Materials Used for Steel Castings and Steel Forgings

Object of Amendment

Rules for the Survey and Construction of Steel Ships Parts D, K, and M
Guidance for the Survey and Construction of Steel Ships Parts D and K

Reason for Amendment

IACS Unified Requirements (UR) W7 and W8 specify requirements for the mechanical properties and test methods of steel forgings (W7) and steel castings (W8) used for hull structures and machinery, and these requirements have already been incorporated into the NK Rules.

Among these requirements, the application of those related to the chemical compositions of steel castings and steel forgings, handling of the chemical composition values is unclear with respect to differences between carbon steel and alloy steel as well as whether they may be used for welded constructions, etc. In addition, the application of requirements related to forging ratios is partially unclear with respect to steel forgings.

Accordingly, relevant requirements are amended in order to clarify the above-mentioned application and to bring requirements for steel forgings and steel castings more in line with current practice.

Outline of the Amendment

The main contents of this amendment are as follows:

(1) Clarify the correspondence between the specified minimum tensile strength values of shaft materials used and Part K of the Rules for the Survey and Construction of Steel Ships.
(2) Specify requirements for rolled steel bars intended for machine structures includes rolled steel bars for hull structures, and that rolled steel bars are required to undergo impact tests in the same manner as steel forgings.
(3) Clarify the chemical composition values of steel castings by categorising them as either steel castings for welded construction or steel castings for non-welded construction.
(4) Clarify requirements related to forging ratios based upon UR W7.
(5) Clarify the chemical composition values of steel forgings by categorising them as either steel forgings for machinery or for hull structures, and also by categorising as either for welded construction or for non-welded construction.
(6) Delete requirements related to the omission of impact tests during approval tests for welding procedures and related specifications with respect to steel castings and steel forgings which are to be of the same weldable quality used for hull structures.

Effective Date and Application

(1) This draft amendment applies to ships for which the date of contract for construction is on or after 1 January 2025.
(2) Notwithstanding (1) above, this draft amendment may be applied to other ships upon shipowner request.

ID: DD24-10

An asterisk (*) after the title of a requirement indicates that there is also relevant information in the corresponding Guidance.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part D MACHINERY INSTALLATIONS** **Chapter 6 SHAFTINGS** **6.2 Materials, Construction and Strength** **6.2.1 Materials** **1** (Omitted) **2** (Omitted) **3** The specified tensile strength of the shaft materials is generally to be between 400 and 760 N/mm^2 and to be between 500 and 760 N/mm^2 for shafts experiencing torsional vibration stress that exceeds 85 % of the value for τ_2 given in **8.2.2**. Steel forgings with a specified tensile strength exceeding 760 N/mm^2 are not to be used for any shafts unless specially approved by the Society. For alloy steel castings, the value "760 N/mm^2" is to be read as "1100 N/mm^2".	**RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part D MACHINERY INSTALLATIONS** **Chapter 6 SHAFTINGS** **6.2 Materials, Construction and Strength** **6.2.1 Materials** **1** (Omitted) **2** (Omitted) **3** The specified tensile strength of the shaft materials is generally to be between 400 and 800 N/mm^2 and to be between 500 and 800 N/mm^2 for shafts experiencing torsional vibration stress that exceeds 85 % of the value for τ_2 given in **8.2.2**. Steel forgings with a specified tensile strength exceeding 800 N/mm^2 are not to be used for any shafts unless specially approved by the Society.	Align with the value given for tensile strength in Table K6.3(a), Chapter 6, Part K of the Rules.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part K MATERIALS** **Chapter 3 ROLLED STEELS**	**RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part K MATERIALS** **Chapter 3 ROLLED STEELS**	
3.7 Rolled Steel Bars for Structures	**3.7 Rolled Steel Bars for Machine Structures**	Delete the word "machine" so as to also include hull structures.
3.7.1 Application **1** The requirements are to apply to the rolled steel bars used for machine structures such as shafts or bolts (hereinafter referred to as "steel bars" in **3.7**) and rolled steel bars used for hull structures such as stern frames. **2** (Omitted)	**3.7.1 Application** **1** The requirements are to apply to the rolled steel bars used for machine structures such as shafts or bolts (hereinafter referred to as "steel bars" in **3.7**). **2** (Omitted)	Clarify that the requirement also applies to rolled steel bars used for hull structures.
3.7.2 Kinds The steel bars are classified into 2 grades as given in **Table K3.26**.	**3.7.2 Kinds** The steel bars are classified into 2 grades as given in **Table K3.26**.	
Table K3.26 Grades of Steel Bars		Add an example of an indication for hull structures.

Kind	Grade
Rolled carbon steel bars	The grade of steel bars is to be indicated by suffixing a letter "*R*" to the grade "*KSF*" specified in **Table K6.3(a)** and **Table K6.3(b)** (e.g. ~~etc.~~ *KSFR*440-*M* and *KSFR*440-*H*)
Rolled alloy steel bars	The grade of steel bars is to be indicated by suffixing a letter "*R*" to the grade "*KSFA*" specified in **Table K6.3(a)** and **Table K6.3(b)** (e.g. ~~etc.~~ *KSFAR*600-*M* and *KSFAR*600-*H*)

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
3.7.7 Selection of Test Specimens Test specimens are to be taken according to **(1)** to **(3)** below: (1) One tensile test specimen is to be taken from one test sample. (2) A set of test specimens are to be taken from one test sample. (3) The requirements specified in **3.6.8-3, -4** and **-5** are to apply.	**3.7.7 Selection of Test Specimens** Test specimens are to be taken according to **(1)** and **(2)** below: (1) One tensile test specimen is to be taken from one test sample. (Newly added) (2) The requirements specified in **3.6.8-3** and **-4** are to apply.	Clarify that impact testing is also required for rolled bars for structures in accordance with the requirements for castings and forgings.
3.7.12 Markings Steel bars which have satisfactorily complied with the required tests are to be marked with the identification mark in accordance with the requirements in **1.5.1**. For steel bars to which the requirements given in **6.1.6-2** have been applied, the value corresponding to the required tensile strength employed is to be suffixed to their respective grade markings (e.g. where the required tensile strength employed is 440 N/mm^2, "*KSFR*440-*M*" or "*KSFR*440-*H*" is to be indicated)	**3.7.12 Markings** Steel bars which have satisfactorily complied with the required tests are to be marked with the identification mark in accordance with the requirements in **1.5.1**. For steel bars to which the requirements given in **6.1.6-2** have been applied, the value corresponding to the required tensile strength employed is to be suffixed to their respective grade markings (e.g. where the required tensile strength employed is 440 N/mm^2, "*KSFR*440-*M*" is to be indicated)	Add an example of an indication for hull structures.
Chapter 5 CASTINGS	**Chapter 5 CASTINGS**	
5.1 Steel Castings	**5.1 Steel Castings**	
5.1.4 Chemical Composition **1** Steel castings are to have the chemical composition given in **Table K5.1**.	**5.1.4 Chemical Composition** **1** Steel castings are to have the chemical composition given in **Table K5.1**. Steel castings for welded construction are to have a chemical composition deemed appropriate by the Society.	Instead of specifying the chemical composition of steel castings intended for welding in Table

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr>
<td>

2 For steel castings intended for welded construction, "*W*" is to be suffixed to their respective grade markings (e.g. *KSC440W* and *KSCA440W*).

(-3 and -4 are omitted.)

</td>
<td>

2 For carbon steel castings intended for welded construction, the carbon content is generally not to exceed 0.23 %. For carbon steel castings complying with this requirement, "*W*" is to be suffixed to their respective grade markings (e.g. *KSC440W*).

(-3 and -4 are omitted.)

</td>
<td>K5.1, delete the text that is no longer necessary.
Same as above.
Add an example of an indication for alloy steel castings.</td>
</tr>
<tr>
<td colspan="2">

Table K5.1 Chemical Composition

Kind		Chemical composition (%)										
		C	*Si*	*Mn*	*S*	*P*	*Cu*	*Cr*	*Ni*	*Mo*	*V*	Total residual elements
Steel castings not intended for welding	Carbon steel castings	0.40 max.	0.60 max.	0.50-1.60	0.035 max.	0.035 max.	0.30 max.(1)	0.30 max.(1)	0.40 max.(1)	0.15 max.(1)	—	0.80 max.
	Alloy steel castings	0.45 max.	0.60 max.	0.50-1.60	0.030 max.	0.035 max.	0.30 min.(2)	0.40 min.(2)	0.40 min.(2)	0.15 min.(2)	—	—
Steel castings intended for welding	Carbon steel castings	0.23 max.	0.60 max.	0.50-1.60	0.035 max.	0.035 max.	0.30 max.(1)	0.30 max.(1)	0.40 max.(1)	0.15 max.(1)	—	0.80 max.
	Alloy steel castings (3)	0.25 max.	0.60 max.	0.50-1.70	0.030 max.	0.035 max.	0.30 max.(1)	0.40 min.(2)	0.40 min.(2)	0.15 min.(2)	0.12 max.(1)	—

Notes:
(1) Elements considered to be as residual elements. Residual elements are not to be intentionally added to the steel.
(2) One or more of the elements is to comply with the minimum content.
(3) The chemical composition of this table are to be applied unless otherwise deemed appropriate by the Society.

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<td>Specify the categorising of steel castings as being either those intended for welding or those not intended for welding, and also as being either carbon steel castings or alloy steel castings.</td>
</tr>
</table>

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks

Table K5.2 Mechanical Properties of Steel Casting

Kind		Grade [4]	Tensile strength [1] (N/mm^2)	Yield point or proof stress (N/mm^2)	Elongation ($L = 5.65\sqrt{A}$) (%)	Reduction of area (%)	Charpy V-notch impact test [2]	
							Test temperature (°C)	Minimum average energy (J)
Steel castings not intended for welding	Carbon steel castings	*KSC*400	400 min.	200 min.	25 min.	40 min.	*AT* [3]	27
		*KSC*440	440 min.	220 min.	22 min.	30 min.		
		*KSC*480	480 min.	240 min.	20 min.	27 min.		
		*KSC*520	520 min.	260 min.	18 min.	25 min.		
		*KSC*560	560 min.	300 min.	15 min.	20 min.		
		*KSC*600	600 min.	320 min.	13 min.	20 min.		
	Alloy steel castings	*KSCA*550	550 min.	340 min.	16 min.	35 min.		
		*KSCA*600	600 min.	400 min.	16 min.	35 min.		
		*KSCA*650	650 min.	450 min.	14 min.	32 min.		
		*KSCA*700	700 min.	540 min.	12 min.	28 min.		
Steel castings intended for welding	Carbon steel castings	*KSC*400*W*	400 min.	200 min.	25 min.	40 min.	0	
		*KSC*440*W*	440 min.	220 min.	22 min.	30 min.		
		*KSC*480*W*	480 min.	240 min.	20 min.	27 min.		
		*KSC*520*W*	520 min.	260 min.	18 min.	25 min.		
		*KSC*560*W*	560 min.	300 min.	15 min.	20 min.		
		*KSC*600*W*	600 min.	320 min.	13 min.	20 min.		
	Alloy steel castings	*KSCA*550*W*	550 min.	355 min.	18 min.	30 min.		
		*KSCA*600*W*	600 min.	400 min.	16 min.	30 min.		
		*KSCA*650*W*	650 min.	450 min.	14 min.	30 min.		
		*KSCA*700*W*	700 min.	540 min.	12 min.	28 min.		

Notes:

(1) A tensile strength range of 150 N/mm^2 may additionally be specified.

(2) Special consideration may be given to alternative requirements for Charpy V-notch impact tests, depending on design and application, and subject to Society approval.

(3) *AT* refers to the ambient temperature specified in *ISO* 148-1:2016 (i.e. 23 °C±5 °C).

(4) For steel castings intended for welded construction, "*W*" is to be suffixed to their respective grade markings in accordance with **5.1.4-2.**

Add Note (4) for clarifica-tion.

Clarify that "W" is to be added after the material symbol in cases where welding is performed.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
Chapter 6 STEEL FORGINGS	**Chapter 6 STEEL FORGINGS**	
6.1 Steel Forgings	**6.1 Steel Forgings**	
6.1.2 Manufacturing Process*	**6.1.2 Manufacturing Process***	
1 Steel forgings are to be manufactured from killed steel.	**1** Steel forgings are to be manufactured from killed steel.	
2 Adequate top and bottom discards are to be made to ensure freedom from piping and harmful segregation in the finished forgings.	**2** Adequate top and bottom discards are to be made to ensure freedom from piping and harmful segregation in the finished forgings.	
3 Primary materials such as ingot supplied to other works are to be manufactured at the works approved by the Society with regard to the manufacturing process of the materials.	**3** Primary materials such as ingot supplied to other works are to be manufactured at the works approved by the Society with regard to the manufacturing process of the materials.	
(Deleted)	**4** Steel forgings are to be hot worked by means specified in **Table K6.1** from ingots, blooms forged or rolled from ingots or blooms made from ingots by a combination of rolling and forging.	Incorporate into -4.
4 Steel forgings are to be forged in accordance with the following **(1)** to **(6)**. (1) The plastic deformation by forging is to be such as to ensure soundness, uniformity of structure and satisfactory mechanical properties after the heat treatment specified in **6.1.5**. (2) The forging ratio is to be calculated with reference to the average cross-sectional area of the cast material. (3) In cases where the cast material is initially upset, the reference area in **(2)** above may be taken as the average cross-sectional area after this operation. (4) The total forging ratio is to be not less than those in **Table K6.1** unless otherwise deemed appropriate by		-4(1) to -4(4): Incorporates UR W7(Rev.4) Para2.4.
	6 Steel forgings are to be subjected to hot work to give sufficient forging ratios that are not less than those in **Table**	Specify in -4(4).

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
the Society.	**K6.1**. The requirements, however, may be suitably modified at the discretion of the Surveyor according to the size or form or the use for which they are intended, except for compression deformations of steel ingots or forging materials in the longitudinal direction (i.e. upsetting).	Transfer to relevant guidance.
(5) Steel forgings are to be gradually and uniformly forged as far as practicable and are to be brought as near as possible to the finished shape and size so as to cause metal flow in the most favourable direction having regard to the mode of stressing in service.	**5** Steel forgings are to be gradually and uniformly hot worked as far as practicable and are to be brought as nearly as possible to the finished shape and size so as to cause metal flow in the most favourable direction having regard to the mode of stressing in service.	Specify in -4(5).
(6) When upsetting, ingots are to be compressed in the axial direction using anvils whose cross-sections are larger than that of the ingot in order to have sufficient internal forging effects (e.g. uniform deformation of internal portions) on the ingot. Forging ratios are to be described on mill sheets.	**9** When upsetting, ingots are to be compressed in the axial direction using anvils whose cross-sections are larger than that of the ingot in order to have sufficient internal forging effects (e.g. uniform deformation of internal portions) on the ingot. Forging ratios are to be described on mill sheets.	Specify in -4(6).
5 Where steel forgings are subjected to surface hardening process such as induction hardening, nitriding or rolling press, data relative to the hardening process is to be submitted for approval to the Society in advance.	**7** Where steel forgings are subjected to surface hardening process such as induction hardening, nitriding or rolling press, data relative to the hardening process is to be submitted for approval to the Society in advance.	
6 Steel forgings shaped by flame cutting or scarfing are to have a sufficient machining allowance for removing the heat-affected zone, and the operation is to be carried out before the final heat treatment. Preheating is to be carried out according to the chemical composition, dimensions and form of the steel forgings.	**8** Steel forgings shaped by flame cutting or scarfing are to have a sufficient machining allowance for removing the heat-affected zone, and the operation is to be carried out before the final heat treatment. Preheating is to be carried out according to the chemical composition, dimensions and form of the steel forgings.	

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr>
<td>

Table K6.1 Forging Ratio

Type	Dimension(1)	Forging ratio(2)
Forgings made from ingots or from forged blooms or billets	$L > D$	S=3
	$L \leq D$	S=1.5
Forgings made from rolled products	$L \leq D$	S=4
	$L > D$	S=2
Forgings made by upsetting (3)	—	U=1/3
Rolled bars	—	S=3

Notes:

(1) L and D are respectively the length and the diameter of the forged products.

(2) Forging ratio is to be calculated by the following equation:

$$S = \frac{A}{a},\ U = \frac{1}{L_i / L_f}$$

where:

A : Mean sectional area of original ingot (m^2)

a : Sectional area of the portion after forging (m^2)

L_i : Length before upsetting (m)

L_f : Length after upsetting (m)

(3) In the case of an initial forging ratio of at least S=1.5, the forging ratio may be not more than U=1/2 of the length before upsetting.

6.1.3 Kinds

Steel forgings are classified as specified in **Table K6.3(a) and Table K6.3(b)**.

6.1.4 Chemical Composition

1 Steel forgings are to have the chemical composition given in **Table K6.2(a) and Table K6.3(b)**.

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Table K6.1 Forging Ratio

Forging	Hot working	Portion	Forging ratio(1)
Shaft forgings	Forging only	Body	S=3
		Others	S=1.5
	Forging and rolling	Body	S=5
		Others	S=3
Ring forgings	Extend hollow forging by forging press ring mill, etc.	—	S=3
Disc forgings	Upsetting from ingot(2)	—	U=1/3

Notes:

(1) Forging ratio is to be calculated by the following equation:

$S = A/a$, $U = L_1/L$

where:

A : Mean sectional area of original ingot (m^2)

a : Sectional area of the portion after forging (m^2)

L : Length before upsetting (m)

L_1 : Length after upsetting (m)

(2) In other cases, upsetting up to 1/2U or more is to be carried out to make the value U, as a whole, 1/3.

6.1.3 Kinds

The steel forgings are classified as specified in **Table K6.3**.

6.1.4 Chemical Composition

1 Steel forgings are to have the chemical composition given in **Table K6.2**.

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Clarify UR W7(Rev.4) Para. 2.4

Specify separately for machinery steel forgings

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</table>

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
		and hull steel forgings. Summarise in Table K6.2(a) and Table K6.2(b).
(Deleted)	**2** Where carbon steel forgings are not intended for welded constructions, carbon content is not to exceed 0.65 %. Carbon content may be increased in cases where the carbon equivalent (C_{eq}) specified in **1.5.2-2(6)** is less than 0.41 %.	
(Deleted)	**3** Where alloy steel forgings are intended for welded constructions, chemical composition is to be approved by the Society.	Same as above.
2 For steel forgings intended for welded constructions, "*W*" is to be suffixed to their respective grade markings (e.g. *KSF*440*W* and *KSFA*600*W-H*).	**4** For steel forgings complying with **-2** or **-3** above, "*W*" is to be suffixed to their respective grade markings (e.g. *KSF*440*W* and *KSFA*600*W-H*).	
3 For steel forgings for rudder stocks and pintles, chemical composition is to be of a weldable quality. In cases where high strength carbon steel forgings are used, **-2** above may be relaxed subject to approval by the Society. In this case, "(*W*)" is to be suffixed to the markings.	**5** For steel forgings for rudder stocks and pintles, the chemical composition is to be weldable quality. In case where high strength carbon steel forgings are used, the requirements in **-2** above may be relaxed subject to the approval by the Society. In this case, "(*W*)" is to be suffixed to the markings.	
4 Steel forgings may be added with *Al*, *Nb* or *V* element for greater grain refining of the metal crystal.	**6** Steel forgings may be added with *Al*, *Nb* or *V* element for greater grain refining of the metal crystal.	
5 The manufacturer is to make an analysis of each melt in ladles (multiple heats tapped into a common ladle are considered as one heat.) and the results are to be reported to the surveyor.	**7** The manufacturer is to make an analysis of each melt in ladles (Multiple heats are tapped into a common ladle is considered as one heat.) and the results are to be reported to the Surveyor.	

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks

Table K6.2(a) Chemical Composition of Machinery Steel Forgings

Kind		Chemical Composition (%) (1)									
		C	*Si*~~(2)~~	*Mn*	*P*	*S*	*Cr* (~~3~~2)	*Mo* (~~3~~2)	*Ni* (~~3~~2)	*Cu* (~~3~~2)	Total residual elements
Steel forgings not intended for welding	Carbon steel forgings	0.65 max. (4)	0.45 max.	0.30～1.50	0.035 max.	0.035 max.	0.30 max.	0.15 max.	0.40 max.	0.30 max.	0.85 max.
	Alloy steel forgings	0.45 max. ~~(5)~~	0.45 max.	0.30～1.00 ~~(5)~~	0.035 max.	0.035 max.	0.40 min. (~~4~~3)~~(5)~~	0.15 min. (~~4~~3)~~(5)~~	0.40 min. (~~4~~3)~~(5)~~	0.30 max.	—
Steel forgings intended for welding	Carbon steel forgings	0.23 max. (4)	0.45 max.	0.30～1.50	0.035 max.	0.035 max.	0.30 max.	0.15 max.	0.40 max.	0.30 max.	0.85 max.
	Alloy steel forgings (5)	0.25 max.	0.45 max.	0.30～1.00	0.035 max.	0.035 max.	0.40 min. (3)	0.15 min. (3)	0.40 min. (3)	0.30 max.	—

Notes:

(1) Where other elements approved by the Society are added, their contents are to be described in the test results.

~~(2) Where a special deoxidation practice is applied, the value of *Si* may be reduced in cases where approved by the Society.~~

(~~3~~2) Elements considered to be residual elements except in cases where a minimum value is indicated. Residual elements are not to be intentionally added to the steel. The contents of residual elements are to be described in the test results.

(~~4~~3) One or more of the elements is to comply with the minimum content.

(~~5~~4) ~~For alloy steel forgings for hulls, regardless of the values in the table, specifications are to be submitted to the Society for approval.~~Carbon content may be increased in cases where the carbon equivalent (C_{eq}) specified in **1.5.2-2(6)** is less than 0.41 %.

(5) The chemical composition in this table is to be applied unless otherwise deemed appropriate by the Society.

Specify separately for machinery steel forgings and hull steel forgings.

Specify separately for not intended for welding and intended for welding.

Delete Note (2) so as to align with UR W7(Rev.4).

<table>
<tr><th>Amended</th><th>Original</th><th>Remarks</th></tr>
<tr><td>

Table K6.2(b) Chemical Composition of Hull Steel Forgings

<table>
<tr><th colspan="2" rowspan="2">Kind</th><th colspan="10">Chemical Composition (%) (1)</th></tr>
<tr><th>C</th><th>Si</th><th>Mn</th><th>P</th><th>S</th><th>Cr (2)</th><th>Mo (2)</th><th>Ni (2)</th><th>Cu (2)</th><th>Total residual elements</th></tr>
<tr><td rowspan="2">Steel forgings not intended for welding</td><td>Carbon steel forgings</td><td>0.65 max. (4)</td><td>0.45 max.</td><td>0.30～1.50</td><td>0.035 max.</td><td>0.035 max.</td><td>0.30 max.</td><td>0.15 max.</td><td>0.40 max.</td><td>0.30 max.</td><td>0.85 max.</td></tr>
<tr><td>Alloy steel forgings (5)</td><td>0.45 max. (6)</td><td>0.45 max.</td><td>0.30～1.00 (6)</td><td>0.030 max.</td><td>0.030 max.</td><td>0.40～3.50 (3)(6)</td><td>0.15～0.70 (3)(6)</td><td>0.40～3.50 (3)(6)</td><td>0.30 max.</td><td>—</td></tr>
<tr><td rowspan="2">Steel forgings intended for welding</td><td>Carbon steel forgings</td><td>0.23 max. (4)</td><td>0.45 max.</td><td>0.30～1.50</td><td>0.035 max.</td><td>0.035 max.</td><td>0.30 max.</td><td>0.15 max.</td><td>0.40 max.</td><td>0.30 max.</td><td>0.85 max.</td></tr>
<tr><td>Alloy steel forgings (5)</td><td>0.25 max. (6)</td><td>0.45 max.</td><td>0.30～1.00 (6)</td><td>0.035 max.</td><td>0.035 max.</td><td>0.40 min. (3)(6)</td><td>0.15 min. (3)(6)</td><td>0.40 min. (3)(6)</td><td>0.30 max.</td><td>—</td></tr>
</table>

Notes:

(1) Where other elements approved by the Society are added, their contents are to be described in the test results.

(2) Elements considered to be residual elements except in cases where a minimum value is indicated. Residual elements are not to be intentionally added to the steel. The contents of residual elements are to be described in the test results.

(3) One or more of the elements is to comply with the minimum content.

(4) Carbon content may be increased in cases where the carbon equivalent (C_{eq}) specified in **1.5.2-2(6)** is less than 0.41 %.

(5) The chemical composition in this table is to be applied unless otherwise deemed appropriate by the Society.

(6) Specification is to be submitted for approval regardless of the values in the table.

</td><td>Same as above</td></tr>
<tr><td>

6.1.6 Mechanical Properties*

1 Regardless of welding, the mechanical properties of steel forgings are to be in accordance with **Tables K6.3(a)** and **K6.3(b)**. However, the mechanical properties of low alloy steel forgings for which the following apply may be as deemed appropriate by the Society.

(1) Where the value of yield point or proof stress of the forgings is different from the values in **Tables K6.3(a)** and **K6.3(b)**.

</td><td>

6.1.6 Mechanical Properties*

1 The mechanical properties of steel forgings are to be in accordance with **Tables K6.3(a)** and **K6.3(b)**. However, the mechanical properties of low alloy steel forgings for which the following apply may be as deemed appropriate by the Society.

(1) Where the value of yield point or proof stress of the forgings is different from the values in **Tables K6.3(a)** and **K6.3(b)**.

</td><td>Clarify that both cases of welding or not welding are applicable.</td></tr>
</table>

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
(2) Where the forgings are used for rudder stokes or pintles, etc. (-2 to -5 are omitted.)	(2) Where the forgings are used for rudder stoke or pintles etc. (-2 to -5 are omitted.)	

Table K6.3(a) Mechanical Properties of Machinery Steel Forgings

Kind		Grade (7)	Tensile strength (1) (N/mm^2)	Yield point or proof stress (N/mm^2)	Elongation ($L = 5.65\sqrt{A}$) (%)		Reduction of area (%)		Brinell hardness(2) *HBW*	Charpy V-notch impact test (6)		
					L	*T*	*L*	*T*		Test temperature (°C)	Minimum average energy (J)(3)	
											L	*T*
For machinery (7,8)	Carbon steel forgings	*KSF*400-*M*	400 min.	200 min.	26 min.	19 min.	50 min.	35 min.	110～150	*AT*(8,9)	27	18
		*KSF*440-*M*	440 min.	220 min.	24 min.	18 min.	50 min.	35 min.	125～160			
		*KSF*480-*M*	480 min.	240 min.	22 min.	16 min.	45 min.	30 min.	135～175			
		*KSF*520-*M*	520 min.	260 min.	21 min.	15 min.	45 min.	30 min.	150～185			
		*KSF*560-*M*	560 min.	280 min.	20 min.	14 min.	40 min.	27 min.	160～200			
		*KSF*600-*M*	600 min.	300 min.	18 min.	13 min.	40 min.	27 min.	175～215			
		*KSF*640-*M*	640 min.	320 min.	17 min.	12 min.	40 min.	27 min.	185～230			
		*KSF*680-*M*	680 min.	340 min.	16 min.	12 min.	35 min.	24 min.	200～240			
		*KSF*720-*M*	720 min.	360 min.	15 min.	11 min.	35 min.	24 min.	210～250			
		*KSF*760-*M*	760 min.	380 min.	14 min.	10 min.	35 min.	24 min.	225～265			
	Alloy steel forgings	*KSFA*600-*M*	600 min.	360 min.	18 min.	14 min.	50 min.	35 min.	175～215			
		*KSFA*700-*M*	700 min.	420 min.	16 min.	12 min.	45 min.	30 min.	205～245			
		*KSFA*800-*M*	800 min.	480 min.	14 min.	10 min.	40 min.	27 min.	235～275			
		*KSFA*900-*M*	900 min.	630 min.	13 min.	9 min.	40 min.	27 min.	260～320			
		*KSFA*1000-*M*	1000 min.	700 min.	12 min.	8 min.	35 min.	24 min.	290～365			
		*KSFA*1100-*M*	1100 min.	770 min.	11 min.	7 min.	35 min.	24 min.	320～385			

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
Notes: (1) For steel forgings whose specified minimum tensile strength is less than 900 *N/mm*^{2}, a tensile strength range of 150 *N/mm*^{2} may additionally be specified. For steel forgings whose specified minimum tensile strength is 900 *N/mm*^{2} or more, a tensile strength range of 200 *N/mm*^{2} may additionally be specified. (2) Hardness values are standard and are given for information purposes only. (3) The letters *"L"* and *"T"* refer to longitudinal and tangential respectively and indicate the direction in which the specimen is to be taken with respect to the product. (4) The requirement for carbon steel forgings is applicable to those annealed, normalized, normalized and tempered, or quench and tempered. (5) The requirement for low alloy steel forgings is applicable to those quenched and tempered. In cases where they are normalized and tempered, their mechanical properties are subject to Society approval. (6) Special consideration may be given to alternative requirements for Charpy V-notch impact test, depending on design and application, and subject to Society approval. (7) For steel forgings complying with **6.1.4-2**, "*W*" is to be suffixed to their respective grade markings. (~~7~~8) For steel forgings complying with the table, "-*M*" is to be suffixed to their respective grade markings (e.g. ~~-~~ *KSF*400-*M* and *KSFA*600*W*-*M*) (~~8~~9) *AT* refers to the ambient temperature specified in *ISO* 148-1:2016 (i.e. 23 °C±5 °C).		Add Note (7) into Table K6.3(a) for clarification. This is clarifying that "*W*" is to be suffixed to their respective grade markings when intended for welded constructions.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks

Table K6.3(b) Mechanical Properties of Hull Steel Forgings

Kind		Grade (6)	Tensile strength (1) (N/mm^2)	Yield point or proof stress (N/mm^2)	Elongation ($L = 5.65\sqrt{A}$) (%)		Reduction of area (%)		Charpy V-notch impact test (5)		
					L	*T*	*L*	*T*	Test temperature (°*C*)	Minimum average energy (*J*)(2)	
										L	*T*
For hull(67)	Carbon steel forgings	*KSF*400-*H*	400 min.	200 min.	26 min.	19 min.	50 min.	35 min.	0	27	18
		*KSF*440-*H*	440 min.	220 min.	24 min.	18 min.	50 min.	35 min.			
		*KSF*480-*H*	480 min.	240 min.	22 min.	16 min.	45 min.	30 min.			
		*KSF*520-*H*	520 min.	260 min.	21 min.	15 min.	45 min.	30 min.			
		*KSF*560-*H*	560 min.	280 min.	20 min.	14 min.	40 min.	27 min.			
		*KSF*600-*H*	600 min.	300 min.	18 min.	13 min.	40 min.	27 min.			
	Alloy steel forgings	*KSFA*550-*H*	550 min.	350 min.	20 min.	14 min.	50 min.	35 min.			
		*KSFA*600-*H*	600 min.	400 min.	18 min.	13 min.	50 min.	35 min.			
		*KSFA*650-*H*	650 min.	450 min.	17 min.	12 min.	50 min.	35 min.			

Notes:

(1) For steel forgings whose specified minimum tensile strength is less than 600 N/mm^2, a tensile strength range of 120 N/mm^2 may additionally be specified. For steel forgings whose specified minimum tensile strength is 600 N/mm^2 or more, a tensile strength range of 150 N/mm^2 may additionally be specified.

(2) The letters *"L"* and *"T"* refer to longitudinal and tangential respectively and indicate the direction in which the specimen is taken with respect to the product.

(3) The requirement for carbon steel forgings is applicable to those annealed, normalized, normalized and tempered, or quench and tempered.

(4) The requirement for low alloy steel forgings is applicable to those quenched and tempered. In cases where they are normalized and tempered, their mechanical properties are subject to Society approval.

(5) Special consideration may be given to alternative requirements for Charpy V-notch impact test, depending on design and application, and subject to Society approval.

(6) For steel forgings complying with **6.1.4-2**, "*W*" is to be suffixed to their respective grade markings.

(~~6~~7) For steel forgings complying with the table, "-*H*" is to be suffixed to their respective grade markings (e.g. *KSF*400-*H* and *KSFA*600*W*-*H*)

Add Note (6) into Table K6.3(b) for clarification.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
		This is clarifying that "*W*" is to be suffixed to their respective grade markings when intended for welded constructions.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part M WELDING** **Chapter 4 WELDING PROCEDURE AND RELATED SPECIFICATIONS** **4.1 General** **4.1.1 Application*** **1** This Chapter applies to the approval of welding procedure and related specifications mainly for hull construction as well as pipes and piping systems, etc., unless specified in another chapter. **2** This chapter correspondingly applies to the welding procedure and related specifications for the approval of steel castings and steel forgings which is to be of a weldable quality used for hull structures.	**RULES FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part M WELDING** **Chapter 4 WELDING PROCEDURE AND RELATED SPECIFICATIONS** **4.1 General** **4.1.1 Application*** **1** The requirements in this Chapter are to be applied to the approval of welding procedure and related specifications mainly for hull construction as well as pipes and piping systems, etc., unless specified in another chapter. **2** The requirements of this chapter correspondingly apply to the welding procedure and related specifications for the approval of steel castings and steel forgings which is to be weldable quality used for hull structures. However, the impact test may be omitted, upon the approval by the Society.	Delete requirement regarding omission so as to align with UR W7(Rev.4) and UR W8(Rev.3).

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
EFFECTIVE DATE AND APPLICATION **1.** The effective date of the amendments is 1 January 2025. **2.** Notwithstanding the amendments to the Rules, the current requirements apply to ships for which the date of contract for construction is before the effective date. **3.** Notwithstanding the provision of preceding **2.**, the amendments to the Rules may apply to ships for which the date of contract for construction is before the effective date upon request by the owner.		

Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part D MACHINERY INSTALLATIONS** **D2 RECIPROCATING INTERNAL CONBUSTION ENGINES** **D2.3 Crankshafts** **D2.3.1 Solid Crankshafts and Semi-Build Crankshafts** **1** (Omitted) **2** The diameters of crankpins and journals are to be not less than the value given by the following formula: $d_c = \left\{\left(M + \sqrt{M^2 + T^2}\right) D^2\right\}^{\frac{1}{3}} K_m K_s K_h$ where d_c : Required diameter of crankshaft (mm) M : $10^{-2} ALP_{max}$ T : $10^{-2} BSP_{mi}$ S : (Omitted) L : (Omitted) P_{max} : (Omitted) P_{mi} : (Omitted) A and B: (Omitted) D : (Omitted) K_m : Value given by the following **(1)** or **(2)** in accordance with the specified tensile strength of the crankshaft material. However, the value of K_m	**GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part D MACHINERY INSTALLATIONS** **D2 RECIPROCATING INTERNAL CONBUSTION ENGINES** **D2.3 Crankshafts** **D2.3.1 Solid Crankshafts and Semi-Build Crankshafts** **1** (Omitted) **2** The diameters of crankpins and journals are to be not less than the value given by the following formula: $d_c = \left\{\left(M + \sqrt{M^2 + T^2}\right) D^2\right\}^{\frac{1}{3}} K_m K_s K_h$ where d_c : Required diameter of crankshaft (mm) M : $10^{-2} ALP_{max}$ T : $10^{-2} BSP_{mi}$ S : (Omitted) L : (Omitted) P_{max} : (Omitted) P_{mi} : (Omitted) A and B: (Omitted) D : (Omitted) K_m : Value given by the following **(1)** or **(2)** in accordance with the specified tensile strength of the crankshaft material. However, the value of K_m	

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
for materials other than steel forgings and steel castings is to be determined by the Society in each case. (1) In cases where the specified tensile strength of material exceeds 440 *N/mm²* $K_m = \sqrt[3]{\frac{440}{440 + \frac{2}{3}(T_s - 440)}}$ where T_s :Specified tensile strength of material (*N/mm²*) The value of *Ts* is not to exceed 760 *N/mm²* for carbon steel forgings and 1100 *N/mm²* for low alloy steel forgings. (2) In cases where the specified tensile strength of material is not more than 440 *N/mm²* but not less than 400 *N/mm²* $K_m = 1.0$ K_s :(Omitted) K_h : (Omitted)	for materials other than steel forgings and steel castings is to be determined by the Society in each case. (1) In cases where the specified tensile strength of material exceeds 440 *N/mm²* $K_m = \sqrt[3]{\frac{440}{440 + \frac{2}{3}(T_s - 440)}}$ where T_s :Specified tensile strength of material (*N/mm²*) The value of *Ts* is not to exceed 760 *N/mm²* for carbon steel forgings and 1080 *N/mm²* for low alloy steel forgings. (2) In cases where the specified tensile strength of material is not more than 440 *N/mm²* but not less than 400 *N/mm²* $K_m = 1.0$ K_s :(Omitted) K_h : (Omitted)	Align with the values given in Table K6.3(a), Chapter 6, Part K of the Rules.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS **Part K MATERIALS** **K6 STEEL FORGINGS** **K6.1 Steel Forgings** **K6.1.2 Manufacturing Process** **1** The wording "unless otherwise deemed appropriate by the Society" in **6.1.2-4(4), Part K of the Rules** means the requirements may be suitably modified at the discretion of the surveyor according to the size or form, or the use for which they are intended, except for compression deformations of steel ingots or forging materials in the longitudinal direction (i.e. upsetting). **2** In relation to **6.1.2-7, Part K of the Rules**, where gas workings are being carried out on the parts subjected to high stress such as mass removal of crankshaft, the data related to the processes (including pre-heating) and change of material due to working are to be submitted approval of the Society.	**GUIDANCE FOR THE SURVEY AND CONSTRUCTION OF STEEL SHIPS** **Part K MATERIALS** **K6 STEEL FORGINGS** **K6.1 Steel Forgings** **K6.1.2 Manufacturing Process** (Newly added) In relation to the requirements of **6.1.2-7, Part K of the Rules**, where gas workings are being carried out on the parts subjected to high stress such as mass removal of crankshaft, the data related to the processes (including pre-heating) and change of material due to working are to be submitted approval of the Society.	Add the provision in 6.1.2-6, Part K of the Rules.

Amended-Original Requirements Comparison Table (Materials Used for Steel Castings and Steel Forgings)

Amended	Original	Remarks
EFFECTIVE DATE AND APPLICATION **1.** The effective date of the amendments is 1 January 2025. **2.** Notwithstanding the amendments to the Guidance, the current requirements apply to ships for which the date of contract for construction is before the effective date. **3.** Notwithstanding the provision of preceding **2.**, the amendments to the Guidance may apply to ships for which the date of contract for construction is before the effective date upon request by the owner.		