau} = -23.420 \left(\frac{\Delta V}{V_0} \right)^3 + 7.910 \left(\frac{\Delta V}{V_0} \right)^2 - 2.747 \left(\frac{\Delta V}{V_0} \right) + 1$$

$\Delta V / V_0 \leq 10\%$

Where: ΔV — Total volume of corrosion pits, mm³;
 V_0 — Original plate area of structures in non-corrosion state, mm³;

1.4.2.3 In addition to corrosion volumes, the effects of the penal flexibility, random feature of corrosion distribution and other factors on the adjustment coefficients of pitting corrosion may also be considered comprehensively.

Section 5 ADJUSTMENT COEFFICIENT OF PITTING CORROSION OF STIFFENED PANEL STRUCTURES

1.5.1 General requirements

1.5.1.1 Stiffened panels are the combined structures composed of stiffeners and their attached plating. There is mainly T-type panel and L-type stiffened panel on mobile offshore units, of which the structures are shown in Figure A1.5.1.1.

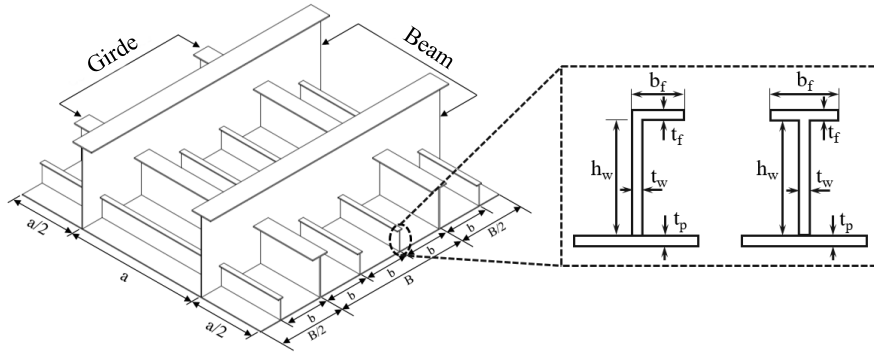


Figure A1.5.1.1 Schematic diagram of structures of stiffened panel

1.5.1.2 The assessment methods in this section apply to the situation where the corrosion of the attached plating is the main corrosion. The volume of corrosion pits in the stiffeners shall be lower than 3% of the total volume of corrosion pits.

1.5.2 Assessment methods of stiffened panel structure with pitting corrosion

1.5.2.1 Adjustment coefficient $\xi_{corr-\sigma}$ for pitting corrosion of T-type stiffened panel:

$$\xi_{corr-\sigma} = 86.26 \left(\frac{\Delta V}{V_0} \right)^3 - 12.06 \left(\frac{\Delta V}{V_0} \right)^2 - 2.23 \left(\frac{\Delta V}{V_0} \right) + 1$$

$$\Delta V / V_0 \leq 10\%$$

Where: ΔV — Total volume of corrosion pits, mm³;
 V_0 — Original plate area of structures in non-corrosion state, mm³;

1.5.2.2 Adjustment coefficient $\xi_{corr-\sigma}$ for pitting corrosion of L-type stiffened panel:

$$\xi_{corr-\sigma} = -85.73 \left(\frac{\Delta V}{V_0} \right)^3 + 20.30 \left(\frac{\Delta V}{V_0} \right)^2 - 3.67 \left(\frac{\Delta V}{V_0} \right) + 1$$

$$\Delta V / V_0 \leq 10\%$$

Where: ΔV — Total volume of corrosion pits, mm³;
 V_0 — Original plate area of structures in non-corrosion state, mm³;

Section 6 BUCKLING TEST OF STRUCTURES WITH PITTING CORROSION

1.6.1 General requirements

1.6.1.1 In special cases, if buckling assessment cannot be completed based on Section 3 to Section 5 of this Appendix, the buckling test for the structures with pitting corrosion may be carried out.

1.6.1.2 This section only applies to the rectangular plates or stiffened panel structures with pitting corrosion, and non-rectangular structures are not considered.

1.6.1.3 Before test, surveys shall be conducted to ensure the following test conditions are met:

(1) Finite element analysis shall be conducted before test, and the structural buckling stress shall be estimated;

(2) Fixtures and jigs, if required for test, shall be subjected to strength assessment to ensure they will not be buckled before specimens;

(3) Before formal test, pre-loading may be conducted to eliminate the remaining stress of the structure; 25% and 50% of the estimated ultimate buckling stress may be taken as the upper limit of loading;

(4) The method with the displacement loading that is small enough shall be adopted to fulfill the quasi-static process and avoid the test failure led by the violent destruction to specimens in ultimate state.

1.6.2 Test report

1.6.2.1 The test report shall include the following information:

(1) Dimensions of specimens and material parameters;

(2) Original deformation of specimens;

(3) Characteristics of corrosion pits;

(4) Boundary conditions and methods for fulfillment;

(5) Load types and loading methods;

(6) Test results and analysis.