# Standards Referenced in IACS Unified Requirements and IACS Recommendations (Materials and Welding)

**Amended Rules and Guidance**

Rules for the Survey and Construction of Steel Ships Part K
Guidance for the Survey and Construction of Steel Ships Parts K, and M
Guidance for the Approval and Type Approval of Materials and Equipment for Marine Use

**Reason for Amendment**

IACS unified requirements (UR) and recommendations (Rec.) related to materials and welding sometimes make reference to international and national standards (e.g. ISO standards) in their respective requirements. When such requirements are incorporated into the NK Rules, the referenced standard numbers are given accordingly and, for some requirements, the relevant parts of the standards are incorporated directly into the NK Rules as well.

In URs and recommendations related to materials and welding, the year of establishment/revision was not given for some of the referenced standards in some cases. In other cases, such information was given, but it had not been reviewed since the original publication of the UR or recommendation. For this reason, IACS reviewed relevant URs and recommendations to clarify their year of establishment/revision. Amended versions were then adopted as UR W2(Rev.3), UR W14(Rev.3), UR W17(Rev.6), UR W25(Rev.6) and Rec.70(Rev.2) in September 2021.

Accordingly, relevant requirements are amended in accordance with the aforementioned URs and recommendations.

**Outline of Amendment**

(1) Adds the year of publication for standards referenced into the NK Rules in accordance with IACS unified requirements and recommendations.
(2) Revises the constants used for the conversion of permissible variations for material specimens and coefficients of correction for proportional test specimens, etc. in accordance with standards referred in the IACS URs and recommendations.

“Rules for the survey and construction of steel ships” has been partly amended as follows:

# Part K MATERIALS

## Chapter 2 TEST SPECIMENS AND MECHANICAL TESTING PROCEDURES

### 2.2 Test Specimens

#### 2.2.2 Tensile Test Specimens*

**1** Tensile test specimens are to be of size and dimensions given in **Table K2.1**, and the both ends of the test specimen may be machined to such a shape as to fit the holder of the testing machine.

**2** The manufacturers may use the test specimens approved by the Society, besides those specified in **Table K2.1**. In this case, the required elongation is to be calculated from the following formula:

$$n = a \cdot E \cdot \left(\frac{\sqrt{A}}{L}\right)^{b}$$

$n$ : Required elongation of test specimen
$E$ : Required elongation for the proportional specimens specified in **Table K2.1**
$A$ : Actual sectional area of test specimen
$L$ : Actual gauge length of test specimen
$a, b$ : Constants given in **Table K2.2** in accordance with the kind of materials.

**3** The permissible variation (difference between the maximum and minimum values) at the machine-finished parallel part of test specimens is to be as specified in **Table K2.3**.

Table K2.2 has been amended as follows.

Table K2.2 Values of *a* and *b*

| Material | Constant | |
|---|---|---|
| | *a* | *b* |
| Material I | 2.0 | 0.40 |
| Material II | 2.6 | 0.55 |
| Material III | 1.25 | 0.127 |

Notes:

(1) Material I: For carbon and low alloy steels with a specified tensile strength not exceeding 600 $N/mm^2$ in the hot rolled, annealed, normalized, or normalized and tempered conditions.

(2) Material II: For carbon and low alloy steels in the quenched and tempered condition.

(3) Material III: For austenitic stainless steels with tensile strengths from 450 $N/mm^2$ to 750 $N/mm^2$ in the solid solution treatment.

(~~3~~4) The values of *a* and *b* for materials other ~~kinds of materials~~ than Material I, Material II and Material III are to be as deemed appropriate by the Society.

Table K2.3 has been amended as follows.

Table K2.3 Permissible Variation

| Diameter of test specimens where they are machined to a circular section, or thickness and width where they are machined to a rectangular section (*mm*) | Permissible variation (*mm*) | |
|---|---|---|
| | Circular cross section | Rectangular cross section |
| Over 3 up to 6 | Max. 0.03 | Max. 0.06 |
| Over 6 up to ~~16~~18 | Max. 0.04 | Max. 0.08 |
| Over ~~16~~18 up to 30 | Max. 0.05 | Max. 0.10 |

## 2.3 Mechanical Testing Procedures

### 2.3.2 Impact Test

Sub-paragraph -1 has been amended as follows.

**1** The impact test is to be conducted on a Charpy impact testing machine having a capacity not less than 150 *J* ~~and a striking velocity between 4.5 and 6 *m/s*~~. with the test specimens at the temperature controlled with in ±2°C of the specified temperature.

“Guidance for the survey and construction of steel ships” has been partly amended as follows:

# Part K MATERIALS

## K2 TEST SPECIMENS AND MECHANICAL TESTING PROCEDURES

### K2.2 Test Specimens

Paragraph K2.2.2 has been amended as follows.

**K2.2.2 Tensile Test Specimens**

**1** The gauge length of the *U*14*B* tensile test specimens specified in **Table K2.1, Part K of the Rules** may be round off as given in **Table K2.2.2-1** in accordance with **Note (2)** in **Table K2.1, Part K of the Rules**:

Table K2.2.2-1 Rounding of Gauge Length

| Thickness of test specimen $t$ (*mm*) | Width of test specimen $W$ (*mm*) | Gauge length $L$ (*mm*) |
|---|---|---|
| $3 \leq t \leq 4$ | 25 | 50 |
| $4 < t \leq 5$ | | 60 |
| $5 < t \leq 7$ | | 70 |
| $7 < t \leq 10$ | | 80 |
| $10 < t \leq 15$ | | 100 |
| $15 < t \leq 20$ | | 120 |
| $20 < t \leq 30$ | | 140 |
| $30 < t \leq 40$ | | 160 |

**2** In **2.2.2-2, Part K of the Rules**, corrections for elongation are to be in accordance with the following:

(1) ~~Stainless steel and~~ ~~a~~Aluminium alloy specified in **Part K of the Rules** are to be considered as Material Ⅰ in **Table K2.2, Part K of the Rules**.

(2) Corrections for elongation may not be required in the case of copper alloy.

(3) Where test specimens differing from those specified in **Table K2.1, Part K of the Rules** are used, the standard value of elongation are to be corrected according to the following formula:

$n = E/F$

$E$ : Elongation equivalent corresponding to standard to where the proportion specimens ($L$ =$5.65\sqrt{A}$) specified in **Table K2.1, Part K of the Rules** are used

$n$ : Elongation where optional test specimens are used

$F$ : Coefficient of correction for elongation are shown in **Table K2.2.2-2, Part K** below according to the gauge length

(4) In case **(3)** above, the elongation ($n$) is to be recorded in the certificates of the material test.

(5) Diagrams for conversion of elongation between the test specimens having gauge length $L$=200 *mm* or $L$=50 *mm* and the proportional specimens are as shown in **Fig. K2.2.2-1** and **Fig. K2.2.2-2**. However, in case the of Material III, the diagram for conversion of elongation is to be according to *ISO* 2566-2:1984.

Table K2.2.2-2 has been amended as follows.

Table K2.2.2-2 Values of $F$

| Gauge length | Material I | Material II | Material III |
|---|---|---|---|
| $L$ =8$D$ | 1.21 | 1.29 | 1.06 |
| $L = 8\sqrt{A}$ | 1.15 | 1.21 | 1.04 |
| $L$ =4$D$ | 0.91 | 0.88 | 0.97 |
| $L = 4\sqrt{A}$ | 0.87 | 0.82 | 0.95 |

Notes:

$D$ : Diameter of the test specimen

$A$ : Sectional area of the test specimen

# K3 ROLLED STEELS

## K3.11 Additional Requirements for Through Thickness Properties

Paragraph K3.11.5 has been amended as follows.

### K3.11.5 Non-destructive Testing

Ultrasonic testing is to be performed, with a probe frequency of 4 *MHz*~~.~~, in accordance with either *EN* 10160 Level S1/E1:1999 or *ASTM* A578 Level C:2017 or with other standards which is left to the discretion of the Society.

# K8 ALUMINIUM ALLOYS

## K8.1 Aluminium Alloy Plates and Extruded Shapes

Paragraph K8.1.8 has been amended as follows.

### K8.1.8 Corrosion Resistance Test

Testing method and judging criteria of corrosion resistance test are to comply with the following requirements.

(1) Metallographic examination

Metallographic examination is to be performed in accordance with *ASTM B* 928:2015 9.6.1 or other standards which is left to the discretion of the Society.

(2) Corrosion test

Corrosion test is to be performed with respect to both exfoliation and intergranular corrosion resistance, and the test requirements are in accordance with the following **(a)** or **(b)**:

(a) *ASTM G* 66:2018 and *ASTM G* 67:2018 carried out under the conditions specified in *ASTM B* 928:2015

The evaluation criteria are as follows:

i) When subjected to the test described in *ASTM G* 66:2018, the samples are to have exhibited no evidence of exfoliation corrosion and a pitting rating of *N*, *PA* or *PB*.

ii) When subjected to the test described in *ASTM G* 67:2018, the samples are to have exhibited resistance to intergranular corrosion at a mass loss no greater than 15 $mg/cm^2$.

(b) Standards deemed appropriate by the Society

# Part M WELDING

## M4 WELDING PROCEDURE AND RELATED SPECIFICATIONS

### M4.2 Tests for Butt Welded Joints

Paragraph M4.2.2 has been amended as follows.

**M4.2.2 Kinds of Test**

As for the welding of aluminium alloys, imperfections detected by visual or non-destructive testing are to be assessed in accordance with *ISO* 10042~~(2005)~~:2018, Level *B*, except for excess weld metal or convexity, excess throat thickness and excess of penetration for which Level *C* applies.

### M4.3 Tests for Fillet Weld Joints

Paragraph M4.3.2 has been amended as follows.

**M4.3.2 Kinds of Test**

As for welding of aluminium alloys, imperfections detected by visual or non-destructive testing are to be assessed in accordance with *ISO* 10042~~(2005)~~:2018, Level *B*, except for excess weld metal or convexity, excess throat thickness and excess of penetration for which Level *C* applies.

## M6 WELDING CONSUMABLES

### M6.2 Electrodes for Manual Arc Welding for Mild and High Tensile Steels and Steels for Low Temperature Service

Paragraph M6.2.11 has been amended as follows.

**M6.2.11 Hydrogen Test**

**1** The glycerin method or the mercury method or the gas chromatography method specified in **6.2.11-1, Part M of the Rules** is to be in accordance with the following~~s~~.

((1) is omitted.)

(2) Mercury method

Mercury method is to be in accordance with the requirements in *ISO* 3690:2018.

(3) Gas chromatography method

Gas chromatography method is to be in accordance with the requirement in *ISO* 3690:2018 or *JIS Z* 3118 (Method of Measurement for Hydrogen Evolved from Steel Welds based on *ISO* 3690:2018).

(-2 is omitted.)

“Guidance for the approval and type approval of materials and equipment for marine use” has been partly amended as follows:

# Part 1 METALLIC MATERIALS

## Chapter 1 APPROVAL OF MANUFACTURING PROCESS OF ROLLED STEELS

### 1.4 Approval Test

#### 1.4.3 Details of Test

Sub-paragraph -1 has been amended as follows.

**1** Approval tests for each of rolled steels are to be performed for each test item indicated with a ○ mark in **Table 1.1-2** and the test procedure and judgement standard are to be accordance with **Table 1.1-3**. However, when deemed necessary by the Society, Society may request the increase of test piece, addition of test item (except the test item indicated in **Table 1.1-2** which is included the test related to hot workability, fatigue test, weld cracking test, *CTOD* tests of welded joints, etc.) and submission of proper technical information.

Table 1.1-3 has been amended as follows.

Table 1.1-3 Approval Testing Method and Acceptance Criteria (continued)

| Approval test item | | Selected location of test samples (1) (2) | Length direction of test specimen (3) (4) | Testing method | Acceptance criteria | Notes |
|---|---|---|---|---|---|---|
| (Omitted) | | | | | | |
| Brittle fracture test | *CTOD* test or deep notch test | Top | Parallel | To be consulted with the Society the dimension of test specimen, test condition etc. When newly performing tests at the time of approval. | To be as deemed appropriate by the Society. | - |
| | Temperature gradient *ESSO* test, double tension test or *CAT* evaluation test | Top | Parallel | In accordance with **Annex K3.12.3-1 or Annex K3.12.3-2, Part K of the Rules.** | | - |
| | *NRL* drop weight test | Top | Parallel | *ASTM E* 208:2019 or equivalent method. | | ・ Nil-ductility transition temperatures (*NDTT*) and photographs of test specimens after testing are to be included in test reports. |
| (Omitted) | | | | | | |

Notes:

(1) In the case of ingot casting, “top” means edge of top side of ingot for length direction specified in **1.4.2-1(2)**, “bottom” means edge of another side. In case of continuous casting, any edge is available of both edge for length direction specified in **1.4.2-1(2)**. However, in the case of ingot casting for high strength rolled steels for offshore structures, “top” and “bottom” mean the edge corresponding to the top and bottom of the ingot specified in **1.4.2-1(3)**.

(2) Selected position at width direction or section for each kind is to meet the requirements in **3.1.6-4**, **Part K of the Rules**.

(3) “Length direction of test specimen” denotes the direction of the test sample to the direction of final rolling.

(4) For steel products other than steel plate (i.e. steel sections, steel bars), when it is difficult to be taken test specimens with their longitudinal axis transverse to the rolling direction, test specimens may be taken parallel to the rolling direction subject to the approval with the Society.

(5) The bevel preparation is to be 1/2V or K related to thickness, and the test sample is to be welded by procedures commonly used for the relevant steels in consideration of the welding heat inputs specified in **Table 1.1-6**.

(6) In test records, the figure indicated the details of edge preparations, layer or pass sequence and measuring position of hardness are to be included, in addition to macroscopic photograph of welded section, welding procedure, welding consumables (brand, mark, shielded gas, backing, etc.), welding parameter (amperage, voltage, welding speed, heat input, current, etc.), preheating temperature and interpass temperature. However, where only requested maximum hardness test, these requirements may not be applied.

(7) Weldability tests are, in principle, to be carried out on the thickest plate.

(8) Regardless of **(2)** above, selected locations of test samples in the width direction are to meet the requirements in **3.12.4-2, Part K of the Rules**.

# Chapter 5 APPROVAL OF MANUFACTURING PROCESS OF ALUMINIUM ALLOYS

## 5.2 Approval Application

### 5.2.2 Data to be Submitted

Sub-paragraph -2 has been amended as follows.

**2** For aluminium alloys specified in **Table K8.3(a)**, **Part K of the Rules**, in the *H*116 and *H*321 tempers intended for use in marine hull construction or in marine applications where frequent direct contact with seawater is expected, the manufacturer is to submit the documents which exhibits the relationship between microstructure and resistance to corrosion in addition to the requirements in preceding **-1**. This documents is to include a reference photomicrograph (approx. 500x) intended for use in metallographic examination as specified in **8.1.8**, **Part K of the Rules**. A reference photomicrograph are to be taken for each of the alloy-tempers under the conditions specified in *ASTM B*928:2015 9.4.1 and thickness ranges relevant from samples which have passed the corrosion test as specified in **K8.1.8(2)**, **Part K of the Guidance for the Survey and Construction of Steel Ships**.

## 5.4 Approval Test

### 5.4.2 Details of Test

Table 1.5-2 has been amended as follows.

Table 1.5-2 Approval Testing Method and Acceptance Criteria

| Approval test items | Selection of test specimen | | Testing method | Acceptance criteria |
|---|---|---|---|---|
| | Location | Direction(1) | | |
| Chemical analysis | T (Top Part) | | *JIS H* 1305, *H* 1306 or equivalent method. Ladle analysis and product analysis are to be performed. | Chemical composition by ladle analysis is to comply with the Requirements in **Chapter 8, Part K of the Rules**(2) |
| | B (Bottom Part) | | | |
| Macro-structure | T | - | To be as deemed appropriate by the Society. | To be as deemed appropriate by ~~T~~the Society. |
| | B | | | |
| Micro-structure | T | - | | |
| | B | | | |
| Tensile test at room temperature | T | Parallel | In accordance with **Part K of the Rules**. | Chemical composition by ladle analysis is to comply with the requirements in **Chapter 8, Part K of the Rules**. |
| | | Transverse | | |
| | B | Parallel | | |
| | | Transverse | | |
| Tensile test at low temperature | T | Parallel | The tensile tests are to be carried out at -196℃ by using of the tensile test specimens of the same size and the room temperature. | To be as deemed appropriate by the Society. |
| | B | Transverse | | |
| | T | Parallel | | |
| | B | Transverse | | |
| Tensile test of notched round bar | T | Parallel | The tensile tests are to be carried out at -196℃ by using of the tensile test specimens of notch; Angle of notch : 60° Root radius of notch: 0.05 *mm* or less | |
| | | Transverse | | |
| | B | Parallel | | |
| | | Transverse | | |
| Tensile test in the direction of thickness | T | Direction of thickness | The test specimens are to be selected in the direction of thickness, and tensile tests are to be carried out. | |
| | B | Direction of thickness | | |
| Bend test | T | Parallel | To be as deemed appropriate by the Society. | No crack is to be accepted. |
| | | Transverse | | |
| | B | Parallel | | |
| | | Transverse | | |
| Tear test | T | Transverse | Tear strength and crack propagation energy are to be determined. Size and dimensions of tear test specimens are to be as deemed appropriate by the Society. | To be as deemed appropriate by the Society. |
| | B | Transverse | | |
| Corrosion test | T | Parallel | *ASTM G* 66:2018 and *G* 67:2018 or equivalent method. | To be as deemed appropriate by the Society. (3) |
| | B | | | |

Notes:

(1) When the test specimens used for the approval test cannot be taken from the test samples because of their dimensions or shapes, the direction of the selection of the specimens to be determined on a case-by-case basis upon mutual consultation by the manufacturer and the Society.

(2) Excess difference in the chemical composition between ladle analysis and product analysis is not to be accepted.

(3) When subjected to the test described in *ASTM G* 66:2018, the samples are to have exhibited no evidence of exfoliation corrosion and a pitting rating of *N*, *PA* or *PB*. When subjected to the test described in *ASTM G* 67:2018, the samples are to have exhibited resistance to intergranular corrosion at a mass loss no greater than 15 $mg/cm^2$.