

ANNEX 3

**RESOLUTION MSC.289(87)
(adopted on 14 May 2010)**

**PERFORMANCE STANDARD FOR ALTERNATIVE MEANS OF CORROSION
PROTECTION FOR CARGO OIL TANKS OF CRUDE OIL TANKERS**

THE MARITIME SAFETY COMMITTEE,

RECALLING Article 28(b) of the Convention on the International Maritime Organization concerning the functions of the Committee,

NOTING regulation II-1/3-11 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended (hereinafter referred to as "the Convention") adopted by resolution MSC.291(87), concerning alternative means of corrosion protection for cargo oil tanks of crude oil tankers,

NOTING ALSO that the aforementioned regulation II-1/3-11 provides that the alternative means of corrosion protection referred to therein shall comply with the requirements of the Performance standard for alternative means of corrosion protection for cargo oil tanks of crude oil tankers (hereinafter referred to as "the Performance standard for alternative means of corrosion protection"),

HAVING CONSIDERED, at its eighty-seventh session, the text of the proposed Performance standard for alternative means of corrosion protection,

1. ADOPTS the Performance standard for alternative means of corrosion protection for cargo oil tanks of crude oil tankers, the text of which is set out in the Annex to the present resolution;
2. INVITES Contracting Governments to the Convention to note that the Performance standard for alternative means of corrosion protection will take effect on 1 January 2012 upon entry into force of SOLAS regulation II-1/3-11;
3. NOTES that, under the provisions of chapter II-1 of the SOLAS Convention, amendments to the Performance standard for alternative means of corrosion protection shall be adopted, brought into force and take effect in accordance with the provisions of article VIII of that Convention concerning the amendment procedure applicable to the annex to the Convention other than chapter I;
4. REQUESTS the Secretary-General to transmit certified copies of this resolution and the text of the Performance standard for protective coatings contained in the Annex to all Contracting Governments to the Convention;
5. FURTHER REQUESTS the Secretary-General to transmit copies of this resolution and the Annex to all Members of the Organization which are not Contracting Governments to the Convention;
6. INVITES Governments to encourage the development of novel technologies aimed at providing for alternative systems and to keep the Organization advised of any positive results;

7. RESOLVES to keep the Performance standard for alternative means of corrosion protection under review and amend it as necessary, in light of experience gained in its application.

ANNEX

PERFORMANCE STANDARD FOR ALTERNATIVE MEANS OF CORROSION PROTECTION FOR CARGO OIL TANKS OF OIL TANKERS

1 PURPOSE

This Standard provides technical requirements for the minimum standard for means of corrosion protection or utilization of corrosion resistant material other than protective coating to be used for cargo oil tanks during construction of crude oil tankers.

2 DEFINITION

2.1 *Alternative means* is a means that is not a utilization of protective coating applied according to the Performance standard for protective coating for cargo oil tanks of crude oil tankers (resolution MSC.288(87)).

2.2 *Corrosion resistant steel* is steel whose corrosion resistance performance in the bottom or top of the internal cargo oil tank is tested and approved to satisfy the requirements in this Standard in addition to other relevant requirements for ship material, structure strength and construction.

2.3 *Target useful life* is the target value, in years, of the durability for which the means of corrosion protection or utilization of corrosion resistance material is designed.

3 APPLICATION

3.1 As of the date of the development of this Standard, corrosion resistant "steel" is the only recognized possible means for corrosion protection or utilization of corrosion resistant material to maintain the required structural integrity for 25 years, as an alternative to protective coating. If corrosion resistant steel is to be used as alternative means, it shall comply with the Performance Standard for corrosion resistant steel as set out in the annex.

3.2 When a novel type of alternative means to which the provisions in the annex are not applicable has been developed, and recognized by the Organization, a specific performance standard including testing procedure(s) should be developed by the Organization by adding a new annex to this Standard, taking into account experience gained through field tests for the novel prototype alternative conducted in accordance with SOLAS regulation II-1/3-11.4.

ANNEX

PERFORMANCE STANDARD FOR CORROSION RESISTANT STEEL

1 PURPOSE

This Standard provides technical requirements for the minimum standard for corrosion resistant steel to be used for cargo oil tanks during construction of crude oil tankers.

2 GENERAL PRINCIPLES

2.1 The ability of corrosion resistant steel to reach its target useful life depends on the type of steel, application and survey. All these aspects contribute to the good performance of corrosion resistant steel.

2.2 Technical File

2.2.1 Documents and information stipulated in 2.2.3 and 2.2.4 shall be documented in the Technical File. The Technical File shall be verified by the Administration.

2.2.2 The Technical File shall be kept on board and maintained throughout the life of the ship.

2.2.3 *New construction stage*

The Technical File shall contain at least the following items relating to this Standard and shall be delivered by the shipyard at new ship construction stage:

- .1 copy of a Type Approval Certificate;
- .2 technical data, including:
 - .2.1 approved welding methods and welding consumables; and
 - .2.2 repairing methods recommended by the manufacturer (if any); and
- .3 records of the application, including:
 - .3.1 applied actual space and area of each compartment; and
 - .3.2 applied product and its thickness.

2.2.4 *In-service maintenance, repair and partial renewal*

In-service maintenance, repair and renewal activities shall be recorded in the Technical File.

3 CORROSION RESISTANT STEEL STANDARD

3.1 Performance standard

This Standard is based on specifications and requirements which intend to provide a target useful life of 25 years, which is considered to be the time period, from initial application, over which the thickness diminution of the steel is intended to be less than the diminution allowance and watertight integrity is intended to be maintained in cargo oil tanks. The actual useful life will vary, depending on numerous variables including actual conditions encountered in service.

3.2 Standard application

Corrosion resistant steel for cargo oil tanks applied to the area specified in 3.4 during the construction of crude oil tankers shall at least comply with the requirements in this Standard and this should be considered as a minimum.

3.3 Special application

3.3.1 This Standard covers corrosion resistant steel requirements for ship's steel structures. It is noted that other independent items are fitted within the tanks to which measures are applied to provide protection against corrosion.

3.3.2 It is recommended that this Standard or the Performance standard for protective coating for cargo oil tanks is applied, to the extent possible, to those portions of permanent means of access provided for inspection within the area specified in 3.4 that are not integral to the ship's structure, such as rails, independent platforms, ladders, etc. Other equivalent methods of providing corrosion protection for the non-integral items may also be used, provided they do not impair the performance of the corrosion resistant steel of the surrounding structure. Access arrangements that are integral to the ship structure, such as increased stiffener depths for walkways, stringers, etc., are to fully comply with this Standard or the Performance standard for protective coating for cargo oil tanks, when located within the areas specified in 3.4.

3.3.3 It is also recommended that supports for piping, measuring devices, etc., be provided with corrosion protection in accordance with the non-integral items indicated in 3.3.2.

3.4 Area of application

The following areas are the minimum areas that shall be protected according to this Standard:

- .1 Deckhead with complete internal structure, including brackets connecting to longitudinal and transverse bulkheads. In tanks with ring frame girder construction the underdeck transverse framing to be protected down to level of the first tripping bracket below the upper faceplate.
- .2 Longitudinal and transverse bulkheads to be protected to the uppermost means of access level. The uppermost means of access and its supporting brackets to be fully protected.

- .3 On cargo tank bulkheads without an uppermost means of access the protection to extend to 10% of the tanks height at centreline but need not extend more than 3 m down from the deck.
- .4 Flat inner bottom and all structure to height of 0.3 m above inner bottom to be protected.

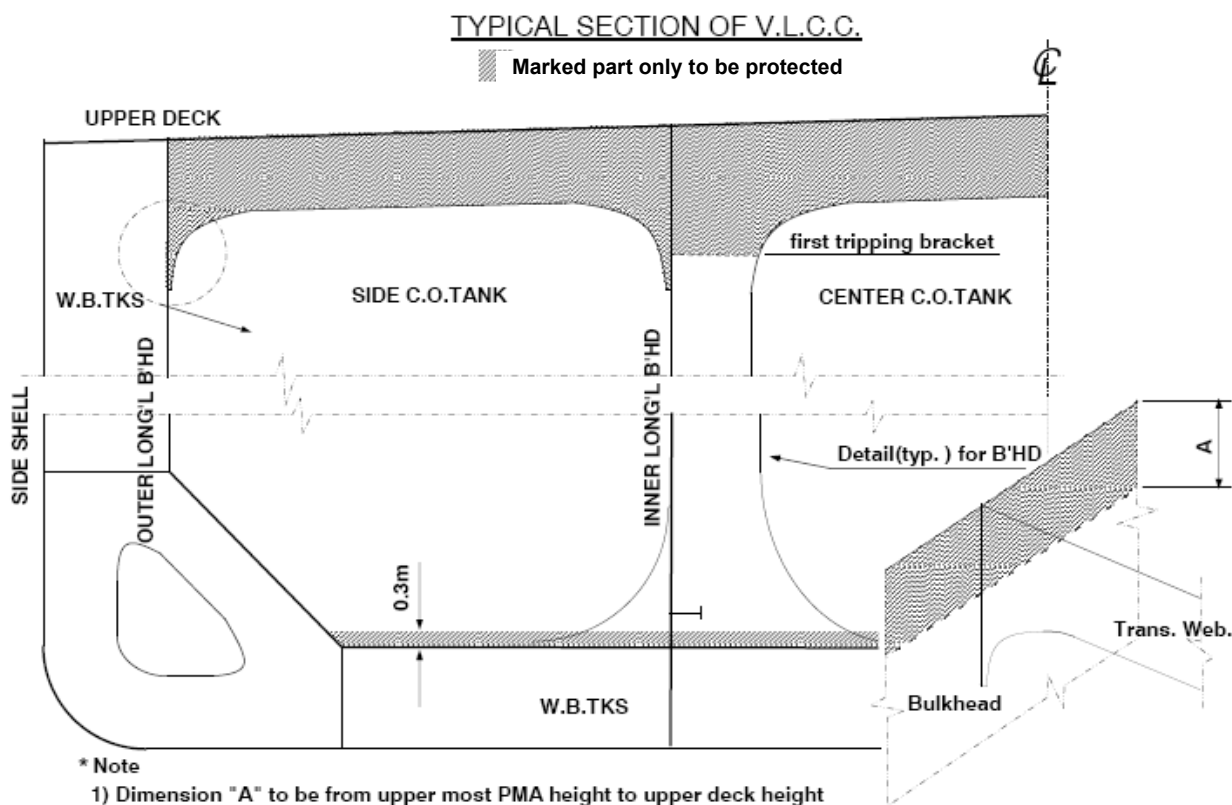


Figure 1

3.5 Basic requirements

The requirements for corrosion resistant steel to be applied at ship construction for cargo tanks in crude oil tankers meeting the performance standard specified in 3.1 are to use approved corrosion resistant steels according to the conditions specified in the Type Approval Certificate and the Technical File to protect the area of application indicated in 3.4.

4 APPROVAL

4.1 Corrosion resistant steel shall be tested according to the appendix, or equivalent, for approval. Corrosion resistant steel tested prior to entry into force of this Standard may be accepted, provided that the steel is tested according to the test procedure in the appendix, or equivalent.

4.2 Results from prequalification tests (4.1) of corrosion resistant steel shall be documented, and a Type Approval Certificate shall be issued if found satisfactory by the Administration.

- 4.3 The Type Approval Certificate shall include following information:
- .1 product name and identification mark and/or number;
 - .2 materials, components and corrosion resistance process of the steel;
 - .3 steel thickness;
 - .4 welding methods and welding consumables; and
 - .5 applicable area (upper and/or inner bottom plate).

5 INSPECTION AND VERIFICATION REQUIREMENTS

To ensure compliance with this Standard, the Administration shall carry out survey(s) during the construction process and verify that approved corrosion resistant steel has been applied to the area required.

APPENDIX

**TEST PROCEDURES FOR QUALIFICATION OF CORROSION RESISTANT STEEL FOR
CARGO TANKS IN CRUDE OIL TANKERS**

1 Scope

These Procedures provide details of the test procedure referred to in 4.1 of this Standard.

2 Testing

Corrosion resistant steel shall be verified by the following tests.

2.1 Test on simulated upper deck conditions

2.1.1 Test condition

Tests on simulated upper deck conditions in cargo oil tank (COT) shall satisfy each of the following conditions:

- .1 Corrosion resistant steel and conventional steel shall be tested at the same time.
- .2 The chemical composition of conventional steel shall comply with the requirements of table 1. The mechanical properties of the test specimen should be representative of steel used in its intended shipboard application.

Table 1 – Chemical composition for conventional steel (%)

C	Mn	Si	P	S
0.13-0.17	1.00-1.20	0.15-0.35	0.010-0.020	0.002-0.008
Al(acid soluble min)	Nb max.	V max	Ti max	Nb+V+Ti max.
0.015	0.02	0.10	0.02	0.12
Cu max.	Cr max.	Ni max.	Mo max.	Others max.
0.1	0.1	0.1	0.02	0.02 (each)

- .3 The tests for corrosion resistant steel shall be carried out for 21, 49, 77 and 98 days. The tests for conventional steel shall be carried out for 98 days. The tests for welded joints shall be carried out for 98 days.
- .4 There are to be five test pieces for each test period.
- .5 The size of each test piece is 25 ± 1 mm x 60 ± 1 mm x 5 ± 0.5 mm. The surface of the test piece shall be polished with an emery paper #600. The size of the test piece for a welded joint is 25 ± 1 mm x 60 ± 1 mm x 5 ± 0.5 mm, including 15 ± 5 mm width of the weld metal part.
- .6 The surface of the test piece, except for the tested surface, shall be protected from corrosive environment in order not to affect the test results.
- .7 The test apparatus consists of a double chamber, and the temperature of the outer chamber is to be controlled.

- .8 Simulating the condition of the actual upper deck, the test cycle runs with distilled water and simulated COT gas ($4 \pm 1\% \text{ O}_2$ - $13 \pm 2\% \text{ CO}_2$ - $100 \pm 10 \text{ ppm SO}_2$ - $500 \pm 50 \text{ ppm H}_2\text{S}$ - $83 \pm 2\% \text{ N}_2$). A sufficient distance between the surface of the test piece and the distilled water is to be kept to avoid splashing of distilled water. The minimum gas flow rate is 100 cc per minute for the first 24 h and 20 cc per minute after 24 h.
- .9 The test pieces shall be heated for $19 \pm 2 \text{ h}$ at $50 \pm 2^\circ\text{C}$ and $3 \pm 2 \text{ h}$ at $25 \pm 2^\circ\text{C}$ and the transition time is to be at least 1 h. The time for 1 cycle is 24 h. The temperature of the distilled water is to be kept at not higher than 36°C , while the temperature of the test pieces is 50°C .

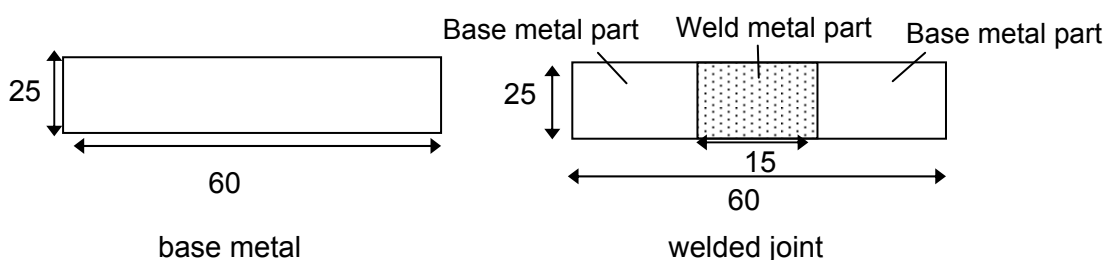


Figure 1 –Test piece of this test

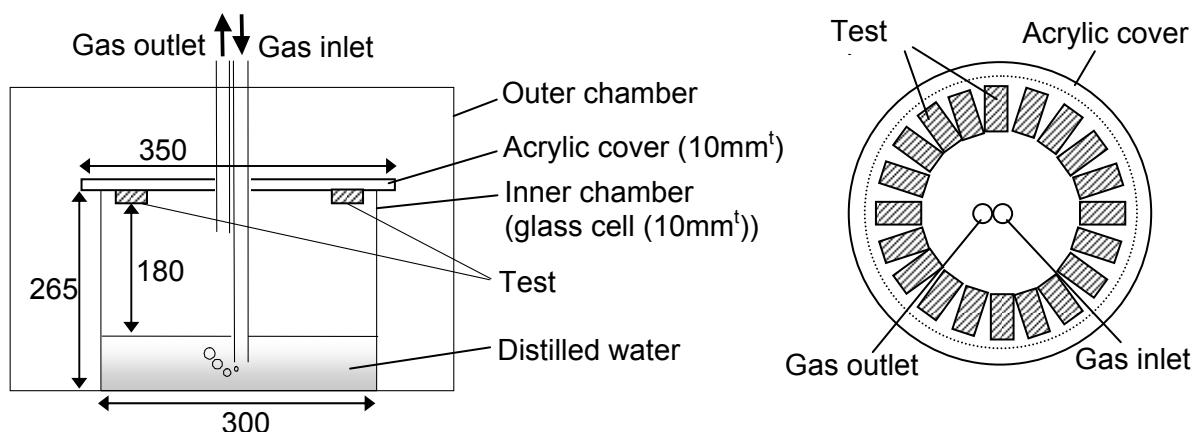


Figure 2 – An example of simulated corrosion test apparatus for upper deck

2.1.2 Test results of base metal

Prior to the testing, the following measured data shall be reported:

- .1 size and weight of the test piece;

and, after the testing, the following measured data shall be reported:

- .2 weight loss (difference between initial weight and weight after testing) of conventional steel (W_C) and corrosion resistant steel (W_{21} , W_{49} , W_{77} and W_{98});

- .3 corrosion loss of conventional steel (CL_C) and corrosion resistant steel (CL_{21} , CL_{49} , CL_{77} and CL_{98}), calculated by the following formulae:

$$CL_C(mm) = \frac{10 \times W_C}{S \times D}$$

$$CL_{21}(mm) = \frac{10 \times W_{21}}{S \times D}$$

$$CL_{49}(mm) = \frac{10 \times W_{49}}{S \times D}$$

$$CL_{77}(mm) = \frac{10 \times W_{77}}{S \times D}$$

$$CL_{98}(mm) = \frac{10 \times W_{98}}{S \times D}$$

whereby:

W_C : weight loss of conventional steel (g) (average of five test pieces)

W_{21} : weight loss of corrosion resistant steel after 21 days (g) (average of five test pieces)

W_{49} : weight loss of corrosion resistant steel after 49 days (g) (average of five test pieces)

W_{77} : weight loss of corrosion resistant steel after 77 days (g) (average of five test pieces)

W_{98} : weight loss of corrosion resistant steel after 98 days (g) (average of five test pieces)

S: surface area (cm^2)

D: density (g/cm^3).

The test is considered to be carried out appropriately if CL_C is between 0.05 and 0.11 (corrosion rate is between 0.2 and 0.4 mm/year). The concentration of H_2S in simulated COT gas may be increased for adjusting CL_C ;

- .4 coefficients A and B of corrosion resistant steel, calculated from the test results for 21, 49, 77 and 98 days by least square method.

Corrosion loss of corrosion resistant steel is described as follows:

$$CL = A \times t^B$$

A(mm) and B: coefficient
t: test period(days);

- .5 estimated corrosion loss after 25 years (ECL) calculated by the following formula:

$$ECL(\text{mm}) = A \times (25 \times 365)^B.$$

2.1.3 *Test results of welded joint*

The surface boundary between base metal and weld metal shall be observed by microscope at 1,000 times magnification.

2.1.4 *Acceptance criteria*

The test results based on provisions of 2.1.2 and 2.1.3 shall satisfy the following criteria:

- .1 $ECL(\text{mm}) \leq 2$ (for base metal); and
- .2 no discontinuous surface (e.g., step) between the base metal and weld metal (for welded joint).

2.1.5 *Test report*

The test report shall include the following information:

- .1 name of the manufacturer;
- .2 date of tests;
- .3 chemical composition and corrosion resistant process of steel;
- .4 test results according to 2.1.2 and 2.1.3; and
- .5 judgement according to 2.1.4.

2.2 ***Test on simulated inner bottom conditions***

2.2.1 *Test condition*

Tests on simulated inner bottom conditions in cargo oil tanks (COT) should satisfy each of the following conditions:

- .1 The test shall be carried out for 72 h for base metal, and 168 h for welded joint.
- .2 There are to be at least five test pieces of corrosion resistant steel for base metal and welded joint, respectively. For comparison, at least five test pieces of base metal of conventional steel should be tested in the same condition.
- .3 The size of each test piece is $25 \pm 1 \text{ mm} \times 60 \pm 1 \text{ mm} \times 5 \pm 0.5 \text{ mm}$ for a specimen with base metal only, and is $25 \pm 1 \text{ mm} \times 60 \pm 1 \text{ mm} \times 5 \pm 0.5 \text{ mm}$ for a specimen with welded joint including $15 \pm 5 \text{ mm}$ width of

weld metal part as shown in figure 3. The surface of the test pieces shall be polished with an emery paper #600, except a hole for hanging.

- .4 The samples are hung in a solution from a fishing line (0.3 mm to 0.4 mm in diameter, made of nylon) to avoid crevice-like and/or localized corrosion. An example of a corrosion test configuration is shown in figure 4.
- .5 The test solution contains 10 mass% NaCl and its pH is 0.85 adjusted by HCl solution. The test solution should be changed to a new one every 24 h to minimize pH change of the test solution. The volume of the solution is more than 20 cc/cm² (surface area of test piece). The temperature of the test solution is to be kept at 30 ± 2°C.

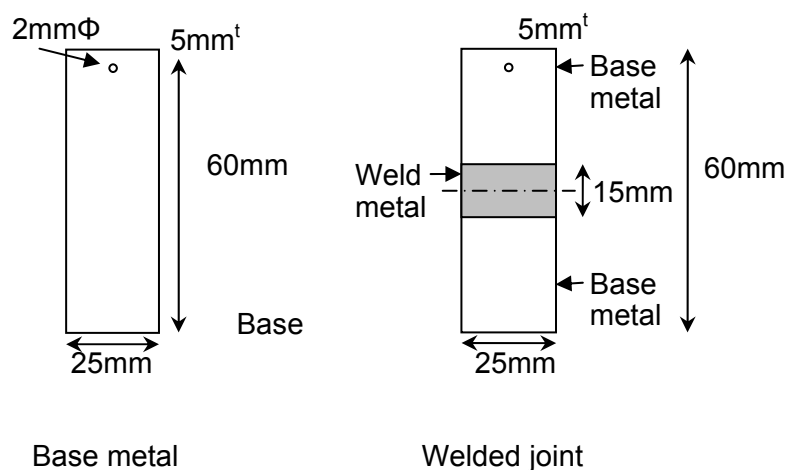


Figure 3 – Test piece for this test

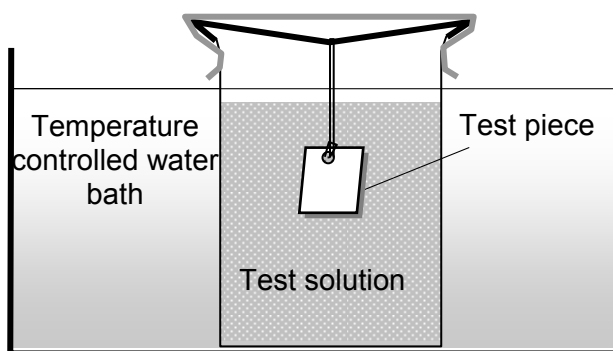


Figure 4 – Simulated corrosion test apparatus for inner bottom

2.2.2 Test results of base metal

Prior to the testing, the following data shall be measured and reported:

- .1 size and weight of test piece;

and, after the testing, the following measured data shall be reported:

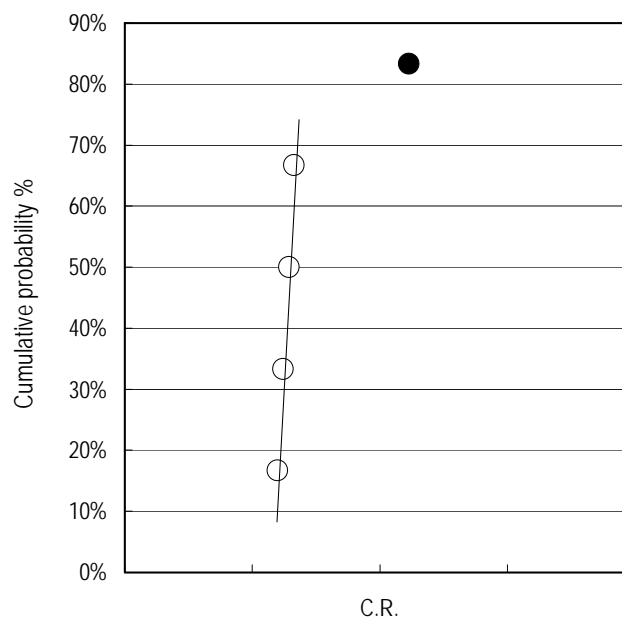
- .2 weight loss (difference between initial weight and weight after testing);
- .3 corrosion rate (*C.R.*) calculated by the following formula:

$$C.R.(mm/ year) = \frac{365(days) \times 24(hours) \times W \times 10}{S \times 72(hours) \times D}$$

whereby:

W: weight loss(g), *S*: surface area(cm²), *D*: density(g/cm³);

- .4 to identify specimen which hold crevice and/or localized corrosion, the *C.R.* is to be plotted on a normal distribution statistic chart. *C.R.* data which deviate from the normal statistical distribution must be eliminated from the test results. An example is shown in figure 5 for reference;
- .5 calculation of average of *C.R.*'s data (*C.R.*_{ave}):



**Figure 5 – An example of plot of *C.R.*s on a normal distribution chart
(In this case *C.R.* data ● should be abandoned and eliminated.)**

2.2.3 Test results of welded joint

The surface boundary between base metal and weld metal shall be observed by microscope at 1,000 times magnification.

2.2.4 Acceptance criterion

The test results based on sections 2.2.2 and 2.2.3 shall satisfy the following criteria:

- .1 $C.R._{ave} (mm/ year) \leq 1.0$ (for base metal); and
- .2 no discontinuous surface (e.g., step) between the base metal and weld metal (for welded joint).

2.2.5 *Test report*

The test report shall include the following information:

- .1 name of the manufacturer;
- .2 date of tests;
- .3 chemical composition and corrosion resistant process of steel;
- .4 test results according to 2.2.2 and 2.2.3; and
- .5 judgement according to 2.2.4.
