Impact Test of Steels for Low Temperature Service

Amended Rules and Guidance

Rules for the Survey and Construction of Steel Ships Parts GF, and N
Guidance for the Survey and Construction of Steel Ships Parts GF, and N

Reason for Amendment

IACS Unified Requirements (UR) W1 stipulates classification requirements regarding the materials and welding used for the tanks of liquefied gas carriers and the tanks of ships using low-flash point fuels (hereinafter referred to as “gas tanks”). These requirements have already been incorporated into the NK Rules.

Since the sizes of gas tanks being installed on ships has been steadily increasing in recent years, the use of steels with thicknesses greater than 40 *mm* for such tanks has also correspondingly increased. Requirements for impact tests of steels with thicknesses greater than 40 *mm*, however, are not stipulated in either the IGC Code or the IGF Code and existing requirements were being correspondingly applied instead. IACS, therefore, reviewed the matter and decided to clarify things by adding requirements for the impact tests of steels with thicknesses greater than 40 *mm* but not more than 50 *mm* to UR W1. This amended version was adopted as UR W1(Rev.4) in April 2021.

Accordingly, relevant requirements are amended based upon UR W1(Rev.4).

Outline of Amendment

Adds requirements for impact tests of steels with thicknesses greater than 40 *mm* but not more than 50 *mm*.

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

Part GF SHIPS USING LOW-FLASHPOINT FUELS

Chapter 7 MATERIAL AND GENERAL PIPE DESIGN

7.4 Regulations for Materials (with reference to *IGF Code* 7.4)

7.4.2 Marking

Steels which have satisfactorily complied with the required test are to be marked with identification mark in accordance with the requirements in **Part K** and in case the impact test has been required, the impact testing temperature and "*T*" are to be suffixed to the markings. (Example: *KL*33-50*T*. -0*T* as suffix for 0°C.)

Table GF7.1 has been amended as follows.

Table GF7.1 Plates, Pipes (Seamless and Welded)(1),(2), Sections and Forgings for Fuel Tanks and Process Pressure Vessels for Design Temperatures not Lower than 0°C

CHEMICAL COMPOSITION AND HEAT TREATMENT Carbon-manganese steel Fully killed fine grain steel Small additions of alloying elements by agreement with the Society Composition limits to be approved by the Society Normalized, or quenched and tempered(4)		
TENSILE AND TOUGHNESS (IMPACT) TEST REGULATIONS Sampling frequency Plates: Each "piece" to be tested Sections and forgings: Each "lot" to be tested. Mechanical properties Tensile properties: Specified minimum yield stress not to exceed 410 N/mm^2(5) Toughness (Charpy *V* -notch impact test) Plates: Transverse test pieces. Minimum average energy value (*KV*) 27 *J* Sections and forgings: Longitudinal test pieces. Minimum average energy value (*KV*) 41 *J*		
Test temperature	Thickness (*mm*)(3)	Test temperature(℃)
	$t \leq 20$	0
	$20 < t \leq 40$(3)	-20
	$40 < t \leq 50$(6)	-20(7)
		-30(8)

Notes

(1) For seamless pipes and fittings the requirements of **Part K** applies. The use of longitudinally and spirally welded pipes is to be specially approved by the Society

(2) Charpy *V*-notch impact tests are not required for pipes.

(3) This Table is generally applicable for material thicknesses up to ~~40~~ 50 *mm*. Proposals for greater thicknesses are to be approved by the Society.

(4) A controlled rolling procedure or thermo-mechanical controlled processing (TMCP) may be used as an alternative.

(5) Materials with specified minimum yield stress exceeding 410 N/mm^2 may be approved by the Society. For these materials, particular attention is to be given to the hardness of the welded and heat affected zones.

(6) In addition to **16.2.2-2**, test specimens are to be taken at portions where the axis of the test specimen corresponds to approximately 1/2 the thickness from the surface. This, however, does not apply to the rolled steels for hulls and high strength rolled steels for offshore structures respectively specified in **3.1** and **3.8, Part K of the Rules**.

(7) Applicable to type *C* independent tanks and process pressure vessels. In addition, post-weld stress relief heat treatment is to be performed. When an alternative approach is to be used lieu of post-weld stress relief heat treatment, the Society's

approval is required.

(8) Applicable to fuel tanks other than type *C* independent tanks.

Table GF7.2 has been amended as follows.

Table GF7.2 Plates, Sections and Forgings(1) for Fuel Tanks, Secondary Barriers and Process Pressure Vessels for Design Temperatures below 0°C and down to -55°C (Maximum Thickness 25 *mm*(2))

Chemical composition and heat treatment				
Carbon-manganese steel (Fully killed, aluminium treated fine grain steel)				
Chemical composition (ladle analysis)				
C	M_n	S_i	*S*	*P*
0.16% max (3)	0.7~1.60%	0.10~0.50%	0.025% max	0.025% max
Optional additions : Alloys and grain refining elements may be generally in accordance with the following				
N_i	C_r	M_0	C_u	N_b
0.80% max	0.25% max	0.08% max	0.35% max	0.05% max
V				
0.10% max				
Al content total 0.02% min (Acid soluble 0.015% min)				
Normalized, or quenched and tempered(4)				
Tensile and toughness (impact) test regulations				
Sampling frequency				
Plates	Each “piece” to be tested			
Sections and forgings	Each “lot” to be tested			
Mechanical properties				
Tensile properties	Specified minimum yield stress not to exceed 410 N/mm^2(5)			
Toughness (Charpy *V* -notch impact test) :				
Plates	Transverse test pieces. Minimum average energy value (*KV*) 27*J*			
Sections and forgings	Longitudinal test pieces. Minimum average energy value (*KV*) 41*J*			
Test temperature	5°C below the design temperature or -20°C whichever is lower			

Notes

(1) The Charpy *V*-notch impact tests and chemistry regulations for forgings may be specially considered by the Society.

(2) For material thickness of more than 25 *mm*, Charpy *V*-notch impact tests are to be conducted as follows:

Material thickness (*mm*)	Test temperature (℃)
$25 < t \leq 30$	10℃ below design temperature or -20℃ whichever is lower
$30 < t \leq 35$	15℃ below design temperature or -20℃ whichever is lower
$35 < t \leq 40$	20℃ below design temperature
~~$40 < t$~~	~~Temperature approved by the Society~~
Type *C* independent tanks and process pressure vessels	
$40 < t \leq 50$	5℃ below design temperature or -20℃ whichever is lower
$50 < t$	Temperature approved by the Society
Fuel tanks other than type *C* independent tanks	
$40 < t \leq 45$	25℃ below design temperature
$45 < t \leq 50$	30℃ below design temperature
$50 < t$	Temperature approved by the Society

The impact energy value is to be in accordance with the table for the applicable type of test specimen.

Materials for tanks and parts of tanks which are completely thermally stress relieved after welding may be tested at a temperature 5°C below design temperature or -20°C whichever is lower.

For thermally stress relieved reinforcements and other fittings, the test temperature is to be the same as that required for the adjacent tank-shell thickness.

Where thickness is greater than 40 *mm*, in addition to **16.2.2-2**, test specimens are to be taken at portions where the axis

of the test specimen corresponds to approximately 1/2 the thickness from the surface. This, however, does not apply to the rolled steels for hulls and high strength rolled steels for offshore structures respectively specified in **3.1** and **3.8, Part K of the Rules**.

Where steels with thicknesses greater than 40 *mm* but not more than 50 *mm* are used for type *C* independent tanks and process pressure vessels, post-weld stress relief heat treatment is to be performed. When an alternative approach is to be used in lieu of post-weld stress relief heat treatment, the Society's approval is required.

(3) By special agreement with the Society, the carbon content may be increased to 0.18% maximum provided the design temperature is not lower than -40°C

(4) A controlled rolling procedure or thermo-mechanical controlled processing (TMCP) may be used as an alternative.

(5) Materials with specified minimum yield stress exceeding 410 N/mm^2 may be approved by the Society. For these materials, particular attention is to be given to the hardness of the welded and heat affected zones.

Guidance:

For materials exceeding 25 *mm* in thickness for which the test temperature is -60°C or lower, the application of specially treated steels or steels in accordance with **Table GF7.3** may be necessary.

Table GF7.3 has been amended as follows.

Table GF7.3 Plates, Sections and Forgings[1] for Fuel Tanks, Secondary Barriers and Process Pressure Vessels for Design Temperatures below -55°C and down to -165°C[2] (Maximum Thickness 25 *mm*[3],[4])

Minimum design temp. (℃)	Chemical composition[5] and heat treatment	Impact test temp. (℃)
-60	1.5%nickel steel - normalized or normalized and tempered or quenched and tempered or TMCP[6]	-65
-65	2.25%nickel steel - normalized or normalized and tempered or quenched and tempered or TMCP[6][7]	-70
-90	3.5%nickel steel - normalized or normalized and tempered or quenched and tempered or TMCP[6][7]	-95
-105	5%nickel steel - normalized or normalized and tempered or quenched and tempered[6][7][8]	-110
-165	9%nickel steel - double normalized and tempered or quenched and tempered[6]	-196
-165	Austenitic stainless steels, such as types *304*, *304L*, *316*, *316L*, *321* and *347* solution treated[9]	-196
-165	Aluminium alloys[10]: such as type *5083* annealed	Not required
-165	Austenitic *Fe-Ni* alloy (36% nickel) Heat treatment as agreed	Not required
Tensile and Toughness (Impact) Test Requirements:		
Sampling frequency:		
Plates	Each “piece” to be tested	
Sections and Forgings	Each “lot” to be tested	
Toughness (Charpy *V*- Notch Impact Test):		
Plates	Transverse test pieces. Minimum average energy value (*KV*) 27*J*	
Sections and Forgings	Longitudinal test pieces. Minimum average energy value (*KV*) 41*J*	

Notes

(1) The impact test required for forgings used in critical applications is to be subject to special consideration by the Society.

(2) The regulations for design temperatures below -165°C are to be specially agreed with the Society.

(3) For materials 1.5% *Ni*, 2.25% *Ni*, 3.5% *Ni* and 5% *Ni*, with thicknesses greater than 25 *mm*, the impact tests are to be conducted as follows:

Material thickness (*mm*)	Test temperature (℃)
$25 < t \leq 30$	10℃ below design temperature
$30 < t \leq 35$	15℃ below design temperature
$35 < t \leq 40$	20℃ below design temperature
$40 < t \leq 45$	25℃ below design temperature
$45 < t \leq 50$	30℃ below design temperature

In no case is the test temperature to be above that indicated in **Table GF7.3**.

The minimum average energy value is to be in accordance with the table for the applicable type of test specimen. For material thickness of more than 40 *mm*, minimum average energy values are to be specially considered.

Where thickness is greater than 40 *mm*, in addition to **16.2.2-2**, test specimens are to be taken at a portion where the axis of the test specimen corresponds to approximately 1/2 of the thickness from the surface.

(4) For 9% *Ni* steels, austenitic stainless steels and aluminium alloys, thickness greater than 25 *mm* may be used.

(5) The chemical composition limits are to be in accordance with recognized standards deemed appropriate by the Society.

(6) Thermo-mechanical controlled processing (TMCP) *Ni* steels will be subject to acceptance by the Society.

(7) A lower minimum design temperature for quenched and tempered steels may be specially agreed with the Society.

(8) A specially heat treated 5% *Ni* steel, for example triple heat treated 5% nickel steel, may be used down to -165°C, provided that the impact tests are carried out at -196°C.

(9) The impact test may be omitted subject to agreement with the Society.

(10) For aluminimum alloys other than type 5083, additional tests may be required to verify the toughness of the material.

Part N SHIPS CARRYING LIQUEFIED GASES IN BULK

Chapter 6 MATERIALS OF CONSTRUCTION AND QUALITY CONTROL

6.4 Requirements for Metallic Materials (with reference to *IGC Code* 6.4)

6.4.1 General Requirements for Metallic Materials*

1 The requirements for materials of construction are shown in the tables as follows:

(1) **Table N6.1**: Plates, pipes (seamless and welded), sections and forgings for cargo tanks and process pressure vessels for design temperatures not lower than 0°C.

(2) **Table N6.2**: Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below 0°C and down to -55°C.

(3) **Table N6.3**: Plates, sections and forgings for cargo tanks, secondary barriers and process pressure vessels for design temperatures below -55°C and down to -165°C.

(4) **Table N6.4**: Pipes (seamless and welded), forgings and castings for cargo and process piping for design temperatures below 0°C and down to -165°C.

(5) **Table N6.5**: Plates and sections for hull structures required by **4.19.1-2** and **4.19.1-3**.

(6) Castings for cargo and process piping for design temperatures not lower than 0°C are to be as deemed appropriate by the Society.

2 Metallic materials specified in this Part, according to the requirements in **1.1.1-2**, **Part K of the Rules**, are to comply with the requirements of **Part K of the Rules** in addition to those specified in this Part.

Table N6.1 has been amended as follows.

Table N6.1 Plates, Pipes (Seamless and Welded)(1)(2), Sections and Forgings for Cargo Tanks and Process Pressure Vessels for Design Temperatures Not Lower than 0°C

Chemical Composition and Head Treatment: Carbon - manganese steel (to be Fully killed fine grain steel) Small additions of alloying elements by agreement with the Society Composition limits to be approved by the Society Normalized, or quenched and tempered(4)		
Tensile and Toughness (Impact) Test Requirements:		
Sampling frequency:		
Plates	Each “piece” to be tested	
Sections and Forgings	Each “lot” to be tested	
Mechanical properties:		
Tensile Properties	Specified minimum yield stress not to exceed $410 N/mm^2$(5)	
Toughness (Charpy *V*- Notch Test):		
Plates	Transverse test pieces. Minimum average energy value (*KV*) 27 *J*	
Sections and Forgings:	Longitudinal test pieces. Minimum average energy value (*KV*) 41 *J*	
Test Temperature:	Thickness *t* (*mm*)(3)	Test temperature (℃)
	$t \leq 20$	0
	$20 < t \leq 40$(3)	-20
	$40 < t \leq 50$(6)	-20(7)
		-30(8)

Notes:

(1) For seamless pipes and fittings the requirements of **Part K** applies. The use of longitudinally and spirally welded pipes are to be specially approved by the Society.

(2) Charpy *V*-notch impact tests are not required for pipes.

(3) This table is generally applicable for material thicknesses up to ~~40~~ 50 *mm*. Proposals for greater thicknesses are to be approved by the Society.
(4) A controlled rolling procedure or *TMCP* may be used as an alternative.
(5) Materials with specified minimum yield stress exceeding 410 N/mm^2 may be specially approved by the Society. For these materials, particular attention is to be given to the hardness of the weld and heat affected zone.
(6) In addition to **6.3.2-2**, test specimens are to be taken at portions where the axis of the test specimen corresponds to approximately 1/2 the thickness from the surface. This, however, does not apply to the rolled steels for hulls and high strength rolled steels for offshore structures respectively specified in **3.1** and **3.8**, **Part K of the Rules.**
(7) Applicable to type *C* independent tanks and process pressure vessels. In addition, post-weld stress relief heat treatment is to be performed. When an alternative approach is to be used in lieu of post-weld stress relief heat treatment, the Society's approval is required.
(8) Applicable to cargo tanks other than type *C* independent tanks.

Table N6.2 has been amended as follows.

Table N6.2 Plates, Sections and Forgings(1) for Cargo Tanks, Secondary Barriers and Process Pressure Vessels for Design Temperatures below 0℃ and down to -55℃ (Maximum Thickness 25 *mm*(2))

Chemical Composition and Head Treatment:					
Carbon-manganese Steel (to be fully-killed aluminium treated grain steel)					
Chemical composition (ladle analysis)					
C	*Mn*	*Si*	*S*	*P*	
0.16%max(3)	0.70 - 1.60%	0.10 - 0.50%	0.025%max.	0.025%max.	
Optional additions: Alloys and grain refining elements may be generally in accordance with the following:					
Ni	*Cr*	*Mo*	*Cu*	*Nb*	*V*
0.80%max.	0.25%max.	0.08%max.	0.35%max.	0.05%max.	0.10%max.
Al content total 0.02% min (Acid soluble 0.015% min)					
Normalized or quenched and tempered(4)					
Tensile and Toughness (Impact) Test Requirements:					
Sampling frequency:					
Plates	Each "piece" to be tested				
Sections and Forgings	Each "lot" to be tested				
Mechanical properties:					
Tensile properties	Specified minimum yield stress not to exceed 410 N/mm^2(5)				
Toughness (Charpy *V*- Notch Test):					
Test Temperatures Plates	Test temperatures 5℃ below the design temperatures or -20℃ whichever is lower				
Sections and Forgings(1)	Transverse test pieces. Minimum average energy value (*KV*) 27 *J*				
	Longitudinal test pieces. Minimum average energy value (*KV*) 41 *J*				

Notes:
(1) The Charpy *V*-notch and Chemistry requirements for forgings may be specially considered by the Society.
(2) For material thickness of more than 25 *mm*, Charpy *V*-notch tests are to be conducted as follows:

Material thickness (*mm*)	Test temperature (℃)
$25 < t \leq 30$	10℃ below design temperature or -20℃, whichever is lower
$30 < t \leq 35$	15℃ below design temperature or -20℃, whichever is lower
$35 < t \leq 40$	20℃ below design temperature
~~$40 < t$~~	~~Temperature approved by the Society~~
Type *C* independent tanks and process pressure vessels	
$40 < t < 50$	5℃ below design temperature or -20℃ whichever is lower
$50 < t$	Temperature approved by the Society
Fuel tanks other than type *C* independent tanks	
$40 < t \leq 45$	25℃ below design temperature
$45 < t \leq 50$	30℃ below design temperature

$50 < t$	Temperature approved by the Society

The minimum average energy value is to be in accordance with the table for the applicable type of test specimen.

Materials for tanks and parts of tanks which are completely thermally stress relieved after welding may be tested at a temperature 5℃ below design temperature or -20℃ whichever is lower.

For thermally stress relieved reinforcements and other fittings, the test temperature are to be the same as that required for the adjacent tank-shell thickness.

Where thickness is greater than 40 *mm*, in addition to **6.3.2-2**, test specimens are to be taken at portions where the axis of the test specimen corresponds to approximately 1/2 the thickness from the surface. This, however, does not apply to the rolled steels for hulls and high strength rolled steels for offshore structures respectively specified in **3.1** and **3.8, Part K of the Rules**.

Where steels with thicknesses greater than 40 *mm* but not more than 50 *mm* are used for type *C* independent tanks and process pressure vessels, post-weld stress relief heat treatment is to be performed. When an alternative approach is to be used in lieu of post-weld stress relief heat treatment, the Society's approval is required.

(3) By special agreement with the Society, the carbon content may be increased to 0.18% maximum provided the design temperature is not lower than -40℃

(4) A controlled rolling procedure or *TMCP* may be used as an alternative.

(5) Materials with specified minimum yield stress exceeding 410 N/mm^2 may be approved by the Society. For these materials, particular attention is to be given to the hardness of the welded and heat affected zones.

Guidance:

For materials exceeding 25 *mm* in thickness for which the test temperature is -60℃ or lower, the application of specially treated steels or steels in accordance with **Table N6.3** may be necessary.

Table N6.3 has been amended as follows.

Table N6.3 Plates, Sections and Forgings[1] for Cargo Tanks, Secondary Barriers and Process Pressure Vessels for Design Temperatures below -55℃ and down to -165℃[2] (Maximum Thickness 25 *mm*[3][4])

Minimum design temp. (℃)	Chemical composition[5] and heat treatment	Impact test temp (℃)
-60	1.5% nickel steel - normalized or normalized and tempered or quenched and tempered or *TMCP*[6]	-65
-65	2.25% nickel steel - normalized or normalized and tempered or quenched and tempered or *TMCP*[6][7]	-70
-90	3.5% nickel steel - normalized or normalized and tempered or quenched and tempered or *TMCP*[6][7]	-95
-105	5% nickel steel - normalized or normalized and tempered or quenched and tempered[6][7][8]	-110
-165	9% nickel steel - double normalized and tempered or quenched and tempered[6]	-196
-165	Austenitic stainless steels, such as types *304*, *304L*, *316*, *316L*, *321* and *347* solution treated[9]	-196
-165	Aluminium alloys[10]: such as type *5083* annealed	Not required
-165	Austenitic *Fe-Ni* alloy (36% nickel) Heat treatment as agreed	Not required
Tensile and Toughness (Impact) Test Requirements: Sampling frequency: Plates — Each "piece" to be tested; Sections and Forgings — Each "lot" to be tested. Toughness (Charpy *V*- Notch Impact Test) Plates Sections and forgings — Transverse test pieces: minimum average energy value (*KV*) 27 *J*; Longitudinal test pieces: minimum average energy value (*KV*) 41 *J*		

Notes:

(1) The impact test required for forgings used in critical applications is to be subject to special consideration by the Society.

(2) The requirements for design temperatures below -165℃ is to be specially agreed with the Society.

(3) For materials 1.5% *Ni*, 2.25% *Ni*, 3.5% *Ni* and 5% *Ni*, with thicknesses greater than 25 *mm*, the impact tests are to be conducted as follows:

Material thickness (*mm*)	Test temperature (℃)
$25 < t \leq 30$	10℃ below design temperature
$30 < t \leq 35$	15℃ below design temperature
$35 < t \leq 40$	20℃ below design temperature
$40 < t \leq 45$	25℃ below design temperature
$45 < t \leq 50$	30℃ below design temperature

In no case is the test temperature to be above that indicated in **Table N6.3**.

The minimum average energy value is to be in accordance with the table for the applicable type of test specimen. For material thickness of more than ~~40~~ 50 *mm*, the Charpy *V*-notch values are to be specially considered.

Where thickness is greater than 40 *mm*, in addition to **6.3.2-2**, test specimens are to be taken at portions where the axis of the test specimen corresponds to approximately 1/2 the thickness from the surface.

(4) For 9% *Ni*, austenitic stainless steels and aluminium alloys, thicknesses greater than 25 *mm* may be used at the discretion of the Society.

(5) The chemical composition limits are to be in accordance with recognized standards deemed appropriate by the Society.

(6) *TMCP* nickel steels will be subject to acceptance by the Society.

(7) A lower minimum design temperature for quenched and tempered steels may be specially agreed with the Society.

(8) A specially heat treated 5% nickel steel, for example triple heat treated 5% nickel steel, may be used down to -165℃ upon special agreement with the Society, provided that the impact tests are carried out at-196℃

(9) The impact test may be omitted subject to agreement with the Society.

(10) For aluminium alloys other than type 5083, additional tests may be required to verify the toughness of the material.

6.6 Other Requirements for Construction in Metallic Materials (*IGC Code* 6.6)

Paragraph 6.6.2 has been amended as follows.

6.6.2 Independent Tank*

(-1 is omitted.)

2 For type *C* tanks of carbon and carbon-manganese steel, post-weld heat treatment is to be performed after welding, if the design temperature is below -10°C. Post-weld heat treatment in all other cases and for materials other than those mentioned above is to be at the discretion of the Society. The soaking temperature and holding time are to be at the discretion of the Society.

3 In the case of type *C* tanks and large cargo pressure vessels of carbon or carbon-manganese steel with thicknesses of not more than 40 *mm* for which it is difficult to perform the heat treatment, mechanical stress relieving by pressurizing may be carried out as an alternative to the heat treatment and subject to the following conditions:

(1) Complicated welded pressure vessel parts such as sumps or domes with nozzles, with adjacent shell plates are to be heat treated before they are welded to larger parts of the pressure vessel;

(2) The mechanical stress relieving process is to preferably be carried out during the hydrostatic pressure test required by **4.23.6**, by applying a higher pressure than the test pressure required by **4.23.6-1**. The pressurizing medium is to be water;

(3) For the water temperature, **4.23.6-2** applies;

(4) Stress relieving is to be performed while the tank is supported by its regular saddles or supporting structure or, when stress relieving cannot be carried out on board, in a manner which will give the same stresses and stress distribution as when supported by its regular saddles or supporting structure;

(5) The maximum stress relieving pressure is to be held for 2 *hours* per 25 *mm* of thickness, but in no case less than 2 *hours*;

(6) The upper limits placed on the calculated stress levels during stress relieving are to be the following:
   (a) Equivalent general primary membrane stress: 0.9 R_e;
   (b) Equivalent stress composed of primary bending stress plus membrane stress: 1.35 R_e, where R_e is the specific lower minimum yield stress or 0.2% proof stress at test temperature of the steel used for the tank;

(7) Strain measurements will normally be required to prove these limits for at least the first tank of a series of identical tanks built consecutively. The location of strain gauges is to be included in the mechanical stress relieving procedure to be submitted in accordance with **6.6.2-3**;

(8) The test procedure is to demonstrate that a linear relationship between pressure and strain is achieved at the end of the stress relieving process when the pressure is raised again up to the design pressure;

(9) High-stress areas in way of geometrical discontinuities such as nozzles and other openings are to be checked for cracks by dye penetrant or magnetic particle inspection after mechanical stress relieving. Particular attention in this respect is to be paid to plates exceeding 30 *mm* in thickness;

(10) Steels which have a ratio of yield stress to ultimate tensile strength greater than 0.8 are to generally not be mechanically stress relieved. If, however, the yield stress is raised by a method giving high ductility of the steel, slightly higher rates may be accepted upon consideration in each case;

(11) Mechanical stress relieving cannot be substituted for heat treatment of cold formed parts of tanks, if the degree of cold forming exceeds the limit above which heat treatment is required;

(12) The thickness of the shell and heads of the tank are to not exceed 40 *mm*. Higher thicknesses may be accepted for parts which are thermally stress relieved;

(13) Local buckling is to be guarded against, particularly when tori-spherical heads are used for

tanks and domes; and

(14) The procedure for mechanical stress relieving is to be submitted beforehand to the Society for approval.

4 Where carbon or carbon-manganese steels with thicknesses of greater than 40 *mm* but not more than 50 *mm* are used for type *C* independent tanks and process pressure vessels, post-weld stress relief heat treatment may be omitted subject to agreement with the Society.

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

Part GF SHIPS USING LOW-FLASHPOINT FUELS

GF7 MATERIAL AND GENERAL PIPE DESIGN

GF7.4 Regulations for Materials

GF7.4.1 Metallic Materials

Sub-paragraph -1 has been amended as follows.

1 For the purpose of the requirements in **Table GF7.1**, **Part GF of the Rules**, the following requirements **(1)** to **(4)** are to be complied with:

(1) The use of the longitudinally or spirally welded pipes given in the Note 1 of the Table is to be in accordance with the relevant requirements in **Chapter 4**, **Part K of the Rules**.

(2) Fittings of Type *C* independent tanks and process pressure vessels with the design pressure not exceeding 3*MPa* and design temperature of 0°C or more and nominal diameter less than 100*A*.

(3) The controlled rolling as a substitution for normalizing may be of the temperature controlled rolling or Thermo-Mechanical Controlled Processing (*TMCP*).

~~(4) For materials with the thickness of greater than 40 *mm* and not more than 50 *mm*, the impact test is to be carried out at the temperature of -30°C.~~

Part N SHIPS CARRYING LIQUEFIED GASES IN BULK

N6 MATERIALS OF CONSTRUCTION AND QUALITY CONTROL

N6.4 Requirements for Metallic Materials

N6.4.1 General Requirements for Metallic Materials

Sub-paragraph -1 has been amended as follows.

1 For the purpose of the requirements in **Table N6.1**, **Part N of the Rules**, the following requirements **(1)** to **(4)** are to be complied with:

(1) The use of the longitudinally or spirally welded pipes given in the Note 1 of the Table is to be in accordance with the relevant requirements in **Chapter 4**, **Part K of the Rules**.

(2) Fittings of Type *C* independent tanks and process pressure vessels with the design pressure not exceeding 3 *MPa* and design temperature of 0°C or more and nominal diameter less than 100*A*.

(3) The controlled rolling as a substitution for normalizing may be of the temperature controlled rolling or Thermo-Mechanical Controlled Processing (*TMCP*).

~~(4) For materials with the thickness of greater than 40 *mm* and not more than 50 *mm*, the impact test is to be carried out at the temperature of -30°C.~~