



RUSSIAN MARITIME REGISTER OF SHIPPING

CIRCULAR LETTER

No. 314-04-1862c

dated 22.11.2022

Re:

amendments to the Rules for the Classification and Construction of Sea-Going Ships, 2022, ND No. 2-020101-152-E, and the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, 2022, ND No. 2-020101-156-E

Item(s) of supervision:

welding

Entry-into-force date:

15.12.2022

~~Cancels / amends / adds Circular Letter No.~~

~~dated~~

Number of pages: 1 + 13

Appendices:

Appendix 1: information on amendments introduced by the Circular Letter

Appendix 2: text of amendments to Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships and to Part III "Technical Supervision during Manufacture of Materials" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships

Acting Director General

Sergey A. Kulikov

Text of CL:

We hereby inform that the Rules for the Classification and Construction of Sea-Going Ships and the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships shall be amended as specified in the Appendices to the Circular Letter.

It is necessary to do the following:

1. Bring the content of the Circular Letter to the notice of the RS surveyors, interested organizations and persons in the area of the RS Branch Offices' activity.
2. Apply the provisions of the Circular Letter when performing technical supervision during certification of friction stir welding procedure and certification of welding operators requested for certification on or after 15.12.2022.

List of the amended and/or introduced paras/chapters/sections:

Rules for the Classification and Construction of Sea-Going Ships

Part XIV: paras 2.10.1 — 2.10.2, paras 2.10.10, 3.3.10.2, 3.3.10.4 and 3.5.5;

Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships

Part III: Table 4.3.2.2, para 4.4.7, 7.1.4, 7.4.1.3 and 7.6.1 — 7.6.3

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**Information on amendments introduced by the Circular Letter
(for inclusion in the Revision History to the RS Publication)**

Nos.	Amended paras/chapters/ sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
1	Rules for the Classification and Construction of Sea-Going Ships, Part XIV, paras 2.10.1 and 2.10.2	Technological requirements for welding of aluminium alloys have been specified	341-04-1862c of 22.11.2022	15.12.2022
2	Rules for the Classification and Construction of Sea-Going Ships, Part XIV, para 2.10.10	Requirements for application and equipment of friction stir welding (FSW) have been specified	341-04-1862c of 22.11.2022	15.12.2022
3	Rules for the Classification and Construction of Sea-Going Ships, Part XIV, para 3.3.10.2	Terminology has been specified	341-04-1862c of 22.11.2022	15.12.2022
4	Rules for the Classification and Construction of Sea-Going Ships, Part XIV, para 3.3.10.4	Terminology has been specified	341-04-1862c of 22.11.2022	15.12.2022
5	Rules for the Classification and Construction of Sea-Going Ships, Part XIV, para 3.5.5	Requirements for assessment of the quality of friction stir welded joints have been specified	341-04-1862c of 22.11.2022	15.12.2022
6	Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, Part III, Table 4.3.2.2	Requirements for certification methods of FSW welding operators have been specified	341-04-1862c of 22.11.2022	15.12.2022
7	Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, Part III, para 4.4.7	Requirements for certification of welding operators of friction stir welding (FSW) have been specified	341-04-1862c of 22.11.2022	15.12.2022
8	Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, Part III, para 7.2.2	Terminology has been specified, methods of FSW have been indicated	341-04-1862c of 22.11.2022	15.12.2022

Nos.	Amended paras/chapters/ sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
9	Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, Part III, para 7.4.1.3	References to ISO standards have been specified	341-04-1862c of 22.11.2022	15.12.2022
10	Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, Part III, paras 7.6.1 — 7.6.2	Paras have been deleted	341-04-1862c of 22.11.2022	15.12.2022
11	Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships, Part III, existing para 7.6.3 (renumbered paras 7.6.1 — 7.6.4)	Para has been revised, structure has been amended and para has been renumbered, requirements for certification of FSW procedures have been specified	341-04-1862c of 22.11.2022	15.12.2022

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS, 2022,

ND No. 2-020101-152-E

PART XIV. WELDING

2 TECHNOLOGICAL REQUIREMENTS FOR WELDING

- 1 **Paras 2.10.1 and 2.10.2** are replaced by the following text:

"2.10.1 Welding operations are allowed to be performed by the following welding processes: 111, 131, 141, 43 which shall ensure good quality welding joints with their maximum strength, chemical composition similar to that of the base metal and having sufficient corrosion resistance.

2.10.2 Wherever possible, welded joints shall be located in areas exposed to the lowest stresses.

Weld reinforcement may be removed only subject to the special approval of the Register."

- 2 **Para 2.10.10** is replaced by the following text:

"2.10.10 Application of friction stir welding.

Friction stir welding (FSW) procedure shall be based on the requirements of ISO 25239:2020.

By the applicable procedures FSW is divided into double-sided single-run welding, double-sided multi-run welding or single-sided welding with adjustable probe tool.

Requirements for certification of welding operators and approval of FSW production process are given in 4.1, 4.4.7, 4.5.10 and 7.6, Part III "Technical Supervision during Manufacture of Materials" of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships.

2.10.10.1 FSW may be applied for butt welds welded with double-sided single-run technique, double-sided multi-run technique or single-sided technique with adjustable probe tool.

FSW may be performed by using single-shoulder tool (with adjustable probe) or by using a tool with two shoulders (separated by a fixed length probe without force control and separated by an adjustable length probe with force control).

2.10.10.2 For welded joints produced by FSW without supporting surface, only double-sided single-run welding or double-sided multi-run welding may be applied.

2.10.20.3 FSW welding equipment.

Welding equipment and FSW tools shall be capable of producing welds that meet the specified requirements for acceptance level.

Welding equipment shall be maintained in good condition and, where necessary, be repaired or adjusted that shall be stated in the firm's documents.

After installation of new or refurbished equipment appropriate tests shall be performed in order to verify correct functioning of the equipment, which shall be stated in the firm's documents.

Reproducibility tests of reference parameters by the FSW equipment shall be performed to demonstrate that the welding equipment can repeatedly produce welds that meet the acceptance levels specified in Table 3.3.5. For this purpose, welding of test assemblies and performance of mechanical tests of test assemblies shall be carried out to the extent of and in compliance with the conditions of passed certification of welding procedure in the following cases:

after installation of new FSW equipment;
after amending FSW procedure;
after replacement of fitting;
after modification or repair of FSW equipment;
after detection of deviations from optimal FSW parameters;
after identification of unacceptable imperfections by non-destructive testing;
after an extended break in work of a welding operator (after illness, leave, etc.) for more than 30 calendar days;
after complying with the standard for the length of welded joints stipulated in technological documentation of the firm-manufacture for specified rolled product thicknesses.
FSW equipment shall provide an automated control and record of welding procedure parameters with the frequency of at least one measurement for 20 mm of the welded joint for each welding parameter."

TESTING OF WELDED JOINTS

3 **Para 3.3.10.2** is replaced by the following text:

"**3.3.10.2** Non-destructive testing of the friction stir welded joints of structures made of aluminium alloys shall be carried out in scope:
visual (VT) and measuring testing — 100% of length of the welded joint;
radiographic testing (RT) or ultrasonic testing (UT) applied for the thickness of 8 mm and more or by advanced non-destructive testing (ANDT) — 100% of length of the welded joint."

4 **Para 3.3.10.4** is replaced by the following text:

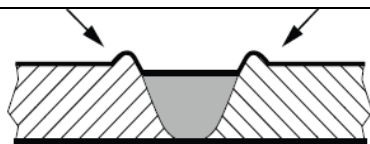
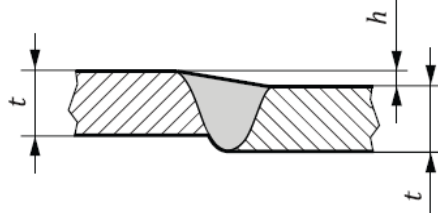
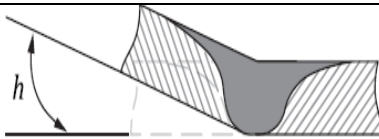
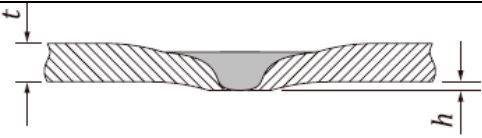
"**3.3.10.4** In case of doubt in the results of visual testing, penetrant testing (in accordance with ISO 3452-1:2021) may be applied."

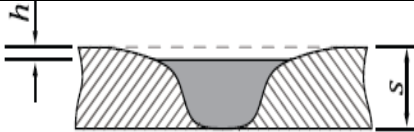
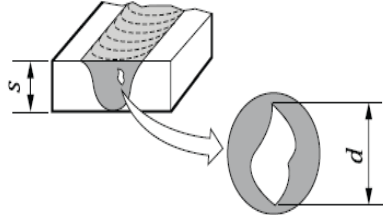
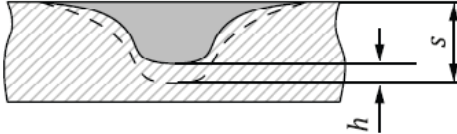
5 **Para 3.5.5** is replaced by the following text:

"**3.5.5** Unless otherwise agreed with the Register, the assessment of the quality of FSW joints of structures made of aluminium alloys shall be carried out in accordance with Table 3.5.5."

Table 3.5.5

Imperfections, testing and examination, acceptance levels in accordance with ISO 25239-5:2020

Reference number in ISO 6520-1:2007	Imperfection	Appearance or description of imperfection	Testing and examination in ISO 25239-4:2020 ^a	Acceptance levels ^a		
				D	C	B
Surface imperfections ^d						
— ^c	Toe flash		VT, ME	— ^b		
507	Linear misalignment		VT, ME	$h \leq 0,3t$ or 4 mm, whichever is less	$h \leq 0,2t$ or 2 mm, whichever is less	$h \leq 0,1t$ or 1 mm, whichever is less
508	Angle misalignment		VT, ME	Not applicable	$h \leq 3^\circ$	$h \leq 2^\circ$
— ^c	Deformation of welded joint area		VT, ME	$h \leq 0,5t$ or 4 mm, whichever is less	$h \leq 0,4t$ or 2 mm, whichever is less	— ^b
514	Irregular surface	Excessive surface roughness	VT	— ^b		

Reference number in ISO 6520-1:2007	Imperfection	Appearance or description of imperfection	Testing and examination in ISO 25239-4:2020 ^a	Acceptance levels ^a		
				D	C	B
Internal imperfections ^d						
— ^c	Underfill		VT, ME	— ^b	$h \leq 0,2 \text{ mm} + 0,1s$	$h \leq 0,1s$
—	Cavity	Cavity deteriorating the surface	VT, ME	Not allowed		
200	Cavity	 2 adjacent cavities distanced less than "d" from the smaller cavity shall be considered as a single cavity	ME, RT, UT	— ^b	$d \leq 0,2s$ or 4 mm, whichever is less	not allowed
402	Lack of fusion	 penetration that is less than required or prescribed	ME, RT, UT	— ^b	$h \leq 0,2s$	not allowed
300	Solid inclusion	sizes of inclusions located in one cross-section shall be summarized: $l = l_1 + l_2 + \dots$ inclusion less than 0,2 mm shall not be considered	ME, RT, UT	— ^b	$h \leq 0,2s$	not allowed

Reference number in ISO 6520-1:2007	Imperfection	Appearance or description of imperfection	Testing and examination in ISO 25239-4:2020 ^a	Acceptance levels ^a		
				D	C	B
UT — ultrasonic testing						
^a Where applicable, non-destructive testing shall be carried out in accordance with ISO 3452-1:2021 (penetrant testing), ISO 17636:2013 (radiographic testing) and ISO 17640:2018 (ultrasonic testing). Testing and examination of other imperfections and their acceptance levels shall be in accordance with the relevant requirements or the design specification. ^b Acceptance levels shall be within the specified limit of the relevant requirements or the design specification. ^c Refer to ISO 25239-1:2020. ^d If weld surfaces are not subject to heat treatment, the design requirements shall apply. ^e Refer to ISO 25239-2:2020.						

All inadmissible imperfections detected on NDT results shall be removed and the location of corrections shall be tested again in compliance with the applicable provisions of 3.2.1.

Technology for elimination of FSW imperfections shall be developed by the firm, practically proved on test assemblies and submitted for approval to the Register."

RULES FOR TECHNICAL SUPERVISION DURING CONSTRUCTION OF SHIPS AND MANUFACTURE OF MATERIALS AND PRODUCTS FOR SHIPS, 2022,

ND No. 2-020101-156-E

PART III. TECHNICAL SUPERVISION DURING MANUFACTURE OF MATERIALS

4 WELDING. REGULATIONS FOR WELDERS' CERTIFICATION

6 **Table 4.3.2.2** is replaced by the following text:

"Table 4.3.2.2

Welding Processes for Welders Qualification

Symbol of welding type	Welding process in actual welding works		Code acc. to ISO 4063:2009
M	Manual welding	Manual metal arc welding with covered electrode (SMAW)	111
		Oxy-acetylene welding (OAW)	311
S	Semi-automatic welding (partly mechanized welding)	Metal inert gas welding (MIG)	131
		Metal active gas welding (MAG)	135
		Flux-cored wire metal arc welding with metal cored wires in active gas (MAG)	138 ¹⁾
		Flux-cored wire metal arc welding with slag cover in active gas (MAG), FCAW-G	136 ²⁾
		Flux cored inert gas arc welding (MIG)	133
		Flux cored self-shielded arc welding (FCAW-S)	114
A	Automatic welding or fully mechanized welding	Submerged arc welding with solid wire electrode (SAW)	121
		Submerged arc welding with flux cored electrode (SAW)	125
		Plasma arc welding	15
		Electroslag welding (ESW)	72
		Electrode gas welding (EGW)	73
T	Tungsten welding in inert gas	Tungsten inert gas (TIG) arc welding with or without solid filler material (wire/rod)	141, 142
FSW	Friction stir welding (FSW), including: double-sided single-run FSW; double-sided multi-run FSW; single-sided FSW with adjustable probe tool	Refer to 1.2.1, Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships	43
			43.1
			43.2
			43.3

¹ A change from Metal active gas welding (MAG) (135) to that with flux-cored wire metal arc welding with metal cored wires in active gas (MAG) (138), or vice versa is permitted without additional testing.

² A change from metal active gas welding (MAG) (135) or flux-cored wire metal arc welding with metal cored wires in active gas (MAG) (138) to flux-cored wire metal arc welding (MAG), FCAW-G (136) requires a new welder qualification test.

7 **Para 4.4.7** is replaced by the following text:

"4.4.7 Welding operators of friction stir welding (FSW) equipment for aluminium alloys.

4.4.7.1 Welding operators shall be qualified and certified in accordance with ISO 25239-3:2020.

4.4.7.2 The welding operator shall weld test pieces within the welding parameters set upon results of welding procedure certification. Each test piece shall be taken from the beginning, center and end of the welded joint in such a way that the length of each sample shall be not less than 500 mm. To be certified welding operator shall weld 3 test pieces.

4.4.7.3 The scope of non-destructive testing of friction stir welded test pieces for certification of welding operators includes:

visual and measurement testing, 100%;

radiographic testing or ultrasonic testing (for thickness of 8 mm and over);

4.4.7.4 The scope of mechanical tests of welded test pieces for certification of welding operators based on the standard test procedure for the welders, dimensions of welded test pieces shall comply with Section 4.3 of ISO 25239-3:2020.

4.4.7.5 Certification of FSW operators may be carried out by a standing commission on certification the members of which are approved by the order (instruction) for the firm.

4.4.7.6 The commission shall include:

chief welder of the firm (or equivalent position) — chairman of the commission;

welding engineer — deputy chairman (Secretary);

head of the Quality Control Department or Inspection Department;

head (supervisor) of the production site;

NDT supervisor;

representative of the Register.

4.4.7.7 Schedule of work of the commission on certification. Issue of documents.

4.4.7.7.1 The commission shall check the theoretical knowledge of welding operators, shall be present during welding of samples, and consider the test results in order to make a decision regarding these results.

4.4.7.7.2 All the members of the commission shall be notified of the date of its meeting:

employees of the firm — not less than 3 days before the date;

employees of other organizations — not less than 10 days before the date.

4.4.7.7.3 The following documents shall be submitted to the commission:

program of welding operators certification;

list of welding operators to be certified with indication of education, rate and professional experience;

certificates of welding operators;

conclusion based on the results of testing of test assemblies;

reference of the quality of welders' works signed by the Quality Control Department (Inspection Department) in order to exempt the welder from retests.

4.4.7.7.4 When practical tests are performed, presence of the following members of the commission shall be sufficient:

head of the Quality Control Department/Inspection Department and Welding Engineer to supervise performance of welding and assess the quality of samples visually;

representative of the Register.

4.4.7.7.5 Proceeding from the results of the practical and theoretical examinations of welding operators the certifying commission draws up and issues a Welding Operators Approval Test Certificates for Friction Stir Welding (form 7.1.30-FSW).

4.4.7.7.6 Terms of validity, endorsement and prolongation of the Certificate are established in accordance with 5.2 of ISO 25239-3:2020. Prolongation of the Certificate (form 7.1.30 FSW) shall be carried out according to option c) in compliance with 4.6.7."

APPROVAL OF WELDING PROCEDURES FOR ALUMINIUM ALLOYS

8 **Para 7.2.2** is replaced by the following text:

"7.2.2 Symbols used in welding procedure approval.

Welding procedure approval for aluminium alloys according to the requirements of the Section is carried out for the following welding processes (the symbols comply with ISO 4063:2009):

- 131 — metal-arc inert gas welding;
- 141 — tungsten inert gas arc welding with solid filler material (wire or rod);
- 15 — plasma arc welding;
- 43 — friction stir welding;
- 43.1 — double-sided single-run SFW;
- 43.2 — double-sided multi-run SFW;
- 43.3 — single-sided SFW with adjustable probe tool.

Depending on the degree of welder's labour mechanization, the welding types/processes are divided into groups as specified in 4.3.2.2.

The welding fillers used for the welding of shipbuilding aluminium alloys are classified by categories according to Tables 4.9.1.3-1 and 4.9.1.3-2, Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships.

Shielding gases used for welding depending on their composition are divided into groups designated with indices in accordance with Table 4.9.1.4, Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships.

Shipbuilding aluminium alloys, to which the requirements of the Section apply, are classified by grades in accordance with Tables 5.1.2, 5.1.3-1 and 5.1.3-2, Part XIII "Materials" of the Rules for the Classification and Construction of Sea-Going Ships. In this case, in the approval of welding procedures, aluminium alloys are additionally grouped according to Table 7.2.2.

Table 7.2.2

Classification of international shipbuilding aluminium alloys by type composition groups according to ISO/TR 15608:2017

Group	Subgroup	Type of alloy/characteristic	Typical specimen
21	—	Pure aluminium with admixtures or alloying elements content up to 1 % including	1050A[Al 99,5] 1200[Al 99,0]
22		Non-heat-treatable alloys	
	22.1	Aluminium-magnesium alloys	3103 [AlMn 1]
	22.2	Aluminium-magnesium alloys with Mg content $Mg \leq 1,5 \%$	5005 [AlMg 1(B)] 5050 [AlMg 1,5(C)]
	22.3	Aluminium-magnesium alloys with Mg content $1,5 \% < Mg \leq 3,5 \%$	5251 [AlMg2] 5052 [AlMg2,5] 5754, 1530 [AlMg3]* 5154 [AlMg3,5]
	22.4	Aluminium-magnesium alloys with Mg content $Mg > 3,5 \%$	5086 [AlMg4]* 5083 [AlMg4,5Mn0,7]* 5383 [AlMg4,5Mn0,9]* 5456, 1550 [AlMg5]* 5059[—]* 1561, 1565ч [AlMg6Mn1]* 1575[AlMg6Mn0,5Sc]* 1581 [AlMg5Sc0,03]*
23		Heat-treatable alloys	
	23.1	Al-Mg-Si alloys	6060[AlMgSi] 6063[AlMg0,7Si] 6005A[AlSiMg(A)]* 6082[AlSi1MgMn]* 6061[AlMg1SiCu]*
	23.2	Al-Zn-Mg alloys	7075[AlZn6MgCu1,5]
24		Al-Si alloys with Cu content $Cu \leq 1 \%$	
	24.2	Al-Si alloys with Cu content $Cu \leq 1 \%$, $5 \% < Si \leq 15 \%$ и $0,1 \% < Mg \leq 0,80 \%$	42100[AlSi7Mg0,3] 42200[AlSi7Mg0,6] 43100[AlSi10Mg(b)] 44100[AlSi12(b)]

* Marks shipbuilding aluminium alloys covered by the classification of Section 5, Part XIII "Materials" of the Rules for the Classification and Construction of Sea-Going Ships.

In the approval of welding procedures, the symbols of welding positions comply with ISO 6947:2019 and are given in Appendix 2, Section 4.

The symbols relating to the type of a welded joint and to the technological peculiarities of its making comply with the requirements in 6.2.2.3."

9 **Para 7.4.1.3** is replaced by the following text:

"7.4.1.3 Unless otherwise specified by the contract or specification for a particular product manufacture, as a result of examination by the NDT methods the quality evaluation of the welded joints test pieces of aluminium alloys shall be carried out in compliance with ISO 10042:2018 for the Acceptance Quality Level B. The reduction criteria down to Quality Level C is therewith acceptable for imperfections associated with oversized welds (excessive height and width of a butt weld reinforcement, excess throat thickness of a fillet weld, excessive reinforcement of a single-side butt weld root).

During examination by specific NDT methods the requirements of ISO 17635:2016 to examination class and Quality Level shall comply:

to perform Level B by visual and measurement testing according to ISO 10042:2018 test methods shall be carried out in compliance with ISO 17637:2016 (Testing Class is not regulated);

for magnetic particle testing the Quality Level 2X in compliance with ISO 23277:2015, test methods shall be carried out in accordance with ISO 3452-1:2021 (Testing Class is not regulated);

for radiographic testing Acceptance Level 1 in compliance with 10675-2:2017, test methods shall be carried out in accordance with ISO 17636:2013 (Testing Class B);

General procedure for performance and basic parameters of NDT test pieces shall comply with 3.2, Part XIV "Welding" of the Rules for the Classification and Construction of Sea-Going Ships."

10 **Paras 7.6.1 — 7.6.2** are deleted.

11 **Existing para 7.6.3** is replaced by the following text:

"7.6.1 Prior to certification of FSW procedure using experience from previous production jobs, the manufacturer shall prepare preliminary welding procedure specification (pWPS) in order to achieve the required quality levels specified in ISO 25239-5:2020. pWPS shall comply with the requirements of ISO 25239-4:2020.

7.6.2 Certification of welding procedure shall be obtained by qualification tests in accordance with ISO 25239-4:2020.

Qualification test reports shall comply with ISO 25239-4:2020.

7.6.3 Welding procedure specification (WPS) shall be prepared after the qualification test report on the Register approved procedure has been drawn up.

7.6.4 Range of approval shall be limited by the following:

.1 manufacturer. Welding procedure approved for the specified firm is only valid for this firm;

.2 types of materials. Certification of FSW procedure is limited by the applicable brand of aluminium alloy and its condition of supply;

.3 pipe thickness and diameter. The scope of approval of FSW procedure is limited by the thickness of test pieces welded within the certification process. Where certification of thickness range is required, it is necessary to perform welding of test pieces with integral values of thicknesses within the specified range upon 1 mm increment and to carry out further tests. In case of approval of FSW procedure, for each thickness of rolled products at least one test piece with the length not less than 500 mm shall be welded.

If in its process activity the firm performs rolled product welding with thickness other than integral values (with indication of decimal values of millimeters of thickness), prior to welding the additional control tests with test pieces welding of these rolled products thicknesses on corrected FSW parameters regarding conditions specified in Welding Procedure Approval Test Certificate (COTΠC) shall be performed.

Scope of approval per pipe diameters welded by FSW shall be determined if FSW parameters remain unchanged (7.6.4.7);

.4 types of joints. Certification of FSW procedure is carried out on butt welds and is limited only by those butt welds that have been produced during welding procedure testing;

.5 welding equipment. Certification of FSW procedure is limited by the specified welding equipment used during qualification tests;

.6 welding tool. Certification of FSW procedure is limited by the specified type of welding tool used during qualification tests:

tool with adjustable probe;

tool with fixed probe;

bobbin tool with shoulders separated by a fixed length probe;

bobbin tool with shoulders separated by an adjustable length probe;

.7 range of welding parameters. Certification of FSW procedure covers only those values of welding parameters that have been fixed during tests. Standard for deviations from these parameters (Δ) shall be indicated in the RS-approved documentation of the firm.

Mandatory limited welding parameters during certification of FSW procedure are:

welding speed (V);

speed of welding tool (ω).

longitudinal tilt angle (α_{xz}) and transverse tilt angle (α_{yz});

force on the probe (p);

force on the welding tool (P);

heel plunge depth (h);

For tools specially developed to form the specified sense of rotation, the limitation shall be the sense of rotation that has been applied during certification. In tools for which the priority of rotation is not applicable and there are no particulars in geometry affecting the sense of rotation, rotation parameters of the tool shall cover both senses;

.8 requirements for assembly. Certification covers only those conditions that have been fixed during tests. The mandatory limited welding parameters during certification of FSW procedure are:

gaps between butt details for welding (a);

permissible transverse misalignment of butt edges (Y);

permissible vertical misalignment of butt edges (Z);

heat-removing method.

.9 method for edge preparation and cleaning. Certification covers the method of edge preparation and cleaning of welded details (mechanical, abrasive or chemical) that is applied during tests. When amending the method of edge cleaning the repeated tests shall be required. Welding shall be performed not later than in one day after their cleaning;

.10 welding position. In general, certification of FSW procedure covers only welding position in which the welding has been carried out during the tests. The scope of approval may include other welding positions if during tests the invariability of welding parameters (refer to 7.6.4.7) is determined.

Standard for deviations from these parameters shall be indicated in the RS-approved documentation of the manufacturer."