RUSSIAN MARITIME REGISTER OF SHIPPING

GUIDELINES

ON TECHNICAL SUPERVISION DURING CONSTRUCTION AND OPERATION OF SUBSEA PIPELINES

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The Guidelines on Technical Supervision during Construction and Operation of Subsea Pipelines have been approved in accordance with the established approval procedure and come into force on 1 September 2020.

These Guidelines have been prepared on the basis of the 2017 edition of the Guidelines on Technical Supervision during Construction and Operation of Subsea Pipelines.

In case of discrepancies between the Russian and English versions, the Russian version shall prevail.

REVISION HISTORY

(Purely editorial amendments are not included in the Revision History)

Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
Section 1, para 1.1.2	Reference to the Recommendations for Design, Construction and Operation of Subsea Pipelines has been introduced	—	01.09.2020
Section 1, para 1.3.3	Reference to the Recommendations for Design, Construction and Operation of Subsea Pipelines has been introduced	—	01.09.2020
Section 1, para 1.7.5	References to the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships have been specified	—	01.09.2020
Section 1, para 1.7.11	Misprint has been corrected in the Russian version	—	01.09.2020
Section 1, para 1.8.1	Name of Certificate has been specified	—	01.09.2020
Section 1, para 1.8.5	New para containing requirements for type approval of coatings has been introduced	—	01.09.2020
Section 1, para 1.9.1.6	Requirements for service suppliers have been specified	—	01.09.2020
Section 1, para 1.10.4	Requirements for testing laboratories have been specified	—	01.09.2020
Section 1, para 1.11.1	Reference to the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships has been specified	—	01.09.2020
Section 1, para 1.11.3	Reference to the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships has been specified	—	01.09.2020
Section 1, para 1.11.5	Requirements for firms subject to inspection for drawing up of Certificate of Firm Conformity have been specified	—	01.09.2020
Section 2, para 2.2.1.4	Requirements for test reports of steel rolled products/ pipes have been specified	—	01.09.2020
Section 2, para 2.2.2.3	Requirements for survey to recognize manufacturer of steel rolled products/pipes have been specified	—	01.09.2020
Section 2, para 2.2.3.7	Requirements for RS Certificates for manufacturers of steel rolled products/pipes have been specified	—	01.09.2020
Section 2, para 2.3.1	Requirements for steel forgings and castings have been specified	—	01.09.2020
Section 2, Table 2.4.2.3	Names in table heading and requirements for bend tests have been specified	—	01.09.2020
Section 2, Table 2.4.3.2	Requirements for bend tests have been specified	—	01.09.2020
Section 2, Table 2.4.3.9	Inspection and Test Plan for welded pipe manufacture has been specified with regard to visual examination and measurement	—	01.09.2020
Section 2, Table 2.4.3.10	Inspection and Test Plan for seamless pipe manufacture has been specified with regard to visual examination and measurement	—	01.09.2020
Section 2, para 2.6.1.7	Requirements for type approval of flexible pipes have been specified	—	01.09.2020
Section 2, para 2.7.1.2.3	New para containing requirements for documentation for supplied materials for coating application has been introduced	—	01.09.2020

Amended paras/chapters/sections	Information on amendments	Number and date of the Circular Letter	Entry-into-force date
Section 2, para 2.7.1.3.2.10	Type of coating testing has been specified	—	01.09.2020
Section 2, Table 2.7.1.4.7	Inspection and Test Plan during application of corrosion protection coating has been specified	—	01.09.2020
Section 2, para 2.7.1.4.8	New para containing requirements for coating defects subject to repair has been introduced	—	01.09.2020
Section 2, para 2.7.3.2.3	Requirement for chemical composition of steel used for reinforcement cage has been specified	—	01.09.2020
Section 2, para 2.7.3.3.4	Requirements for cracks on aluminium alloy galvanic anodes and zinc alloy anodes have been specified	—	01.09.2020
Section 2, para 2.8.1.7	Requirements for preparation of corrosion protection coating prior to concrete coating application have been specified	—	01.09.2020
Section 2, para 2.8.3.5	Para has been supplemented by requirements for allowable deviations of concrete coating thickness	—	01.09.2020
Section 2, Table 2.8.4.4	Scope of tests for approval of concrete weight coatings has been specified	—	01.09.2020
Section 2, para 2.10.1.5	Requirements for design of thermal insulation coatings have been specified	—	01.09.2020
Section 2, para 2.10.2.2	Requirements for design of thermal insulation coatings have been specified	—	01.09.2020
Section 2, Table 2.10.4.3	Scope of tests for approval of thermal insulation coatings has been specified	—	01.09.2020
Section 2, Table 2.12.4.2	Requirements for acceptance criteria of bends have been specified	—	01.09.2020
Section 2, Fig. 2.12.4.6	Designation of the base metal of the straight end has been corrected	—	01.09.2020
Section 2, Chapter 2.15	New Chapter containing requirements for polymer compounds has been introduced	—	01.09.2020
Section 2, Chapter 2.16	New Chapter containing requirements for internal anti-friction coatings has been introduced	—	01.09.2020
Section 3, Chapter 3.5	Requirements for subsea pipeline route have been specified	—	01.09.2020
Section 3, para 3.6.2.1	Requirement for stations for the non-destructive testing has been specified	—	01.09.2020
Section 3, para 3.6.2.5	Reference to the SP Rules has been specified	—	01.09.2020
Section 3, Table 3.7.1.1	Check procedures have been added into the list of items and types of technical supervision during SP construction	—	01.09.2020
Section 3, para 3.7.1.12	Para has been supplemented by the requirements for account of items on the route	—	01.09.2020
Section 3, para 3.7.3	New para containing requirements for installation and laying of steel subsea pipelines on shoreline crossing section has been introduced; existing paras 3.7.3 — 3.7.5 have been renumbered 3.7.4 — 3.7.6, accordingly	—	01.09.2020
Section 4, Chapter 4.2	Chapter has been completely amended considering the results of scientific research No. 17-18041	—	01.09.2020

1 GENERAL

1.1 SCOPE OF APPLICATION

1.1.1 The Guidelines on Technical Supervision during Construction and Operation of Subsea Pipelines (hereinafter referred to as "the SP Guidelines") of the Russian Maritime Register of Shipping (hereinafter referred to as "the Register", or "RS") apply to the pipelines specified in 1.1.1, Part I "Subsea Pipelines" of the Rules for the Classification and Construction of Subsea Pipelines (hereinafter referred to as "the SP Rules") and to the materials and products thereof.

1.1.2 During survey of subsea pipelines and their materials and products, in addition to the requirements of these Guidelines, the Rules for the Classification and Construction of Sea-Going Ships (hereinafter referred to as "the RS Rules"), the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships (hereinafter referred to as "the Rules for Technical Supervision during Construction of Ships"), the Rules for the Oil-and-Gas Equipment of Floating Offshore Oil-and-Gas Production Units, Mobile Offshore Drilling Units and Fixed Offshore Platforms (hereinafter referred to as "the Rules for the Oil-and-Gas Equipment"), Recommendations for Design, Construction and Operation of Subsea Pipelines (hereinafter referred to as the "SP Recommendations") and also the standards and rules of national technical supervision bodies, as appropriate, shall be followed.

1.1.3 In compliance with Federal Law No.116-FZ dated 21 July 1997 "On industrial safety of hazardous production facilities", the subsea oil pipelines and gas pipelines are classified as hazardous production facilities, which implies the observance of mandatory procedures for these types of subsea pipelines according to the Russian legislation requirements.

1.2 TERMS, DEFINITIONS AND ABBREVIATIONS

Terms, definitions and abbreviations relating to the RS general terminology are given in Part I "Classification" of the Rules for the Classification and Construction of Sea-Going Ships and in Part I "General Provisions on Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

The following terms and definitions are used in these Guidelines.

1.2.1 Terms and Definitions.

Flexible pipes for subsea pipelines mean polymeric-metal pipes with end connecting fittings which allow large deflections from straightness without a significant increase in bending stresses.

Date of subsea pipeline construction means the date of the actual completion of the RS surveys during the subsea pipeline construction as specified in the report signed by the customer and contractor.

Customer means a firm, legal person concluded a contract with (submitted a written request to) the Register for its services.

As-built documentation means records, reports, conclusions, construction logs and other documents developed by the contractor/subcontractor during construction and commissioning of the subsea pipeline.

Qualification tests mean tests of the pilot batch of materials or products carried out prior to manufacture and aimed at confirming the manufacturer's capability to manufacture them according to technical documentation approved by the Register.

Subsea pipeline modernization means the replacement of subsea pipeline components with expired service life (pipes, coatings, ballasting, valves and fittings, control systems, etc.) with the new ones with improved quality characteristics.

Subsea pipeline in operation means a subsea pipeline in use, under repairs, during modernization or conservation with valid RS class confirmed by the documents issued by the Register.

Substantiation of investments in subsea pipeline construction means a development phase of a subsea pipeline project design (also within the framework of the offshore oil-and-gas field/offloading terminal on a sea shelf) supplemented with the development of technology and the determination of economic indexes to the extent sufficient for customer's (investor's) decision making on the expediency of further investments.

Technical supervisory bodies mean the RF executive authority bodies performing control and supervision functions in the field of industrial safety.

RS Branch Office means a branch, district office of a branch, Regional Office, district office of a Regional Office, associated company, affiliated company, district office of an affiliated company, joint stock company, the RS representation. The RS Branch Office has Regulations of Status approved in accordance with the established procedure to define its legal status, region of its activities, its objectives and functions, as well as duties, rights and responsibilities of the Head of the RS Branch Office.

Construction of subsea pipeline means the processes of pipeline installation, laying and testing.

Manufacturer means a firm producing materials and/or products.

Contractor means a firm carrying out construction, repair/modernization of the subsea pipeline.

Feasibility study (project) of a subsea pipeline means a project of subsea pipeline construction (also within the framework of the construction project of an oil-and-gas field/offloading terminal on a sea shelf) developed in compliance with the requirements of the SP Rules and/or the RF normative documents in the area of capital construction.

Detailed design documentation means a set of design and production documents intended for construction (manufacture), check, acceptance, supply of materials and products, service, repair/ modernization of the item of supervision.

Operating organization means a legal/an individual entity legally carrying out the process of subsea pipeline operation or conservation.

1.2.2 Abbreviations.
FPMP — flexible polymeric-metal pipes;
RHO — Register Head Office;
ACS — another classification society;
SP — subsea pipeline.

1.3 GENERAL PROVISIONS ON TECHNICAL SUPERVISION

1.3.1 The SP technical supervision consists of verifying the SP conformity to the RS requirements during:
review and approval (agreement) of technical (design and detailed design) documentation;
survey of materials and products for subsea pipelines;
survey of items of supervision at construction (manufacture) and service stages including modernization and repair.

1.3.2 The RS activities on technical supervision during SP design, construction and operation are carried out on the basis of the contracts voluntarily concluded with customers.

1.3.3 The RS technical supervision during SP design, construction and operation, being considered as items of the construction of offshore oil-and-gas structures on sea shelves, is carried out along with the procedures for supervising these items by the RF supervisory bodies in compliance with the requirements of the Russian legislation (refer to 2.2 of the SP Recommendations).

1.3.4 The RS technical supervision items and the technical requirements thereto are established by the SP Rules and are listed in the Nomenclature of items of the RS technical supervision of subsea pipelines (refer to Table 1.6.1).

1.3.5 In technical supervision during SP design, construction and operation, the Register may, according to 1.1.1 and 1.1.7, Part I "Subsea Pipelines" of the SP Rules, approve the application of ACS normative and technical documents, other national and international rules, regulations and standards.

1.3.6 The construction of subsea pipelines and the manufacture of their materials and products shall be carried out in compliance with the technical documentation approved (agreed) by the Register.

1.3.7 The SP technical supervision is generally carried out with the purpose of its classification and verification of class conditions and the SP compliance with the RS requirements during construction, operation, modernization and repairs. Upon request of the SP customer/operator, the RS technical supervision may be carried out for other purposes as specified in the appropriate contract (services rendered by third parties, expertise of documentation, etc.).

1.3.8 The RS class notation may be assigned to the following pipelines (refer to 1.3, Part I "Subsea Pipelines" of the SP Rules):

.1 subsea pipelines constructed in accordance with the RS rules and under the RS technical supervision;

.2 subsea pipelines constructed in accordance with the rules and under supervision of the classification society or national supervisory body recognized by the Register;

.3 subsea pipelines constructed without supervision of the classification society or national supervisory body recognized by the Register.

1.3.9 The classification of subsea pipelines specified in 1.3.8.2 and 1.3.8.3 shall be subject to special consideration by the Register based on 1.4.4.3, Part I "Subsea Pipelines" of the SP Rules. In addition to design and detailed design documentation for the SP construction, as-built documentation shall be considered and approved by the Register.

1.3.10 Otherwise, the general provisions on the SP technical supervision shall comply with the requirements of Section 2, Part I "General Regulations on Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.3.11 In order to specify the types and scope of the RS surveys in the course of technical supervision during SP construction, manufacture of materials and products, it is recommended to apply the Inspection and Test Plans developed by the manufacturers and agreed upon with the Register. The types of surveys specified in 1.1, Part I "General Provisions on Technical Supervision" of the Rules for the Technical Supervision during Construction of Ships provided in these plans may be presented as types of inspections and tests specified in Table 1.3.11.

Table 1.3.11

Surveys, tests and inspections carried out by the Register

Inspections		Surveys specified in 1.1, Part I "General Provisions on Technical Supervision" of the Rules for Technical Supervision during Construction of Ships				
Designation	Description	Check for availability of the approved documentation	Inspection and participation in measurements and tests	Random inspection and participation in measurements and tests	Assessment of measurements and test results	Drawing up of survey results
H	Acceptance *(Hold point)*	+	+	—	+	+
W	Check *(Witness point)*	+	—	+	+	—
M	Monitoring	+	—	+	—	—
R	Document review	+	—	—	—	—
Note: "+" — surveys performed by the Register during any inspection.						

1.3.12 When preparing the Inspection and Test Plans for each testing with the RS Surveyor participation (RS survey) the reference to the RS approved technical documentation shall be specified.

The Inspection and Test Plan developed by the manufacturer and agreed upon with the Register may be based on inspections other than those specified in Table 1.3.11 as well as contain the following information:

area location and process operation;

parameters to be checked;

test/inspection intervals;

acceptance criteria;

type of records (acceptance logs, reports, computer system, etc.);

actions in case of non-conformities.

1.4 REQUESTS, CONTRACTS AND AGREEMENTS ON TECHNICAL SUPERVISION

1.4.1 Requests for the SP project review shall be generally submitted to RHO where they are considered and reviewed. The request shall contain the information on SP sufficient for its review and execution.

1.4.2 Requests for review of the SP detailed design documentation and technical supervision during SP construction and manufacture of materials and products for SP are also generally submitted to RHO. After reviewing the request the RHO management takes a decision on its execution by the RHO departments or grants authorization to the RS Branch Offices.

1.4.3 The requests for the RS technical supervision of SP during operation, repair or modernization are generally submitted to the RS Branch Office involved in technical supervision during SP construction and in its classification.

1.4.4 The requests for classification of subsea pipelines specified in 1.3.8.2 and 1.3.8.3 are generally submitted to RHO. After reviewing the request the RHO management takes a decision on its execution by the RHO departments to the RS Branch Offices and/or grants authorization.

1.4.5 Based on results of request reviewed, RHO/the RS Branch Office concludes a contract on technical supervision.

1.4.6 The RS technical supervision within the framework of one contract may be performed by different RS Branch Offices. The work share and the cost of services for each RS Branch Office shall be agreed between them at the stage of request analysis and review.

1.4.7 General requirements to requests, contracts and Agreements on Survey (CO) to be concluded between the manufacturer and RS in order to confirm the compliance of the product batches, shall comply with Section 4, Part I "General Regulations on Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.5 TECHNICAL DOCUMENTATION

1.5.1 Prior to commencement of the SP technical supervision, RS shall be provided with technical documentation to certify that the SP Rules and these Guidelines requirements regarding the SP and its materials and products in question, as well as the quality of services being rendered are fully met.

1.5.2 The amendments to be introduced in the technical documentation approved by RS and applicable to the SP components and structures covered by the SP Rules and Guidelines shall be submitted for the RS approval prior to their implementation.

1.5.3 Depending on types of requests specified in 1.4.1 to 1.4.4, technical documentation may be submitted to RS as one of the following alternatives:

.1 SP project including within the framework of the construction project of an oil-and-gas field/ offloading terminal on a sea shelf;

.2 detailed design documentation for SP construction;

.3 detailed design documentation for SP repair or modernization;

.4 normative and technical documents, process procedures, specifications including check test programs for recognition of manufacturers;

.5 regulations of SP technical operation and reports on SP survey and its routes during operation;

.6 as-built documentation during SP construction (for classification of subsea pipelines specified in 1.3.8.2 and 1.3.8.3) including the following:

permission documentation (permit for commencement of construction, reports for mobilization of technical facilities for pipe laying and burial, preparation of routes/trenches, etc.);

welding documentation (welders' certification reports, welding procedure approval certificates with reports on mechanical tests, procedures for assessing the permissible defects during welding and for non-destructive examination (testing));

Inspection and Test Plan for pipeline construction;

certificates for materials and products including pipes and welding consumables;

concealed work reports;

pipe welding and laying logs;

pipe weld non-destructive test logs;

weld joint insulation connections;

route in-water study reports;

reports on checking for correct position of pipelines after laying/burial into the seabed;

hydraulic test reports;

certificates of SP completion of construction and commissioning.

1.5.4 The design technical documentation for subsea pipelines shall be reviewed by RHO.

1.5.5 The review of documents specified in 1.5.3.2 to 1.5.3.4 is carried out by RHO or on its behalf by the RS Branch Office in which area of activity the SP is laid and where there is qualified personnel specialized in performing similar works.

1.5.6 The review of the documents specified in 1.5.3.5 and 1.5.3.6 is carried out by the RS Branch Office that performs or will perform technical supervision of subsea pipelines in operation in the course of the RHO final review.

1.5.7 The scope of design technical documentation for subsea pipelines to be reviewed by the Register shall comply with the requirements specified in 1.5, Part I "Subsea Pipelines" of the SP Rules.

1.5.8 In the course of the RS technical supervision both during manufacture of materials and products as well as SP construction/laying/installation, Inspection and Test Plans agreed upon with the Register are recommended to be applied as one of the forms of detailed design documentation as agreed upon with the customer in order to specify the types of the RS surveys during manufacture/construction (refer to 1.3.11).

1.6 NOMENCLATURE OF ITEMS OF THE REGISTER TECHNICAL SUPERVISION

1.6.1 The Nomenclature of items of the RS technical supervision of subsea pipelines (refer to Table 1.6.1) developed on the basis of the SP Rules (hereinafter referred to as "the SP Nomenclature"), specifies the items, supervised by RS during their construction at manufacturer's, during installation, laying and testing of SP, as well as the necessity for their branding.

Table 1.6.1

Nomenclature of items of the Register technical supervision of subsea pipelines

Code of item of technical super-vision	Item of technical supervision	RS technical supervision						
		of prototype	Type approval/ Recogni-tion of manu-facturer	at manufacturer's with steady production		during construction of SP		
				Document to be issued	Branding	Installation, application	Laying	Pressure testing
23000000	**Subsea pipelines:**							
23100000	main/export	—	—	—	—	P	P	P
23200000	infield/to single point mooring	—	—	—	—	P	P	P
23300000	interfield	—	—	—	—	P	P	P
23400000	standby	—	—	—	—	P	P	P
23001000	**Steel rolled product[1]:**							
23001001	plates/skelp	P	СПИ	С, С3	К	—	—	—
23001002	sections	P	СПИ	С, С3	К	—	—	—
23001003	bars	P	СПИ	С, С3	К	—	—	—
23001004	pipe billet	P	СПИ	С, С3	К	—	—	—
23002000	**Steel pipes[1]:**							
23002001	seamless	P	СПИ	С, С3	К	P	—	—
23002002	welded	P	СПИ	С, С3	К	P	—	—
23003000	**Steel bends and fittings[1]**	P	СПИ	С, С3	—	P	—	—
23004000	**Steel castings and forgings[1]**	P	СПИ	С, С3	—	—	—	—
23005000	**Flexible polymeric-metal pipes**	P	СТО	С, С3	—	P	—	—
23006000	**Valves:**							
23006001	manually controlled	P	СТО	С, С3	—	P	P	P
23006002	remotely controlled	P	СТО	С, С3	—	P	P	P
23006003	safety valves	P	СТО	С, С3	—	P	P	P
23007000	**Parts of joints:**							
23007001	flanged joints	P	СТО	С, С3	—	P	P	P
23007002	fastenings	P	СТО	С, С3	—	P	—	—
23007003	sealing gaskets	P	СТО	С, С3	—	P	—	—
23008000	**Corrosion protection and thermal insulation:**							
23008001	internal coatings (anti-friction and/or corrosion-protection)	P	СТО	С, С3	—	P	—	—
23008002	external corrosion-protection coatings	P	СТО	С, С3	—	P	P	—
23008003	cathodic protection system	P	СТО	С, С3	—	P	P	—
23008004	galvanic anode system	P	СТО	С, С3	—	P	P	—
23008005	thermal insulation coatings	P	СТО	С, С3	—	P	P	—
23008006	heat-shrink sleeves	P	СТО	С, С3	—	P	P	—
23009000	**Ballasting**							
23009010	Single weights:							
23009011	cast-iron	P	СТО	СТО	—	P	P	—
23009012	concrete	P	СТО	СТО	—	P	P	—
23009013	reinforced concrete	P	СТО	СТО	—	P	P	—
23009020	Continuous coatings:							
23009021	concrete	P	СТО	С, С3	—	P	P	—
23009022	reinforced concrete	P	СТО	С, С3	—	P	P	—
23009023	asphalt concrete	P	СТО	С, С3	—	P	P	—

Table 1.6.1 — continued

Code of item of technical super-vision	Item of technical supervision	RS technical supervision						
		of prototype	Type approval/ Recogni-tion of manu-facturer	at manufacturer's with steady production		during construction of SP		
				Document to be issued	Branding	Installation, application	Laying	Pressure testing
23010000	**Alarm and automated control systems:**							
23010001	excess of pressure	P	CTO	C, C3	—	P	—	—
23010002	leakage and consumption control	P	CTO	C, C3	—	P	—	—
23010003	corrosion monitoring	P	CTO	C, C3	—	P	—	—
23011000	**Welding consumables:**							
23011001	electrodes for "dry" welding	P	COCM	COCM	—	—	—	—
23011002	electrodes for underwater welding	P	COCM	COCM	—	—	—	—
23011003	welding wire/flux	P	COCM	COCM	—	—	—	—
23011004	welding wire/gas	P	COCM	COCM	—	—	—	—
23011005	type production processes	P	СОТПС	СОТПС	—	—	—	—
23012000	**Computer software (Programs for computer-aided calculations)**	P	СТОП	СТОП	—	—	—	—
23013000	**Clamps:**							
23013010	Repair clamps:							
23013011	steel	P	CTO	C, C3	—	P	P	P
23013012	composite	P	CTO	C, C3	—	P	P	P
23013020	Insulating composite clamps	P	CTO	C, C3	—	P	P	—
23013030	Rock shield/casing	P	CTO	C, C3	—	P	P	—
23014000	**Electrical insulating arrangements:**							
23014001	flanges	P	CTO	C, C3	—	P	P	P
23014002	joints	P	CTO	C, C3	—	P	P	P

[1]Rolled products and pipes made of other alloys are subject to special consideration by the Register.

1.6.2 The materials and products used during construction and operation of subsea pipelines under the RS technical supervision shall be supplied to the firm, which carries out the SP construction/operation, along with the certificates or other documents that confirm their compliance with the requirements of the RS Rules, the SP Guidelines and/or the RS-approved standards according to the SP Nomenclature.

1.6.3 The list of the SP materials and components subject to the RS mandatory survey is given in the SP Nomenclature. Any changes of the SP Nomenclature shall be agreed upon with the Register. The materials and products missing in the SP Nomenclature may be surveyed upon the customer's request.

1.6.4 While carrying out the technical supervision of construction/operation of subsea pipelines and of manufacture of materials and products of a new original design, the Register is entitled to unilaterally introduce changes to the SP Nomenclature as well as confirm the compliance (certify) the materials and products not included into the SP Nomenclature.

1.6.5 The following symbols are used in the SP Nomenclature (refer to Table 1.6.1):

P — technical supervision directly carried out by the Surveyor;

K — branding of items of technical supervision;

C — Certificate filled in and signed by the Register (Form 6.5.30);

C3 — Certificate filled in and signed by an official of a firm (manufacturer) and drawn up by the Register (form 6.5.31);

CTO — Type Approval Certificate (form 6.8.3);

СПИ — Recognition Certificate for Manufacturer (form 7.1.4.1);

COCM — Certificate of Approval for Welding Consumables (form 6.5.33);

СОТПС — Welding Procedure Approval Test Certificate (form 7.1.33);

СТОП — Type Approval Certificate for Computer Program (form 6.8.5).

1.7 RECOGNITION OF MANUFACTURERS

1.7.1 The manufacturers of the materials and products listed in the SP Nomenclature (refer to Table 1.6.1) and specified in 1.7.3 shall be recognized by the Register. The recognition of a manufacturer means the RS documentary confirmation of its capability to produce materials and products in compliance with the RS requirements.

1.7.2 The requirements of technical supervisory bodies imposed upon the manufacturers of materials and products for subsea pipelines shall be confirmed by the relevant documents irrespective of the manufacturer recognition by the Register.

1.7.3 In compliance with Section 4, Part I "Subsea Pipelines" of the SP Rules and the SP Nomenclature (refer to Table 1.6.1), the RS recognition covers all the manufacturers involved in production of the following subsea pipeline related products:

all types of steel rolled products (including tubular billets used as a semi-product by other firms (manufacturers));

all types of steel pipes;

steel bends and fittings;

steel castings and forgings.

1.7.4 When the materials other than those specified in Section 4, Part I "Subsea Pipelines" of the SP Rules are used for subsea pipelines, the necessity of recognizing the manufacturers of those materials is subject to special consideration by the Register.

1.7.5 In addition to the provisions of this Chapter, the recognition of the manufacturers of materials and products for subsea pipelines shall comply with the following:

applicable provisions of Section 11, Part I "General Provisions for Technical Supervision" and Sections 1 and 2, Part III "Technical Supervision during Manufacture of Materials" of the Rules for Technical Supervision during Construction of Ships;

requirements of Chapters 4.1 and 4.2, Part I "Subsea Pipelines" of the SP Rules.

1.7.6 The procedure for recognition of the manufacturer is carried out on the basis of the request submitted to the RS Branch Office by the manufacturer (refer to 1.4.2). The RS recognition of the manufacturer is confirmed by drawing up a Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1).

1.7.7 The RS recognition of the manufacturer includes:

review of the documents which confirm manufacturer's conformity to the RS requirements;

surveys of the manufacturer.

1.7.8 The review of manufacturer's documents is aimed at ascertaining the compliance of the documents with the RS requirements. The manufacturer shall have valid normative and technical documents, which are required for activities in the area stated.

1.7.9 The review of technical documentation for the products manufactured is aimed at confirming the products' compliance with the SP Rules, the SP Guidelines and the RS approved detailed design documentation. Upon agreement with the Register, the materials may be in compliance with national and/or international standards.

1.7.10 The test program for manufacturer recognition shall be developed by the manufacturer and approved by the Register.

1.7.11 The purpose of surveying the manufacturer is to directly ascertain the manufacturer's conformity to the RS requirements. Based on the RS approved program, the check tests of the material and product specimens from the area stated shall be carried out by the manufacturer in the presence of the RS representative. During the tests, it shall be confirmed that the production and product parameters comply with the requirements of the RS-approved documentation and the SP Rules, and that the adequate level of product quality stability is maintained.

1.7.12 In particular cases, at the RS discretion, where a single approval is given for the material or product, the Certificate (С) (form 6.5.30) may be drawn up without issuing of the Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1). Where deemed necessary, the tests for manufacturer recognition shall be carried out in a scope as required by the Register.

1.8 TYPE APPROVAL

1.8.1 The materials, products and software specified in the SP Nomenclature (refer to Table 1.6.1) are subject to type approval with drawing up of the following documents:

Type Approval Certificate (CTO) (form 6.8.3);

Type Approval Certificate for Software (СТОП) (form 6.8.5).

1.8.2 The type approval procedure for materials, products and software shall comply with Section 6, Part I "General Provisions for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.8.3 The materials and products subject to the RS type approval according to the SP Nomenclature shall be supplied under the Agreement on Survey (CO) between the manufacturer and the Register in compliance with the requirements specified in 4.5, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships with the Certificate (С3) (form 6.5.31) drawn up by the manufacturer and affirmed by the Register. At drawing up the Agreement on Survey, the manufacturer shall be checked for compliance with the requirements specified in 1.7 with Report (form 6.3.19) based on the check results issued.

In particular cases, at the RS discretion, the type approved materials and products may be manufactured without concluding the Agreement on Survey (CO) but under the RS direct technical supervision during production with Certificate (C) (form 6.5.30) issued.

1.8.4 In separate cases, at the RS discretion, where a single approval is given for the material or product, the Certificate (C) (form 6.5.30) may be drawn up without issuing of the Type Approval Certificate (CTO) (form 6.8.3). Where deemed necessary, the type approval tests shall be carried out in a scope as required by the Register.

1.8.5 Requirements for type approval of materials and products for subsea pipelines are listed in the relevant chapters of Section 2 of these Guidelines. The following shall be taken into account:

coatings of different purposes including weight coatings applied on pipelines at the firms under the Register technical supervision are subject to type approval; Type Approval Certificate (form 6.8.3) for finished coating shall be issued for these firms;

upon submitting a request the suppliers of coating materials may voluntarily pass the procedure of type approval of the specified materials with drawing up of Type Approval Certificate (form 6.8.3) — refer to 2.7.1.2.3.

1.9 RECOGNITION OF SERVICE SUPPLIERS

1.9.1 General.

1.9.1.1 Where the operating results of firms are used by the Register during technical supervision or are an integral part thereof, these firms shall be surveyed by the Register prior to the commencement of such works to confirm their capability to execute similar works.

1.9.1.2 The firms carrying out activities listed in Table 1.9.1.2 shall be recognized by the Register. The recognition of a firm means the confirmation with the RS document of firm's capability to provide services/execute works in compliance with the RS requirements.

Table 1.9.1.2

Types of service supplier's activities

Code	Kind of activity
24001000	In-water surveys of pipelines under supervision of the RS surveyor:
24001001	measurements of pipe wall thickness
24001002	location of coating damages, measurements of corrosion-protection and insulating coating thickness
24001003	measurements of cathode potential
24001004	external in-water survey of the pipeline and its route
24001005	non-destructive examination of welds and pipes
24002000	In-line inspection of the underwater pipeline under supervision of the RS surveyor

1.9.1.3 The requirements of technical supervisory bodies imposed upon the service suppliers shall be confirmed by the relevant documents irrespective of the manufacturers' recognition by the Register.

1.9.1.4 The procedure for recognizing service suppliers is carried out on the basis of the request submitted to the RS Branch Office by the supplier. The RS recognition of the supplier is confirmed by drawing up a Recognition Certificate (СП) (form 7.1.4.2) to be issued with regard to requirements of 3.4 to 3.7, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.9.1.5 In order to be recognized by the Register, the service supplier shall meet the requirements of Section 7 and Chapter 8.2, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships and the requirements of this Chapter.

1.9.1.6 The RS recognition of the service supplying firm includes:

review of the documents, which confirm supplier's conformity to the RS requirements and the experience to perform works in the field of activity in question;

surveys of the firm including the demonstration test of services performance.

1.9.2 Requirements for firms carrying out in-water SP surveys.

1.9.2.1 The service supplier is responsible for the qualification and safety of the divers involved and the proper operation of diving equipment used in in-water surveys.

1.9.2.2 The service supplier may render services related to in-water survey both with involvement of divers and using instrument systems including those installed on remotely operated or autonomous underwater vehicles complying with the requirements specified below.

1.9.2.3 The operating procedures and guidelines which determine the procedure for surveys and applied equipment shall be documented as well as the documents confirming the knowledge and skills of service supplier's personnel in the areas stated (for codes of activity 24001001 to 24001005) shall be submitted:

underwater thickness measurements of pipe wall;

underwater thickness measurements of corrosion-protection and insulation coatings;

location of corrosion-resistant coating damages;

underwater measurements of a protective cathode potential;

external underwater visual examinations, including measurements of the technical condition of the pipeline and its route (including the use of remotely-operated or autonomous underwater vehicles);

non-destructive testing of welds and pipe metal using the selected physical methods which allow to locate and dimension the normalized defects;

underwater video filming (video recording) and photographing;

underwater communication and diver's guidance along the pipeline route;

use of special equipment and tools for in-water operations.

1.9.2.4 Divers' qualification shall comply with the requirements specified in 8.3.3.4 and 8.3.3.5, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships. The plans for personnel training on the lines of activities stated (for codes of activity 24001001 to 24001005) shall be developed.

1.9.2.5 The service supplier shall have the equipment to be used for in-water surveys of divers specified in 8.3.3.6, Part I "General Provisions for Technical Supervision" of the Rules for the Technical Supervision during Construction of Ships.

The supplier shall additionally have:

.1 for code of activity 24001001 — special purpose instruments for underwater thickness measurements capable of providing at least the following:

metal thickness measurements without preliminary preparation of the surface and removal of protective coating;

use of instrument together with the data display and storage unit on board the ship;

.2 for code of activity 24001002 — equipment for measuring coating thickness and location of corrosion-protection coating damages by means of electrometry;

.3 for code of activity 24001003 — equipment for measuring a cathode protection potential of the pipeline;

.4 for code of activity 24001004 — equipment for:

sonar and bathymetrical surveys of pipeline routes including spatial location of the pipeline and detection of free spans and soil drifts (for unburied pipelines);

determination of the depth of the seabed soil protective layer above the top line of the pipeline including spatial location of the pipeline by acoustical profiling or electro/magnetometric survey including identification of the strippings (for pipelines buried into the seabed soil);

external underwater visual examinations, including measurements of the technical condition of the pipeline and its route using remotely operated or autonomous underwater vehicles equipped with digital photo and video cameras and underwater aids to navigation;

collection and integrated processing of data from multiple/single-beam echo sounders, sonars and other equipment including GPS/GLONASS receivers, using licensed software for digital modeling of the pipeline;

.5 for code of activity 24001005 — equipment for underwater flaw detection for welds and base pipe metal for external marine environment.

1.9.2.6 The basic requirements for in-water survey services shall comply with 4.1.2.2.

1.9.3 Requirements for service suppliers engaged in in-line inspections of subsea pipelines.

1.9.3.1 The service supplier is responsible for the qualification of the personnel engaged in in-line inspections and for the safety of this work performance.

1.9.3.2 The operating procedures and guidelines which determine the procedure for in-line inspection and applied equipment shall be documented as well as the documents confirming the knowledge and skills of service supplier's personnel in the areas stated (for code of activity 24002000) shall be submitted:

preparing the pipeline for in-line inspection, pigging and gauging of the pipeline bore (pigging and gauging of the pipeline bore shall be performed on the fully or partially installed pipeline containing pig launchers and pig traps);

in-line inspection including interpretation of its results, location of detected defects and assessment of their permissibility/service life for the pipeline with the detected defects as well as drawing up of the data sheet for the detected defect to be submitted as an archive in electronic form making it possible to monitor its further propagation.

1.9.3.3 The service supplier shall have available the following equipment:

pipeline scrapers;

geometry tools and gauging pigs;

inspection (smart) pigs that allow to establish the presence, dimensions and location of standardized defects of welds and pipe walls;

equipment for control, monitoring of pigs performance and movement as well as for recording and processing of data;

software for processing of in-line inspection data and assessment of permissibility of detected defects/ service life for the pipeline with the detected defect;

equipment for video filming (video recording) of the pipeline bore or intrascopy.

1.9.3.4 The requirements for the above mentioned in-line pigging and inspection tools shall comply with 4.1.2.3.

1.10 RECOGNITION OF TESTING LABORATORIES

1.10.1 The tests of the RS items of subsea pipeline technical supervision shall be carried out by the testing laboratories recognized by the Register.

1.10.2 The procedure for recognition of the testing laboratory is carried out on the basis of its request submitted to the RS Branch Office.

1.10.3 The requirements for testing laboratories are specified in Sections 7 and 9, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.10.4 During SP construction on the RF shelf, the recognition of the testing laboratory by the Register does not release it from licensing and/or accreditation in compliance with the requirements of the RF technical supervisory bodies in the industrial safety and the Federal Agency on Technical Regulation and Metrology (Rosstandart).

1.10.5 The RS recognition of the testing laboratory includes:

review of documents confirming the compliance of the testing laboratory with the RS requirements;

survey of the testing laboratory including its check tests.

1.10.6 The Register recognition of the testing laboratory is confirmed by drawing up a Recognition Certificate of Testing Laboratory (form 7.1.4.3) to be issued considering the requirements of 3.4 to 3.7, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.10.7 In particular cases, including drawing up of a Recognition Certificate for Manufacturer (СПИ) and Type Approval Certificate (СТО), at the Register's discretion, tests may be carried out by the testing laboratory without the RS recognition. In this case, the testing laboratory conformity to the requirements listed in Section 7 and 9.2.1.1, 9.2.2.1, 9.2.2.2, 9.2.4.1, 9.2.4.2, 9.2.5 and 9.2.6, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships shall be verified prior to test performance and carried out under supervision of the RS surveyor.

1.11 AUDITS OF FIRMS

1.11.1 The firms engaged in the activities specified in Table 1.11.1 with regard to SP and being under the RS technical supervision shall be audited by the Register for compliance with the requirements of Section 8, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

Table 1.11.1

Type of firm's activities

Code	Kind of activity
24003000	SP construction, modernization, repairs and maintenance
24004000	Diagnostics of SP technical condition
24005000	Installation, commissioning, repairs and maintenance of SP automation and alarm systems
24006000	Theoretical training and SP welders' practical qualification tests (at certification centres)
24007000	SP design

1.11.2 In addition to the requirements specified in 1.11.1, firms may voluntarily be audited for the compliance with the requirements listed in 11.2, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.11.3 Design offices (code of activity 24007000) are audited only on a voluntary basis. In this case, the firm shall meet the general requirements specified in 12.1.3, Part I "General Provisions for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.11.4 The conformity of firms to the requirements specified in 1.11.1 to 1.11.3 is confirmed by a Certificate of Firm Conformity (ССП) (form 7.1.27) to be issued and confirmed in compliance with the requirements of 3.4 to 3.7, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships.

1.11.5 To draw up the Certificate of Firm Conformity (ССП, form 7.1.27) the firms engaged in the activities with codes 24003000 and 24004000 and audited according to these codes, shall additionally comply with:

for code 24003000: the requirements for the service suppliers with codes 23001001 — 23001005 depending on the works performed and the conditions of their execution;

for code 24004000: the requirements for the service suppliers with codes 23001001 — 23001005 and 24002000.

1.12 TECHNICAL SUPERVISION OF SUBSEA PIPELINES CONSTRUCTION AND OPERATION

1.12.1 Technical supervision of SP construction and operation is carried out by the Register on the basis of a contract on technical supervision concluded between the Register and the customer (a firm carrying out SP construction, a SP owner or operator).

1.12.2 The scope and procedure for the RS technical supervision, the types of checks, tests and surveys are established by the SP Nomenclature (refer to Table 1.6.1), the SP Rules and the SP Guidelines.

1.12.3 In addition to the SP Rules and these Guidelines, the contract on technical supervision concluded between the Register and the customer may include the list of normative and technical documents (ACS Rules, international and national standards, etc.) to be complied with in carrying out the technical supervision.

1.12.4 The total scope of the RS works on the SP technical supervision includes the following services:

review and approval of technical documentation;

technical supervision during manufacture of materials and products intended for SP construction, repairs and modernization in accordance with the SP Rules requirements and/or the applicable normative base, with the procedures of recognition of manufacturers and service suppliers;

technical supervision of SP construction with issuance of the RS classification documents;

periodical survey of subsea pipelines in operation (including that after repairs or modernization) for confirmation of the RS class notation.

1.12.5 During the RS classification of subsea pipelines constructed without technical supervision of the Register, the contract with the customer shall stipulate submission of design, detailed design and as-built documentation for the RS review as well as initial survey according to the requirements specified in 1.4.4.2 and 1.4.4.3, Part I "Subsea Pipelines" of the SP Rules.

1.12.6 Any changes made by builders and owners regarding the materials and separate structures (products) of the subsea pipelines covered by the SP Rules and listed in the SP Nomenclature shall be approved by the Register prior to their implementation.

2 TECHNICAL SUPERVISION DURING MANUFACTURE OF MATERIALS AND PRODUCTS FOR SUBSEA PIPELINES

2.1 GENERAL

2.1.1 The provisions of this Section shall apply during technical supervision of all materials and structural accessories used during SP manufacture and repair and listed in the Nomenclature of items of the RS technical supervision of subsea pipelines (refer to Table 1.6.1).

2.1.2 The general provisions on technical supervision during manufacture of SP materials and products shall correspond to the requirements of Section 1, Part III "Technical Supervision during Manufacture of Materials" and Section I, Part IV "Technical Supervision during Manufacture of Products" of the Rules for Technical Supervision during Construction of Ships.

2.1.3 In the course of technical supervision during manufacture of SP materials and products, the Register performs the works specified in Section 3, Part I "General Regulations for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships (where these works are not contradictory to the requirements specified in 1.6 to 1.11 of the SP Guidelines).

2.1.4 In addition to this Section requirements, SP materials and products shall meet the requirements of the relevant chapters of the SP Rules as well as the requirements of the RS approved technical documentation, specifications and other normative documents used in SP design and agreed upon with the Register.

2.1.5 Materials and products without Certificates or other documents confirming their compliance with the RS requirements shall not be used during SP construction and operation.

2.1.6 The materials and products of the subsea pipelines laid within inland water areas and on the RF shelf, with no regard to their conformity to the RS requirements, shall meet the requirements of the RF technical supervisory bodies.

2.1.7 The materials for SP pipes shall meet the following requirements:

for steel pipes — the requirements specified in 4.4, Part I "Subsea Pipelines" of the SP Rules;

for FPMP — the requirements specified in 4.6, Part I "Subsea Pipelines" of the SP Rules;

and be selected considering the following:

.1 operational reliability levels as specified in 1.3.3, Part I "Subsea Pipelines" of the SP Rules, namely:

0 — basic (**L** and **G**);

1 — increased (**L1** and **G1**);

2 — for corrosive media transportation (**L2** and **G2**);

3 — for seismically active regions and ice resistant standpipes (**L3** and **G3**);

.2 physical-chemical characteristics of the transported medium with regard to its corrosive and chemical activity;

.3 SP operational conditions (working pressure, temperature, water area depth, currents, waves, ice formations, etc.);

.4 loads and deformations during SP installation, laying and testing;

.5 consequences of accidental and special (emergency) loads during operation.

2.1.8 During technical supervision, the Register may check compliance with design, technological and productive standards and processes not regulated by the SP Rules and these Guidelines, but affecting the fulfilment of their requirements.

2.1.9 The new or first submitted for the RS survey materials, products or process procedures subject to the Register technical supervision during manufacture of materials and products, and SP construction, repair and modernization shall be approved by the Register. For these purposes, the specimens of materials and products or the new process procedures after the RS review of technical documentation shall be tested according to the program agreed with the Register.

2.1.10 Materials and products during technical supervision of their manufacture shall be subject to surveys and tests, as appropriate according to the procedure and to the extent specified by the Register. These materials and products shall be provided with the documents established by the Register, and, where necessary, shall have brands confirming their surveys thereof, and/or marking that allows to determine their compliance with these documents.

2.1.11 Where necessary, the Register may demand the performance of the incoming inspection of materials and components at the firm if it is ascertained that they do not meet the RS requirements or their use will make the items of technical supervision inconsistent with these requirements. In case of unsatisfactory results of the incoming inspection, the use of such materials shall not be allowed regardless of the availability of the Certificate and other documents certifying their compliance with the RS requirements.

2.1.12 To eliminate any doubts concerning stability of products quality, the Register may, during technical supervision at the firm, impose additional requirements concerning changes in the scope of tests as compared to those required by the RS Rules and the SP Guidelines.

2.1.13 For launching the production of products/materials with Type Approval Certificate (СТО) (form 6.8.3) or Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1) at the firm's (manufacturer's), the Register shall survey the qualification tests where the firm (manufacturer) works out quality control and technological procedure for each standard size of the product/material. A single pilot batch is generally subject to qualification tests and each product is subject to all acceptance tests.

2.2 STEEL ROLLED PRODUCTS FOR SUBSEA PIPES

2.2.1 General.

2.2.1.1 Steel rolled products for manufacture of welded pipes (skelp) and pipe billets (hereinafter referred to as "rolled products") for the SP being produced/repaired or modernized under the RS technical supervision shall meet the requirements of Section 4, Part I "Subsea Pipelines" of the SP Rules and take into account the reliability level required for subsea pipelines (refer to 4.1.3, Part I "Subsea Pipelines" of the SP Rules).

2.2.1.2 According to 1.7, the SP steel rolled products shall be produced by the firms with the RS Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1).

2.2.1.3 In some cases, by agreement with the Register, the rolled products may be produced by the manufacturer without the RS recognition provided that additional tests during manufacture in a scope required for manufacture without the RS recognition are carried out (refer to 4.2.3.5.1 and 4.2.3.5.2, Part I "Subsea Pipelines" of the SP Rules).

2.2.1.4 Test results for rolled products/pipes subject to the RS surveys shall be documented in the issued report with the following information:

identification number;
date of test;
name of the testing laboratory;
name of the customer;
test type;
type and size of metal products to be tested, grade of material and heat treatment;
number and name of the normative document regulating the test performance;
marking (number of cast/batch, plate/pipe, size of plate/pipe, etc.);
location of cutting-out and specimen orientation;
results of tests with indication of temperature at which they have been carried out;
any deviations from the procedures;
type of a testing machine, metrological calibration.

The report signed by the authorized person of the testing laboratory shall be submitted for the RS review.

2.2.1.5 Where the test results are unsatisfactory, unless otherwise specified in this Chapter, retesting shall be conducted with the following conditions being observed:

.1 in case the test for recognition of manufacture show unsatisfactory results, the Register may suspend the test performance until the relevant explanations are submitted and stop the tests unless it is associated with the adverse effect on the test results of such factors as sampling, manufacture or defects of specimens, equipment faults, etc.;

.2 during manufacture with unsatisfactory test results of even one of the tests, additional testing shall be conducted on the doubled number of rolled products/pipes from the submitted batch. Where the results of one of the additional tests are unsatisfactory, the batch shall be rejected.

The rolled products/pipes from the rejected batch may be accepted on the basis of the test results of each products among the remained ones in the batch. Where the total number of the rejected rolled products/pipes exceeds 25%, the batch shall be also rejected. In this case, the Register may suspend technical supervision of the rolled products/pipes at the firm (manufacturer) manufactured with regard to the same technology as the rejected batch. The firm (manufacturer) shall submit the results of an occurrence review and the Register is entitled to require test performance in the scope of the control tests;

.3 in any case, where the test results of any type of tests are unsatisfactory, their cause shall be identified and corrective actions shall be determined.

Where the adverse effect on the test results of such factors as sampling, manufacture or defects of specimens, equipment faults, etc. is revealed, the equipment and/or specimens may be repaired/replaced by other specimens of the same pipe and the tests shall be repeated.

At the firm recognized by the Register during manufacture, if agreed by the Register, it is allowed to submit, as a new batch, the rolled products/pipes rejected due to the mechanical characteristics, grain size and corrosion test results, but repeatedly heat treated;

.4 where necessary, the requirements related to unsatisfactory test results specified in 1.3.2.3, Part XIII "Materials" of the RS Rules may be additionally applied;

.5 where confusion of specimens is detected or the test results do not allow to assess the material properties with the required degree of accuracy, the Register may require any tests to be repeated in the presence of its representative;

.6 the manufactured product or the semi-finished product with the properties which deviate from the requirements of this Section, but not essential for the operation of the structure or product, may be used in accordance with their purpose only after the RS special consideration of the deviations and in case a relevant application from the manufacturer and agreement of the customer are available.

2.2.1.6 The rolled product characteristics shall meet the requirements specified in 4.5, Part I "Subsea Pipelines" of the SP Rules, the RS-approved technical documentation for supply of the rolled products and/or national or international standards agreed upon with the Register.

2.2.2 Technical supervision for recognition of the rolled products manufacturer.

2.2.2.1 The RS technical supervision for recognition of the rolled products manufacturer is performed on the basis of an application/contract in compliance with the requirements of 4.2, Part I "Subsea Pipelines" of the SP Rules, Section 2, Part III "Technical Supervision during Manufacture of Materials" of the Rules for the Technical Supervision during Construction of Ships and provisions of the SP Guidelines.

2.2.2.2 The procedure for recognition of the rolled products manufacturer shall meet the general requirements specified in 1.7.

2.2.2.3 In order to be recognized by the Register, a survey shall include:

review and approval of the technical documentation confirming the compliance of the manufacturer with the RS requirements;

review of the technical documentation for the products manufactured (specifications, etc.) that defines the material properties and conditions of production, where necessary, including standards based on which the products are manufactured;

review of the check test program for recognition of the manufacturer including standard size of the batch and location of test specimens;

survey of manufacture and the firm's (manufacturer's) quality control system;

survey of control tests performance;

issue of the survey results (Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1) or preparation of the conclusion that the above RS documents cannot be issued (where the survey results are unsatisfactory).

In addition to the RS technical specifications/standards according to which the products are manufactured, strength categories, standard sizes and heat treatment methods covered by the RS recognition, the Recognition Certificate for Manufacturer shall include the following:

minimum operating temperature of steel product;

operational reliability levels of the pipeline according to 2.1.7.1 (class of pipeline) for which the steel product can be applied.

2.2.2.4 In the course of carrying out the above arrangements, the conformity of production and product parameters to the approved documentation and the RS rules as well as the proper level of product quality stability shall be confirmed.

2.2.2.5 For recognition of the rolled products manufacturer, the control test program and methods for sampling shall comply with the requirements specified in 4.2, Part I "Subsea Pipelines" of the SP Rules and provisions of the SP Guidelines. In such case, the standard sizes and number of test batches for control tests according to the stated area of the manufacturer's recognition shall be agreed upon with the Register.

In cases of small production output, the control tests are allowed to be conducted for the first production batches upon agreement with the Register.

2.2.2.6 The control tests for manufactured steel plates and pipe billets (skelp) shall be performed on 2 batches. The batch shall consist of 3 plates of one grade, steel cast and similar thickness. Plates submitted for testing shall be selected one after another in the course of rolling.

When the plates of various thickness and dimensions are manufactured according to the uniform technology (including heat treatment modes), it is permitted to perform the tests of rolled product with the maximum (first batch) and the minimum (second batch) thickness upon agreement with the Register. In this case, statistical data (chemical composition, mechanical properties) shall be submitted additionally to confirm the quality stability of the rolled product delivered. The scope of sampling shall be established as agreed upon with the Register.

The scope of check tests for recognition of the rolled products manufacturer with regard to accepted reliability level and type of transported medium according to 2.1.7.1 (refer to Table 2.2.2.6).

Table 2.2.2.6

Scope of tests for recognition of the rolled products manufacturer

Type of tests[1]	Position of samples and specimens cutting-out	Quantity			Notes
		casts/plates/ cast samples	specimens of a plate	Total number of specimens	
Chemical analysis (4.3.4)	From one end	2/3/3	1	6	Complete metal analysis, including microalloying and ladle sample
Tensile tests (4.3.2)	From both ends, transverse	2/3/3	2	12	To be determined: R_{eH}, R_m, A_5, Z
Compression tests after pretension (4.3.2)	From one end, transverse	2/3/3	2	12	To be determined: R_{eH} under compression
Impact tests to establish transition curve (4.3.3)	From both ends, transverse	2/3/3	18	108[2]	Test temperature: 0, −20, −40, −60, −80 °C depending on operating temperature
Impact tests on strain aged specimens (4.3.3.6)	From one end (upwards) transverse, 1/4 of the width	2/3/3	9	54[2]	Test temperature: 0, −20, −40, −60, −80 °C depending on operating temperature
Sulphur segregation (4.3.4)	From one end	2/3/3	1	6	—
Metallography and hardness (4.3.5)	From one end	2/3/3	1	6	—
Corrosion test[3] (4.3.9.5)	From one end	2/3/1	6	12	—
Drop-weight tear test (DWTT)[4] (4.3.9.2, Section 1, Appendix 4)	From one end, transverse	2/3/1	10	20	Test to determine critical temperature
Tests to determine the value of ductile brittle transition temperature T_{kb}[5] (4.3.9.6)	From one end, transverse	2/3/3	10	60	Test to determine critical temperature
Test to determine nil-ductility temperature (NDT)[5] (4.3.9.7)	From one end, transverse	2/3/3	8	48	Test to determine critical temperature
CTOD test (crack tip opening displacement)[6] (4.3.9.3, Section 2, Appendix 4)	From one end, transverse	2/3/1	9	18[2]	Test temperature: 0, −20, −40, −60, −80 °C depending on operating temperature
Ultrasonic testing (4.3.8)	Throughout the length	2/3/3	the whole plate	—	—
Weldability test (5.1, 5.2)			—	—	According to the RS-approved test procedure

[1]According to paras of Part I "Subsea Pipelines" of the SP Rules.
[2]Here the number of specimens is determined based on testing at three temperature values specified in the test program approved by the Register.
[3]For pipes designed of class **L2** and **G2** pipelines.
[4]Except pipes of class **L** — **L2** pipelines.
[5]Except pipes of class **L** — **L2**, **G** pipelines.
[6]Except pipes of class **L** and **G** pipelines.

2.2.2.7 The weldability test program is aimed at manufacturer's recognition based on the requirements specified in 5.2, Part I "Subsea Pipelines" of the SP Rules and submitted as an appendix to the General check test program.

2.2.2.8 Types and number of tests may be modified by the Register based on preliminary information submitted by the manufacturer. In particular, the indicated number of casts, semi-finished products and steel grades to be tested may be reduced or, at the RS discretion, the tests may be omitted at all. The decision shall be taken based on the following provisions:

.1 the manufacturer has already been recognized by ACS, and the documentation is available confirming the completion of the appropriate tests and their results;

.2 for rolled products/pipes grades, applied for recognition by the Register, some statistical data are available confirming the stability of chemical analysis results as well as physical and mechanical properties;

.3 the production technology, condition of supply, inspection and test procedure as compared to those specified in 2.2.2.8.1 are not changed;

.4 recognition of rolled products/pipe manufacture from steel of one strength level may be extended to rolled products/pipes manufactured from steel of a lower strength level, provided that the latter is manufactured using the same procedure, including deoxidation and grain-refinement, as well as the casting method and condition of supply, thickness of rolled products/diameter and wall thickness of the pipe, inspection and test procedures;

.5 changes in condition of the manufacturer recognition by the Register as compared to the application;

.6 recognition of manufacture of rolled products/pipes, semi-finished products, such as slabs, blooms and billets by the Register or ACS is available.

2.2.3 Technical supervision during manufacture of rolled products.

2.2.3.1 Technical supervision during manufacture of rolled products is generally performed by the Register at its recognized firms. Otherwise, the requirements specified in 2.2.1.3 shall be taken into account.

2.2.3.2 The RS technical supervision during manufacture of rolled products is performed on the basis of an application/contract with the manufacturer in compliance with the requirements specified in 4.2, Part I "Subsea Pipelines" of the SP Rules and Section 2, Part III "Technical Supervision during Manufacture of Materials" of the Rules for the Technical Supervision during Construction of Ships and provisions of the SP Guidelines.

2.2.3.3 Technical supervision during manufacture is performed on the basis of the RS-approved technical documentation (technical conditions, specifications, inspection and test plans, etc.), national/ international standards agreed upon with the Register and includes the following:

tests and examinations witnessed by the RS representative;

issuing of the RS documents according to the test and examination results.

2.2.3.4 The scope of tests during rolled products manufacture and the sampling methods shall meet the requirements of Table 2.2.3.4. Testing of rolled product batch shall be carried out on the samples taken from one plate of the batch. The batch shall consist of plates with similar cast, delivery condition and size. Unless otherwise specified in the RS-approved technical documentation, the batch weight shall not exceed 50 t.

2.2.3.5 The test results shall be documented in the drawn up report with the data specified in 2.2.1.4.

2.2.3.6 Where the test results are unsatisfactory, retesting shall be conducted with the conditions specified in 2.2.1.5 being observed.

2.2.3.7 Each batch of tested rolled products/pipes shall be accompanied by the RS Certificate or the manufacturer's document certified by the RS representative. The RS certificate, as a minimum, shall contain the following:

order number;

building project number, if known;

name, number, dimensions and mass of skelp/pipes;

grade (mark) of steel with indication of minimum operating temperature;

batch number or identification number which allows to identify the material supplied.

Table 2.2.3.4

Scope of tests for rolled products approval

Type of tests[1]	Position of samples and specimens cutting-out	Quantity			Notes
		casts/plates/ cast samples	specimens of a plate	total number of specimens	
Chemical analysis (4.3.4)	From one end	1/50 t/1	1	1	Complete metal analysis, including microalloying and ladle sample
Tensile tests (4.3.2)	From one end, transverse	1/50 t/1	2	2	To be determined: R_{eH}, R_m, A_5
Bending impact tests (4.3.3)	From one end, transverse	1/50 t/1	3	3	Tests at temperature corresponding to minimum operating temperature[2]
Test to determine the fracture type according to Drop-weight tear test (DWTT)[3] (4.3.9.2, Section 1, Appendix 4)	From one end, transverse	1/50 t/1	2	2	Tests at temperature corresponding to minimum operating temperature
Ultrasonic testing (4.3.8)		Each product			

[1]According to paras of Part I "Subsea Pipelines" of the SP Rules.
[2]Test temperature is assigned according to 4.3.3.6, Part I "Subsea Pipelines" of the SP Rules. When the data of the minimum operating temperature is missing, tests shall be carried out at temperature equal to −40 °C.
[3]Except pipes for **L** to **L2** pipelines, as well as for any pipes with the diameter less than 500 mm.

2.2.3.8 The Manufacturer Quality Certificates attested by the authorized representative of the manufacturer shall be the obligatory supplement to the RS Certificate. The Certificate shall contain the results of chemical analysis, mechanical tests and, if required, ultrasonic testing of the rolled products/ pipe. The form and contents of the Manufacturer Quality Certificate shall be agreed with the customer and the Register.

2.2.3.9 Each plate of rolled product/pipe shall have clearly visible manufacturer's marking and the RS brand marked by the specified method and in specified location.

The marking, as a minimum, shall include:

name and/or designation of the manufacturer;

steel grade according to the requirements specified in 4.5, Part I "Subsea Pipelines" of the SP Rules;

batch number, cast number or identification number according to the firm's (manufacturer's) system which allows tracing the whole production process.

Where due to some reasons, the application of the RS brand impression by impact method is impeded, the RS stamp imprint may be applied with indelible paint according to Appendix 2, Part I "General Provisions for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships or any other method as agreed upon with the manufacturer.

2.2.3.10 During rolled products manufacture according to 1.3.11, the RS technical supervision is recommended to be carried out on the basis of inspection and test plan given in Table 2.2.3.10 as agreed upon with the customer. For each test supervised by the RS surveyor (during the RS survey), the inspection and test plan shall contain reference to the RS-approved technical documents including detailed design documentation, technical conditions, specifications, standards, etc. In all other respects, Inspection and Test Plans shall comply with the requirements specified in 1.3.12.

Table 2.2.3.10

Inspection and Test Plan for rolled product manufacture

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
1. Steel melting and casting				
1.1 Liquid steel degassing	Chemical composition	Each cast	R	
1.2 Continuous casting	Chemical composition	Each cast	R	
2. Rolling				
2.1 Slab rolling	Rolling temperature	Each rolled stock	R	
2.2 Accelerated cooling of rolled pieces	End point cooling temperature	Each rolled stock	R	
2.3 Stack cooling	Time, start and end point of cooling	Each rolled stock	R	
2.4 Surface quality of rolled stocks	Surface defects	Each rolled stock	M	
2.5 Ultrasonic testing of plate body and edges	Internal defects	Each rolled stock	R	
2.6 Ultrasonic testing calibration	—	Each rolled stock	M	
2.7 Plate marking	Marking quality	Each plate	M	
2.8 Sampling for mechanical tests	Proper sampling	One plate from the batch	W	According to 2.2.3.4
2.9 Testing of specimens	Mechanical properties	One plate from the batch	W	According to 2.2.3.4
2.10 Acceptance of rolled products	Dimensions, marking, mechanical properties	Each batch	R	
2.11 Issue of Manufacturer's Certificate		Each batch	R	According to 2.2.3.8
2.12 Issue of the RS Certificate/endorsement of the Manufacturer's Certificate		Each batch	H	

[1]For description of test types, refer to Table 1.3.11.

2.3 STEEL FORGINGS AND CASTINGS FOR SUBSEA PIPELINES

2.3.1 The requirements for steel forgings and castings for subsea pipelines are subject to special consideration by the Register in each case. The documentation submitted to the Register for approval shall contain information related to the following:

chemical composition;

mechanical and specific properties;

heat treatment;

non-destructive testing methods and assessment criteria for detected defects;

scope and methods of tests with indication of temperature at which they have been carried out including location of test specimens.

2.3.2 Forged billets and castings for manufacture of flanges and valves for subsea pipelines shall meet the requirements specified in 4.7, 4.8, Part I "Subsea Pipelines" of the SP Rules and 2.11.5 of the SP Guidelines.

2.4 STEEL PIPES FOR SUBSEA PIPELINES

2.4.1 General.

2.4.1.1 Steel pipes for subsea pipelines constructed (subject to repair or modernization) under the RS technical supervision shall meet the requirements of Section 4, Part I "Subsea Pipelines" of the SP Rules and take into account the required SP reliability level (refer to 2.1.7.1).

2.4.1.2 SP steel pipes shall be produced by the manufacturers with the Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1) issued by the Register and under the RS technical supervision.

2.4.1.3 In some cases, by agreement with the Register, SP pipes may be produced by the manufacturer without the RS recognition provided that additional tests during manufacture in a scope required for manufacturer's recognition shall be carried out (refer to 4.2.3.5.1 and 4.2.3.5.3, Part I "Subsea Pipelines" of the SP Rules).

2.4.1.4 Welding techniques specified in Section 5, Part I "Subsea Pipelines" of the SP Rules shall be used for welded pipes manufacture. Welding procedures and welding consumables used during pipe manufacture shall be approved by the Register during survey of the manufacturer for its recognition.

2.4.1.5 Where rolled products and/or billets are delivered to a tube-rolling mill from other firms, the manufacturers of those semi-finished products for pipe manufacturing shall be recognized by the Register.

2.4.1.6 Test results for pipes subject to the RS survey shall be documented in the drawn up report with the data specified in 2.2.1.4.

2.4.1.7 Where the test results are unsatisfactory, retesting shall be conducted with the conditions specified in 2.2.1.5 being observed.

2.4.1.8 The pipe characteristics shall meet the requirements specified in 4.5, Part I "Subsea Pipelines" of the SP Rules, the RS-approved technical documentation for the rolled products supply and/or national or international standards agreed upon with the Register.

2.4.2 Technical supervision for recognition of pipe manufacturer.

2.4.2.1 The technical supervision procedure for recognition of pipe manufacturer shall meet the general requirements specified in 2.2.2.1 to 2.2.2.5.

2.4.2.2 Generally, samples for making specimens for seamless pipes testing shall be cut directly from the pipe, and those for testing of welded pipes — from the pipe body and welded joint.

2.4.2.3 Check tests of SP pipe manufactures shall be performed for each production process and pipe size on two batches of 10 pipes.

The batch shall consist of pipes of the same grade, cast and heat treatment mode, diameter and wall thickness.

Where possible, the test pipe batch shall be manufactured for testing with the maximum ratio of the pipe wall to the diameter and in the course of testing the pipes with the maximum values of the ratio of yield point to ultimate strength (according to the tensile test results) shall be selected for mechanical tests from the test batch.

For the scope of tests for recognition of SP pipe manufacturer, refer to Table 2.4.2.3.

2.4.2.4 The weldability test program shall be compiled for the recognition of manufacturer of welded and seamless pipes based on the requirements specified in 5.2, Part I "Subsea Pipelines" of the SP Rules and submitted as a supplement to the general check test program.

2.4.2.5 The types and the number of pipe tests for recognition of the manufacturer may be modified by the Register on the basis of the manufacturer submitted preliminary information in accordance with 2.2.2.8.

Table 2.4.2.3

Scope of tests for recognition of SP pipe manufacturer

Type of tests[1]	Position of samples and specimens cutting-out	Quantity			Notes
		casts/pipes/ cast samples	specimens of a pipe	Total number of specimens	
Chemical analysis (4.3.4)	From one end	2/10/1	1	2	Complete metal analysis, including microalloying and ladle sample
Tensile tests (4.3.2)	From both ends, lengthwise and transverse	2/10/10	4	80	To be determined: R_{eH}, R_m, A_5, Z
Compression tests (4.3.2)	From one end, transverse	2/10/1	2	4	To be determined: R_{eH} under compression
Bend tests of base metal and weld (4.3.9.4, 5.2.2.3.2 and Section 3, Appendix 4)	From both ends, transverse	2/10/2	5	20	Bending angle has to be determined at normal bend from both sides and additionally for weld at side bend
Impact tests to establish transition curve (4.3.3)	From one end, transverse	2/10/3	9	54[2]	Test temperature: 0, −20, −40, −60, −80 ºC depending on operating temperature
Impact bending test of factory welded joint (4.3.3, 5.2.2.3.3)	From both ends, transverse	2/10/1	72	144[2]	Test temperature: 0, −20, −40, −60, −80 ºC depending on operating temperature
Sulphur segregation (4.3.4)	From one end	2/10/2	1	4	—
Metallography and hardness (4.3.5)	From one end	2/10/2	1	4	—
Corrosion test[3] (4.3.9.5)	From one end	2/10/2	6	24	—
Drop-weight tear test (DWTT)[4] (4.3.9.2, Section 1, Appendix 4)	From one end, transverse	2/10/1	10	20	Test to determine critical temperature
Test to determine nil-ductility temperature (NDT)[5] (4.3.9.7)	From one end, lengthwise	2/10/2	8	32	Test to determine critical temperature
CTOD test (crack tip opening displacement)[6] (4.3.9.3, Section 2, Appendix 4)	From one end, transverse	2/10/1	9	18[2]	Test temperature: 0, −20, −40, −60, −80 ºC depending on operating temperature
Non-destructive testing (4.3.8)	Throughout the length and edges	2/10/10	the whole pipe	—	—
Hydraulic pressure test (4.3.7)	—	2/10/10	the whole pipe	—	—
Weldability test (5.1, 5.2)	—	—	—	—	According to RS-approved test procedure

[1]According to paras of Part I "Subsea Pipelines" of the SP Rules.
[2]Here the number of specimens is determined based on testing at three temperature values specified in the test program approved by the Register.
[3]For pipes designed of class **L2** and **G2** pipelines.
[4]Except pipes of **L** — **L2** pipelines as well as for any pipes less than 500 mm in diameter.
[5]Except pipes of **L** — **L2**, **G** pipelines.
[6]Except pipes of **L** and **G** pipelines.

2.4.3 Technical supervision during manufacture of pipes.

2.4.3.1 The RS technical supervision during pipe manufacture shall meet the requirements specified in 2.2.3.1 to 2.2.3.4.

2.4.3.2 The scope of tests during manufacture of pipes and the sampling methods shall meet the requirements provided in Table 2.4.3.2. In general, one pipe from a batch of 50 pipes shall be selected for testing.

Table 2.4.3.2

Scope of tests for steel pipes approval

Type of tests[1]	Position of samples and specimens cutting-out	Quantity			Notes
		casts/pipes/ cast samples	specimens of a pipe	Total number of specimens	
Chemical analysis (4.3.4)	From one end	1/50/1	1	1	Complete metal analysis, including microalloying and ladle sample
Tensile tests of base metal (4.3.2)	From one end, transverse	1/50/1	2	2	To be determined: R_{eH}, R_m, A_5
Tensile tests of welding joint (4.3.2)	From one end, transverse	1/50/1	2	2	R_m shall be determined
Bending impact test of base metal (4.3.3)	From one end, transverse	1/50/1	3	3	Tests at temperature corresponding to minimum operating temperature[2]
Bending impact test of welding joint (4.3.3, 5.2.2.3.3)	From one end, transverse	1/50/1	12	12	Tests at temperature corresponding to minimum operating temperature[2]
Determination of fracture type according to Drop-weight tear test (DWTT)[3] (4.3.9.2 and Section 1, Appendix 4)	From one end, transverse	1/50/1	2	2	Tests at temperature corresponding to minimum operating temperature
Bend test for welding joint (5.2.2.3.2 and Section 3, Appendix 4)	From one end, transverse	1/50/1	3	3	Normal from both sides and side bend testing
Metallography and vickers hardness (4.3.5)	From one end, transverse	1/50/1	3	3	For one section: base metal, weld and HAZ
Non-destructive testing (4.3.8)	Throughout the length and edges	1/50/50	the whole pipe	—	—
Hydraulic pressure test (4.3.7)	—	1/50/50	the whole pipe	—	—
Remanent magnetization (4.3.10)	At both ends	1/50/1	4	4	Not more than 2 mT (20 G)

[1]According to paras of Part I "Subsea Pipelines" of the SP Rules.
[2]Test temperature shall be assigned according to 4.3.3.6, Part I "Subsea Pipelines" of the SP Rules. When the data of the minimum operating temperature is missing, tests shall be carried out at temperature equal to − 40 °C.
[3]Except pipes for **L** to **L2** pipelines as well as for any pipes less than 500 mm in diameter.

The batch shall consist of pipes of the same cast, steel grade, heat treatment mode, diameter and wall thickness.

2.4.3.3 For pipes intended for subsea pipelines with the minimum operating temperature of –20 °C and below, RS may require bending impact tests to be carried out on each fifth pipe.

2.4.3.4 The test results shall be documented in the drawn up report with the data specified in 2.2.1.4.

2.4.3.5 Where the test results are unsatisfactory, retesting shall be conducted with the conditions specified in 2.2.1.5 being observed.

2.4.3.6 Data specified in the RS Certificate for pipes and marking of the RS-approved steel pipes shall comply with the requirements specified in 2.2.3.7 to 2.2.3.9.

2.4.3.7 All pipes shall be subjected to hydraulic pressure tests. The recommended internal test pressure p_t, in MPa, shall be obtained from the formula

$$p_t = \frac{2 \cdot R_e \cdot t_{\min}}{D_0 - t_{\min}} \cdot 0{,}95 \qquad (2.4.3.7)$$

where R_e = minimum yield stress of a pipe metal, in MPa;
$t_{\min}$ = minimum (considering a negative tolerance) thickness of a pipe wall, in mm;
D_0 = nominal external diameter of a pipe, in mm.

The pipe shall withstand the test pressure during at least 10 s without leakages or residual distortions. The manufacturer's test bench for hydraulic testing shall be provided with devices for recording the

pressure and the time of test performance. The test results shall be documented in reports with one copy handed over to the Register.

2.4.3.8 The non-destructive testing of pipes shall be performed in compliance with the requirements specified in 4.3.8, Part I "Subsea Pipelines" of the SP Rules.

2.4.3.9 During manufacture of welded pipes according to 1.3.11, the RS technical supervision is recommended to be carried out on the basis of the Inspection and Test Plan specified in Table 2.4.3.9 as agreed upon with the customer.

Table 2.4.3.9

Inspection and Test plan for welded pipe manufacture

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Notes
1 Incoming inspection				
1.1 Plate stacking	By steel grade, width and thickness	All plates	M	
1.2 Incoming inspection of plates	Certificate data and selection by the range	Each batch	R	
1.3 Incoming inspection of welding wire	Checking for compliance with normative and technical documentation, marking, packaging	Each batch	M	
1.4 Incoming inspection of flux	Checking for compliance with normative and technical documentation, marking, packaging	Each batch	M	
2 Pipe moulding				
2.1 Plate pass	Identification and parameters of plates	Each plate	R	
2.2 Edge milling	Plate dimensions, bevelling	2 times per shift	M	
2.3 Forming of pipe billet	Gap between edges, deflection of edges, width of flat areas	Each billet	M	
2.4 Post-bending of edges	Edge radius, diameter deviation at pipe ends	2 times per shift	M	
3 Welding				
3.1 Tack welding, run-off plate welding	Parameters of welding and weld	Each pipe	M	
3.2 Welding of internal weld	Parameters of welding and weld	Each pipe	M	
3.3 Welding of outside weld	Parameters of welding and weld	Each pipe	M	
3.4 Preliminary acceptance of pipes	Visual examination and measurement of weld and base metal, geometric parameters of pipes	Each pipe	M	
3.5 Weld repairs	Parameters of welding and weld	Each pipe repaired	W	
3.6 Automated and manual ultrasonic testing including calibration	Defects of welds and HAZ	Each pipe	W	Calibration every 4 h
3.7 Radiography	Defects of welds and HAZ based on automated ultrasonic testing (AUT) marks	Each pipe	M	
4 Expansion of pipes	Out-of-roundness, expansion coefficient	Each fifth pipe	M	
5 Treatment of pipe ends	Bevelling, cutting obliquity	Each tenth pipe	M	
6 Hydrostatic tests	Test pressure value, holding time	Each pipe	M	According to 2.4.3.7
7 Acceptance of pipes				
7.1 Magnetic particle examination of the weld, pipe edges	Defects of weld and edge zones	Each pipe	M	
7.2 Automated and manual ultrasonic testing including calibration	Defects of welds, HAZ and base metal of pipe ends	Each pipe	W	Calibration every 4 h
7.3 Radiography	Defects of welds, HAZ and pipe ends based on automated ultrasonic testing (AUT) marks	Each defective and repaired pipe	M	
7.4 Sampling for mechanical tests	Proper sampling	One pipe from the batch	W	According to 2.4.3.2
7.5 Mechanical tests of specimens	Mechanical properties of weld metal and base metal	One pipe from the batch	W	According to 2.4.3.2
7.6 Pipe weighing	Pipe weight	Each pipe	R	
8 Final acceptance of pipes				
8.1 Visual examination and measurement	Weld, external and internal surface of base metal, geometrical parameters of pipe	Each pipe or each twentieth pipe	M	According to Table 4.5.5.3-2, Part I of the SP Rules
8.2 Remanent magnetization test	Magnetization	Each tenth pipe	M	
8.3 Pipe marking		Each pipe	R	
8.4 Issue of Manufacturer's Certificate		Each batch	R	
8.5 Issue of the RS Certificate/endorsement of the Manufacturer's Certificate		Each batch	H	

[1]For description of type of tests, refer to Table 1.3.11.

For each test witnessed by the RS surveyor (during the RS survey), the Inspection and Test Plan shall contain reference to the RS-approved technical documents including detailed design documentation, specifications, standards, etc. In all other respects, Inspection and Test Plans shall comply with the requirements specified in 1.3.12.

2.4.3.10 During manufacture of seamless pipes according to 1.3.11, the RS technical supervision is recommended to be carried out on the basis of the inspection and Test Plan specified in Table 2.4.3.10 as agreed upon with the customer.

For each test witnessed by the RS surveyor (during the RS survey), the Inspection and Test Plan shall contain reference to the RS-approved technical documents including detailed design documentation, specifications, standards, etc. In all other respects, Inspection and Test Plans shall comply with the requirements specified in 1.3.12.

Table 2.4.3.10

Inspection and test plan for seamless pipe manufacture

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Notes
1 Steel melting and casting				
1.1 Continuous casting	Chemical composition	Each cast	R	
2 Rolling				
2.1 Preliminary inspection after rolling	External and internal surface, geometrical parameters of pipes	Each pipe	M	
2.2 Marking		Each pipe	R	
3 Heat treatment				
3.1 Pipe heating in quenching furnace	Heating temperature, cycle time	Each pipe	M	
3.2 Pipe quenching	Water temperature, water flow rate	2 times per shift	M	
3.3 Pipe heating in tempering furnace	Heating temperature, cycle time	Each pipe	M	
4 Sampling for mechanical tests and chemical analysis	Proper sampling	One pipe from the batch		According to 2.4.3.2
5 Mechanical tests of specimens and chemical analysis	Mechanical properties and chemical composition of the pipe metal	One pipe from the batch	W	According to 2.4.3.2
6 Acceptance of pipes				
6.1 Visual examination and measurement	External and internal surface, geometrical parameters of pipe	Each pipe or each twentieth pipe	M	According to Table 4.5.5.3-2, Part I of the SP Rules
6.2 Repair of defective areas		Each defective pipe	W	
6.3 Treatment of pipe ends	Bevelling, cutting obliquity	Each tenth pipe	M	
6.4 Hydrostatic tests	Test pressure value, holding time	Each pipe	M	According to 2.4.3.7
6.5 Magnetic particle examination of pipe edges	Defects in edge zones	Each pipe	M	
6.6 Ultrasonic testing of pipe ends	Availability of delaminations	Each pipe	M	
6.7 Automated ultrasonic testing of pipe body including calibration	Surface defects, delaminations, wall thickness	Each pipe	W	Calibration every 4 h
6.8 Remanent magnetization test	Magnetization	Each tenth pipe	M	
6.9 Weighing and checking of pipe length	Length and weight of a pipe	Each pipe	M	
6.10 Marking		Each pipe	R	
6.11 Issue of Manufacturer's Certificate		Each batch	R	
6.12 Issue of the RS Certificate/endorsement of the Manufacturer's Certificate		Each batch	H	

[1]For description of type of tests, refer to Table 1.3.11.

2.5 VALVES

2.5.1 SP valves shall be manufactured according to the international (for example, ISO 14723) and/or national standards and the RS-approved documentation at the firms with the Register Type Approval Certificate (CTO) (form 6.8.3) for the manufactured type of products, issued by RS with regard to the requirements of 2.6.1.3, 2.6.1.5 to 2.6.1.7.

2.5.2 The materials for bodies of SP valves shall meet the requirements imposed to materials for pipes of the same diameters by the SP Rules considering the assigned SP reliability level (refer to 2.1.7.1) including the operation with aggressive media. The SP valves shall be of full-opening design.

2.5.3 The materials of fasteners of valve flange connections (bolts/studs, nuts, gaskets) as well as flange structures themselves shall comply with the requirements specified in 4.7, Part I "Subsea Pipelines" of the SP Rules.

2.5.4 Stamping, casting and/or welding may be used for valve bodies and parts manufacture. In case of welding, the appropriate process procedure complying with the RS requirements shall be developed and submitted for approval.

2.5.5 Generally the scope and procedure of surveys during technical supervision of SP valves manufacturing shall comply with the similar procedures for the valves of class I pipelines in accordance with 8.1 and 8.2, Part IV "Technical Supervision during Manufacture of Products" of the Rules for Technical Supervision during Construction of Ships. The provisions of 4.7.2.3 and 4.8.2.2, Part I "Subsea Pipelines" of the SP Rules shall be taken into account.

2.5.6 Technical supervision during manufacture of SP valves shall provide for checking and testing in compliance with 8.2.1, Part IV "Technical Supervision during Manufacture of Products" of the Rules for Technical Supervision during Construction of Ships. Control, safety and measuring valves as well as self-acting valves shall be checked in operation to confirm their conformity to the RS-approved technical documentation requirements.

2.5.7 When checking remotely operated valves, it is necessary to make sure that locking devices are capable of taking up position specified in technical documentation in case of automatic remote control system failure as well as that the "open" and "close" position indicators are properly positioned.

2.5.8 During technical supervision of the pilot and prototype specimens of the valves, provision shall be made for the supplementary check of their continuous operation under vibration, at limiting temperature and pressure as well as operation under other special conditions which depend on their purpose (during corrosive media transportation, etc.).

2.5.9 Where necessary, the specification for SP valves shall include the requirements for carrying out the special tests of products and their welded joints in corrosive media in accordance with 4.3.9.5, Part I "Subsea Pipelines" of the SP Rules.

2.5.10 According to 1.6, the SP valves shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be completed and signed by manufacturer's official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.6 FLEXIBLE PIPES

2.6.1 General.

2.6.1.1 Flexible pipes for SP manufactured/subject to repair or modernization under the RS technical supervision shall meet the requirements specified in 3.8, 4.2.4 and 4.6, Part I "Subsea Pipelines" of the SP Rules.

2.6.1.2 Flexible pipes shall be manufactured according to the RS-approved documentation at firms (manufacturers) with the Type Approval Certificate (CTO) (form 6.8.3) for the manufactured type of products, issued by the Register. To obtain the Type Approval Certificate (CTO), the firm (manufacturer) shall submit a request to the Register.

2.6.1.3 To issue the Type Approval Certificate (CTO) for the manufacturer, the procedure for technical supervision during manufacture of SP flexible pipes shall include:

review and analysis of manufacturer's application with attachments thereto;

review of technical documentation;

survey of the manufacturer including the quality system assessment and check tests (type tests);

issue of the Type Approval Certificate (CTO) (form 6.8.3).

2.6.1.4 The firm's (manufacturer's) application shall be supplemented by the documents specified in 6.1.3.2.2, Part XIII "Materials" of the RS Rules.

2.6.1.5 In case of positive results of review of the above documentation, the survey of the manufacturer is conducted including the following:

establishing the actual condition of the organization and quality control processes including products manufacture;

carrying out check (type) tests according to the RS-approved program.

2.6.1.6 Where the survey results are satisfactory, check and type tests, the Type Approval Certificate for products is issued to the firm (manufacturer). The basic requirements for issuing the Type Approval Certificate (CTO) shall comply with 1.8.

2.6.1.7 Where the manufacturer has the quality assurance system in compliance with ISO 9001 confirmed by a certificate, and during the survey it is confirmed that the system of testing and control ensuring the required level of manufactured products quality is actually in operation, the Type Approval Certificate (CTO) may be issued on the basis of satisfactory results of technical documentation review and check tests of products.

The Register may consider the results of type approval tests carried out at the firm's (manufacturer's) under supervision of the RS surveyor and/or Register recognized (or RS-recognized classification/ supervisory body) testing laboratory provided that the deliveries of accessories/products are identical, process procedures and structural design remain unchanged.

2.6.1.8 According to 1.6, FPMP for subsea pipelines shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by firm’s (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.6.1.9 Each pipe shall have marking which contains an identification number, the values of specification working pressure and temperature (if the pipe is used at temperatures other than an ambient temperature), the value of the minimum radius in storage.

2.6.2 Requirements for flexible pipe materials.

2.6.2.1 The nomenclature of the Register controlled characteristics of polymeric and metal materials used during manufacture of flexible pipes shall comply with the requirements specified in 4.6, Part I "Subsea Pipelines" of the SP Rules.

2.6.3 Testing of polymeric materials of flexible pipes.

2.6.3.1 The quality of polymeric materials used at the firm (manufacturer) for flexible pipes manufacture shall be confirmed by testing in a scope as agreed upon with the Register.

2.6.3.2 The test specimens used for determining mechanical, physical and other properties of polymers, which are used in the flexible pipe structure, shall be cut out from the materials produced in compliance with industrial operating practices. If the polymer contains a plasticizer, tests shall be performed to determine the properties of both the plasticized and deplasticized materials.

2.6.3.3 Polymeric materials shall be tested in accordance with the requirements of the standards recognized by the Register as allowed for use. The nomenclature of tests and the standards recommended for testing the polymeric materials for flexible pipes are specified in Table 2.6.3.3.

Table 2.6.3.3

Tests and recommended standards for testing polymer materials

Tests and trials	GOST	Foreign standards
Tensile strength, limiting elongation	GOST 11262	ISO 527-1, ISO 527-2
Compression strength	GOST 4651	ISO 604
Shear strength	GOST 17302	—
Flexural properties	GOST 4648	ISO 178
Modulus of elasticity	GOST 9550	ISO 527-1, ISO 527-2
Impact strength	GOST 4647	ISO 179
Hardness	GOST 4670	ISO 868, ISO 2039-1
Abrasion resistance	GOST 11012	ISO 9352
Density	GOST 15139	ISO 1183
Linear thermal expansion coefficient and softening point	GOST 15088, GOST 15173	ISO 11359-2, ISO 306
Water absorption	GOST 4650	ISO 62
Coefficient of thermal conductivity and heat capacity	GOST 23630.2, GOST 23630.1	ASTM C 177, ISO 11357-4
Ageing	GOST 9.708	ISO 9142
Resistance to creep	GOST 18197	ISO 899-1
Resistance to chemical substances	GOST 12020	ISO 15314

2.6.3.4 Tests to determine resistance to rapid decompression (blistering) shall be conducted observing the following conditions:

fluid mixtures — according to design requirements;

soak time in fluid mixtures — to ensure complete saturation;

test cycles of decompression — according to design requirements but not less than 20 cycles;

decompression rate — use the expected decompression rate, if possible otherwise at least 7 MPa/min;

specimen thickness — not less than internal pressure sheath wall thickness;

test temperature — an assumed operational temperature of the flexible SP;

test pressure — not less than operating pressure in the flexible subsea pipeline;

survey procedure — after each depressurization the specimen shall be examined at a magnification of 20 for signs of blistering, swelling and slitting cracking;

acceptance criterion — no blisters, swelling and slitting cracking.

2.6.3.5 Tests for determining the durability of polymeric materials used for flexible pipes shall be conducted according to the special program developed by the manufacturer and approved by the Register. The program is based on the experiment-based model for prediction of polymer durability which takes into account the effect of the environment and loading conditions. The hypothesis of the linear damage accumulation may be used. Special emphasis shall be placed on the polymer deplasticization and water absorption as well as on the change of the specimens geometry. The effect of creep, relaxation and strain cycling shall be studied in aged and non-aged specimens.

2.6.3.6 Tests of polymeric material to determine the residual compressive strengths, a coefficient of thermal expansion, gas-/watertightness, notch sensitivity, the range of working temperatures are conducted according to the procedures to be developed by the manufacturer and approved by the Register.

2.6.4 Testing of metal materials of flexible pipes.

2.6.4.1 The metal tests for the armouring layers of flexible pipes (carcass, radial and axial armour layer) and end fittings, unless otherwise specified, shall be conducted in accordance with the requirements of Section 2, Part XIII "Materials" of the RS Rules.

2.6.4.2 The mechanical tests of materials for armouring layers and end fittings shall follow heat treatment, rolling-off and final moulding, and shall meet the requirements of national or international standards and/or the RS-approved documentation. The specimens for the mechanical tests of sectional strips are selected parallel to the bar axis, unless otherwise specified.

2.6.4.3 Depending on the type of flexible pipe components and the type of tests, metal materials are sampled in compliance with the requirements specified in 3.2.5, 3.7.5, 3.8.5 and 3.13.5, Part XIII "Materials" of the RS Rules.

2.6.4.4 Tensile, impact (for end fittings) and hardness tests shall be conducted in compliance with the requirements specified in 2.2, Part XIII "Materials" of the RS Rules or according to the RS-approved procedures.

2.6.4.5 Where the end fitting components are made of the metal of the same batch and heat treatment mode, to determine mechanical properties, it is sufficient to test one series of specimens cut out from the items of the largest dimensions extending the obtained results to the whole batch.

2.6.4.6 Impact tests are conducted for the materials of end fitting components, with thickness above 6 mm if the minimum design temperature is less than 0 °C. The test temperature shall be equal to − 20 °C or the design minimum temperature if the latter is lower.

2.6.4.7 The methods for determination the chemical composition, Poisson's ratio and coefficient of thermal expansion of metal materials are established by standards.

2.6.4.8 Corrosion tests in transported medium and seawater, determination of hydrogen-induced and sulphide stress cracking resistance are conducted in compliance with the requirements specified in 4.3.9, Part I "Subsea Pipelines" of the SP Rules. The test procedure shall take into account the requirements of Appendix 4, Part I "Subsea Pipelines" of the SP Rules and be agreed with the Register.

2.6.4.9 The erosion resistance of metal materials is determined according to the procedure to be developed by the firm (manufacturer) and approved by the Register.

2.6.4.10 Fatigue curve in the coordinates "loading-number of cycles" is determined on the cyclic base corresponding to the expected number of cycles of a dynamic loading component according to the procedure agreed with the Register.

2.6.5 Requirements for flexible pipes and their test programs.

2.6.5.1 General.

2.6.5.1.1 The general requirements for the composition and scope of flexible pipe tests shall comply with 4.2.4, Part I "Subsea Pipelines" of the SP Rules.

2.6.5.1.2 The specimens for pipe testing shall be fitted with the same types of end fittings which will be used for the pipe types to be approved.

2.6.5.1.3 Special tests shall be conducted to confirm the safe operation of flexible pipes under the conditions which require to impart special properties specified in 4.2.4.3.3, Part I "Subsea Pipelines" of the SP Rules to the pipes. The special test programs for flexible pipes are developed by the firm (manufacturer) and approved by the Register.

2.6.5.2 Type tests of flexible pipes.

2.6.5.2.1 Type tests are conducted to confirm the basic design parameters for the pipes of a certain dimension-type series to be ranged taking into account the following:

internal/external diameter;

number and designation of layers;

construction of metallic and polymeric layers;

manufacturing procedures including spiralling angles;

transported medium;

internal/external temperature;

operational conditions and service life.

2.6.5.2.2 Type tests are generally conducted before the fracture of specimens and shall include the following:

internal pressure burst test;

buckling (collapse) under external hydrostatic pressure;

rupture by tensile loading;

bending stiffness (checking the minimum radius of a flexible pipe bend);

torsion resistance.

2.6.5.2.3 One to three specimens for each kind of type tests are selected from each type of flexible pipes. During manufacture of the given type of pipes of various diameters, the tests may be performed on the pipes with the maximum diameter.

2.6.5.2.4 Internal pressure burst tests.

2.6.5.2.4.1 The tests shall be conducted on the specimens with a length equal to 20 internal nominal pipe diameters, but not more than 3,0 m without the length of end fittings. The tests shall be carried out with a straight specimen and the one bent on the minimum radius of the FPMP bend in operation (refer to 3.7.3.6, Part I "Subsea Pipelines" of the SP Rules).

2.6.5.2.4.2 Prior to the burst tests, the specimen shall be exposed to stabilization which provides for 20 loading/unloading cycles from zero to the design pressure value.

2.6.5.2.4.3 Following the stabilization, the specimen shall be subject to loading by an internal pressure at a rate of not more than 10 MPa/min until bursting. The bursting pressure value shall be at least two times the design pressure. The maximum air content in a test fluid shall be within 0,5 % for the flexible pipes with smooth bore and 1,0 % for the ones having the rough bore.

2.6.5.2.5 Buckling (collapse) tests by external hydrostatic pressure.

2.6.5.2.5.1 Tests shall be conducted on straight specimens with dimensions as specified in 2.6.5.2.4.1.

2.6.5.2.5.2 The external pressure at which the specimen undergoes buckling (collapse) shall be at least 1,5 times the design buckling (collapse) pressure of the flexible pipe.

2.6.5.2.5.3 Depending on the test performance technique (the way of external collapse pressure application), the action of axial forces and/or an internal pressure on the specimen shall be taken into account.

2.6.5.2.6 Tension tests by tensile loading.

2.6.5.2.6.1 Tests shall be conducted on straight specimens with dimensions as specified in 2.6.5.2.4.1. The arrangement for pipe specimens tensioning shall prevent their torsion.

2.6.5.2.6.2 The force at which the specimen fails shall be at least two times the design tension load for the flexible pipe.

2.6.5.2.7 Minimum bending radius checking (Bending stiffiness tests).

2.6.5.2.7.1 Tests are aimed at determining the forces required for pipe bending on its minimum radius and the characteristics of flexible pipe relaxation after bending. The specimen length shall prevent the end fittings influence. The diagram of bending loads application shall be agreed with the Register.

2.6.5.2.7.2 During tests performance, the dependence between the load applied leading to bending and the bend radius up to its minimum value shall be established. The pipe shall be held at the minimum bend radius at least one hour and then the process is repeated. The difference in loads to attain the minimum bend radius represents the characteristic of pipe relaxation.

2.6.5.2.7.3 A series of tests is recommended to be conducted at different combinations of temperature and pressure. Other test techniques may be used as agreed upon with the Register.

2.6.5.2.8 Torsion resistance tests.

2.6.5.2.8.1 Tests shall be conducted on straight specimens with dimensions as specified in 2.6.5.2.4.1.

2.6.5.2.8.2 During tests performance one of end fittings shall be fixed and torsion moment is applied at the other one. The pipe specimen shall be pressurized to the design pressure.

2.6.5.2.8.3 The torsional moment values of both directions resulting in failure or loss of the pipe integrity shall be at least 1,5 times the design ones.

2.6.5.3 Tests during manufacture of flexible pipes.

2.6.5.3.1 Every pipe shall be tested during manufacture, the scope of tests shall comply with the requirements specified in 4.2.4.3, Part I "Subsea Pipelines" of the SP Rules.

2.6.5.3.2 Every flexible pipe after manufacture shall be subject to the following tests:

drift test;

hydrostatic internal pressure test;

adhesive strength (adhesion) between layers (for bonded flexible pipes only);

vacuum test (for bonded flexible pipes only).

2.6.5.3.3 The firm (manufacturer) shall specify and agree with the Register the minimum time between the completion of end fittings mounting and the commencement of acceptance tests.

2.6.5.3.4 Flexible pipes shall be subject to 100 % non-destructive examination including: visual examination, magnetic particle examination for end fittings, physical methods of non-destructive examination specified in the technical documentation approved by the Register.

2.6.5.3.5 During pipes delivery, the firm (manufacturer) shall submit the records related to all production procedures, non-destructive examination, tests, the certificates for all materials and semi-products. In addition, the parameters of reeling on/reeling off processes shall be defined by the firm (manufacturer) and agreed upon with the Register.

2.6.5.3.6 Drift test.

The minimum diameter of the flexible pipe bore is determined (gauging) prior to the hydrostatic internal pressure test. The gauging pig shall be equipped with disks with diameters of at least 95 % of the nominal internal diameter of the flexible pipe. The disks shall pass through the bore of the flexible pipe undamaged (no dents), but minor scratches are acceptable.

2.6.5.3.7 Hydrostatic internal pressure test.

2.6.5.3.7.1 Hydrostatic internal pressure tests shall be conducted under the following conditions:

.1 Stabilization conditions:

holding the pipe tested for a period of 2 h at the hydrostatic pressure by 2 % to 10 % above the test pressure;

holding the pipe tested for a period of 1 h at the hydrostatic pressure equal to 50 % of the test pressure;

holding the pipe tested for a period of 4 h at the hydrostatic pressure equal to the test pressure.

.2 Test conditions: at least 24 h at the test pressure with temperature (ambient and internal) and pressure being monitored.

2.6.5.3.7.2 The test pressure shall be 1,5 times above the design pressure. The maximum air content in the test fluid shall comply with 2.6.5.2.4.3.

2.6.5.3.7.3 The permissible pressure fluctuation during the tests including that caused by the test fluid temperature fluctuations shall be within 4 % for a period of 24 h. Potential pressure changes due to temperature fluctuations shall be confirmed by a calculation. No leakages, permanent deformations and damages to the flexible pipe, including the area of end fittings shall be observed.

2.6.5.3.7.4 The temporary and residual elongation of pipes shall be monitored and the spacing shall be at least 10 times the nominal internal diameter of the pipe. The residual elongation after testing for bonded flexible pipes shall not exceed 0,7 %.

2.6.5.3.8 Adhesion tests of bonded flexible pipes.

Adhesion tests of bonded flexible pipes are generally conducted for the specimens, which are cut out from the pipe material in the form of strips, according to the procedures developed by the firm (manufacturer) on the basis of international and/or national standards, and approved by the Register.

2.6.5.3.9 Vacuum tests of bonded flexible pipes.

Vacuum tests of bonded flexible pipes are conducted to confirm bond strength of the liner to external layers. For this purpose, the vacuum pressure of 85 kPa shall be maintained for a period of 10 min within the flexible pipe. The collapse of the pipe liner, failure of adhesion between layers, blisters of polymer material are typical causes for rejection. Vacuum tests are not conducted if a steel liner is used.

2.6.5.4 Special tests of flexible pipes.

Depending on the purpose and operational conditions of flexible pipes, special tests agreed with the Register are carried out:

measurements of electrical resistance (for flexible pipes with an internal carcass when using the cathodic protection for end fittings);

check of a capability of being used at low temperatures (cold endurance) (if pipe sections above the water surface are available);

resistance to aggressive (corrosive/erosive) transported media;

resistance to transported media at higher temperature (over 100 °C);

fire tests (if pipe sections above the water surface are available).

The scope and procedures for special tests are developed by the firm (manufacturer) on the basis of international/national standards, and approved by the Register.

2.7 MATERIALS FOR CORROSION PROTECTION

2.7.1 Corrosion-protection coatings.

2.7.1.1 General.

2.7.1.1.1 Internal and external corrosion-protection coatings of steel pipes for subsea pipelines manufactured under the RS technical supervision shall comply with the requirements specified in 7.2 and 7.3, Part I "Subsea Pipelines" of the SP Rules, national and/or international standards and the SP Guidelines.

2.7.1.1.2 The corrosion-protection coatings shall be applied to pipes according to RS-approved technical documentation, and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1). To receive the Type Approval Certificate (CTO), the firm (manufacturer) shall submit a request to the Register.

2.7.1.1.3 Requirements for type approval of corrosion-protection coatings shall comply with 2.6.1.3, 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of corrosion-protection coatings shall be subject to tests according to the requirements specified in 2.7.1.3 and 2.7.1.4.

2.7.1.1.4 For type approval of the coating and its application procedure the firm (manufacturer) involved in application of corrosion-protection coatings to steel pipes for SP shall submit to the Register for approval a set of documents which, as a minimum, includes:

.1 list of technical data for each main coating component;

.2 certificates of conformity for the basic coating components;

.3 specifications (manufacturer's procedures and/or standards) on coatings application and required tests including type (periodical) and check (production) tests;

.4 Inspection and Test Plan for coating application;

.5 manufacturer's data on the safety of each coating component;

.6 instructions on coating defects repair.

2.7.1.1.5 According to 1.6, steel pipes for subsea pipelines with corrosion-protection coatings applied shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by the firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.7.1.1.6 In the course of the RS technical supervision during application of the corrosion protection coatings, the pipes supplied to the firm (manufacturer) shall be approved by the Register (have RS type approval certificate) according to the requirements specified in 2.4.

2.7.1.1.7 When applying the concrete weight coating to the external corrosion-protection coatings, the requirements of 2.8.1.7 shall be complied with.

2.7.1.2 Requirements for materials of corrosion-protection coatings.

2.7.1.2.1 The materials of corrosion-protection coatings shall meet the requirements of the international and/or national standards and technical documentation approved by the Register. The materials shall be selected with regard to SP operating conditions according to the requirements specified in 7.2 and 7.3, Part I "Subsea Pipelines" of the SP Rules.

2.7.1.2.2 The firm (manufacturer) shall perform incoming inspection of materials of corrosion-protection coatings in a scope as agreed upon with the Register.

2.7.1.2.3 Documentation approved by the Register shall include technical requirements for supplied materials for coating application (or references to specifications/standards for their supply).

By the request of material suppliers, the Register is able to carry out type approval of coating materials according to the applicable requirements of 2.7.1.1.

2.7.1.3 Requirements for type approval tests of corrosion-protection coatings.

2.7.1.3.1 These tests are aimed at the RS type approval of corrosion-protection coatings of steel pipes for subsea pipelines. In such case, the provisions of 2.6.1.7 may be taken into account. The scope of type approval tests may be amended by RS as agreed upon with the customer.

2.7.1.3.2 Type (periodical) testing are performed to check, as a minimum, the following parameters of corrosion-protection coatings:

.1 impact resistance (at three temperatures);

.2 coating adhesion to steel (at two temperatures);

.3 decrease in coating adhesion to steel after water soating for 1000 h (at three temperatures);

.4 delamination area during cathodic polarization after soating in 3 % solution of NaCl for 30 days (at two temperatures);

.5 transient resistance of the coating when soating in 3 % solution of NaCl (at two temperatures);

.6 penetration/indentation resistance of coating (at two temperatures);

.7 tensile strength and elongation for the delaminated coating (at two temperatures);

.8 heat cycling resistance (at two temperatures);

.9 flexural strength at specified temperature;

.10 coating stress-cracking resistance at specified temperature;

.11 steel shear resistance at maximum operating temperature.

The test temperatures with regard to operating and storage conditions for SP pipes as well as maximum temperature of transported medium shall be specified and agreed upon with the Register.

2.7.1.3.3 The above tests shall be carried out in compliance with the requirements of national and/or international standards and documentation approved by the Register.

2.7.1.3.4 The internal corrosion-protection coatings shall be additionally subject to the following tests:

.1 abrasion resistance test;

.2 impact indirect test;

.3 thermal ageing resistance test at specified test temperature;

.4 crude oil exposure resistance test at specified test temperature;

.5 autoclave test in 5 % solution of NaCl + 0,5 % CH_3OOH in the presence of H_2S at specified pressure and temperature;

.6 test for pores and roughness test (for anti-friction coating only).

The scope of tests may be amended as agreed upon with the customer and with regard to type of transported medium.

2.7.1.3.5 For significant production outputs, type approval tests may be additionally performed as required by the Register when the order is being executed for more than 12 months, etc. as duration of operation is increased.

2.7.1.4 Requirements to tests of corrosion-protection coatings during manufacture.

2.7.1.4.1 The RS technical supervision during application of corrosion-protection coatings is carried out at firms (manufacturers) with the type approval certificate for this type of coatings. Otherwise, for approval of production batch, both type approval tests of corrosion-protection coatings and tests during manufacture shall be carried out under the RS technical supervision according to the requirements of this Section.

2.7.1.4.2 The RS technical supervision during application of corrosion-protection coating is carried out on the basis of application/contract with the firm (manufacturer) in compliance with the requirements specified in 7.2 and 7.3, Part I "Subsea Pipelines" of the SP Rules and provisions of the SP Guidelines.

2.7.1.4.3 Technical supervision during manufacture is performed on the basis of the RS-approved technical documentation (specifications, Inspection and Test Plans, etc.), national/international standards and includes the following:

tests and inspections witnessed by the RS representative;

issue of the RS documents according to the test and inspection results.

2.7.1.4.4 The pipes with corrosion-protection coatings applied are subject to acceptance by batches. The batch consists of pipes with the same range, steel grade, with coating applied based on the accepted practice with the use of insulating materials of the same grade. The pipes manufactured within a working shift (without personnel replacement and stops for more than 2 h) shall be considered a batch.

2.7.1.4.5 The tests and check operations during application of corrosion-protection coatings of SP pipes at the firm (manufacturer) shall take into account the following parameters:

.1 measuring the length of non-insulated pipe ends (for each pipe);

.2 measuring the angle of skew between the coating and pipe body (for each end of each pipe);

.3 check of coating appearance (for each pipe);

.4 coating thickness measurement (on at least 10 % pipes from the batch and in suspected areas);

.5 holiday detection (the whole external surface of pipes except for non-insulated end areas and bevels);

.6 impact strength test at temperature of $+(20\pm5)$ °C (for at least two pipes from the batch);

.7 test to determine adhesion to steel at temperature of $+(20\pm5)$ °C (for at least two pipes from the batch);

.8 check for marking of insulated pipes (for each pipe).

2.7.1.4.6 Where the test results are unsatisfactory, the repeated tests to check at least one parameter shall be conducted on the double number of pipes taken from the same batch. In case of unsatisfactory results of repeated tests, the insulated pipes may be accepted individually with checks for parameters for which unsatisfactory results were obtained.

In case of unsatisfactory results of individual testing, the coating shall be rejected.

2.7.1.4.7 During application of corrosion-protection coatings according to 1.3.11, the RS technical supervision is recommended to be carried out on the basis of the Iinspection and Test Plan specified in Table 2.7.1.4.7 as agreed upon with the customer.

For each test supervised by the RS surveyor (during the RS survey), in the inspection and test plan the reference shall be made to the RS approved technical documents including the following: detailed design documentation, specifications, standards, etc. In other cases, Inspection and Test Plans shall comply with the requirements specified in 1.3.12.

Table 2.7.1.4.7

Inspection and Test Plan during application of corrosion-protection coating

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
1 Incoming inspection				
1.1 Incoming inspection of coating materials	Certificate data and compliance with requirements of detailed design documentation	Each batch	R	
1.2 Identification of pipes	Full marking	Each pipe	R	
1.3 Surface quality of pipes	Damages and dirt	Each pipe	R	
2 Preparation of pipe surface				
2.1 Preheating of pipes prior to abrasive blasting	Pipe surface temperature	2 times per shift	R	
2.2 Inspection of pipes prior to coating	Surface defects	Each pipe	M	
	Wall thickness at the defect grinding area	Defect grinding area	M	
	Quality of external surface treatment	For each pipe	R	
	Roughness, dedusting degree, quality, salt content	Every 4 hours	R	
3 Application and quality check				
3.1 Checking application of primer, adhesive and top coating	Thickness of coating layers	Layer-by-layer for first pipe of the batch	W	
3.2 Checking the adhesive and impact strength	Adhesion and impact strength at temperature of + 20 ºC	2 pipes per shift	R	
3.3 Continuity test	Coating continuity	Each pipe	W	
3.4 Remanent magnetization	Remanent magnetization	Each pipe on both ends	R	
3.5 Appearance	Coating appearance	Each pipe	R	
3.6 Coating thickness	Coating thickness	2 pipes per shift	R	
3.7 Coating repair	Coating appearance	Each pipe repaired	R	
3.8 Marking the pipe coatings	Marking	Each pipe	M	
4 Issue of Firm's Certificate		Each batch	R	
5 Issue of the RS Certificate/endorsement of the Firm's Certificate		Each batch	H	

[1]For description of type of tests, refer to Table 1.3.11.

2.7.1.4.8 Sizes of coating defects subject to repair according to the procedure agreed with the Register, unless otherwise specified in the documentation approved by the Register, shall comply with the requirements of the following standards:

ISO 21809-1: for polyolefin coatings (PE and PP);

ISO 21809-2: for epoxy coatings.

The total number of defects repaired shall not exceed 1 defect per one meter of pipe length. If the size or number of defects exceed the permissible values, pipe coating shall be removed and reapplied.

2.7.2 Sleeves for corrosion protection of steel pipe welds.

2.7.2.1 General.

2.7.2.1.1 The heat-shrink sleeves for corrosion protection of steel pipe welds (hereinafter referred to as "sleeves") in the course of the RS technical supervision during SP construction shall comply with the requirements specified in 7.3, Part I "Subsea Pipelines" of the SP Rules, national and/or international standards and provisions of the SP Guidelines.

2.7.2.1.2 The sleeves shall be fitted onto pipes according to the RS approved technical documentation and have the Type Approval Certificate (CTO, (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1). To obtain the Type Approval Certificate (CTO), the firm shall submit a request to the Register.

2.7.2.1.3 Requirements for type approval of corrosion-protection coatings shall comply with 2.6.1.3, 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of sleeves shall be tested according to the requirements specified in 2.7.2.3 and 2.7.2.4 (refer also to 1.8.3 and 1.8.4).

2.7.2.1.4 The types of sleeves shall be selected with regard to possible restrictions for their maximum operating temperature caused by transportation of heated media through subsea pipelines.

2.7.2.1.5 It shall be noted that sleeves shall be tested at the following stages:

type (periodical) tests for sleeves in initial condition and fitted sleeves;

check tests of fitted sleeves during production;

check tests of fitted sleeves during SP laying.

2.7.2.1.6 The technical documentation submitted to the Register for type approval of sleeves shall include the following:

specifications indicating the type and basic characteristics of sleeves;

preparation procedure for the surface and basic insulation coating for fitting of sleeves;

sleeve installation guidelines;

test procedure for prefabricated and fitted sleeves;

guidelines for repairing the sleeve base after fitting.

2.7.2.2 Requirements for materials of corrosion protection sleeves.

2.7.2.2.1 The materials of sleeves shall meet the requirements of the international and/or national standards and technical documentation approved by the Register. The materials shall be selected with regard to the SP operating conditions according to the requirements specified in 7.3, Part I "Subsea Pipelines" of the SP Rules and with regard to materials of the basic corrosion-protection coating of pipes.

2.7.2.2.2 During SP laying the incoming inspection of sleeves shall be carried out in a scope as agreed upon with the Register and considering that the sleeve may be available with special purpose two component epoxy primer.

2.7.2.3 Requirements for type approval tests for corrosion protection sleeves.

2.7.2.3.1 These tests shall be aimed at RS type approval of sleeves of steel pipes for subsea pipelines. In such case, the provisions specified in 2.6.1.7 may be taken into account. The scope of type approval tests may be amended by RS as agreed upon with the customer. In such a case, it shall be taken into account that the sleeves shall be tested in prefabricated state and after fitting. The test temperatures with regard to operating and storage conditions for SP pipes as well as maximum temperature of transported medium shall be specified and agreed upon with RS.

2.7.2.3.2 The type (periodical) testing of prefabricated sleeves shall be carried out for verification, as a minimum, the following parameters:

.1 oxidation induction time for polyolefin base: after ageing in the air for 500 h as compared to the initial time;

.2 brittleness temperature.

2.7.2.3.3 The type (periodical) tests of fitted sleeves shall be carried out for verification, as a minimum, the following parameters:

.1 sleeve adhesion to steel and corrosion-protection coating at maximum operating temperature;

.2 sleeve adhesion to steel and factory corrosion-protection coating when soaking in water for 1000 h (at two temperatures);

.3 delamination area during cathodic polarization after soaking in 3 % solution of NaCl for 30 days (at two temperatures);

.4 transient resistance of the coating when soaking in 3 % solution of NaCl (at two temperatures);

.5 impact strength (at three temperatures);

.6 shear stability at maximum operating temperature.

2.7.2.4 Requirements for tests of corrosion protection sleeves during manufacture.

2.7.2.4.1 General provisions on technical supervision during manufacture of sleeves shall comply with the requirements specified in 2.7.1.4.1 to 2.7.1.4.3.

2.7.2.4.2 During sleeves manufacture, the following parameters shall be checked:

.1 dimensions including thickness and appearance of sleeves in initial condition;

.2 elongation and longitudinal tensile strength at temperature of + 20 °C;

.3 degree of full longitudinal shrinkage;

.4 maximum heat shrink stress in longitudinal direction;

.5 total thickness;

.6 holiday detection of the fitted sleeve;

.7 sleeve adhesion to steel and corrosion-protection coating at temperature of + 20 °C.

2.7.2.4.3 Inspections and check procedures specified in 2.7.2.4.2.1 to 2.7.2.4.2.4 shall be performed for the sleeve in initial condition, the others — for the fitted sleeve.

2.7.2.5 Requirements for fitting of sleeves during SP laying.

2.7.2.5.1 When fitting sleeves onto pipe welds during SP laying (refer to 3.7), the quality of these operations shall be provided by the following:

.1 check for compliance with the requirements for preparation of sleeve fitting points (purity, roughness, dust, surface temperature, etc. according to the normative and technical documentation);

.2 applying the primer including the wet film thickness;

.3 check for proper fitting of sleeves;

.4 holiday detection;

.5 adhesion check (upon the customer's request).

The intervals of the above check procedures shall be specified in the RS-approved Inspection and Test Plan during SP laying (refer to Table 3.7.1.1).

2.7.3 Galvanic anode system.

2.7.3.1 General.

2.7.3.1.1 Galvanic anodes for subsea pipelines shall comply with the requirements specified in 7.4, Part I "Subsea Pipelines" of the SP Rules, national and/or international standards.

2.7.3.1.2 Galvanic anodes shall be manufactured and fitted onto SP according to the RS-approved technical documentation and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1).

2.7.3.1.3 The requirements for type approval of galvanic anodes shall comply with 2.6.1.3 and 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of galvanic anodes shall be subject to tests according to the requirements specified in 2.7.3.3.

2.7.3.1.4 According to 1.6, galvanic anodes shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by the firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.7.3.1.5 The galvanic anodes used for SP are generally of bracelet type made from two symmetrical parts (semi-rings) with reinforcement cage allowing connection of two parts when fitting these anodes onto the pipeline.

2.7.3.1.6 The delivery set of bracelet galvanic anodes shall include two cables for electrical contract with the steel pipe or a reliable electrical contact between the anode reinforcement and pipe shall be provided for the selected way of fitting (for example, by welding).

2.7.3.1.7 The galvanic anodes may be fitted and connected at the stage of applying the concrete weight coating of SP pipes (refer to Table 2.8.4.4) or during laying of subsea pipeline from pipes without concrete weight coating (refer to Table 3.7.1.1).

2.7.3.2 Requirements for materials of galvanic anodes.

2.7.3.2.1 The materials of galvanic anodes shall comply with the RS-approved documentation, national and/or international standards.

2.7.3.2.2 The alloys used for manufacture of galvanic anodes shall provide the required parameters of specific ampere-hour efficiency and protective negative potential.

2.7.3.2.3 Generally, the equivalent carbon content in steel used for manufacture of reinforcement cage shall not exceed 0,43 %.

2.7.3.3 Requirements for tests of galvanic anodes.

2.7.3.3.1 Type approval and check tests of galvanic anodes are generally performed directly during manufacture and confirmation of compliance of production batches.

2.7.3.3.2 The batch includes the galvanic anodes with material manufactured by one casting of the manufacturer's melting unit. During casting for checking chemical composition of the alloy, at least two samples shall be casted from each cast before and after metal spout. In such case, no fusion between samples shall be allowed.

2.7.3.3.3 During the RS survey of galvanic anode batch manufacture, the following checks and tests shall be performed unless the greater scope is provided in the RS approved documentation:

.1 chemical analysis of cast as specified in 2.7.3.2.2;

.2 monitoring of weight and dimensions for all galvanic anodes manufactured;

.3 visual examination and measurement to detect surface defects (cracks, contractions, output points of reinforcement, etc.) for all manufactured galvanic anodes;

.4 test for electrochemical capacity combined with measurement of the closed circuit potential in seawater, at least one measurement for every 15 t of the product or batch, whichever is less;

.5 burst test for at least one anode from the batch;

.6 thickness measurement of protective coating on non-working surface for three anodes, if applicable;

.7 resistance measurement between the anode material and anode reinforcement at least for three anodes.

2.7.3.3.4 The following is not allowed for aluminum alloy galvanic anodes:

visible cracks on the anode sections not fully supported by reinforcement cage;

longitudinal cracks more than 1,0 mm wide, with length more than 100 mm or 20 % anode length, whichever is greater;

transverse cracks more than 1,0 mm wide, with length more than 200 mm or 50 % anode diameter whichever is greater;

transverse cracks with depth more than 50 % thickness of anode material covering the reinforcement cage.

Visible cracks on zinc alloy anode are not allowed.

2.7.3.3.5 The anode weight shall be at least equal to that specified in design requirements. The augmentation tolerance shall not exceed 6 %.

2.7.4 Rock shield.

2.7.4.1 General.

2.7.4.1.1 Rock shields for SP (protective polymeric plates wrapped around and attached to the pipe where the sleeves are installed) shall comply with the requirements specified in 7.3, Part I "Subsea Pipelines" of the SP Rules, national and/or international standards.

2.7.4.1.2 Rock shields shall be manufactured and fitted onto SP according to the RS-approved technical documentation and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1).

2.7.4.1.3 Requirements for type approval of rock shields shall comply with 2.6.1.3, 2.6.1.5 and 2.6.1.6. To draw up the Type Approval Certificate (CTO) (form 6.8.3), the specimens of rock shields shall be subject to tests according to the requirements specified in 2.7.4.2.

2.7.4.1.4 According for 1.6, rock shields for subsea pipelines shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.7.4.1.5 The rock shield shall overlap the heat-shrink sleeve being protected at least for 50 mm from each side. The rock shields are generally secured with band ties based on tapes of polypropylene/polyester or similar material with tensile strength of at least 6,0 kN.

2.7.4.2 Tests of rock shields.

2.7.4.2.1 Type (periodical) testing of rock shields as a minimum shall be aimed at confirmation of the following parameters according to the test procedures agreed upon with the Register:

sea water resistance;

impact strength (at two temperatures);

tensile strength and elongation;

indentation resistance;

resistance to abrasion (based on breaking load decrease).

The Register may consider the results of type approval tests performed at the firm under supervision of the RS surveyor and/or the RS-recognized (or RS-recognized classification/supervisory body) testing laboratory not more than 2 years ago provided that the deliveries of materials and components are identical as well as process procedures and structural design remain unchanged.

2.7.4.2.2 Check (production) tests shall include the following:

verification of dimensions and visual and measuring testing;

verification of weight and thickness;

impact strength test (at one temperature).

The production tests shall be aimed at confirmation of compliance of production batch to include the plate of the same standard size, manufactured on the basis of the same formulation, procedure with the use of the same raw materials. The batch size and amount of selected specimens shall be agreed upon with the Register (at least three specimens from the batch of 100 rock shields).

2.8 CONCRETE WEIGHT COATINGS

2.8.1 General.

2.8.1.1 Concrete/reinforced concrete (weight) coatings (hereinafter referred to as "concrete weight coatings") of pipes for SP manufactured under the RS technical supervision shall meet the requirements specified in 6.2, Part I "Subsea Pipelines" of the SP Rules and provisions of the SP Guidelines.

2.8.1.2 Concrete weight coatings shall be applied to pipes according to the RS-approved technical documentation and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1). To obtain the Type Approval Certificate (CTO), the firm shall submit a request to the Register.

2.8.1.3 Requirements for type approval of corrosion-protection coatings shall comply with 2.6.1.3, 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of concrete weight coatings shall be subject to testing according to the requirements specified in 2.8.3 and 2.8.4.

2.8.1.4 According to 1.6, concrete coated pipes for subsea pipelines shall be delivered with the copy of the Type Approval Certificate (CTO) and the Certificate to be filled in and signed by firm's (manufacturer's) official and issued (verified) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.8.1.5 In the course of the RS technical supervision during application of the concrete weight coatings, the pipes supplied to the manufacturer shall be approved by the Register (have the RS Type Approval Certificate) according to the requirements specified in 2.4.

Internal coatings (corrosion-protection and/or anti-friction), external corrosion-protection coatings for pipelines under the RS technical supervision shall be approved by the Register (have the RS Type Approval Certificate) according to the requirements specified in 2.7 prior to application of concrete weight coatings to pipes.

Thermal insulation coatings shall comply with the requirements of 2.10.

2.8.1.6 The concrete weight coatings may be applied by the following methods:

.1 concrete grouting in the spaces between steel pipe and mantle pipe (generally, a galvanized steel strip helically wound with external polymer corrosion-protection coating) based on "pipe-in-pipe" technology;

.2 compression wrap process using special purpose equipment;

.3 impringement process using special purpose equipment;

.4 grouting in the formwork including the slip form.

2.8.1.7 The external corrosion-protection coatings subject to concrete weight coatings application shall not have defects not complying with the requirements for corrosion-protection coatings.

The external corrosion-protection coatings (for a steel pipe or a mantle pipe) shall be properly roughened in some manner according to the RS-approved documentation, with the minimum coating thickness being retained.

2.8.1.8 The deviations from the design weight of concrete coated pipes are determined by design requirements. The lower acceptable tolerable deviation from the design weight of 50 pipes (batch) shall not be negative.

2.8.1.9 Where SP pipes shall be heat insulated, the concrete weight coating shall be applied to a layer of thermal insulation coating carried out according to "pipe-in-pipe" technology using the mantle pipe (plastic or galvanized steel strip helically wound) with filling of intertubular space with thermal insulation material (refer to 2.10).

2.8.2 Requirements for materials of concrete weight coatings.

2.8.2.1 The materials used for concrete weight coatings manufacture (cement, plasticizers and different fillers, water, reinforcement) shall comply with the requirements of national and/or international standards and the RS-approved documentation.

2.8.2.2 The manufacturer shall carry out incoming inspection of concrete fillers by the following parameters: gradation, organic impurities, content of dust-like and clay particles.

During incoming inspection of concrete grouts, the density and workability/consistency are checked according to the requirements of national and/or international standards.

2.8.2.3 During incoming inspection of steel pipes with applied corrosion-protection coating subject to application of concrete coatings, the quality of corrosion-protection coating including continuity test shall be subject to special inspection. Where necessary, the coating shall be repaired according to the procedure agreed upon with the Register.

2.8.3 Requirements for type approval tests of concrete weight coatings.

2.8.3.1 These tests are aimed at the RS type approval of concrete weight coatings. In such case, the provisions of 2.6.1.7 may be taken into account. The scope of type approval tests may be amended by the Register as agreed upon with the customer.

2.8.3.2 Type approval tests are aimed at checking the following parameters of concrete weight coatings:

.1 impact strength of pipe structure with concrete weight coating;

.2 shear resistance of concrete weight coating relative to insulating polypropylene/polyethylene coating;

.3 thickness of protective concrete layer above the reinforcing element and proper longitudinal and transverse locations of reinforcing elements.

The tests specified in 2.8.3.2.1 and 2.8.3.2.2 may be carried out based on procedures of ACS recognized by the Register.

2.8.3.3 The impact strength of pipe structure with concrete weight coating is determined by design requirements, but shall be not less than 5 kJ.

2.8.3.4 Shear resistance of concrete weight coating relative to corrosion-protection coating is determined by design requirements but shall be not less than 1,0 MPa.

2.8.3.5 Thickness of protective concrete layer above the reinforcing element and proper longitudinal and transverse locations of reinforcing elements are checked during breaking tests of concrete weight coating specimen (cutting of mantle pipe and/or cutting out the specimen longitudinally and transversely).

Deviation of concrete coating thickness from nominal value shall not exceed ±6,0 mm if not otherwise agreed in the documentation approved by the Register.

2.8.4 Requirements for tests of concrete weight coatings during manufacture.

2.8.4.1 The RS technical supervision during application of concrete weight coatings is carried out at manufacturers with the Type Approval Certificate for this type of coatings. Otherwise, for approval of production batch, both type approval tests of concrete coating and in-production tests shall be performed under the RS technical supervision according to the requirements of this Section.

2.8.4.2 The RS technical supervision during application of concrete weight coating is carried out based on an application/contract with the manufacturer in compliance with the requirements specified in 6.2, Part I "Subsea Pipelines" of the SP Rules and provisions of the SP Guidelines.

2.8.4.3 Technical supervision during manufacture is carried out based on the RS-approved technical documentation (specifications, Inspection and Test Plans, etc.), national/international standards and includes the following:

tests and examinations witnessed by the RS representative;

drawing-up of the RS documents according to the tests and examinations results.

2.8.4.4 The scope of tests and inspections during application of concrete weight coatings shall comply with Table 2.8.4.4.

The concrete weight coatings during production shall be tested on pipes taken from a single batch. The batch shall comprise not more than 50 concrete coated pipes manufactured of the same steel grade, with the same diameter, with continuous coating applied based on accepted formulation using raw materials and purchased products of the same batch within a single working shift.

2.8.4.5 The requirements for galvanic anodes to be fitted on pipes for SP during application of concrete coating shall comply with 2.7.

Table 2.8.4.4

Scope of tests for approval of concrete weight coatings

Type of test	Number of pipes from the batch	Notes
Thickness and diameter of concrete weight coating	Each pipe	
Deviation between centerlines of steel pipe and mantle pipe (concrete coating)	Each pipe	
Concrete compression strength	One pipe from the batch	One sample for the pipe batch and/or minimum three core specimens cut out from the coating
Concrete water absorption	One pipe from the batch	
Density of concrete weight coating	One pipe from the batch	
Weight of pipes with concrete weight coating	Each pipe	
Length of non-concrete coated ends of pipes	Each pipe	
Appearance of concrete weight coating	Each pipe	
Absence of contact between steel pipe and steel wire mesh or reinforcement cage	Each pipe	
Location of galvanic anode	Each pipe with galvanic anode	For pipes with galvanic anode fitted
Resistivity of pipe insulation coating after application of concrete coating and fitting of galvanic anode	Each pipe with galvanic anode	For pipes with galvanic anode fitted
Breaking test for the repaired insulation coating in the area where cathodic protection cable is welded to the pipe	Each pipe with galvanic anode	For pipes with galvanic anode fitted
Absence of contact between galvanic anode and steel wire mesh or reinforcement cage	Each pipe with galvanic anode	For pipes with galvanic anode fitted
Electrical resistance between steel pipe and galvanic anode	Each pipe with galvanic anode	For pipes with galvanic anode fitted

2.8.4.6 The following defects are allowed for the concrete coating surface (for packing and spraying up methods):

longitudinal cracks of not more than 300 mm long and not more than 0,3 mm wide;

circumferential cracks of not more than 1,6 mm wide and propagating at angle of not more than 180° along the perimeter of the pipe concrete coating;

separate areas with defective (delaminated or absent) concrete coating with the depth less than 25 % of concrete coating thickness and surface area of not more 1000 cm^2.

2.8.4.7 The concrete coating defects subject to repair:

longitudinal cracks of more than 300 mm long with any width;

longitudinal cracks of more than 0,3 mm wide with any length;

circumferential cracks of more than 1,6 mm wide with any length;

circumferential cracks propagating at angle of more than 180° along the perimeter of the pipe coating for any width;

separate areas with defective (delaminated or absent) concrete coating with the depth more than 25 % of concrete coating thickness and surface area 1000 to 3000 cm^2.

2.8.4.8 The concrete weight coating shall be rejected and removed if the total area of separate defective areas exceeds 10 % of concrete weight coating total area.

2.8.4.9 The concrete weight coating defects shall be repaired using shotcrete according to the RS-approved procedure. In case of unsatisfactory test results of concrete coating, refer to provisions of 2.2.1.5.2.

2.8.4.10 The pipe protective coating shall be equal to 15 mm from the reinforcing element.

Minimum thickness of concrete coating protective layer from the external face to the reinforcing element shall be as follows:

15 mm for concrete coatings up to 50 mm thick;

20 mm for concrete coatings of more than 50 mm thick;

Thickness of concrete coating protective layer from the external face to the steel wire mesh shall be at least 25 mm (when reinforcement mesh is used).

2.8.4.11 During application of concrete weight coatings according to 1.3.11, the RS technical supervision is recommended to be carried out based on the Inspection and Test Plan specified in Table 2.8.4.11 as agreed upon with the customer.

For each test witnessed by the RS surveyor (during the RS survey), in the Inspection and Test Plan reference shall be made to the RS approved technical documents including the following: detailed design documentation, specifications, standards, etc. In all other respects, Inspection and Test Plans shall comply with the requirements of 1.3.12.

Table 2.8.4.11

Test and inspection plan for concrete ballast coating application

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
1 Incoming inspection				
1.1 Pipes with external corrosion-protection coating	Certificate data and compliance with requirements of detailed design documentation, geometrical parameters, surface quality	Each pipe	W	As per 2.8.2.3
1.2 Cement (or finished concrete grout)	Certificate data and compliance with requirements of detailed design documentation, grout quality	Each batch	M	As per 2.8.2.2
1.3 Concrete grout fillers	Certificate data and compliance with requirements of detailed design documentation, grading	Each batch	R	As per 2.8.2.2
1.4 Reinforcement (mesh or bars)	Certificate data and compliance with requirements of detailed design documentation, geometrical parameters	Each roll or batch	R	
1.5 Galvanized steel strip for mantle pipes	Certificate data and compliance with requirements of detailed design documentation, geometrical parameters	Each roll	R	When using a mantle pipe
1.6 Mantle pipe for heat insulating coating	Certificate data and compliance with requirements of detailed design documentation, geometrical parameters	Each batch	R	For insulating pipes
1.7 Corrosion-protection materials for steel mantle pipe	Certificate data and compliance with requirements of detailed design documentation	Each batch	R	When using a mantle pipe
1.8 Polymer-bitumen mastic	Certificate data and compliance with requirements of detailed design documentation	Each batch	R	For pipes with galvanic anodes
1.9 Galvanic anodes with cable	Certificate data and compliance with requirements of detailed design documentation, geometrical parameters and weight	Each galvanic anode	W	For pipes with galvanic anodes
1.10 Markers	Certificate data and compliance with requirements of detailed design documentation	Each marker	R	For pipes with markers
1.11 Heat insulating material	Certificate data and compliance with requirements of detailed design documentation	Each batch	R	For insulating pipes
2 Quality and continuity test for corrosion-protection coating on a steel pipe/mantle pipe	Surface quality, defective areas	Each pipe	M	
3 Corrosion-protection coating repair on a steel pipe/mantle pipe	Surface defects as per normative and technical documentation	Each pipe repaired	M	
4 "Pipe-in-pipe" assembly for application of thermal insulation coating	As per requirements of detailed design documentation	Each pipe	W	For insulating pipes
5 Application of thermal insulation material	As per requirements of detailed design documentation	Each pipe	M	For insulating pipes
6 Manufacture of reinforcement cage (when used)	As per requirements of detailed design documentation including welding quality	Twice a shift	M	
7 Manufacture of mantle pipe for concrete application (when used)				
7.1 Manufacture of steel mantle pipe (helically wound pipe)	As per normative and technical documentation	Twice a shift	R	When using a mantle pipe
7.2 Application of corrosion-protection coating including roughening	As per 2.7	Each mantle pipe	R	When using a mantle pipe
8 "Pipe-in-pipe" assembly for application of concrete coating	As per requirements of detailed design documentation	Each pipe	W	When using a mantle pipe

Table 2.8.4.11 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
9 Application of concrete weight coating				
9.1 Application of concrete weight coating		Each pipe	W	
9.2 Checking thickness, surface quality and reinforcement location	As per detailed design documentation	Each pipe	R	
9.3 Sampling of concrete grout	As per detailed design documentation	One pipe from the batch	R	
9.4 Testing of concrete specimens	Checking density, strength and water absorption	One pipe from the batch	R	
9.5 Concrete weight coating repair	Defects of concrete weight coating	Each pipe repaired	W	As per 2.8.1.8
10 Fitting galvanic anode onto pipes with concrete weight coating applied				
10.1 Preparation of the fitting locations	As per detailed design documentation	Each pipe with galvanic anode	R	
10.2 Fitting of galvanic anode	As per detailed design documentation	Each pipe with galvanic anode	R	
10.3 Welding of cable including insulation of welding area	As per detailed design documentation, normative and technical documentation	Each pipe with galvanic anode	M	
10.4 Checking for proper fitting of galvanic anode	Geometrical parameters and resistance measurements	Each pipe with galvanic anode	W	
11 Fitting of marker	Geometrical parameters and polarity	Each pipe with marker	R	
12 Application of polymer-bitumen mastic	As per detailed design documentation	Twice a shift	R	
13 Weighing of pipes with concrete weight coating (including galvanic anode and marker)	As per detailed design documentation	Each pipe and each batch	R	As per 2.8.4.8
14 Marking		Each pipe	R	
15 Issue of Manufacturer's Certificate		Each batch	R	
16 Issue of the RS Certificate/endorsement of the Manufacturer's Certificate		Each batch	H	

[1]For description of type of tests, refer to Table 1.3.11.

2.9 BALLAST WEIGHTS

2.9.1 General.

2.9.1.1 Ballast weights for subsea pipelines manufactured under the RS technical supervision shall meet the requirements specified in 6.2, Part I "Subsea Pipelines" of the SP Rules and provisions of the SP Guidelines.

2.9.1.2 The ballast weights shall be manufactured according to the RS approved technical documentation, and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1).

2.9.1.3 Requirements for type approval of ballast weights shall comply with 2.6.1.3 and 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of concrete weight coatings shall be subject to tests according to the requirements of 2.9.3 and 2.9.4.

2.9.1.4 According to 1.6, ballast weights for subsea pipelines shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.9.2 Concrete ballast weights.

2.9.2.1 The requirements of this Section apply to concrete/reinforced concrete (hereinafter referred to as "concrete") elements used in ballast weights of different structures to provide required stability level for subsea pipelines laid/buried on/into seabed soil.

2.9.2.2 The concrete ballast weights are manufactured from cementitious materials, inert fillers of different composition and chemical admixtures providing operation in sea water for a period equal to design service life of subsea pipelines.

2.9.2.3 Requirements for materials of concrete ballast weights shall comply with 2.8.2.1 and 2.8.2.2.

2.9.3 Requirements for type approval tests of concrete ballast weights.

2.9.3.1 Type approval tests of concrete ballast weights are carried out according to 2.8.3.2.3 and 2.8.3.5.

2.9.4 Requirements for tests of concrete ballast weights during manufacture.

2.9.4.1 The scope of tests of a batch comprising not more than 50 concrete ballast weights manufactured within a single shift shall be as follows:

compression strength test;

water absorption test;

concrete surface quality check;

check of concrete density according to design data;

check of geometrical parameters.

2.9.4.2 The test results shall comply with applicable requirements of 2.8.4.6 and 2.8.4.7 of the SP Guidelines and 6.2, Part I "Subsea Pipelines" of the SP Rules.

2.10 THERMAL INSULATION COATINGS

2.10.1 General.

2.10.1.1 The thermal insulation coatings for pipes manufactured under the RS technical supervision shall be made according to the RS-approved technical documentation, and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1).

2.10.1.2 Requirements for type approval of thermal insulation coatings shall comply with 2.6.1.3 and 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of thermal insulation coatings shall be subject to tests according to the requirements specified in 2.10.3 and 2.10.4.

2.10.1.3 According to 1.6, insulating pipes for subsea pipelines shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.10.1.4 In the course of RS technical supervision during application of the thermal insulation coatings, the pipes supplied to the manufacturer shall be approved by RS (have the RS Type Approval Certificate) according to the requirements of 2.4.

Internal coatings (corrosion-protection and/or anti-friction), external corrosion-protection coatings for pipelines under the RS technical supervision shall be approved by RS (have the RS Type Approval Certificate) according to the requirements of 2.7 prior to application of thermal insulation coatings to pipes.

2.10.1.5 The thermal insulation coatings are generally applied according to "pipe-in-pipe" technology using a mantle pipe (plastic or galvanized steel strip helically wound) with filling of intertubular space with thermal insulation material.

Thermal insulation end surfaces shall be protected by end-face heat-shrink sleeves of the Register approved type.

2.10.2 Requirements for materials of thermal insulation coatings.

2.10.2.1 The ozone-safe closed cellular polyurethane foams shall be generally used for thermal insulation coatings. Other thermal insulation materials may be used as agreed upon with the Register.

2.10.2.2 Pipes of low-pressure polyethylene or galvanized steel strip helically wound with corrosion-protection coating may be used for mantle pipes considering requirements of 2.8.1.7.

2.10.3 Requirements for type approval tests of heat insulating coatings.

2.10.3.1 These tests are aimed at the RS type approval of thermal insulation coatings. In such case, the provisions of 2.6.1.7 may be taken into account. The scope of type approval tests may be amended by RS as agreed upon with the customer.

2.10.3.2 Type approval tests are aimed at checking the following parameters of thermal insulation coatings:

.1 water absorption;

.2 thermal conductivity;

.3 volume fraction of closed pores;

.4 axial shear strength.

The tests specified in 2.10.3.2.1 to 2.10.3.2.4 may be carried out according to procedures of national and/or international standards for compliance with the RS-approved technical documentation.

2.10.3.3 The shear strength of the polyurethane thermal insulation coating in axial direction relative to corrosion-resistant coating of the pipe is determined by design data but shall be not less than 0,12 MPa.

2.10.3.4 The thermal conductivity of the polyurethane thermal insulation coating at average temperature of + 50 °C shall be not more than 0,033 W/m °C, unless otherwise specified in design data.

2.10.3.5 For polyurethane coating, the volume fraction of closed pores shall be not less than 85 %, water absorption when boiling for 90 min shall be not more than 10 % by the volume.

2.10.4 Requirements for tests of thermal insulation coatings during manufacture.

2.10.4.1 The RS technical supervision during application of thermal insulation coatings is performed at manufacturers with the Type Approval Certificate for this type of coatings. Otherwise, for approval of production batch, both type approval tests of thermal insulation coating and tests during manufacture shall be carried out under the RS technical supervision according to the requirements of this Section.

2.10.4.2 The RS technical supervision during application of thermal insulation coating is carried out on the basis of an application/contract with the manufacturer in compliance with the requirements of the SP Guidelines. General requirements for the RS technical supervision shall comply with 2.8.4.3.

2.10.4.3 The scope of tests and inspections during application of thermal insulation coatings shall comply with Table 2.10.4.3.

The thermal insulation coatings during manufacture shall be tested on pipes taken from a single batch. The batch shall comprise not more than 50 insulating pipes manufactured from the same steel grade, with the same diameter, with continuous coating applied based on established formulation procedure using raw materials and purchased products of the same batch within a single working shift.

Table 2.10.4.3

Scope of tests for approval of thermal insulation coatings

Type of test	Number of pipes from the batch	Notes
Thickness and diameter of thermal insulation coating, deviation between centerlines of steel pipe and mantle pipe	Each pipe	
Shear strength of thermal insulation coating on corrosion-protection coating of steel pipe	One pipe from the batch	if required by the Register
10 % radial compression strength	One pipe from the batch	not less than 0,3 MPa
Density of a medium layer of thermal insulation coating	One pipe from the batch	not less than 60 kg/m^3
Weight of pipes with thermal insulation coating applied	Each pipe	
Length of non-insulated ends of pipes	Each pipe	
Appearance of thermal insulation coating	Each pipe	

2.11 STEEL FLANGES

2.11.1 General.

2.11.1.1 Steel flanges for spool pieces (spools) and subsea pipelines (hereinafter referred to as "flanges") manufactured under the RS technical supervision shall meet the requirements specified in 4.7, Part I "Subsea Pipelines" of the SP Rules and provisions of the SP Guidelines and take into account the reliability level required for subsea pipelines (refer to 2.1.7.1).

2.11.1.2 Flanges shall be manufactured according to the RS-approved technical documentation, and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1). To obtain the Type Approval Certificate (CTO), the firm (manufacturer) shall submit a request to the Register.

2.11.1.3 Requirements to type approval of flanges shall comply with 2.6.1.3, 2.6.1.5 and 2.6.1.6. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the flange specimens shall be subject to tests according to the requirements specified in 2.11.4.

2.11.1.4 According to 1.6, the flanges for subsea pipelines shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by the firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.11.1.5 In the course of the RS technical supervision during manufacture of flanges, billets (forged, cast and in some cases, steel plates) supplied to the manufacturer shall be type approved by RS (have the RS Type Approval Certificate) according to the requirements specified in 2.2 and 2.3.

The billets having a certificate issued by ACS (including the Manufacturer's Certificate endorsed by ACS) or supervisory body recognized by RS may be used as agreed upon with the Register.

2.11.2 Requirements for flange materials.

2.11.2.1 The flanges are made of fully killed steel with strength grade up to PC550T(W). When connecting linear pipes made of higher strength steel, the full strength of flanges shall be reached by increasing the thickness of neck at a welding groove. The application of flanges made of stronger materials shall be agreed with the Register.

2.11.2.2 The chemical composition of metal of flanges, gaskets and bolted joints shall comply with national and/or international standards to ensure the equivalence of the RS requirements to pipes for subsea pipelines. Compatibility with the material of linear pipes for underwater application considering the transported medium parameters shall be additionally provided.

2.11.2.3 Upon agreement with the Register, the chemical composition of flange material may be modified with respect to the standards for pipes to obtain satisfactory combination of weldability, hardenability, strength, ductility, viscosity and corrosion resistance as well as properties required for manufacture of forgings/castings (if used for manufacture of flanges). In such case, the carbon equivalent for carbon steels (C_{eq}) shall not exceed 0,46, for low alloy steels P_{cm} may exceed the requirements to the base metal of pipes of appropriate grade not more than 0,02.

2.11.2.4 The nominal chemical composition of stainless steel flanges shall correspond to that of linear pipes.

2.11.2.5 For operation in the acidic media, the sulphur content in forgings and castings of carbon and low alloy steels shall not exceed 0,003 %.

2.11.3 Requirements for technical documentation.

2.11.3.1 The documentation on flanges submitted for the RS review shall contain the following:

.1 number of flanges (gaskets) of specific type of each size and pressure class within the project;

.2 applied design standard, specific requirements for swivel flanges;

.3 type of billets, supplier, supply conditions;

.4 material grade;

.5 specification and certificates for billet material including the data on chemical composition, heat treatment, mechanical properties, dimensional and non-destructive testing;

.6 welding procedure and chemical composition of weld metal if welding is used;

.7 weld repairs procedure for billets, if applicable;

.8 product geometry (for example, nominal or internal diameter, minimum neck wall thickness, thickness and diameter of flange body, projections and grooves on contact surface, treatment of contact surfaces, deviations from circular shape of section including required tolerances), dimensions of connected pipe;

.9 minimum/maximum operating temperature;

.10 heat treatment conditions after manufacture;

.11 requirements for scope and methods of testing of type (test) and specified during manufacture;

.12 requirements for inspection and hydraulic tests;

.13 surface conditions at supply, coatings or painting.

2.11.3.2 Prior to commencement of type approval procedure for flanges by the Register, the firm (manufacturer) shall develop and agree upon with the Register the type approval test program according to the requirements of 2.11.4.

2.11.4 Requirements for flange tests.

2.11.4.1 According to the RS-approved technical documentation a test flange (i.e. a pair of matching flanges) shall be manufactured and tested prior to commencement of series production. Based on the results of standard tests of the test flanges, the technical documentation may be amended.

2.11.4.2 The scope of tests for test flanges and flanges during manufacture shall comply with Table 2.11.4.2. If a number of flanges to be manufactured is less than 50, the type approval tests and test during manufacture may be combined.

Table 2.11.4.2

Scope of flange tests

Type of test and inspection	SP operational reliability level			Acceptance criteria
	0 and 1	2	3	
Chemical composition	1	1	1	Ladle sample and finished product as per specifications
Tensile testing of the base metal on transverse specimens (base metal parameters to be determined: R_m, $R_{t0,5}$, $R_{p0,2}$, A_5)	1	1	1	As per specifications, compliance with the strength class Non-straightened cylindrical specimens
Impact, base metal (and welded joint, if applicable) for wall thickness more than 5 mm	1	1	1	Temperature T_p – 10 °C, impact energy for both linear pipes of appropriate strength class, correction proportional to the length of specimens
Hardness on transverse sections	—	T, 1	—	Not more than 250 HV10
Surface hardness	—	T, 1	—	Not more than 250 HV10
Weldability (for flanges welded by a girth weld and for external welded rings of swivel flanges)	T	T	T	As for the base metal
Metallography	T	T, 1	T	The maximum grain size in the base metal and weld area — 7
Hydrogen cracking	—	T	—	CSR $\leqslant$ 2 %, CLR $\leqslant$ 15 %, CTR $\leqslant$ 5 %
Stress-corrosion tests	—	T	—	Absence of cracks and tears on the extended surface
Pitting corrosion (for stainless steel only)	T	T	T	Weight loss of 4,0 g/m^2
Visual examination	T, M	T, M	T, M	As per specifications
100% magnetic particle/dye-penetrant testing	T, M	T, M	T, M	Readings up to 3 mm in the circumferential direction
100% ultrasonic testing in the edge zone of at least 50 mm wide	T, S	T, S	T, S	As accepted for linear pipes. For requirements of level 2, delamination area is limited to 100 mm^2
Repair	M	M	M	As per specifications
Internal diameter at flange ends	M	M	M	As per specifications
Deviation from the round shape at flange ends	M	M	M	Not more than 1,5 %
Dimensions according to specifications	M	M	M	As per specifications
Treatment of flange ends	M	M	M	As per specifications
Surface condition	M	M	M	As per specifications
Hydraulic tests	T	T	T	With no cracks, tears and visible distortions, test pressure as per design documentation

Symbols:
T — on test flange;
M — on all manufactured flanges;
1 — on one single flange from the batch;
S — on the first ten flanges from the batch and then in general scope of 10 %, if no defects are detected (otherwise, 100 % tests).

2.11.4.3 The flanges shall be subject to tests and inspections after final heat treatment. Samples for mechanical tests are taken from special allowances or flange itself. Upon agreement with the Register, the single billet of the metal with the same cast may be used. The sample shall be subject to the same treatment as flanges from which it was taken.

2.11.4.4 The RS type approval for the type (test) flange based on results of tests specified in Table 2.11.4.2 may be applied to production batches of flanges that differ from test flange as specified in Table 2.11.4.4.

Table 2.11.4.4

Permissible deviations from type flange parameters during manufacture

Significant parameter	Permissible deviations relative to parameters of pilot flange
Steel smelting and billet manufacture procedure	Without deviations
Chemical composition by ladle analysis	For carbon and low-alloyed steels — $\pm$0,02 % C, $\pm$0,03 C_{eq} and/or $\pm$0,02 P_{cm}, for stainless steel and cladding layer without deviations of nominal composition
Nominal size of billet (thickness, diameter)	Without deviations
Casting procedure	Type of process procedure: without deviations, parameters to be agreed upon with the Register
Casting temperature	$\pm$25 °C with no changes in number and arrangement of pyrometers used
Heating device	Without deviations
Welding procedure, consumables	Without deviations
Surface condition	To be agreed upon with the Register
Geometrical similarity of flanges	Without deviations. Exceptions: the flanges with neck and flanges with projecting contact surface may be replaced with flat flanges
Geometrical dimensions of flanges: diameter to thickness ratio, cross-section area	At least one half and not more than doubled size of test flange
Heat treatment	Method — without deviations, holding time (0 to + 15) min, holding temperature: $\pm$15 °C, heating and cooling rates shall be agreed

2.11.4.5 The batch comprises not more than 50 flanges of the same size, cast, manufactured on the basis of the same procedure and subjected to the same heat treatment.

2.11.4.6 Examples of specimens cutting-out locations for mechanical tests are specified in Figs. 2.11.4.6-1 and 2.11.4.6-2, for the number, orientation and position of specimens refer to Table 2.11.4.6.

The impact tests are carried out if manufacture of specimens of 5 mm thick is technically practicable. The design length of specimens for tensile tests shall be five times their diameter and their dimensions shall be as much as possible. The thickness of specimens for impact tests shall be as much as possible from the following values: 5; 7,5 and 10 mm.

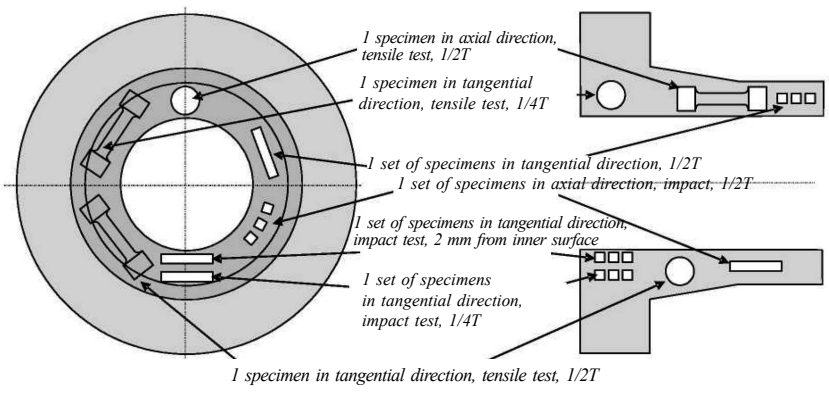

Fig. 2.11.4.6-1
Position of specimens during tensile and impact tests, neck flange with section thickness T > 50 mm

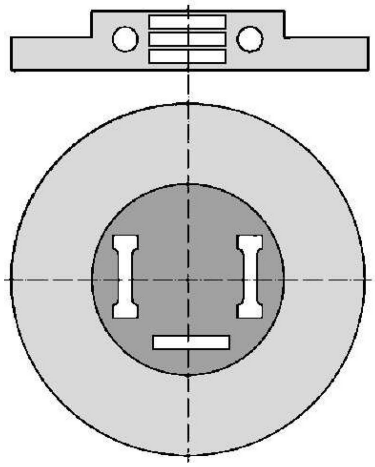

Fig. 2.11.4.6-2
Position of specimens during tensile and impact tests, blind flange

Table 2.11.4.6

Number, orientation and arrangement of specimens

Type of test	Number of specimens	Position of specimens
Tensile test for flanges with the largest section thickness $T \leqslant 50$ mm	3	One specimen in the tangential direction from the section with the largest thickness at a position of 1/2 thickness from the internal surface, the middle of the specimen length shall be at least 50 mm apart from the external surface. One sample from the middle of thickness in tangential and axial directions from the highest stress area after final treatment, for example, from neck at weld
Tensile test for flanges with the largest section thickness $T > 50$ mm	3	One specimen in the tangential direction from the section with the largest thickness at a position of 1/4 thickness from the internal surface, the middle of the specimen length shall be at a position of the lesser (thickness and 100 mm) from the back surface. One sample from the middle of thickness in tangential and axial directions from the highest stress area after final treatment, for example, from neck at weld
Impact test, specimens in axial and tangential directions, at the largest section thickness $T \leqslant 50$ mm	3 sets of 3 specimens	One set in the tangential direction from the section with the largest thickness at a position of 1/2 thickness from the internal surface. One set from the middle of thickness in tangential and axial directions and from the highest stress area after final treatment, for example, from neck in way of weld. Notch along the thickness
Impact test, specimens in axial and tangential directions, at the largest section thickness $T > 50$ mm	3 sets of 3 specimens	One set in the tangential direction from the section with the largest thickness at a position of 1/4 thickness from the internal surface. One set from the middle of thickness in tangential and axial directions and from the highest stress area after final treatment, for example, from neck at weld. Notch along the thickness
Microstructure	3	At two surfaces and in the middle of thickness in the section with the largest thickness
Hardness	3	At least three measurements at two surfaces and in the middle of thickness in the section with the largest thickness
Weldability (for flanges welded by a girth weld or welded rings)		Based on individual program agreed upon with the Register
Hydrogen crack tests	3	For flanges of level 2 requirements only as per NACE TM 0284 − in longitudinal direction
Sulphide stress cracking tests	3	For flanges of level 2 requirements only as per NACE TM 0284 − in longitudinal direction, from the wall internal surface
Pitting corrosion (for stainless steel only)	1	According to ASTM G48 — in any direction, without straightening

2.11.4.7 Hydrostatic test shall be mandatory for test flanges. The test shall be carried out by producing a test pressure in a pair of prototype flanges with gaskets and bolted joint, adjoining pipe sections and blank covers. Manufactured flanges are subject to hydrostatic tests on installed pipelines/spool pieces.

2.11.4.8 Requirements for gaskets and fasteners (bolts/studs, nuts and washers) shall comply with 4.7, Part I "Subsea Pipelines" of the SP Rules.

2.11.5 Manufacture of flanges.

2.11.5.1 Flanges are manufactured by forging or centrifugal casting with further machining. Forged flanges are preferable.

2.11.5.2 Blind flanges may be manufactured from hot-rolled plates.

2.11.5.3 The minimum yield stress of forgings, castings, rolled plates and sections made of carbon and low-alloy steels shall be up to 555 MPa. The use of stronger materials is subject to the RS special consideration. Steels are smelted in the electric furnace or mainly by basic oxygen. Steels shall be fully killed and fine grain treated.

2.11.5.4 Forging shall be carried out according to the RS-approved documentation. Minimum forging reduction shall be 4:1. Forgings are supplied in the normalized condition, normalized and tempered condition, or in the quenched and tempered condition.

2.11.5.5 Castings are manufactured by centrifugal casting. Casting shall be made as a single part from the metal of the same cast. Castings of carbon and low alloy steels are supplied after the following types of heat treatment: homogenization, normalization and stress relief or homogenization, quench and tempering.

2.12 STEEL BENDS

2.12.1 General.

2.12.1.1 Steel hot bends (hereinafter referred to as "bends") for subsea pipelines/spool pieces manufactured (subject to repair or modernization) under the RS technical supervision shall meet the requirements of Section 4.8, Part I "Subsea Pipelines" of the SP Rules and take into account the reliability level required for subsea pipelines (refer to 2.1.7.1).

2.12.1.2 Steel bends for SP shall be produced by the manufacturers having the Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1) issued by the Register (refer to the SP Nomenclature, Table 1.6.1) and under the RS technical supervision.

2.12.1.3 General requirements for recognition of bend manufacturer shall comply with 2.2.2.2 to 2.2.2.4.

In some cases, upon agreement with the Register, the bends for SP may be produced at the manufacturer without the RS recognition provided that additional tests during manufacture in a scope required for manufacture recognition are carried out.

2.12.1.4 According to 1.6, bends for subsea pipelines shall be delivered with the Certificate to be filled in and signed by firm's (manufacturer's) official and issued (affirmed) by the Register (СЗ) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (СЗ), the manufacturer shall submit a request to the Register.

2.12.1.5 In the course of the RS technical supervision during manufacture of bends, billets (mother pipes) supplied to the manufacturer shall be type approved by the Register (have the RS Type Approval Certificate) according to the requirements of the RS-approved documentation.

The mother pipes having a certificate issued by ACS (including the Manufacturer's Certificate endorsed by ACS) or supervisory body recognized by RS may be used as agreed upon with the Register.

2.12.2 Requirements for bend materials.

2.12.2.1 The metal chemical composition of bends shall correspond to pipe steel grades. Upon agreement with the Register, the chemical composition of bend material may be modified with respect to the standards for pipes to obtain satisfactory combination of weldability, hardenability, strength, ductility, viscosity and corrosion resistance as well as properties required for manufacture of forgings/castings (if used for manufacture of fittings). In such case, the carbon equivalent (P_{cm}) may exceed the requirements for the base metal of pipes of appropriate grade not mote than 0,02.

2.12.2.2 Mother pipes and rolled products used for manufacture of bends shall meet the requirements for linear pipes designed for operation in the acidic media. The sulphur content shall not exceed 0,003 % (0,002 for steels subject to thermo-mechanical rolling).

2.12.3 Requirements for technical documentation.

2.12.3.1 The documentation on bends submitted for the RS review shall contain the following:

.1 number of bends of specific type of each size within the project;

.2 applied design standard;

.3 type of billets, supplier, supply conditions;

.4 material grade;

.5 specification and certificates for billet material indicating data on chemical composition, heat treatment, mechanical properties, dimensional and non-destructive testing;

.6 repair procedure for billets, if applicable;

.7 bend geometry (for example, nominal or internal diameter, maximum wall thickness, bending radius, bending angle, lengths of straight sections on bend edges, treatment of ends, deviations from the round section shape including required tolerances);

.8 specific dimensional requirements and tolerances;

.9 minimum and maximum operating temperature;

.10 heat treatment conditions after manufacture, if applicable;

.11 requirements for the scope and methods of testing for bend metal specimens;

.12 requirements for inspection and hydraulic tests;

.13 surface conditions at delivery, coatings or painting.

2.12.3.2 Prior to commencement of type approval procedure by the Register, the manufacturer shall develop and agree upon with the Register the type approval test program according to the requirements of 2.12.4.

2.12.4 Requirements for bend tests.

2.12.4.1 According to the RS-approved technical documentation a test bend specimen subject to tests and inspection prior to commencement of series production shall be manufactured. Based on the results of check tests of the test bends, the technical documentation may be amended.

2.12.4.2 The scope of tests for test bends and bends during manufacture shall comply with Table 2.12.4.2. If a number of bends to be manufactured is less than 50, the type approval tests and tests during manufacture may be combined.

Table 2.12.4.2

Requirements to scope of tests and inspections of bends

Type of test and inspection	SP operational reliability level			Acceptance criteria
	0, 1	2	3	
Chemical composition	P	P	P	As for linear pipes, unless otherwise agreed with the Register
Tensile testing (parameters of base metal to be determined — R_m, $R_{t0,5}$, $R_{p0,2}$, A_5, weld joint parameter to be determined — R_m)	T	T	T	As for linear pipes, non-straightened cylindrical specimens are allowed
Impact test for wall thickness t, in mm, of more than 5 mm	—	T	T	Test temperature $T_p - t$, mm + 10 °C but not exceeding $T_p - 10$ °C. Impact energy for both metal of linear pipes, correction is proportional to the thickness of specimens
Hardness on transverse sections	T	T	T, S	For requirements of level 1 and 3 — not more than 300 HV10 or equivalent when using the other method. For level 2 requirements — not more than 250 HV10
Surface hardness	T, M	T, M	T, M	The value is similar to that on transverse sections. Average values along the manufactured branch areas shall not deviate from the appropriate average values on the prototype branch by more than equivalent 30 HV10
Metallography	T	T	T	The maximum grain size in the base metal and weld area — 7
Hydrogen cracking	—	T(P)	—	CSR $\leqslant$ 2 %, CLR $\leqslant$ 15 %, CTR $\leqslant$ 5 %
Stress-corrosion tests	—	T(P)	—	Absence of cracks and tears on the extended surface
Drop weight tests at wall thickness t, in mm, of more than 7,5 mm	—	T, S	T, S	80% fibre component in the fractures at T_p for full thickness specimens, or at $[T_p - 20\ln(t/19\ \text{мм})]$ °C for specimens 19 mm thick from the wall above 19 mm thick
CTOD at wall thickness above 7,5 mm	—	T, S	T, S	As for linear pipes
Face-bend of weld joints from both sides of the weld	P	P	P	At least 120°
Visual testing	T, M	T, M	T, M	As per specifications
Ultrasonic or radiographic weld testing	P	T, M	T, M	As for linear pipes
100 % ultrasonic testing of the weld made by high-frequency current welding (longitudinal defects)	—	T, M	—	A signal corresponds to notch with the depth of 10 % thickness
Magnetic particle/dye-penetrant testing of bend ends in the area 100 mm wide	M	M	M	Delaminations up to 6 mm in the circumferential direction
Ultrasonic testing of the area 50 mm wide around bend butt ends	M	M	M	Delaminations up to 6 mm in the circumferential direction or of area up to 100 mm^2
Magnetic particle/dye-penetrant testing of the metal of the extended bend part	T, M	T, M	T, M	Readings up to 3 mm
Ultrasonic testing of the extended bend part (transversal defects)	—	T, M	T, M	As accepted in specifications
100 % ultrasonic testing of the pipe body	—	T, M	T, M	As accepted for linear pipes. For requirements of level 2, delamination area is limited to 100 mm^2
100 % ultrasonic testing weld area 50 mm wide	—	T, S	—	Length up to 6 mm, max. three per 1 m length
Remanent magnetization of bend ends	M	M	M	Remanent magnetization shall not exceed 2 mT (20 G)
Repairs	M	M	M	As per specifications
Wall thickness	T, M	T, M	T, M	Generally minimum thickness is equal to nominal thickness of linear pipes, and maximum thickness is as accepted in specifications
Diameter of bend body D	M	M	M	As per specifications or as for linear pipes
Diameter of bend ends	M	M	M	As per specifications or as for linear pipes
Out-of-roundness of bend ends	M	M	M	Not more than 1,5 % or as for linear pipes
Out-of-roundness of bend body	M	M	M	Not more than 2,5 % at $r_b \geqslant 5D$, not more than 3 % at $3D < r_b < 5D$
Linear dimensions including length of straight parts	M	M	M	$\pm$30 mm
Bending angle	M	M	M	$\pm$0,75°

Table 2.12.4.2 — continued

Type of test and inspection	SP operational reliability level			Acceptance criteria
	0, 1	2	3	
Bending radius r_b	S	S	S	$\pm$1 %, but not more than $\pm$10 mm
Squareness of ends edges	M	M	M	Not more than 1,6 mm
Out-of-plane position of bend ends	M	M	M	$\pm$(Bending angle $\times$ 10) / 90, mm, but not more than 5 mm
Waving on internal surface of bend	M	M	M	Maximum height of waving not more than 1 % of actual outside bend diameter, ratio of distance between adjacent waves to their height no less than 25
Treatment of bend ends	M	M	M	As per specifications
Surface condition	M	M	M	As per specifications
Hydraulic tests	T, M	T, M	T, M	With no cracks, tears and visible distortions, test pressure according to design documentation
Gauging of bend bore	T, M	T, M	T, M	According to 2.6.5.3.6

S y m b o l s :
P — test results for pipe billets are used. Otherwise, the test bend shall be tested;
T — on test bend only;
M — on all manufactured bends;
S — on some manufactured bends (depending on manufacture stability indicators as agreed upon with the Register).

2.12.4.3 The hardness of hot bends for SP/spool pieces of class **L2** and **G2** shall be up to 250 HV10. Upon agreement with the Register, for external side of the bend, the hardness shall be up to 275 HV10 provided that the outer surface is not exposed to the acidic media, wall thickness more than 9 mm and absence of hydrogenation.

2.12.4.4 The RS recognition based on check test results of the test bend specified in Table 2.12.4.2 may be applied to production batches of bends that differ from test bend as specified in Table 2.12.4.4.

T a b l e 2.12.4.4

Permissible deviations from type bend parameters during manufacture

Significant parameter	Permissible deviations relative to parameters of test bend manufacture
Steel smelting and pipe billet manufacture procedure	Without deviations
Chemical composition by ladle analysis	For carbon and low alloy steels — $\pm$0,02 % C, $\pm$0,03 C_{eq} and/or $\pm$0,02 P_{cm}, for stainless steel and cladding layer without deviations of nominal composition
Pipe billet seam, welding procedure, consumables	Without deviations
Surface condition	To be agreed upon with the Register
Nominal diameter of pipe billet D	Without deviations
Nominal wall thickness of pipe billet	$\pm$3 mm
Bending radius r_b	For $r_b \leqslant 5D$ (0 to + 25) %, for $5D < r_b \leqslant 10D$ (0 to + 100) % for $r_b > 10D$ — without limitations
Casting rate	$\pm$2,5 mm/min
Casting temperature	$\pm$25 °C with no changes in number and arrangement of pyrometers used
Structure of heating coil and its alignment tolerances	Without deviations
Induction heating power	$\pm$5 % in steady mode (for seamless pipes to be agreed upon with the Register)
Induction heating frequency	$\pm$20 %
Cooling liquid, number and size of cooling metal tubes	Without deviations
Flow rate/pressure of cooling liquid	Without deviations ($\pm$10% upon agreement)
Cooling liquid temperature	$\pm$15 °C
Weld position relative to bending plane	$\pm$15° of position on the test bend
Heat treatment after bending	Method — without deviations, holding time (0 to + 15) min, holding temperature +15 °C, heating and cooling rates shall be agreed

2.12.4.5 The batch comprises not more than 50 branches of the same size, steel grade, manufactured on the basis of the same procedure and subjected to the same heat treatment.

2.12.4.6 Examples of specimens cutting-out locations for mechanical tests are shown in Fig. 2.12.4.6, for the number, orientation and position of specimens, refer to Table 2.12.4.6.

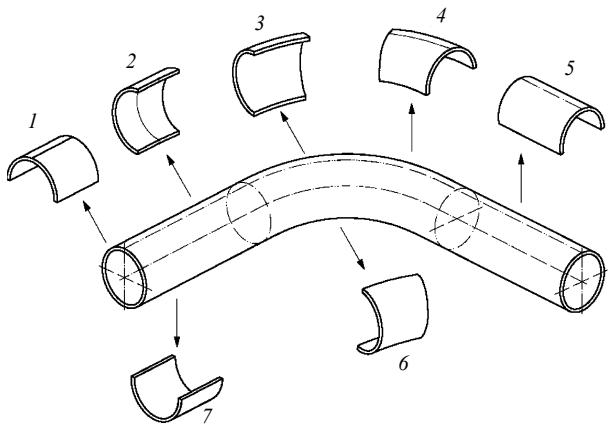

Fig. 2.12.4.6
Cutting-out specimens locations of bends:
1 — weld of the straight end, 2 — metal of transient area (start and end heating areas),
3 — metal of external side of the bend, 4 — bent weld, 5 — weld of transient area (start and end),
6 — metal of internal side of the bend, 7 — base metal of the straight end

Table 2.12.4.6

Number, orientation and position of specimens

Position	Test
Base metal of the straight end[1]	Tension, impact, hardness on transverse sections
Weld of the straight end[1]	Tension across the weld, impact, hardness on transverse sections, metallography, bending on a mandrel
Start and end heating areas, base metal from the external side of the bend[2]	Tension, impact, hardness on transverse sections, metallography
Start and end heating areas, weld[2]	Transverse tension, impact
Base metal of the bend from the external side of the bend	Tension, impact, hardness on transverse sections, drop weight test[3], CTOD[3], hydrogen cracking[4] and stress-corrosion[4]
Base metal of the bend from the internal side of the bend	Tension, impact, hardness on transverse sections
Metal of the bent weld[5]	Tension across the weld, impact, hardness on transverse sections, metallography, bending on a mandrel, CTOD[3], hydrogen cracking[4] and stress-corrosion[4]

[1]No tests after bending are required if test results for mother pipe are available and branch ends are not subject to heat treatment during and after bending.
[2]If the whole length of the mother pipe is subject to the uniform induction heating, the transient areas are considered to be absent, unless otherwise provided in specifications.
[3]As required by the Register.
[4]For requirements of level 2 only.
[5]Spiral-welded pipes are subject to additional tests as required by the Register.

2.13 STEEL FITTINGS

2.13.1 General.

2.13.1.1 Steel fittings for subsea pipelines constructed (subject to repair or modernization) under the RS technical supervision shall meet the requirements of Section 4.8, Part I "Subsea Pipelines" of the SP Rules and take into account the reliability level required for subsea pipelines (refer to 2.1.7.1).

2.13.1.2 Steel fittings for SP shall be produced by the manufacturers having the Recognition Certificate for Manufacturer (СПИ) (form 7.1.4.1) issued by the Register (refer to the SP Nomenclature in Table 1.6.1) and under the RS technical supervision.

2.13.1.3 General requirements for recognition of fittings manufacturer shall comply with 2.2.2.2 to 2.2.2.4.

In some cases, upon agreement with the Register, fittings for SP may be produced at the manufacturer without the RS recognition provided that additional tests during manufacture in a scope required for manufacture recognition are carried out.

2.13.1.4 According to 1.6, supply of fittings for subsea pipelines shall be carried out with the Certificate to be filled in and signed by the firm's (manufacturer's) official and issued (affirmed) by the Register (С3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (С3), the manufacturer shall submit a request to the Register.

2.13.1.5 In the course of the RS technical supervision during manufacture of fittings, billets (forged, stamped or cast) supplied to the firm (manufacturer) shall be type approved by the Register (with the RS Type Approval Certificate) according to the requirements of the RS-approved documentation.

The billets with a certificate issued by ACS (including the Manufacturer's Certificate endorsed by ACS) or supervisory body recognized by RS may be used as agreed upon with the Register.

2.13.2 Requirements for fitting materials.

2.13.2.1 The requirements for fitting materials shall comply with 2.12.2.1.

2.13.3 Requirements for technical documentation.

2.13.3.1 The documentation on fittings submitted for the RS review shall contain the data specified in 2.12.3.1. Technical documentation shall also contain the following:

.1 information on billet type, steel grade and method of smelting;

.2 methods and parameters of forming (forging, stamping, casting), welding, machining;

.3 welding procedure and chemical composition of weld metal including repair by welding;

.4 parameters of post manufacture heat treatment;

.5 requirements to tests and inspection of test and manufactured fittings including sampling procedure for pilot and manufactured fittings;

.6 procedures for visual and measuring as well as non-destructive testing.

2.13.3.2 Prior to commencement of type approval procedure by the Register, the manufacturer shall develop and agree upon with the Register the type approval test program according to the requirements specified in 2.13.4.

2.13.4 Requirements for fitting tests.

2.13.4.1 According to the RS-approved technical documentation a test fitting specimen subject to tests and inspection prior to commencement of series production shall be manufactured. Based on the results of test fittings check tests, the technical documentation may be amended.

2.13.4.2 The scope of tests for type (test) fittings and fittings during manufacture shall comply with Table 2.13.4.2. If a number of flanges to be manufactured is less than 50, the type approval tests and test during manufacture tests may be combined.

2.13.4.3 The fittings are tested and inspected after final heat treatment. If steady conditions for heat treatment cannot be followed, test specimens shall be taken from the metal of each heat treatment furnace charge.

2.13.4.4 Specimens for mechanical tests shall be taken from finished (test) fittings or special allowances for sampling formed and treated integral with the fitting.

Table 2.13.4.2

Requirements to scope of tests for fittings

Type of test and inspection	SP operational reliability level			Acceptance criteria
	0, 1	2	3	
Chemical composition	S	S	S	Ladle sample and finished product according to specifications
Tensile testing of the base metal on transverse specimens (base metal parameters to be determined — R_m, $R_{t0,5}$, $R_{p0,2}$, A_5)	T, S	T, S	T, S	As for linear pipes of appropriate strength class, non-straightened cylindrical specimens are allowed. If nominal diameter is less than 210 m, specimens are longitudinal
Welded joint tensile testing (R_m to be determined) for nominal diameter at least 210 mm	T, S	T, S	T, S	As for linear pipes, non-straightened cylindrical specimens are allowed
Impact test of the base metal and welded joint for wall thickness t, in mm, of more than 5 mm	T, S	T, S	T, S	Test temperature $T_p - t$, mm + 10 °C but not exceeding T_p – 10 °C. Impact energy for both metal of linear pipes, correction is proportional to the thickness of specimens
Hardness on transverse sections	T, S	T, S	T, S	For requirements level 1 and 3: not more than 300 HV10 or equivalent when using the other method. For level 2 requirements not more than 250 HV10
Surface hardness	T, S	T, S	T, S	The value is similar to that on transverse sections. Average values along the manufactured fitting areas shall not deviate from the appropriate average values on the prototype fittings by more than equivalent 30 HV10
Metallography	T	T, S	T	The maximum grain size in the base metal and weld area — 7
Hydrogen cracking	—	T(P)	—	CSR ⩽ 2 %, CLR ⩽ 15 %, CTR ⩽ 5 %
Stress-corrosion tests	—	T(P)	—	Absence of cracks and tears on the extended surface
CTOD at wall thickness above 7,5 mm	—	T	T	As for linear pipes
Face-bend test of weld joints from both sides of the weld	T	T	T	At least 120°
Visual examination	T, M	T, M	T, M	As per specifications
Ultrasonic testing/radiographic weld testing	P	T, M	T, M	As for linear pipes
Magnetic particle/dye-penetrant testing of the treated fitting ends	M	M	M	Readings up to 2 mm
Magnetic particle/dye-penetrant testing of fitting ends in the area 100 mm wide	M	M	M	Delaminations up to 6 mm in the circumferential direction
Ultrasonic testing of the area 50 mm wide at fitting butt ends	M	M	M	Delaminations up to 6 mm in the circumferential direction or of area up to 100 mm^2
Ultrasonic/magnetic particle testing of the fitting body	S	S	S	As accepted for linear pipes. For level 2 requirements, delamination area is limited to 100 mm^2
100 % ultrasonic testing weld area 50 mm wide	M (P)	M (P)	M (P)	Length up to 6 mm, max. three per 1 m length
Remanent magnetization at fitting ends	S	S	S	Remanent magnetization shall not exceed 2 mT (20 G)
Repair	M	M	M	As accepted in specifications
Wall thickness	T, M	T, M	T, M	Minimum thickness without tolerance, maximum as per specifications
Internal diameter at fitting ends	M	M	M	As accepted in specifications
Deviation from the round shape at fitting ends	M	M	M	Not more than 1,5 %
Dimensions as per specifications	M	M	M	As per specifications
Treatment of ends	M	M	M	As per specifications
Surface condition	M	M	M	As per specifications
Hydraulic tests	T, M	T, M	T, M	With no cracks, tears and visible distortions, test pressure as per design documentation

Symbols:
P — test results for pipe billets are used. Otherwise, the test fitting shall be tested;
T — on test fitting only;
M — on all manufactured fittings;
S — on some manufactured fittings.

2.13.4.5 The scope of tests for fittings shall comply with the requirements specified in Table 2.13.4.5.

Table 2.13.4.5

Requirements to scope of tests for fittings

Type of test	Scope of tests
Chemical composition	One per cast
Base metal tensile testing	One per batch[1]
Tensile testing transverse to the weld	One per batch[1]
Impact test, fitting body	One set — 3 specimens per batch
Impact test, weld	For thickness up to 26 mm — one set, for thickness of 26 mm and above — two sets[2]
Hardness on transverse sections	One per batch[1]
Surface hardness	As agreed
Metallography	As agreed
Hydrogen cracking	As agreed
Stress-corrosion	As agreed
Pitting corrosion (for stainless steel only)	One per batch
CTOD	As agreed
Weld bend	Two during recognition
Non-Destructive Testing (NDT)	Each fitting
Remanent magnetization	Upon agreement for fittings subject to demagnetization during manufacture or 25 % of random fittings
Dimensional check	Each fitting

[1]Fittings subject to heat treatment based on the same documented procedure with recorded treatment cycle parameters may be considered as a single batch.

[2]The second set shall be taken from the mid-thickness.

2.14 INSULATING JOINTS AND FLANGES

2.14.1 General.

2.14.1.1 The insulating joints for SP shall comply with the requirements of 7.5, Part I "Subsea Pipelines" of the SP Rules, national and/or international standards.

2.14.1.2 Insulating joints shall be manufactured and fitted onto SP according to the RS approved technical documentation, and have the Type Approval Certificate (CTO) (form 6.8.3) (refer to the SP Nomenclature in Table 1.6.1).

2.14.1.3 Requirements for type approval of insulating joints shall comply with 2.6.1.3 and 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens shall be subject to tests according to the requirements of 2.14.3.

2.14.1.4 According to 1.6, the insulating joints for subsea pipelines shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by firm's (manufacturer's) official and issued (affirmed) by the Register (C3) (form 6.5.31) (refer also to 1.8.3 and 1.8.4). To obtain the Certificate (C3), the firm shall submit a request to the Register.

2.14.2 Requirements for technical documentation.

2.14.2.1 Technical documentation on insulating joints subject to the RS-approval shall include the following:

structural drawings for insulating joints;

design drawings for insulating joints with indication of the materials used (refer to 2.14.2.2);

strength calculation;

welding procedures for insulating joints;

assembly procedure;

coating procedure;

installation procedure.

2.14.2.2 Specifications and/or certificates for the following components and materials of insulating joints:

metal forgings;

insulating and sealing rings;

filler;

external and internal coating;

external spark gap, if any.

2.14.3 Requirements for insulating joints tests.

2.14.3.1 At survey by the Register during insulating joints manufacture, the following type (periodical) and check (production) tests and checks shall be performed.

2.14.3.2 The insulating joints of each type and size are subject to type (regular) tests in the following scope:

combined internal hydraulic pressure and torsional moment;

combined internal hydraulic pressure and bending moment;

fracture strength tests.

2.14.3.3 The check tests during manufacture for each product shall include the following:

the scope of non-destructive testing for welded joints shall comply with 4.3.8, Part I "Subsea Pipelines" of the SP Rules;

check of overall and end-to-end dimensions of the insulating joint;

the insulating joint shall be subject to strength test with internal hydraulic pressure of 1,5 times the design pressure within at least 60 min. Leakage and yielding is not allowed;

the insulating joint shall be subject to cycle strength fatigue test with internal hydraulic pressure from 1,0 MPa to 85 % of 1,5 the design pressure. The number of cycles shall be equal to 40. Following cycle fatigue test, internal pressure is increased up to 1,5 times the design pressure within at least 30 min. Leakage and yielding is not allowed;

leak tests of the insulating joints shall be carried out after internal hydraulic pressure strength test. Leak test is carried out with internal pressure at least 0,6 MPa by pneumatic method within at least 30 min. Air bubbles are not allowed;

dielectric strength test of insulating joints shall be carried out with AC voltage of at least 3500 V, frequency 50 Hz. Creepage current shall not exceed 25 mA. This test shall be carried out before strength tests and after leak tests;

measurement of 1000 V DC resistance of the insulating joint is carried out before strength tests and after leak tests. Electric resistance shall be at least 5 MOhm;

corrosion-protection coating is subject to thickness measurements and holiday detection.

2.14.4 The insulating joint shall be marked with the following information:

name of manufacturer and trademark;
number of serial/batch;
designation of product;
date of manufacture;
material grade for metal tubes;
external diameter, in mm;
wall thickness, in mm;
working pressure, in MPa;
test pressure, in MPa;
weight, in kg;

The marking method shall ensure its integrity during the service life of the insulating joint.

2.15 POLYMER COMPOUNDS

2.15.1 General.

2.15.1.1 Polymer compounds (two and multicomponent) for SP under construction or in service under the RS technical supervision shall be applied according to the technical documentation approved by the Register and shall have Type Approval Certificate (CTO, form 6.8.3), refer to the SP Nomenclature (Table 1.6.1).

2.15.1.2 Requirements for type approval of polymer compounds shall comply with 2.6.1.3, 2.6.1.5 to 2.6.1.7. To issue Type Approval Certificate (form 6.8.3) the specimens of polymer compound shall be tested according to the requirements of 2.15.2.

2.15.1.3 Firm (manufacturer) applying polymer compound, for example, to fill the gaps between galvanic anode and concrete coating or on non-concrete coated areas of pipe joints including with thermal insulation shall submit for approval to the Register a set of documentation comprising as a minimum the following:

.1 list of technical data for each main component of polymer compound;

.2 Certificates of Compliance (certificates/statements, including ones issued by supervisory bodies) for main components of polymer compound;

.3 specifications (firm's procedures and/or standards) for application of polymer compound and necessary testing including type (periodical) and check (production) tests;

.4 Inspection and Test Plan for polymer compound application;

.5 firm's (manufacturer's) data on safety of each component of polymer compound.

2.15.2 Requirements for type approval tests of polymer compounds.

2.15.2.1 This type of testing is carried out for the RS type approval of polymer compounds, and the provisions specified in 2.6.1.7 may be taken into account. The scope of type approval tests may be changed by RS as agreed with the customer.

2.15.2.2 Type approval tests are carried out to check the parameters of polymer compounds specified in Table 2.15.2.2:

Table 2.15.2.2

Parameters of polymer compounds

Description (process sample testing is allowed)	Recommended parameters of polyurethane compounds
1 Pot life/curing time, minutes	2 — 8 / 10 — 40
2 Apparent density, kg/m^3, max	1,1
3 Tensile stress at break, MPa, min	2,5 — 8,0
4 Relative elongation at break, %, min	150 — 60
5 Breaking stress at tear, N/mm, min	6,0 — 15,0
6 Shore hardness, value units	(50 — 90) $\pm$ 5
7 Water absorption after boiling in distilled water for 90 minutes, %, max	5
8 Thermal conductivity, W/(m·°C), max	0,2
9 Adhesion to pipeline materials	if required by the Register

2.15.2.3 The tests specified in Table 2.15.2.2 are allowed to be carried out according to methods of national and/or international standards to confirm compliance with requirements of the RS-approved technical documentation.

2.15.3 Requirements for survey of polymer compound during manufacture.

2.15.3.1 The RS technical supervision during polymer compound application is carried out by the Register at the firms with type approval for this type of applied compound and is performed on the basis of the RS-approved technical documentation (specifications, Inspection and Test Plans, etc.).

2.15.3.2 The RS technical supervision when applying polymer compound is carried out on the basis of an application/contract with the firm in accordance with the requirements specified in 1.4 of the SP Guidelines.

2.15.3.3 The technical supervision during manufacture is carried out based on RS-approved technical documentation (specifications, Inspection and Test Plans, etc.), national/international standards. The RS shall mandatorily check material incoming inspection procedure according to the approved documentation.

2.15.3.4 After the compound is applied and cured, its appearance shall be checked: no delamination from forming surfaces, cracks, unfilled spaces and large cavities are allowed. Two times per shift and at the beginning of new compound batch application, the quality of process sample is checked for parameters 1 and 2 of Table 2.15.2.2. To determine the structure, the obtained specimen is cut along its vertical axis, and the section shall be homogeneous and solid (no porosity and irregularities are allowed).

2.15.3.5 Pipes and pipeline strings with applied polymer compound shall be delivered with the copy of the firm's Type Approval Certificate (CTO).

2.16 INTERNAL ANTI-FRICTION COATINGS

2.16.1 General.

2.16.1.1 Internal anti-friction coatings designed to reduce hydraulic resistance and provide corrosion protection of SP steel pipes and bends manufactured under the RS technical supervision shall comply with the requirements of 7.2, Part I "Subsea Pipelines" of the SP Rules, national and/or international standards and this Section of the SP Guidelines.

2.16.1.2 Internal anti-friction coatings shall be applied on steel pipes and bends in accordance with the RS-approved technical documentation and have Type Approval Certificate (CTO, form 6.8.3), refer to the SP Nomenclature (Table 1.6.1).

2.16.1.3 Requirements for type approval of internal anti-friction coatings shall comply with 2.6.1.3, 2.6.1.5 to 2.6.1.7. To obtain the Type Approval Certificate (CTO) (form 6.8.3), the specimens of anti-friction coatings shall be subject to tests according to the requirements of 2.16.3.

2.16.1.4 Internal anti-friction coating may be applied on steel pipes and bends with or without external corrosion protection coating. Internal anti-friction coating may be applied before and after application of external corrosion protection coating.

2.16.1.5 For type approval of the coating and its application procedure the firm (manufacture) involved in application of internal anti-friction coating to SP steel pipes and bends shall submit to the Register for approval a set of documents which as a minimum includes:

.1 specifications (firm's procedures and/or standards) for application of internal anti-friction coating and necessary tests including type (periodical) and check (production) tests;

.2 list of technical data sheets for materials included in anti-friction coating composition and ensuring coating properties complying with specifications;

.3 Certificates of Compliance (certificates/statements including ones issued by supervisory bodies) for each batch of materials which shall contain the information on material manufacturer, name (type) of material, date of manufacture and material shelf life;

.4 Inspection and Test Plan for coating application;

.5 firm's (manufacturer's) data on safety of each coating component;

.6 instruction on internal anti-friction coating defects repair.

2.16.1.6 According to 1.6, steel pipes and bends for subsea pipelines with internal anti-friction coating applied shall be delivered with the copy of Type Approval Certificate (CTO) and the Certificate to be filled in and signed by the firm's (manufacturer's) official and issued (affirmed) by the Register (C3, form 6.5.31), refer also to 1.8.3 and 1.8.4. To obtain the Certificate (C3), the manufacturer shall submit a request to the Register.

2.16.1.7 In the course of the RS technical supervision during application of internal anti-friction coating, the pipes and bends/fittings supplied to the firm (manufacturer) shall be approved by the Register (have RS Type Approval Certificate) according to the requirements specified in 2.4, 2.12 and 2.13.

2.16.2 Requirements for materials contained in anti-friction coatings.

2.16.2.1 Materials of internal anti-friction coatings shall comply with the requirements of national and/or international standards and RS-approved documentation. Selection of materials depending on SP operating conditions shall comply with the requirements of 7.2, Part I "Subsea Pipelines" of the SP Rules. In general, paint coatings on the basis of epoxy resin, modified epoxy resin and other types of paint coatings are used to prepare internal anti-friction coatings.

2.16.2.2 Materials contained in internal anti-friction coating shall be subject to incoming inspection at the firm (manufacturer) in a scope as agreed upon with the Register to show compliance with the certificate (passport) data, check package (container) integrity and individual indices of material properties.

2.16.3 Requirements for type approval tests of internal anti-friction coatings.

2.16.3.1 These tests are aimed at the RS type approval of internal anti-friction coatings. In such case, the provisions of 2.6.1.7 may be taken into account. The scope of type approval tests may be amended by the RS as agreed upon with the customer.

2.16.3.2 Type tests are performed to check as a minimum the following parameters of internal anti-friction coatings:

.1 coating thickness (compliance with rated thickness in accordance with RS-approved specifications and other technical documentation);

.2 holiday detection at voltage of 9 V;

.3 coating roughness, R_z, not more than 15 μm;

.4 Buchholz hardness at specified temperature, not less than 94;

.5 coating adhesion to steel after water soaking;

.6 blistering tests (absence of swelling);

.7 resistance in salt spray within specified time, but not less than 500 hours;

.8 immersion in saturated $CaCO_3$ solution in distillate water for 21 days;

.9 resistance to solvent after soaking for not less than 4 hours;

.10 resistance to abrasion;

.11 coating resistance under changes in gas/hydraulic pressure.

The test temperatures shall be specified and agreed upon with the Register depending on operating and storage conditions for pipes and bends/fittings as well as minimum and maximum temperatures of transported medium.

The tests specified in 2.16.3.2.1 to 2.16.3.2.11 are allowed to be carried out according to methods of national and/or international standards to confirm compliance with requirements of the RS-approved technical documentation.

2.16.4 Requirements for tests of internal anti-friction coating during manufacture.

2.16.4.1 The RS technical supervision during internal anti-friction coating application is carried out by the Register at firms (manufactures) with the type approval for this type of coating. Otherwise, for approval of production batch, both type approval tests of internal anti-friction coating and tests during manufacture shall be carried out under the RS technical supervision according to the requirements of this Section.

2.16.4.2 The RS technical supervision during application of internal anti-friction coating is carried out on the basis of an application/contract with the firm in accordance with the requirements of 7.2, Part I "Subsea Pipelines" of the SP Rules and the requirements of this Section. General requirements for the RS technical supervision shall comply with 2.7.1.4.1 to 2.7.1.4.4.

2.16.4.3 The RS technical supervision during manufacture is performed on the basis of the RS-approved technical documentation (specifications, Inspection and Test Plans, etc.), national/ international standards and includes the following:

tests and inspections witnessed by the RS representatives;

issue of RS documents according to the test and inspection results.

2.16.4.4 The tests and check operations during application of internal anti-friction coating of SP pipes and bends at the firm (manufacturer) shall take into account the following parameters:

.1 check of coating appearance;

.2 measurement of coating thickness (on at least 10 % of pipes from the batch and 100 % of bends);

.3 length measurement of the end areas of pipes and bends without coating in accordance with the RS-approved technical documentation (on each pipe or bend);

.4 coating holiday detection (the whole internal surface of pipes and bends except for end areas);

.5 Buchholz hardness test (on at least 10 % of pipes from the batch and 100 % of bends).

2.16.4.5 Where the results of tests of internal anti-friction coating are unsatisfactory for at least one of the parameters, the repeated tests to check this parameter shall be conducted on the doubled number of pipes from the same batch. In case of unsatisfactory results of repeated tests, the pipes and bends may be accepted individually with checks of parameter for which unsatisfactory results were obtained. In case of unsatisfactory results of individual testing, the coating shall be rejected.

2.16.4.6 During application of internal anti-friction coatings according to 1.3.11, the RS technical supervision is recommended to be carried out on the basis of RS-agreed Inspection and Test Plan as agreed upon with the customer. For each test supervised by the RS surveyor (during the RS survey), the Inspection and Test Plan shall contain reference to the RS-approved technical documents including the following: detailed design documentation, specifications, standards, etc. In all other respects, Inspection and Test Plans shall comply with the requirements specified in 1.3.12.

3 TECHNICAL SUPERVISION DURING CONSTRUCTION OF SUBSEA PIPELINES

3.1 GENERAL

3.1.1 Technical supervision during SP construction shall be performed on the basis of the agreement (contract) concluded between the Register and the customer (contractor carrying out SP construction) in accordance with the requirements specified in 1.4.

3.1.2 The firm shall ensure the necessary conditions for performance of the RS technical supervision according to the requirements of 12.7, Part I "General Provisions for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships. Any offshore/shore-based operations shall be carried out according to the firm's duly approved normative documents which regulate health and environmental protection in compliance with the requirements of the RF supervisory bodies.

3.1.3 Prior to commencement of technical supervision during SP construction, the firm shall be audited for conformity to the requirements of 1.11. Based on the results of the audit, a Report (form 6.3.19) with an Annex (form 6.3.19f) shall be issued or the Certificate of Firm Conformity may be issued (refer to 1.11).

3.1.4 The technical supervision scope and procedure, types of checks, tests and inspections are specified in the List of SP technical supervision items during construction. The List shall be developed by the firm and agreed with the RS Branch Office which carries out technical supervision during SP construction. The List is based on the Nomenclature of items of the RS technical supervision of subsea pipelines (refer to Table 1.6.1), the requirements of this Section and the scope of approved detailed design documentation on each subsea pipeline subject to the RS technical supervision during its construction.

3.1.5 The List shall specify the items of technical supervision (including processes and individual works subject to the RS technical supervision) for:

pipes (including the preliminary applied corrosion-protection and weight coatings);

control of pipeline route design parameters;

procedure for pipeline assembly/welding (including repair of defective welds);

technical equipment for pipeline laying and laying procedure;

non-destructive testing of welded joints;

control of laying parameters;

application of corrosion-protection coatings to field joints;

fitting of galvanic anodes and/or cathodic protection;

setting of valves and inspection of flanged (mechanical) joints;

pigging and hydraulic tests of the pipeline;

mounting of automation, alarm and technological communications systems;

control of laid pipeline parameters along the route (including the value of a pipeline burial into the seabed).

3.1.6 Scope of surveys, numbers of approved drawings, layouts, procedures, programs of tests, production processes, etc. shall be indicated in the List for each item of technical supervision.

3.1.7 Each presentation to the surveyor, covering one or several similar items of technical supervision or works completed at the particular stage of construction shall correspond to each item of the List. The construction sequence and other SP construction conditions shall be taken into account.

3.1.8 Upon agreement with the RS Branch Office may use one or several documents elaborated by the firm in compliance with its existing practice such as Inspection and Test Plan (refer to 1.3.11 and 1.3.12), Technical Acceptance Book, a standard of the firm for submitting completed works to the Register or another similar document.

3.1.9 The surveys according to the List are conducted by the RS surveyor after submitting by the firm's technical control body, the technical supervision item or the scope of completed works and documented which is finally checked and properly prepared for submission to the Register.

3.1.10 The survey under the List is mainly aimed at checking of the quality of the item of technical supervision at a particular stage of manufacture as provided by the production process, and permission for further stages of SP construction.

3.1.11 If nonconformities or deviations from approved documentation are revealed, the surveyor shall demand their elimination and, if necessary, repeated submission of item of supervision to the survey.

3.1.12 Along with surveys performed according to the List (or documents replacing it according to 3.1.8), the surveyor may conduct periodical inspections not associated with the official presentation by the firm's technical control body, but resulting from the Register's functions on technical supervision at the firm or specified by the SP Rules and other normative documents of the Register, and also stipulated by the contract on technical supervision. Based on results of the inspections, the surveyor may impose the requirements specified in 3.1.11.

3.1.13 The RS technical supervision during SP construction in the Russian offshore and inland water areas is carried out irrespective of the control by the RF supervisory bodies, unless otherwise specified by special agreements.

3.2 TECHNICAL DOCUMENTATION

3.2.1 Technical supervision during SP construction shall be carried out on the basis of the SP design and detailed documentation approved by the Register.

3.2.2 Prior to commencement of technical supervision of steel SP construction, the Register shall thoroughly check the availability of the following documents:

RS Welding Procedure Approval Test Certificates, for welding processes used at the firm, including those for welds repair;

RS certificates which confirm the qualification of welders and personnel with regard to non-destructive testing of welds;

RS certificates which confirm the conformity of welding consumables.

3.2.3 While carrying out the technical supervision of SP construction in compliance with 8.1.2, Part I "Subsea Pipelines" of the SP Rules and 3.1.6 of the SP Guidelines, the Register shall examine and approve the relevant technical documentation (refer to 3.3.3, 3.4.1, 3.4.3, 3.5.1, 3.6.1.3, 3.6.2.5, 3.7.1.2 to 3.7.1.4, 3.7.2.2 to 3.7.2.4, 3.7.3.2, 3.7.4.3).

3.3 WELDING. CERTIFICATION OF WELDERS

3.3.1 The approval test for welders, the Welder Approval Test Certificate, the conditions of validity and extension of the Welder Approval Test Certificate during construction (pipe laying) of steel subsea pipelines shall meet the requirements of 5.3.5, Part I "Subsea Pipelines" of the SP Rules.

3.3.2 Prior to commencement of technical supervision of steel SP construction, the tests of the base metal of pipes for weldability shall be submitted to the Register for survey in accordance with the requirements of 5.2.2, Part I "Subsea Pipelines" of the SP Rules which shall be conducted at the stage of recognition of the rolled products and/or pipes manufacturer.

3.3.3 The approval of welding procedures for circular field welded joints shall be carried out in accordance with the requirements of 5.2.3 and 5.3, Part I "Subsea Pipelines" of the SP Rules.

3.3.4 The requirements for inspection of girth field welded joints during SP construction shall be specified with regard to 5.4, Part I "Subsea Pipelines" of the SP Rules.

3.4 MATERIALS FOR SUBSEA PIPELINES

3.4.1 Pipes delivered to the firm (pipe-laying vessel/barge) for SP construction shall be submitted to the Register for inspection and checking the availability of the RS documents or other types of certificates agreed with the Register. In such case, the following parameters shall be generally monitored.

3.4.1.1 Field weld reinforcement inside the welded pipes and the pipeline welded parts manufactured with the use of double metal arc welding shall be removed to a residual value from 0 to 0,5 mm at a distance of at least 150 mm from the pipe ends.

3.4.1.2 Field weld reinforcement outside the pipe shall be removed by mechanical treatment (grinding) to a residual value from 0,5 to 1,0 mm at a distance from 10 to 15 mm from the pipe end. Removal of the weld outside reinforcement may be provided at a distance of at least 150 mm from the pipe ends to a value from 0 to 0,5 mm.

3.4.2 The storage conditions for pipes and welding consumables at the firm (pipe-laying vessel/barge) shall be surveyed at the stage of the firm's recognition.

3.4.3 The other materials and products for subsea pipelines are surveyed by the Register by checking the availability of the RS documents or other types of certificates agreed with the Register.

3.5 SUBSEA PIPELINE ROUTE

3.5.1 General.

3.5.1.1 Prior to SP construction, the route (or its sections for a long subsea pipeline) shall be prepared according to the technical documentation approved by the Register and be surveyed by the Register immediately before commencement of SP construction (pipe laying).

3.5.1.2 In cases specified in 8.2.1.8, Part I "Subsea Pipelines" of the SP Rules, the data on engineering surveys and route preparation shall be updated before commencement of SP construction works.

3.5.1.3 The following shall be separately surveyed by the Register:

profile of a trench for laying the subsea pipelines buried into the seabed considering the requirements of 8.2.10 and 8.2.11, Part I "Subsea Pipelines" of the SP Rules;

design of crossings (transitions) with the preliminary laid SP and cables considering the requirements of 8.2.3, 8.2.4 and 8.2.12, Part I "Subsea Pipelines" of the SP Rules.

3.5.2 Route crossing.

3.5.2.1 Prior to SP construction, route of existing pipelines and other subsea facilities at the area of SP crossing with linear facilities shall be marked with special buoys.

3.5.2.2 Directly prior to commencing construction of crossing with the preliminary laid SP, the Register shall be provided with the following for review and survey:

specifications from owners and/or operators of utilities to be crossed;

technical documentation on crossing with preliminary laid SP or cables;

method statement (MS) for design of crossing and laying of crossing SP;

materials of supports, concrete slabs, concrete mats, etc.;

any arrangements and equipment for pipelines handling (tensile forces for pipe-laying, towing tensions, additional supporting forces at SP negative buoyancy, etc.) which are pertinent in installation of SP crossings;

computational justification of the magnitude of the applied efforts to pipelines with allowable parameters of wind-wave effects and currents.

3.5.2.3 During construction the Register surveys certain operations according to approved MS depending on the selected method of crossing. Work control may include surveying using side-scan sonars, divers and CCTV via ROV.

SP shall not be laid (pulled) in the trench until the contractor confirms via engineering surveys that the parameters of the trench including construction of temporary supports comply with the requirements of the technical documentation on crossing approved by the Register.

Any alterations in procedures and parameters of SP laying as compared to the approved technical documentation shall be agreed with the Register.

3.6 FIRM'S PREPARATIONS (MOBILIZATION OF PIPE-LAYING VESSEL OR BARGE) FOR SUBSEA PIPELINES CONSTRUCTION

3.6.1 General.

3.6.1.1 The firm's preparations or the mobilization of a pipe-laying vessel/barge for SP construction shall be surveyed by the Register prior to commencement of works irrespective of the availability of the Register Recognition Certificate (ССП) (form 7.1.27) for the firm.

3.6.1.2 Prior to commencement of works, the pipe-laying vessel/barge shall be surveyed by the Register or ACS, which has classed the one, as a sea-going ship for the conformity to the requirements of the RS Rules (or ACS) and international conventions taking into account the need of a passage/towing to an operating area and of remaining there during SP laying.

3.6.1.3 The Register shall check the availability of the RS documents at the firm or the pipe-laying vessel/barge in compliance with the requirements of 1.9 to 1.11.

3.6.2 Mobilization of pipe-laying vessel/barge.

3.6.2.1 Prior to the immediate commencement of works on SP construction the following shall be submitted for the RS survey:

arrangements for pipe-laying vessel/barge positioning;

means for the initial anchoring of the SP to be laid;

a pipe-roller assembly or a reel for reeling on/reeling off strings;

a stinger for pipeline laying;

arrangements for string tensioning;

pipe welding stations (or stations for mounting circular flanged joints of FPMP);

stations for the non-destructive testing of field welds (butts) and reference blocks;

stations for coating process to field welds (butts);

stations for fitting anodes and/or ballast weights;

arrangements for additional buoyancy (supporting) forces for keeping the string of the laid SP afloat.

3.6.2.2 The following production accessories shall be subject to the RS survey:

arrangements for emergency abandonment and recovery of a string from water;

anchoring used at the initial stage of SP laying;

arrangement for lining-up of pipes;

devices to monitor the mode of deformation of the SP section being laid;

equipment for hoisting and movement of pipes.

3.6.2.3 The list of auxiliary vessels servicing the pipe-laying vessel/barge (tugs, anchor handling tugs, supply vessels, etc.) shall be in compliance with the project of work performance on SP construction approved by the Register, and the vessels themselves shall meet the requirements of 3.6.1.2.

3.6.2.4 The arrangements for pipe-laying vessel/barge positioning along with the vessel's (SP laid) position fixing system shall be tested before the commencement of works under operational conditions and witnessed by the Register. The positioning arrangements shall have at least 100 % redundancy with the positioning accuracy specified in a design ensured.

3.6.2.5 Where anchoring systems are used for positioning pipe-laying vessel/barge, the diagrams of anchors layout during the pipe-laying vessel/barge's movement along the SP route considering the requirements of 8.4.3 and 8.4.4, Part I "Subsea Pipelines" of the SP Rules shall be submitted to the Register.

3.6.3 Firm's preparations for SP construction.

3.6.3.1 The procedure for the RS survey shall be agreed with the firm before the commencement of works and shall be established with due regard for SP pipeline installation and laying.

3.6.3.2 In any case, the following shall be subject to preliminary survey:

technical documentation;

materials;

personnel;

equipment for pipe welding (installation) and non-destructive testing;

any arrangements and equipment for pipeline handling (tensile forces for pipe-laying, towing tensions, additional supporting forces at SP negative buoyancy, etc.) which are pertinent in SP installation, laying and burial.

3.6.3.3 Burial systems, if used, shall be fitted with the instruments for monitoring the value of the SP burial depth.

3.7 INSTALLATION, LAYING AND TESTS OF SUBSEA PIPELINES

3.7.1 Installation and laying of steel SPs with the use of pipe-laying vessels/barges.

3.7.1.1 The technical supervision scope and procedure are specified in the List of SP technical items of supervision during construction, which is developed by the firm and agreed with the RS Branch Office that carries out technical supervision during SP construction. The List is based on the Nomenclature of items of the RS technical supervision of subsea pipelines (refer to Table 1.6.1) and the design and production documentation approved by the Register. Where the pipe-laying vessel/barge is used for steel SP installation and laying, the List is based on Table 3.7.1.1.

Table 3.7.1.1

Items and types of technical supervision during SP construction

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
1 Welding procedures and non-destructive testing processes (at the stage of recognizing a firm and laboratory):				
1.1 Approval of welding procedures including those for weld repairs	For issue of Welding Procedure Approval Test Certificate (COTIIC)	Each procedure	H	
1.2 Welders' certification	Welders' certification	Each procedure	H	
1.3 Approval of non-destructive testing		Each type of non-destructive testing	H	
1.4 Recognition of a non-destructive testing laboratory	For issue of Recognition Certificate of Testing Laboratory (CIIJI)		H	
1.5 Validation of automated ultrasonic testing system (if applicable)	Compliance with detailed design documentation	Each procedure	H	According to 5.4.2, Part I of the SP Rules
1.6 Surveys on engineering critical assessment (ECA) for defects at welding of butt girth welded joints (if applicable)	Compliance with detailed design documentation	Each procedure	H	According to 5.5, Part I of the SP Rules
2 Materials (after delivery to a pipe-laying vessel/barge):				
2.1 Pipes	Incoming inspection	Each batch	M	
2.2 Welding consumables	Incoming inspection	Each batch	M	
2.3 Other SP materials and products	Incoming inspection	Each batch	R	
3 Preparation of pipeline route before pipe-laying:				
3.1 Route without SP burial	Compliance with detailed design documentation	Total SP route	R	
3.2 Bottom trenches for SP burial	Compliance with detailed design documentation, trench depth	Total SP route	R	
3.3 Structural units of crossings with previously laid pipelines and/or cables	Compliance with detailed design documentation	Each crossing	W	
4 Mobilization of a pipe-laying vessel/barge:	As per 3.6.2	Prior to commencement of work	H	
5 Preparation of pipes for assembling and welding:				
5.1 Condition of pipe surfaces	Compliance with detailed design documentation	Each pipe	M	
5.2 Preparation of places on the pipe surface for fitting welded-on strips (for galvanic anodes, ballast weights, etc., if any)	Compliance with detailed design documentation	Each pipe	M	
5.3 Welding edges preparation	Compliance with detailed design documentation	Each pipe	M	
6 Pipe assembly and welding:				
6.1 Checking the availability of approved welding processes specifications and certificates of welders' qualification	RS certificates	Each certificate	R	
6.2 Heating of welding edges	Compliance with detailed design documentation	Each pipe	M	
6.3 Assembly of a butt for welding	Compliance with detailed design documentation	Each pipe	M	
6.4 Welding parameters	Compliance with Welding Procedure Approval Test Certificate (COTIIC)	Each pipe	M	

Table 3.7.1.1 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
6.5 Welding consumables	Compliance with Welding Procedure Approval Test Certificate (СОТПС)	Each pipe	M	
7 Visual examination, measurements and non-destructive testing of welds:				
7.1 Visual examination and measurement	Compliance with detailed design documentation	Each pipe	W	
7.2 Non-Destructive Testing (NDT)	Compliance with detailed design documentation	Each pipe	W	
7.3 Calibration of automated ultrasonic testing system (if applicable)	Compliance with detailed design documentation	After each weld	W	
8 Repairs of defective welds:				
8.1 Checking the availability of approved welding processes specifications and certificates of welders' qualification	RS certificates	Each certificate	R	
8.2 Identification and marking-out of weld repair locations	Compliance with detailed design documentation	Each pipe repaired	M	
8.3 Elimination of weld defect	Compliance with detailed design documentation	Each pipe repaired	M	
8.4 Non-destructive testing at the place of defect elimination	Compliance with detailed design documentation	Each pipe repaired	W	
8.5 Weld repairs	Compliance with Welding Procedure Approval Test Certificate (СОТПС)	Each pipe repaired	W	
9 Visual examination, measurements and non-destructive testing of repair welds:				
9.1 Visual examination and measurement	Compliance with detailed design documentation	Each pipe repaired	W	
9.2 Non-Destructive Testing (NDT)	Compliance with detailed design documentation	Each pipe repaired	W	
10 Cutting of a weld:				
10.1 Marking-out of cutting locations, inspection of pipe surface condition after removal of insulating coating	Compliance with detailed design documentation	Each pipe repaired	M	
10.2 Cutting and edge preparation for welding	Compliance with detailed design documentation	Each pipe repaired	M	
10.3 Non-destructive testing of edges	Compliance with detailed design documentation	Each pipe repaired	W	
11 Fitting of galvanic anodes for non-concrete coated pipes				
11.1 Marking-out of anode locations and surface preparation for fitting of welded-on strips	Compliance with detailed design documentation	Each pipe with galvanic anode	M	
11.2 Fitting of welded-on strips	Compliance with detailed design documentation	Each pipe with galvanic anode	R	
11.3 Non-destructive testing of weld of welded-on strips	Compliance with detailed design documentation	Each pipe with galvanic anode	R	
11.4 Fitting of galvanic anodes	Compliance with detailed design documentation	Each pipe with galvanic anode	M	
11.5 Welding of galvanic anode contacts	Compliance with detailed design documentation	Each pipe with galvanic anode	R	
11.6 Non-destructive testing of the weld of galvanic anode contacts	Compliance with detailed design documentation	Each pipe with galvanic anode	W	
12 Insulating coating of welded joints:				
12.1 Preparation of pipe surface in way of the welded joints	Compliance with detailed design documentation	Each pipe	M	
12.2 Application of coatings and/or fitting of sleeves	Compliance with detailed design documentation	Each pipe	M	
12.3 Inspection of quality of coating application/sleeve fitting, coating repairs if needed	Compliance with detailed design documentation	Each pipe	W	
13 Pipeline laying:				
13.1 Monitoring of height of supporting rollers, forces acting on rollers and stinger parameters	Compliance with detailed design documentation	Each pipe	R	
13.2 Monitoring of deformation mode for SP bent sections (bending sensor, etc.)	Compliance with detailed design documentation	Each pipe	R	
13.3 Monitoring of pipeline tension forces	Compliance with detailed design documentation	Each pipe	M	
13.4 Monitoring of heading during pipe-laying	Compliance with detailed design documentation	Each pipe	R	

Table 3.7.1.1 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
13.5 Check of anchor chain tension and anchors layout (when positioned with the use of anchoring systems)	Compliance with detailed design documentation	Each pipe	R	
13.6 In-water surveys of the SP sections laid	Compliance with detailed design documentation	The whole SP	M	
14 Fitting of spool pieces (pipe spools), valves and connection of the pipeline				
14.1 Manufacture of spool pieces (pipe spools), standpipes or SP shore approach section	Compliance with detailed design documentation	Each spool piece	W	
14.2 Valves, flanges and fasteners	Compliance with detailed design documentation	Each product	W	
14.3 Fitting of pipeline spool pieces	Compliance with detailed design documentation	Each spool piece	W	
14.4 Installation of valves	Compliance with detailed design documentation	Each product	W	
14.5 Installation of the riser/standpipes or SP shore approach section	Compliance with detailed design documentation	Each pipe	W	
15 Pigging and gauging of pipeline				
15.1 Materials and equipment including consumables	Compliance with detailed design documentation	Each product	R	
15.2 Verification of measuring devices	Compliance with detailed design documentation	Each product	R	
15.3 Preparation of a gauging pig and scraper pigs	Compliance with detailed design documentation	Each product	M	
15.4 Gauging and pigging processes	Compliance with detailed design documentation	The whole SP	M	
16 Hydraulic tests				
16.1 Verification of instrumentation and measuring equipment	Compliance with detailed design documentation	Each product	R	
16.2 Hydraulic strength and leak tests	Compliance with detailed design documentation	The whole SP	W	
17 Alarm and automated control systems:				
17.1 Materials and products	Compliance with detailed design documentation	Each product	R	
17.2 Systems installation	Compliance with detailed design documentation	The whole SP	M	
17.3 Systems testing	Compliance with detailed design documentation	The whole SP	W	
18 Cathodic protection system				
18.1 Materials and products	Compliance with detailed design documentation	Each product	R	
18.2 System installation	Compliance with detailed design documentation	The whole SP	M	
18.3 System testing	Compliance with detailed design documentation	The whole SP	W	
19 Inspection of the laid SP along its route				
19.1 Inspection of the SP along its route for detecting free spans	Compliance with detailed design documentation	The whole route	M	
19.2 Inspection of SP position in a trench, trench backfilling	Compliance with detailed design documentation	The whole route	M	
20 Issue of the RS reports and certificates based on the technical supervision results	Report (form 9.9.1) and Certificate (form 9.9.2)	The whole SP	H	

[1]For description of type of tests, refer to Table 1.3.11.

3.7.1.2 Prior to SP installation, laying and testing the procedures of installation, laying, cheek operations and acceptance tests containing the detailed information on the equipment, arrangements and devices in use, their characteristics and sequentially specifying all stages of work shall be submitted for the RS approval including the following:

pipes storage, transportation and handling;

pipe alignment and assembly for welding;

welding;

visual and non-destructive instrumental testing;

repairs on welding defects elimination;

application of insulating coating to field joints;

manufacture of SP spool pieces and SP connections;

SP pigging, gauging and hydraulic testing;

elimination of inadmissible SP free spans after laying;

installation of electrochemical protection (cathode protection or galvanic anode system);

installation of alarm and automated control systems.

The developed technologies shall take into account limitations associated with the environmental conditions, including waves, wind, etc. and the SP route.

3.7.1.3 Prior to SP laying the firm shall execute and submit for the Register approval the checking calculations for buckling and strength of the pipeline to be laid with due regard for actual current velocities, the pipeline route profile, sea depths, the shape of a launching arrangement and other parameters representative for the specified pipe-laying vessel/barge.

3.7.1.4 Documentation on procedures approved by the Register, which are applicable to the listed below, shall be available on board pipe-laying vessel/barge:

anchoring (securing) of a pipeline string at the initial stage of laying;

elimination of minor pipe defects;

repairs of weight coating damages and/or insulating coating of pipes;

emergency abandonment/recovery of the pipe string from water in stormy weather;

monitoring of the parameters of the deformation mode of the SP section being laid;

actions in emergency (failures of the tensioning system, positioning system, one or more welding stations, etc.).

3.7.1.5 Any alterations in procedures and parameters of SP laying as compared to the approved technical documentation shall be agreed with the Register.

3.7.1.6 If pipe surface is overheated due to joints welding, production workshops (stations) on non-destructive testing and corrosion-protection coating application shall be provided with means of pipe surface cooling.

3.7.1.7 In the course of assembly and welding operations during the SP installation on the pipelaying vessel/barge the following requirements shall be generally complied with.

3.7.1.7.1 During pipe assembly field welds of welded pipes and the SP welded parts shall be located in the upper half of the pipe section, and in such case, they shall be offset relative to each other to a distance of at least:

100 mm for the pipe welded joints DN 500 and over;

75 mm for the welded joints DN less than 500.

3.7.1.7.2 If steady technical conditions for the field welds offset cannot be followed during assembly of tie-ins, etc., the distance between adjacent field welds shall be approved by the Register.

3.7.1.7.3 It is recommended to assemble butt girth welded joints at the Internal Line-Up Clamp (ILUC) without tack welds.

3.7.1.7.4 Where tack weld application is justified by technical conditions, they shall be removed mechanically while providing the weld root pass. Tack welds shall be made using welding consumables intended for root pass welding.

3.7.1.7.5 Tack welds shall be arranged at a distance of not closer than 100 mm from the field welds of welded elements.

3.7.1.8 If an anchoring system for pipe-laying vessel/barge positioning is used before starting pipe-laying operations, the holding power of an anchor shall be checked by applying the force equal to 110% of the design anchor winch pull or the data confirming the accepted holding power shall be submitted.

3.7.1.9 The NDT results for each weld (field joint) shall be identified and filed.

The same part of a (field) weld may not be repaired more than once.

3.7.1.10 The laying parameters listed below shall be monitored (and checked with regard to the design values) and recorded on board the pipe-laying vessel/barge during pipe-laying:

anchor chain cable loads (if an anchoring system is used);

rollers height and loadings on the rollers of the pipe-roller assembly for moving the SP section being laid;

pipe tension at each tensioner;

stinger inclination;

pipe-laying vessel/barge's heading, trim and draught;

water area depth;

environmental conditions.

3.7.1.11 The pipeline laying onto the seabed for the subsequent burial thereof shall be allowed only provided that preliminary checking measurements and calculations show that bending radii in laying will exceed the minimum acceptable ones for strength ensuring. The measurement and calculation results shall be submitted to the Register.

The preliminarily laid pipeline sections may be buried and backfilled only after confirmation that the laid sections are within the boundaries of the approved project corridor.

3.7.1.12 The design of SP crossings with the previously laid pipelines and cables shall meet the requirements of 8.2.1.12, Part I "Subsea Pipelines" of the SP Rules.

Prior to starting works, all structures that may be affected by SP construction shall be defined. All safety measures required to protect indicated structures during construction shall be established.

Where the SP to be laid crosses existing pipelines, up to 35 kV electric cables and communication cables including their protected area, the works are only permitted upon agreement with the owner and/or operator of these utilities.

3.7.1.13 The correct position of pipelines after laying onto the seabed along the design route and burial into the seabed shall be checked by divers or remotely-operated vehicles (ROV) with video equipment as well as special purpose arrangements of pipe burying craft.

3.7.1.14 The pipe-laying vessels/barges using the anchoring systems for positioning and handling shall be provided with openings for emergency passing of a string due to failure in bow anchors located at all bulkheads from the pipe assembly position at the fore where the pipe assembly and welding lines are located. There shall be no crew and production personnel of pipe-laying vessels within this area during pipeline laying.

3.7.2 Other installation and laying methods of steel SP.

3.7.2.1 Technical supervision scope and procedure when using steel SP laying methods specified in 8.5.4 and 8.5.5, Part I "Subsea Pipelines" of the SP Rules shall be established by the List of SP items of technical supervision during construction which is developed by the firm and agreed with the RS Branch Office that carries out technical supervision during SP construction depending on the specific laying method in use. The List is based on the RS Nomenclature on subsea pipelines (refer to Table 1.6.1), the design and production documentation approved by the Register, and instructions of this Section.

3.7.2.2 In addition to the documentation specified in 3.7.1.2, the Register shall approve the production documentation on SP laying depending on the used methods given in 8.4.9, 8.5.4.3, 8.5.5.3 and 8.5.5.4, Part I "Subsea Pipelines" of the SP Rules. The developed technologies shall take into account limitations associated with the environmental conditions, including waves, wind, etc. and the SP route.

3.7.2.3 Prior to SP laying, the firm shall execute and submit for the Register approval the checking calculations for buckling and strength of the pipeline to be laid with due regard for actual current velocities, the pipeline route profile, sea depths and other parameters representative for the given method of pipe-laying.

3.7.2.4 The firm's production workshop carrying out SP laying shall have the documentation on the procedures approved by the Register and applicable in case of:

elimination of minor pipe defects;

repairs of damages of weight coating and/or insulating coating of pipes;

monitoring of the parameters of the mode of deformation of the SP section being laid;

application of towing tension to the SP string;

actions in emergency (break of a tow line, break of buoyancy pontoon fastenings, an excessive wave height in string towing, etc.).

3.7.2.5 The NDT results for each weld (field joint) shall be identified and filed.

3.7.2.6 The parameters listed below shall be monitored (and checked with regard to the design values) and recorded at the firm's production workshop during pipe-laying:

tension (its locations shall be indicated) applied to/removed from the SP string being laid (pontoon lifting force, string tensile forces, string filling with water, etc.);

changes in the SP string geometry (bend);

water area depth;

environmental conditions, including wind and waves.

3.7.2.7 Pipe-laying shall be monitored according to 3.7.1.10 to 3.7.1.13.

3.7.3 Installation and laying of steel subsea pipelines on shoreline crossing section.

3.7.3.1 Shoreline crossing involving trenching.

3.7.3.1.1 Prior to trenching when SP crosses the shoreline, documentation on trenching, inspection and acceptance shall be submitted to the Register including the documents on:

trenching including trench trace and profile;

pipeline pulling;

connection of offshore and onshore sections of the pipeline.

3.7.3.1.2 Prior to subsea trenching the following shall be performed:

checking measurements of seabed in the cross section of landfall area to define deviations from their design profile;

examination of seabed by divers or ROV to check for foreign objects.

3.7.3.1.3 Continuous inspection of trench parameters (width, depth, slopes) via measurements by echo sounder or other means with mandatory in-process and acceptance inspection shall be performed while subsea trenching.

3.7.3.1.4 The finished subsea trench shall be surveyed by the Register before laying SP in it by comparing requirements of detailed design documentation to actual data obtained by checking measurements of the trench parameters by measurement devices as well as by divers and ROV.

3.7.3.1.5 If actual parameters of the trench do not comply with parameters indicated in the detailed design documentation, follow-up modifications of the trench shall be performed before laying the pipeline in the trench with subsequent survey according to 3.7.3.1.4.

3.7.3.1.6 Backfilling of subsea trench where the pipeline is laid is allowed only after checking measurements confirming pipeline laying on the design elevations considering requirements of 8.2.1.10, Part I "Subsea Pipelines" of the SP Rules.

Width and depth of the trench, trench slopes and dumping on edge, backfilling top elevations shall be checked. Backfilling of SP is followed by diver/instrumental examination of the buried pipeline to monitor its spatial position and size of protective soil layer.

Any alterations in procedures and parameters of SP laying as compared to the approved technical documentation shall be agreed with the Register.

3.7.3.2 Shoreline crossing involving cofferdam construction.

3.7.3.2.1 Prior to cofferdam construction, documentation on its construction, inspection and acceptance shall be submitted to the Register for approval, including the documents on:

layout and profile of the cofferdam including potential rock-fill dams;

trenching including areas within cofferdam limits;

pipeline pulling;

connection of offshore and onshore sections of the pipeline.

Any alterations in procedures and parameters of SP laying as compared to the approved technical documentation shall be agreed with the Register.

3.7.3.2.2 In case the cofferdam is used as a shoreline stabilization structure for pipeline operation, in addition to the specified in 3.7.3.2.1, the following shall be submitted to the Register:

geological profiles for areas of sheet pile driving;

detailed design of sheet pile structure;

log and summary list for sheet pile driving;

as-built profile of the driven sheet pile.

3.7.3.2.3 When using the cofferdam on the shore crossing of the pipeline, the applicable requirements of 3.7.3.1.2 and 3.7.3.1.3 shall be met.

3.7.3.2.4 Readiness of cofferdam for pipeline laying and its backfilling shall be surveyed in accordance with 3.7.3.1.4 to 3.7.3.1.6.

3.7.3.2.5 Dismantling of cofferdam sheet pile wall shall rule out any damage to the pipeline buried into the soil.

3.7.3.3 Shoreline crossing applying Horizontal Directional Drilling.

3.7.3.3.1 Prior to horizontal directional drilling (HDD) of the pilot bore, technical documentation on drilling works, inspections and acceptance shall be submitted to the Register for information, including the documents on:

pilot bore drilling;

reaming and calibration of well;

pulling the casing (casing pipe) when using the "pipe-in-pipe" method.

Technical documentation on pipeline pulling into well and connection of offshore and onshore sections of the pipeline shall be approved by the Register.

3.7.3.3.2 Where pipeline string is manufactured separately and shall be pulled into HDD well, the procedures for installation, check operations and acceptance tests containing information on equipment in use and its characteristics shall be submitted for the RS approval, including the following:

pipes storage, transportation and handling;

pipe alignment and assembly for welding;

welding;

visual and non-destructive testing;

repair for welding defects elimination;

application of insulation coating to field joints and its repair;

cleaning and hydraulic testing of pipeline string;

mounting of roller supports;

control of pulling force exerted on the pipeline being pulled;

emergency response activities (drilling mud return, failure of drilling tools, etc.).

3.7.3.3.3 The developed technologies shall take into account limitations associated with environmental conditions and geological conditions of shoreline crossing (HDD methods, refer to 10.2 of the SP Recommendations).

It is recommended to provide extended thickness as compared to the linear section for protective coating of the pipeline string to be pulled in HDD well or to use safety and centering rings (spacers) on the external surface of the string.

3.7.3.3.4 Prior to pulling the pipeline in the bored well the firm shall carry out check calculations and submit them to the Register:

pulling force necessary to pull the pipeline (for full target length or separate strings);

checking of strength of the pipeline string at bending in the bore hole;

additional ballasting or filling the pipeline with water during pulling.

3.7.3.3.5 When carrying out HDD operations, the contractor shall monitor (and check with regard to the design values) and record the parameters listed below:

position of layout axis of crossing, existing structures, utilities and obstacles;

position of drilling unit on entry point and initial spudding angle;

drilling parameters including monitoring of three-dimensional position of the pilot bore;

check of drilling mud composition and quality indices including field laboratory analysis at least two times per shift.

Drilling mud discharge into marine environment (especially when drilling tools emerge below water level) is not allowed.

3.7.3.3.6 When the drilling operations are completed, the compliance of outlet point coordinates and outlet angle of the drilling tool with the requirements of the design documentation shall be checked and the pilot bore profile shall be assessed. If any deviation of the profile and outlet point of the pilot bore from the design is identified, further works on crossing construction shall be permitted only after approval of actual profile by the design office and customer.

3.7.3.3.7 During reaming and calibration of the pilot bore the contractor shall monitor the following parameters:

number of passes and reamer diameter;

thrust and rate of reamer pulling;

torque;

characteristics and consumption of drilling mud.

3.7.3.3.8 The pipeline (or, preliminary, casing) shall be pulled with minimum break after calibration of the well. During the pulling, the drilling string shall consist of drill pipes, reamer, flex joint, swivel, pull head and pipeline.

When pulling the pipeline into the well at least the following parameters shall be monitored:

pulling force and string movement;

pulling rate;

drilling mud supply pressure and consumption.

The pipeline shall be pulled continuously through the well filled with sea water and/or drilling mud (when necessary, a break to weld another string is allowed if it was impossible to assemble the pipeline for the full length of the well) while rotating the drilling string and reamer.

3.7.3.3.9 The pipeline shall be pulled towards the drilling unit. Its power shall be at least twice as much as the design pulling force. If provided by design, the pipe pushing technology may be used.

3.7.3.3.10 The correct pipeline position after pulling into the well shall be checked as follows:

horizontal position of the pipeline shall be checked by pulling a sonde-transmitter;

vertical position shall be checked by means of location systems.

Any alterations in procedures and parameters of SP laying as compared to the approved technical documentation shall be agreed with the Register.

3.7.4 Installation and laying of flexible SP.

3.7.4.1 The scope and procedure of technical supervision during laying of flexible SP made of FPMP shall be established by the List of items of RS technical supervision during construction which is developed by the firm and agreed with the RS Branch Office that carries out the technical supervision during SP construction. The List is based on the Nomenclature of items of the RS technical supervision of subsea pipelines (refer to Table 1.6.1), the design and production documentation approved by the Register, and instructions of this Section.

3.7.4.2 Prior to installation, laying and testing of flexible subsea pipelines, the procedures of installation, laying, check operations and acceptance tests which contain the detailed information on the equipment, arrangements and devices to be used, their characteristics, and sequentially specifying all the stages of works carried out during those procedures shall be submitted for the RS approval including the following:

storage, transportation and handling of flexible pipes (reels);

unreeling and laying of flexible pipes;

connection of flexible pipe end fittings (connecting components);

leak tests for fitting joints;

installation of electrochemical protection (cathodic protection or galvanic anode system);

SP pigging and hydraulic testing;

installation of alarm and automated control systems. The developed technologies shall take into account limitations associated with the environmental conditions, including waves, wind, etc. and the SP route.

3.7.4.3 During flexible SP laying the following shall not be permitted:

twisting about a longitudinal axis;

bending less than a permissible bending radius;

movement over the seabed (bottom pull).

3.7.4.4 The fasteners for joining FPMP end fittings shall meet the requirements of 2.5.3.

3.7.4.5 In other cases, the technical supervision during installation and laying of flexible subsea pipelines shall be subject to special consideration by the Register.

3.7.5 Steel SP pressure testing.

3.7.5.1 Instructions on SP pressure testing are specified in 8.6, Part I "Subsea Pipelines" of the SP Rules.

3.7.5.2 SP pressure tests shall be carried out after complete installation of the pipeline or its section, its pigging and gauging using scraper and gauging pigs.

3.7.5.3 SP pressure tests shall be carried out in compliance with the documentation approved by the Register and specified in 8.6.2, Part I "Subsea Pipelines" of the SP Rules.

3.7.5.4 Prior to test procedure, the Register shall survey the testing for instrumentation and equipment in accordance with 8.6.7.2, Part I "Subsea Pipelines" of the SP Rules.

3.7.5.5 The pressure for strength tests shall be equal to at least 125 % of the SP design pressure.

During hydrostatic strength testing the total stresses in the steel pipe shall not exceed 0,95 of the metal yield stress.

3.7.5.6 The pressure during leak testing shall be at least 110 % of the SP design pressure.

3.7.5.7 When testing the SP pressure build-up/drop rates as well as the holding time of SP under pressure and permissible pressure fluctuations shall be in compliance with the requirements of 8.6.4 and 8.6.5, Part I "Subsea Pipelines" of the SP Rules. While specifying the test pressure values, the difference in heights (depths) along the SP route or part thereof shall be taken into account.

3.7.5.8 It is recommended to carry out in-line inspection or fault detection to determine the initial technical condition of the constructed SP after completion of hydraulic tests before commissioning. In such case, the provisions of 4.3.8.1.5, Part I "Subsea Pipelines" of SP Rules shall be taken into consideration.

3.7.6 The RS documents issued according to the results of technical supervision during SP construction.

3.7.6.1 Based on satisfactory results of all the surveys specified by the List of items of the SP technical supervision as well as of the surveys performed but not included in the List, the RS Branch Office that has carried out the technical supervision during SP construction shall carry out technical supervision in operation with regard to the date of completion of the SP construction based on the report signed between the customer and contractor, namely:

registration of the SP with a register number assigned;

issue of Report on Survey of Subsea Pipeline (SP) after construction (form 9.9.1) with specified terms of the SP periodical surveys;

issue of Classification Certificate of Subsea Pipeline (SP) (form 9.9.2).

3.7.6.2 A register number which is indicated in the RS documents issued according to the results of technical supervision during construction shall be assigned to the RS-classed subsea pipelines with RS class and according to the valid internal RS procedure.

3.7.6.3 The SP record keeping by the RS Branch Office shall be executed in compliance with the valid internal RS procedure.

3.7.6.4 The Report on Survey of Subsea Pipeline (SP) (form 9.9.1) for SP constructed to the RS class in accordance with 1.3.8.2, 1.3.8.3 shall be drawn up based on the design, detailed design and as-built documentation review results (refer to 1.5.3.6) as well as all survey results in compliance with 1.4.4.3, Part I "Subsea Pipelines" of the SP Rules.

4 TECHNICAL SUPERVISION OF SUBSEA PIPELINES IN OPERATION

4.1 SURVEYS OF SUBSEA PIPELINES IN OPERATION

4.1.1 General.

4.1.1.1 Maintenance of the RS-classed subsea pipelines shall be carried out under the RS technical supervision in the form of periodical surveys. Where necessary (including SP accidents or incidents), occasional surveys shall be carried out. General requirements for the RS surveys are specified in Section 1.4, Part I "Subsea Pipelines" of the SP Rules.

4.1.1.2 The regulations of SP technical operation shall be specified by its owner/operator. The document containing such regulations including those in the form of the firm's standards shall be submitted to the Register for approval prior to the SP commissioning.

It is recommended to harmonize the SP owner's examinations and inspections with the RS periodical surveys.

4.1.1.3 The contract concluded by the Register with the SP owner/operator provides for the Register the basis for carrying out the SP technical supervision.

4.1.1.4 All structural and technological SP changes introduced to the design by the owner/operator as a deviation from the project shall be approved by the Register. The latter shall be notified of all planned works being carried out at SP items, including planned maintenance, repairs or modernization.

4.1.1.5 External examinations and in-line inspections for SP shall be conducted by the Register recognized service suppliers engaged in SP in-water surveys and/or in-line inspections (refer to 1.9).

4.1.1.6 The basic requirements for the inspections, their schedule and assessment of their results are specified in 9.1.1 to 9.1.6, Part I "Subsea Pipelines" of the SP Rules and this Section.

The SP examination and in-line inspection procedures shall provide for the system of recording and reporting their results with drawing up of appropriate reports and information database during the whole SP service life to compare the results of examinations/inspections with regard to SP operation time.

4.1.1.7 Based on SP examination and in-line inspection results, the service supplier shall prepare the reports according to performance specification, requirements of SP technical operation regulations, national and/or international standards and standards of the SP owner/operator. The reports on results of SP external examinations and in-line inspections shall be submitted to the Register for review.

4.1.1.8 Along the SP route the protected area shall be implemented with the width limited by two parallel planes drawn depending on the water area type and depth at a distance from 100 to 500 m from each side of the axes of the outside SP strings.

4.1.2 Requirements for SP surveys.

4.1.2.1 General.

4.1.2.1.1 The requirements for SP examination and technical condition inspections are developed by the owner/operator. The requirements of the RF supervisory bodies in the field of industrial safety and the standards of firms/organizations associated with SP owners/operators shall be taken into account for the subsea pipelines laid within inland waters/Russian shelf water areas.

The SP examinations and technical condition inspections shall be performed under the RS technical supervision.

4.1.2.1.2 The SP surveys shall be aimed at:

.1 general external in-water studies of SP and its route;

.2 SP in-line inspection;

.3 technical condition inspection of SP or its sections (SP fault detection):

which requires in-line inspection results to be specified;

for which in-line inspection is impossible or impractical.

4.1.2.1.3 The survey schedule shall comply with 4.1.4 and the RS-approved operational documentation (refer to 4.1.1.2).

4.1.2.2 External in-water surveys of SP and its route.

4.1.2.2.1 External in-water survey of SP and its route shall be aimed at:

detection of any exposure along the route (anchoring tracks, use of fishing gear, wave effects and currents, ice gouging, seabed soil drift/erosion, etc.);

detection of SP external defects including damages to coatings and/or their consequences (leakage of transported medium);

checking of horizontal location and elevation of SP including seabed soil protective layer depth/berm above the pipeline top (for SP buried into seabed soil/berm);

monitoring of free span SP sections relative to sea bottom (for SP not buried into seabed soil);

determination of parameters of bottom ice gouging, seabed soil erosion/drift, if any;

monitoring of hydrological characteristics (water temperature, current velocities and directions, bathymetry, etc.);

checking of electrochemical corrosion protection means of the pipeline;

photographing and video filming along the SP route;

drawing up of the report on SP conditions and data archiving.

4.1.2.2.2 The external in-water survey procedure (or separate procedures by types of work) shall comply with the requirements of performance specification, regulations of SP technical operation, national and/or international standards and standards of SP owner/operator and be approved by the Register.

4.1.2.2.3 The external in-water surveys of SP and its route may be performed by divers and/or with the use of instruments fitted on craft or vessels depending on route extension, type and depth of water area. Requirements for service suppliers involving divers shall comply with 1.9.2.5.

Check dives are usually carried out when the required data cannot be obtained by instruments or to be specified to obtain more reliable survey results.

4.1.2.2.4 Instruments for checking condition of SP and its route as well as devices for correction of measured quantities shall be checked and calibrated.

Geodetic data (physical integrity and coordinates of known benchmarks) shall be also checked.

Where necessary, the following shall be performed:

installation and deployment points of base stations for positioning with the use of satellite navigation aids shall be selected;

water-level gange shall be provided.

4.1.2.2.5 Based on the pipeline route study results, the following shall be performed:

construction of 3D digital elevation model (DEM) for SP route;

drawing up of bathyorographical map along SP route (as a rule, at scale 1:5000).

4.1.2.2.6 DEM shall provide for comparison (mapping) of survey results to the previous ones to reveal the changes in spatial position of the SP and seabed deformation dynamics.

4.1.2.2.7 All data files and mapping materials shall be referenced to geographical coordinates (for example, WGS, CK-42) and SP route pickets.

4.1.2.2.8 The following shall be shown in DEM and mapping materials specified in 4.1.2.2.5:

the design/as build and actual position of SP with boundaries and lengths of free span/uncovered sections or sections where SP is buried beyond the limits as prescribed by the project;

bathymetric data indicating the signs of external exposure (ice gouging, fishing gear tracks, foreign objects, etc.);

SP longitudinal profile with soil marks, boundaries and lengths of free span/uncovered sections or sections where SP is buried beyond the limits as prescribed by project;

horizontal and longitudinal views (for maps in larger scale) for each free span/uncovered section or section where SP is buried beyond the limits as prescribed by project, with transverse profiles.

4.1.2.2.9 The SP route shall be studied to obtain data required for construction of the above DEM and/or maps using sonars which usually include the following:

multibeam echo sounders;

side-scan sonars;

single-beam echo sounders;

equipment to determine the seabed soil protective layer depth (for SP buried into seabed soil) (refer to 4.1.2.2.11);

equipment to correct data from sonar measuring instruments (refer to 4.1.2.2.21);

remotely operated or autonomous underwater vehicles (ROV/AUV) of different class and application[1].

The particular equipment for pipeline route study shall be selected with regard to depth ranges along the SP route and its length.

4.1.2.2.10 The horizontal location measurement accuracy for geometrical parameters of SP sections (with saggings, strippings, washouts, etc.) shall be equal to + 0,1 m, and elevation measurement accuracy shall be $\pm$1,0 cm.

4.1.2.2.11 The protective layer depth above the SP shall be determined by elevation marks at the pipeline top with the use of equipment for positioning of SP buried into seabed soil (electromagnetic, magnetic, sonar and other profilographs — pipe/route finders) which ensures the following:

for depths of up to 10 m — absolute accuracies for SP plan position of not more than 0,5 m and not more than 0,1 m for elevation position;

for depths from 10 to 20 m — absolute errors of not more than 0,7 m and 0,2 m, correspondingly;

for other depths — as agreed upon with the Register.

4.1.2.2.12 The sonar equipment used for studies shall detect any technogenic and natural foreign object of 0,3 × 0,3 × 0,3 m and more in a close vicinity of SP at a distance of up to 10 m which shall be recorded on maps.

4.1.2.2.13 For pipeline routes studies, multibeam echo sounders with angular resolution of not more than 1,5° and operating frequency at least 300 kHz shall be used. In such case, multibeam echo sounder shall operate as much as possible.

The data from multibeam echo sounders shall be verified by single-beam echo sounder which is also used for bathymetry.

4.1.2.2.14 Side-scan sonars shall be generally provided in towed underwater carriers. Side-scan sonars used shall have minimum angular resolution of 1,0° and maximum distance resolution of 0,1 m at operating frequency of 400 kHz and above. The distance between the seabed and side-scan sonar carrier shall be 10 to 12 % of the used inclined range.

4.1.2.2.15 If ice gouges are detected and studied on the seabed, their parameters specified in 8.3.2, Part I "Subsea Pipelines" of the SP Rules shall be recorded.

4.1.2.2.16 For areal survey of SP route, at least three longitudinal tacks shall be planned: central located above the SP centreline and two parallel to the right and to the left, 15 to 25 m wide from the SP centreline. Generally, the number of longitudinal tacks depends on the following:

required survey width of SP route, for example, with regard to a number of SP strings;

distance between tacks;

swath width of multibeam echo sounder.

4.1.2.2.17 For areal survey of SP route, at least 50 % overlap of adjacent swaths shall be provided, the recommended value is 100 % (in this case, each section of seabed is surveyed by multibeam echo sounder two times in order to increase the measurement points).

4.1.2.2.18 To enhance the reliability of results, at least three calibration tacks passing through the reference sections of the seabed shall be used. These sections are easy to unscramble during office analysis-based processing.

4.1.2.2.19 The maximum permissible speed of watercraft/vessel during measurements shall be calculated with regard to full covering of the seabed with the survey results and at least 100 % of acoustic lighting. The multibeam echo sounder shall be calibrated at a speed equal to speed of watercraft/vessel during measurement.

4.1.2.2.20 During external in-water survey, the sections of SP and its route which demonstrated the targets as specified in 4.1.2.2.1 based on sonar survey shall be generally subject to surveys with the use of ROV/AUV.

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[1]Besides/instead of using ROVs, diver's examinations with the appropriate equipment may be carried out.

Besides carrying sonar and other equipment for surveys, ROV/AUV shall be equipped with underwater navigational positioning system (the same also applies to divers). The underwater positioning system shall provide relative measurement accuracy of horizontal location and elevation of an object not more than 5 % of distance between this object and system antenna.

4.1.2.2.21 Data obtained with the use of sonars shall be corrected using water sound speed meters (at least three times a day) and displacement sensors of watercraft/vessels during motions based on gyrocompasses.

4.1.2.2.22 During in-water surveys using hydroacoustic sonars, the Inspection and Test Plan shall be developed and submitted to the Register for review. The plan shall generally include the following:

monitoring of measurement accuracy of multibeam echo sounder by vertical beam;

operative 2D and 3D representation of swath of multibeam echo sounder and visual measurement of bottom contour;

assessment of depth deviations measured from different tacks in the adjacent swath overlapping area;

measurement of sound speed in water and calibration of sensors;

checking of work procedure;

positioning;

adjustment of starboard and portside channels of side-scan sonar and their performance;

monitoring of navigational survey equipment operation;

accuracy of differential corrections (DGPS);

checking for overlap width of adjacent swath during measurement.

4.1.2.2.23 The firm rendering services on SP in-water surveys shall have the required licensed software for stitching the measurement results for different tacks throughout the SP route during office analysis-based processing, complementation of survey results obtained with the use of multibeam echo sounder, side-scan sonar, single-beam echo sounder and other instruments used for construction of DEM and maps as specified in 4.1.2.2.8.

4.1.2.2.24 Electromagnetic, electrometric and other systems which ensure the detection of insulation fault locations with probability of at least 0,8 may be used for monitoring the condition of corrosion-protection SP insulation and for locating its defective areas. The absolute accuracy of measuring the horizontal position of defective area shall be not more than 0,5 m (relative to the ship or the measurement position on ice).

4.1.2.2.25 The SP ballasting condition is determined by a diver's examination and/or with the use of ROV/AUV fitted with TV systems. Where concrete/reinforced concrete weight coatings are used, the sections with coating integrity damages (delaminations, cracks, flattening, etc.) shall be located. When ballast weights are used, the SP sections with the instability of weights and the changes in their positioning shall be identified. The dimensions of permissible damages for all types of ballasting shall be agreed with the Register.

4.1.2.3 In-line inspection of subsea pipelines.

4.1.2.3.1 In-line inspection with the use of in-line inspection (smart) pigs shall be carried out for detecting, recording and determining the position (reference to the SP stringing/SP route) of the following abnormalities and structural members:

shape defects of a pipe cross-section (out-of-roundness, corrugations, dents);

defects of wall pipes and welded joints of the metallurgical, corrosive and mechanical origin (delaminations, pores, slag inclusions, internal and external corrosion, scores, scratches, etc.);

cracks and crack-like defects (longitudinal and transversal in welds and the base metal);

displacement of edges of girth welds;

decrease in pipe wall thickness;

recording of welds, structural members of SP and pipe stringing;

measurements of turning radii, determination of spatial position and length of SP.

The range of the defects to be recorded with the use of in-line inspection (smart) pigs for the subsea pipelines not buried into the seabed soil may be changed in compliance with the scope of work being performed during the external in-water SP inspection (fault detection).

4.1.2.3.2 The procedure for preparation and performance of in-line inspection shall comply with the requirements of performance specification for the work, requirements of SP technical operation regulation, national (e.g., GOST R 54907 and GOST R 55999) and/or international standards (in particular, POF standard (Pipeline Operator Forum) and standards of the SP owner/operator and be approved by the Register.

This procedure shall contain the type (or types/sections) of the in-line inspection pig (physical principle of non-destructive testing applied), methodology used/regulatory documents on assessment of defect acceptability. The application of in-line inspection pigs of several types/sections prevents low probability of defect detection due to their orientation in the direction of physical field action used for inspection purposes (for example, the use of ultrasonic and magnetic pigs/sections which allow for location of various defects).

4.1.2.3.3 The in-line inspection process shall generally include the following:

drift test of in-line inspection pigs;

pigging and gauging of the pipeline bore;

profile logging of the pipeline bore;

in-line inspection;

interpretation of inspection data;

automatically for all abnormalities and manually for defects detected as critical;

the ECA procedure;

report preparation.

In addition, the required measures shall be developed for occasional stop/locking of the in-line pig in the SP bore.

4.1.2.3.4 The service supplier involved in in-line inspection shall carry out the ECA procedure according to the requirements of the RS-approved documentation, national, international standards and/or standards of firms based on interpretation of inspection data to be generally performed by the manufacturer of in-line inspection (smart) pig. The RS-recommended criteria for assessment of defect acceptability may be used (refer to Appendices 3 to 6).

All detected defects/abnormalities shall be recorded and ranked by a degree of their compliance with the accepted critical parameters. This combination of defects shall be statistically processed to determine the concentration of particular defects and their distribution throughout the length of SP.

Based on calculations of static strength, corrosion propagation and fatigue strength, the service life of each defect which exceeds the specified level shall be determined. Based on calculation results, the permissible working pressure and recommended timeframe for defect removal are determined for subsequent preparation of the program for repair and recovery of SP performance by the customer, if required.

4.1.2.3.5 Prior to commencement of in-line inspection, the SP bore shall be cleaned (multiple cleaning, if necessary) and calibrated using pipeline scraper pigs and magnetic gauging pigs with diameter of at least 85% of the SP internal diameter.

4.1.2.3.6 Prior to commencement of work, in-line inspection (smart) pigs including geometry tools shall be subject to calibration on bench with defect simulators. In this case, the calibration results shall be subject to interpretation and analytical processing in standard way. The calibration report for in-line inspection (smart) pigs may be required by the Register for review.

4.1.2.3.7 The in-line inspection (smart) pigs shall be equipped with systems for tracking their location within SP and recording the fact and time of their passage through marker posts.

4.1.2.3.8 During in-line inspection with the use of different inspection (smart) pigs/various service supplies, the inspection data (so-called "matching of runs" — using the consecutive numeration for butt welds and pipes) obtained by these pigs shall be synchronized to allow tracking of dynamics of existing defects and detection of new ones.

4.1.2.3.9 The geometry tools designed for measuring flow area and geometrical defects of SP shall ensure the following:

receipt and recording of inspection data on geometrical deviations of the SP bore including structural components of SP, welds, out-of-roundness, corrugations, dents;

receipt and recording of data on SP vertical and horizontal profile — measurement of turning radii, determination of SP spatial position and length (if navigational module is available);

storage and transmission of this information for further processing and interpretation.

4.1.2.3.10 The geometry tools shall be capable of automatically detecting and measuring with the following tolerances:

depths of dents and corrugations with detection probability of 0,8 — not more than $\pm 0{,}5$ % of SP external diameter;

lengths of dents and corrugations with detection probability of 0,8 — not more than ± 10 mm;

widths of dents and corrugations with detection probability of 0,8 — not more than ± 100 mm;

out-of-roundness with detection probability of 0,9 — maximum 2,0 % of SP external diameter or 6 mm, whichever is larger.

The defects measured manually, generally is more precise.

4.1.2.3.11 The probability for correct identification of defects specified in 4.1.2.3.10 as well as SP structural members (welds, valves and fittings, T-joints, etc.) shall be at least 0,9 in automatic mode.

4.1.2.3.12 The navigational module shall be equipped with gyro system, accelerometers and equipment for recording signals of marker and odometry system as well as high precision time measurement channel.

The distance measurement tolerance from the nearest weld shall be not more than $\pm 0{,}05$ m for reliability of 0,8. The tolerance for measuring distance between markers by odometry system shall be not more than $\pm 0{,}3$% of this distance for reliability of 0,8.

4.1.2.3.13 The distance between markers fitted outside the SP during application of concrete weight coatings to pipe or SP laying (for SP without weight coating) shall be maximum 2,0 km.

After SP laying/burial, the GPS/GLONASS position of both markers and galvanic anodes shall be fixed. For buried SP during backfilling of trench it is recommended to lay any mark on seabed soil (near-bottom buoy, lead weight, etc.) corresponding to locations of markers on SP.

When correcting navigational module data using marker position, the measurement accuracy for SP position in horizontal plane shall be equal to not more than 1,0 m, in vertical — 0,5 m (the speed of inspection (smart) pigs shall be generally equal to not more than 1 to 2 m/s).

4.1.2.3.14 The magnetic inspection (smart) pigs shall be equipped with longitudinal and/or transverse magnetic flux leakage (MFL/CMFL or TFI) as well as system of different magnetic sensors allowing the following:

recording of transverse and/or longitudinal defects in the pipe body and welds;

determination of internal and external surface of pipe where the defect is located;

determination of pipe wall thickness.

The magnetic inspection (smart) pigs shall be equipped with source of power, data processing and recording system, equipment for recording signals of marker and odometry systems as well as high precision time measurement channel.

4.1.2.3.15 Magnetic inspection (smart) pigs of longitudinal (MFL) and/or transverse (CMFL or TFI) magnetization shall automatically identify the following internal and external defects with possibility of at least 0,9:

corrosive (general and pitting) wear;

marks, scores, pits;

changes in pipe wall thickness;

corrugations and dents with sharp profile and in combination with metal loss;

transversal and/or longitudinal cracks in the pipe body and welds (with regard to magnetization direction);

abnormalities in transversal and/or longitudinal welds (with regard to magnetization direction);

presence of SP structural members and special features outside the pipe wall (foreign metal objects).

It should be noted that flat delaminations in the pipe wall is poorly detected by magnetic inspection (smart) pig. The inclined delaminations including those on surface are detected better (with probability of 0,5 to 0,9).

4.1.2.3.16 The tolerances for automatically measured metal loss defect dimensions with probability of 0,9 shall be as follows:

depth: ± (0,13 to 0,25) of pipe wall thickness;

width and length: ± (18 to 24) mm;

wall thickness: ± (0,10 to 0,15) of pipe wall thickness,

the measurement tolerances for longitudinal or transverse defects may change depending on magnetization direction and wall thicknesses.

Measuring the defects manually is generally more precise.

4.1.2.3.17 The tolerances for automatically measured cracks/crack-like defects with probability of 0,8 shall be as follows:

depth: ±0,20 of pipe wall thickness;

length: ±(20 to 25) mm;

minimum crack opening: 0,15 mm,

the measurement tolerances for longitudinal or transverse defects may change depending on magnetization direction and wall thicknesses.

Measuring the defects manually is generally more precise.

4.1.2.3.18 To apply the ultrasonic inspection (smart) pigs, there shall be an acoustic contact between its converters and pipe wall, which is possible during transportation of liquid media through SP (oil, oil products, water) with limited gaseous phase.

The ultrasonic inspection (smart) pigs with direct (WM) and inclined transducers (CD) may be used. In other cases, ultrasonic inspection (smart) pigs shall be equipped with source of power, data processing and recording system, equipment for recording signals of marker and odometry systems as well as high precision time measurement channel.

4.1.2.3.19 Ultrasonic inspection (smart) pigs of WM type shall automatically identify the following internal and external defects with probability of at least 0,9:

corrosive (general and pitting) wear;

marks, scores, pits;

changes in pipe wall thickness;

various delaminations in the pipe body;

corrugations and dents with sharp profile;

presence of SP structural members.

Cracks/crack-like defects of different directions in the base metal and welds are not properly identified by WM pigs.

4.1.2.3.20 The measurement tolerances for metal loss defect dimensions (above 10 mm) with probability of 0,9 provided by the WM pigs shall be as follows:

depth: ±(0,7 to 1,0) mm;

width: ±(10 to 16) mm;

length: ±(6 to 9) mm;

edge displacement of welded pipes ±(0,7 to 1,4) mm;

wall thickness: ±0,7 mm.

4.1.2.3.21 Ultrasonic inspection (smart) pigs of CD type shall automatically identify the following internal and external defects with probability of at least 0,9:

cracks/crack-like defects of the pipe body;

weld defects (lack of fusion, undercuts, poor fusion, etc.);

delaminations of pipe walls on surface.

To identify cracks/crack-like defects of different orientation (longitudinal and transverse), different combinations of transducers may be used:

CDL for identifying the longitudinal defects;

CDC for identifying the transverse defects.

4.1.2.3.22 Minimum dimension of defects detected with probability of at least 0,9 for CD type pig shall be 50 mm long and 1,5 mm deep.

The measurement accuracy of crack-like defect length with probability of 0,9 shall be not more than ± 10 mm.

4.1.2.3.23 The in-line inspection (smart) pigs using eddy current or electromagnetic-acoustic method shall be applied based on the RS approved technical documentation.

4.1.2.3.24 Ultrasonic and other types of thickness gages with an absolute accuracy of measurements less than 0,5 mm may be applied for measuring of SP wall thicknesses during SP external in-water inspection (fault detection).

4.1.2.3.25 The pipeline defects specified in 4.1.2.3.1 shall be detected during of external in-water inspection (fault detection) of subsea pipelines including those for which in-line inspection is impossible. These operations may be carried out along with operations specified in 4.1.2.2.1. The equipment based on various physical principles and specially designed for underwater performance (for instance, the alternating current field measurement method (ACFM) for detecting surface and subsurface defects in metal subsea pipelines) shall be applied for non-destructive testing.

4.1.2.3.26 The cathodic protection or galvanic anode system of steel subsea pipelines shall be examined for identification and/or measurements (in this case, the monitoring data of cathodic protection stations are used) of the following:

cathodic potential at SP sections (particularly at those with corrosive damages);

anodes condition, anode voltage and anode current density;

condition of galvanic anodes and their connections;

condition of insulating flanges and measuring electrical insulation resistance;

underwater electric cables of anode lines and components of their connection.

The cathodic protection and galvanic anode system parameters shall correspond to the design data agreed with the Register with regard to changes of these parameters specified in the project as well as to the specific SP service life.

4.1.2.3.27 The electrometric inspection of SP in addition to that specified in 4.1.2.3.26 are aimed at the following:

measurement of polarization potentials of unburied SP with detachable equipment application for ROV or for diver's examination;

searching of areas of defective corrosion-protection coatings with the use of SP induced electromagnetic field recording equipment when connected to the special purpose AC generator;

searching of areas of defective corrosion-protection coatings based on "object-soil" potential difference when cathodic protection is operative, based on protective current density and/or "object-water" transient resistance.

4.1.2.3.28 Where free spans of the permissible length are available along the SP route (refer to 4.1.3.1.2), the vibration loads due to underwater currents (vortex shedding) at the specified SP section shall be determined and the fatigue strength of the SP in this span shall be verified. The fatigue strength calculation shall be approved by the Register.

4.1.3 Fault detection of subsea pipelines.

The fault detection means SP survey by the Register for determining the types of SP defects with the instrumental determination of defect parameter values, the recording of these parameters and assessment of the acceptability (unacceptability) of further SP operation with the defects revealed. The fault detection for SP shall be carried out by the organization recognized by the Register and witnessed by the RS surveyors.

4.1.3.1 Fault detection for steel SP.

4.1.3.1.1 The steel SP defects are classified as follows:

.1 global defects:

SP deviation from the initial route including soil washouts under a bottom pipeline;

soil washouts resulting in the partial or complete stripping of the pipeline initially buried into the soil;

pipeline seal failure;

insulation failure and weight coating damages.

.2 local defects:

shape defects — deviations from the regular geometric pipe shape;

metal loss defects — scores, marks, corrosion (pitting) damages characterized by the definite affected depth and affected area — extension both along the pipeline length and in its circumferential direction;

continuity defects — delaminations, cracks and crack-like defects characterized by the depth and extension in the same direction.

4.1.3.1.2 The assessment of the above defects acceptability is carried out by analyzing the mode of stress-deformation of the SP material in way of the defect at the known design pressure and material characteristics. The acceptability of SP defects is assessed according to the procedures, which describe:

.1 deviations from the original route — according to Appendix 1;

.2 sagging of the pipeline section as the result of soil washout — according to Appendix 2;

.3 dents on the pipe surface — according to Appendix 3;

.4 surface corrosion of pipes (metal loss defect) — according to Appendix 4;

.5 pit (pitting) corrosion of pipes — according to Appendix 5;

.6 scores, marks, delaminations, cracks and crack-like defects: according to Appendix 6.

When assessing the acceptability of defect, the possibility of their increase within the period before the next inspection shall be taken into account according to the above mentioned Appendices.

Upon agreement with the Register, the national and/or international standards, standards adopted by firms, ACS regulatory documents/national technical supervisory bodies may be applied for the assessment of SP defects acceptability.

4.1.3.1.3 Based on the results of fault detection with the design procedures for verifying the acceptability of the detected defects, the owner (organization carrying out fault detection) issues a report with the attached design procedures which shall be approved by the Register.

4.1.3.1.4 If the parameters of the detected defects exceed their permissible values, these defects shall be considered inadmissible. For the subsea pipelines with such defects, the following may be carried out as agreed upon with the Register:

repairs on eliminating inadmissible defects;

decrease in working parameters of a transported medium (pressure) with periodical checking of defect condition;

SP withdrawal (temporary until defects are rectified, or final decommissioning).

The repair procedure and justification of the decrease in working parameters of a transported medium are developed by the SP owner and approved by the Register.

4.1.3.2 Fault detection of flexible polymeric-metal subsea pipelines.

The procedure for fault detection of flexible polymeric-metal subsea pipelines and the parameters of admissible defects are established by the SP owner on the basis of the FPMP firm's (manufacturer's) standards and shall be subject to special consideration by the Register.

4.1.4 Schedule of subsea pipeline surveys.

4.1.4.1 The basic requirements for the RS periodical surveys shall comply with 1.4.4, Part I "Subsea Pipelines" of the SP Rules and are specified for steel subsea pipelines in Table 4.1.4.1.

4.1.4.2 In addition to periodical surveys, the Register may conduct an initial survey which is carried out in order to assign a class to the SP:

first submitted for the RS classification, including the one previously classed by the Register, but withdrawn for whatever reasons;

constructed according to the rules other than the Register ones and without the RS technical supervision.

The scope of initial SP surveys is specified by the Register.

4.1.4.3 The special SP survey for class renewal is aimed to ascertain that the subsea pipeline is in a satisfactory technical condition and meets the requirements of the SP Rules as well as includes testing of the pipeline, valves, automated control system, alarms, protection and indication system. The special surveys with the scope specified by the Register (refer to Table 4.1.4.1) are generally carried out at five-year intervals.

Table 4.1.4.1

Scope of periodical surveys of subsea pipelines

O — examination with access, opening-up or dismantling, and also use of means for locating of buried SPs, where necessary;
C — external examination;
M — measurements (of thicknesses, insulation resistance, defect dimensions, etc.);
H — pressure tests;
P — operation tests (of drives, alarms, etc.);
E — check of the availability of valid documents and/or brands of instrumentation calibration.

SP item to be surveyed	SP surveys																			
	1st annual	2d annual	Intermediate	4th annual	1st special	1st annual	2d annual	Intermediate	4th annual	2d special	1st annual	2d annual	Intermediate	4th annual	3rd special	1st annual	2d annual	Intermediate	4th annual	4th special
SP service life, years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20, etc.
1 SPs buried into seabed soil																				
1.1 General survey of SP route	C	C	CM[1]E	C	CM[1]E	C	C	CM[1]E	C	CM[1]E	C	C	CM[1]E	C	CM[1]E	C	C	CM[1]E	C	CM[1]E
1.2 SP location and the depth of protective layer of soil above SP	O	O	OM[2]E	O	OM[2]E	O	O	OM[2]E	O	OM[2]E	O	O	OM[2]E	O	OM[2]E	O	O	OM[2]E	O	OM[2]E
1.3 In-line inspection including that on the item specified in 1.9			M[3]E		M[3]E			M[3]E		M[3]E			M[3]E		M[3]E			M[3]E		M[3]E
1.4 Hydraulic tests including those on items specified in 1.5, 1.6, 1.9					OHE[4]					OHE[4]					OHE[4]					OHE[4]
1.5 Isolation valves	O	O	OM[5]EP	O	OM[5]EP	O	O	OM[5]EP	O	OM[5]EP	O	O	OM[5]EP	O	OM[5]EP	O	O	OM[5]EP	O	OM[5]EP
1.6 Flanged joints	C	C	CM[5]E	C	CM[5]E	C	C	CM[5]E	C	CM[5]E	C	C	CM[5]E	C	CM[5]E	C	C	CM[5]E	C	CM[5]E
1.7 Cathodic protection system/ galvanic anode system	O	O	OM[6]E	O	OM[6]E	O	O	OM[6]E	O	OM[6]E	O	O	OM[6]E	O	OM[6]E	O	O	OM[6]E	O	OM[6]E
1.8 Alarm and automation systems	O	O	OP	O	OP	O	O	OP	O	OP	O	O	OP	O	OP	O	O	OP	O	OP
1.9 Riser and/or SP shore approach	C	C	CM[7]E	C	CM[7]E	C	C	CM[7]E	C	CM[7]E	C	C	CM[7]E	C	CM[7]E	C	C	CM[7]E	C	CM[7]E
2 Unburied SPs																				
2.1 General survey of SP route	C	C	CM[1]E	C	CM[1]E	C	C	CM[1]E	C	CM[1]E	C	C	CM[1]E	C	CM[1]E	C	C	CM[1]E	C	CM[1]E
2.2 Determination of SP spatial position on seabed soil	C	C	OM[8]E	C	OM[8]E	C	C	OM[8]E	C	OM[8]E	C	C	OM[8]E	C	OM[8]E	C	C	OM[8]E	C	OM[8]E
2.3 Insulating coating	O	O	OM[9]E	O	OM[9]E	O	O	OM[9]E	O	OM[9]E	O	O	OM[9]E	O	OM[9]E	O	O	OM[9]E	O	OM[9]E
2.4 Weight coating (weights)	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
2.5 Measurements of thicknesses, external defects	O	O	OM[10]E	O	OM[10]E			OM[10]E		OM[10]E			OM[10]E		OM[10]E			OM[10]E		OM[10]E
2.6 In-line inspection including that on the item specified in 2.12			M[10]E		M[10]E			M[10]E		M[10]E			M[10]E		M[10]E			M[10]E		M[10]E
2.7 Hydraulic tests including those on items specified in 2.8, 2.9, 2.12					OHE[4]					OHE[4]					OHE[4]					OHE[4]
2.8 Isolation valves	O	O	OM[5]EP	O	OM[5]EP	O	O	OM[5]EP	O	OM[5]EP	O	O	OM[5]EP	O	OM[5]EP	O	O	OM[5]EP	O	OM[5]EP
2.9 Flanged joints	C	C	CM[5]E	C	CM[5]E	C	C	CM[5]E	C	CM[5]E	C	C	CM[5]E	C	CM[5]E	C	C	CM[5]E	C	CM[5]E
2.10 Cathodic protection system/ galvanic anode system	O	O	OM[6]E	O	OM[6]E	O	O	OM[6]E	O	OM[6]E	O	O	OM[6]E	O	OM[6]E	O	O	OM[6]E	O	OM[6]E
2.11 Alarm and automation systems	O	O	OP	O	OP	O	O	OP	O	OP	O	O	OP	O	OP	O	O	OP	O	OP
2.12 Riser and/or SP shore approach	C	C	CM[7]E	C	CM[7]E	C	C	CM[7]E	C	CM[7]E	C	C	CM[7]E	C	CM[7]E	C	C	CM[7]E	C	CM[7]E

[1]measurements of current velocities, bottom sediments and soil deformations;
[2]measurements of SP burial into seabed soil;
[3]measurements of defect dimensions according to 4.1.2.3;
[4]hydraulic tests shall be carried out after repairs, modification, modernization and expiration of the estimated service life as well as when the SP fault detection is not performed (incomplete performance);
[5]measurements of defect dimensions in non-destructive testing (considering accessibility);
[6] measurements according to 4.1.2.3.27;
[7]fault detection as agreed with the Register considering accessibility;
[8] measurements according to 4.1.2.2.5 and 4.1.2.2.8;
[9]measurements according to 4.1.2.3.27;
[10]methods of defects measurements (in-line inspection or external fault detection) are agreed with the Register.

4.1.4.4 A mandatory annual survey means the SP survey, including the valves, automated control systems, alarm, safety protection and indication system and other components, in the scope adequate to confirm that the pipeline and its components keep complying with the SP Rules requirements, its class being thus confirmed.

The scope of annual surveys is specified by the Register in compliance with Table 4.1.4.1.

4.1.4.5 Intermediate survey of the subsea pipeline shall be carried out between special surveys within the terms agreed with the Register. The scope of survey shall be established by the Register.

4.1.4.6 Occasional surveys of the SP (or its individual components) shall be carried out upon submission for survey in all cases other than initial and periodical surveys. Occasional survey after an accident is aimed at identifying the type and nature of damages, determining the scope of work to eliminate the accident consequences and the possibility and conditions of pipeline class retaining after their elimination.

The scope of the surveys and the procedure for their performance are specified by the Register based on the purpose of the survey, the SP service life and technical condition.

4.1.5 Documents issued by the Register based on the results of surveys.

4.1.5.1 Based on the results of the annual/intermediate/special survey of the SP, the Register shall issue Report (form 9.9.3) which in case of satisfactory results of the survey, confirms the validity of Classification Certificate (form 9.9.2).

4.1.5.2 Upon satisfactory results of the special or initial survey of the SP, the Register issues the Classification Certificate of Subsea Pipeline (form 9.9.2) being valid (if annually confirmed) until the next special survey.

4.2 REPAIRS OF SUBSEA PIPELINES

4.2.1 General.

4.2.1.1 Any repairs affecting the SP items, which are specified in the SP Nomenclature (refer to Table 1.6.1), shall be carried out in compliance with the technical documentation approved by the Register which contains descriptions and technical requirements on repair works.

4.2.1.2 General requirements for preparation and carrying out of SP repairs shall comply with the provisions of 9.2, Part I "Subsea Pipelines" of the SP Rules.

4.2.1.3 The SP repair works specified in 4.2.1.1 shall be performed by the firms verified by the Register according to the requirements of 1.11 and having the Certificate of Firm Conformity (ССП, form 7.1.27, code 24003000). External underwater surveys and/or in-line inspection for confirmation of the quality of repair works shall be carried out by the firms having the Recognition Certificate (СП, form 7.1.4.2) confirming capability to provide these services in accordance with the requirements specified in 1.9.

4.2.1.4 The SP repair works are planned on the basis of Chapter 9.2, Part I "Subsea Pipelines" of the SP Rules with due regard to nature and hazard degree of the defects detected during the RS surveys and the conclusion on the technical state of the SP in the documents specified in 4.1.5.1.

4.2.1.5 The SP scheduled preventive repair is generally carried out by its owner in combination with the pipeline maintenance according to the approved schedule as agreed with the Register.

4.2.1.6 The Register technical supervision covers the following typical repair methods:

restoration of design (or safe) pipeline position on/in seabed soil including free spans of unacceptable length;

cutting and replacement of defective pipeline section with the pipeline string lifting to surface;

underwater cutting and replacement of defective section (with the use of welding or mechanical joints);

underwater repair involving installation of repair devices (fitting of pre-welded or non-welded clamps, banding of strained sections without metal loss, etc.);

repair of insulating coatings and ballasting;

repair of steel pipes by grinding.

In some cases, a combination of typical repair methods may be established to eliminate defects.

4.2.1.7 Applied repair devices and facilities according to the Nomenclature of items of the RS technical supervision of subsea pipelines (Table 1.6.1) shall be type approved by the Register.

4.2.1.8 Owner and/or operator of the pipeline shall have necessary normative support, equipment and materials to carry out a full scope of typical repair methods or concluded contractor agreement with the firms capable of executing these types of works. The indicated firms shall be checked by the Register according to 1.11 of these Guidelines.

4.2.2 Technical documentation.

4.2.2.1 To repair detected SP defects the Register shall approve technical documentation indicated in Table 4.2.2.1 in accordance with typical repair method.

4.2.2.2 The Method Statement (MS) for pipeline repair shall contain at least the following sections:

technical background justifying repair method to be applied and indicating used normative documents;

information on subsea pipeline subject to repair and features of defects to be eliminated;

features of route section and hydrometeorological limitations for execution of works;

schedule plan of preparation and main works;

qualification structure of engaged personnel;

watercraft, equipment and production accessories used;

technological flow chart for repair method to be applied;

operational instructions (procedures) for execution of repair works and use of special repair devices (technical equipment).

Table 4.2.2.1

Scope of technical documentation subject to Register approval for SP typical repair methods

Typical repair method	Scope of technical documentation
Restoration of design (or safe) position of pipeline on/in seabed soil including free spans of unacceptable length	1. Method Statement (MS) and Inspection and Test Plan. 2. Pipeline strength calculation for post-trenching/restoration of design or safe position. 3. Calculation of allowable free span (where necessary).
Cutting and replacement of defective section with pipeline string lifting to surface	1. MS and Inspection and Test Plan. 2. Strength calculation of pipeline string for lifting/lowering operations. 3. Calculations of anchor lines and transfer of specialized watercraft for lifting/lowering operations. 4. Diagram of sling arrangement and handling accessories. 5. Welding and non-destructive testing procedure. 6. Hydraulic test procedure (if necessary).
Underwater cutting and replacement of defective section (using "dry" welding) and underwater repair without replacement of defective section by mounting pre-welded clamps (using "dry" welding)	1. MS and Inspection and Test Plan. 2. Calculations of anchor lines and transfer of specialized watercraft to hold the caisson or stability on the soil of a specialized self-lifting platform. 3. Diagram for sealing the caisson/chamber on the pipeline. 4. Welding and non-destructive testing procedure. 5. Strength calculation of defective section with installed clamp (if the clamp is installed). 6. Hydraulic test procedure (if necessary).
Underwater repair without replacement of defective section by fitting non-welded clamps	1. MS and Inspection and Test Plan. 2. Strength calculation of defective section with non-welded clamp fitted.
Underwater repair of strained sections without metal loss	1. MS and Inspection and Test Plan. 2. Strength calculation of defective section with installed wrapping clamp with filler.
Underwater repair of concrete coated pipelines	1. MS and Inspection and Test Plan. 2. Strength calculation of defective section with non-welded clamp fitted and wrapping clamp with filler.
Repair of steel pipe surface defects by grinding	1. MS and Inspection and Test Plan. 2. Non-destructive testing and thickness measurement.
Repair of insulation and ballasting	1. MS and Inspection and Test Plan.

4.2.3 Restoration of design (or safe) position of pipeline on/in seabed soil.

4.2.3.1 Restoration of design (or safe) position of pipeline on/in seabed soil shall be carried out in the following cases:

change of pipeline position buried in the seabed soil, first of all when there is reduction in design protective soil layer above the subsea pipeline top;

occurrence or exceedance of allowable free spans of subsea pipelines laid without burial in seabed soil.

To eliminate the above mentioned defects, the SP repair is carried out according to the following procedures:

additional burial (post-trenching) of partially or fully washed-out or sagging pipeline to provide its further reliable operation, thus, obtaining design position in the seabed soil;

elimination (or reduction to the safe value) of pipeline free spans by installing intermediate supports and/or additional backfilling by a specially brought soil.

4.2.3.2 Overhaul of subsea pipelines by means of post-trenching or elimination of unacceptable free spans is not allowed if bent branches as well as pipe defects subject to separate repair (corrugations, dents, scores, marks, etc.), significant insulation failure, unacceptable bend radii are present on the pipeline.

4.2.3.3 When developing the Method Statement (MS) for repair of subsea pipeline by post-trenching, calculation of the deformation mode of the pipeline agreed with the Register shall be mandatorily performed and the results shall be used to define the method and technology of post-trenching.

If there is change of horizontal location and elevation and change of technical state of the pipeline as compared to the assumed initial one, a new calculation and subsequent verification of the detailed design and MS conformance is required.

4.2.3.4 When defining design post-trenching loads and impacts, the following pipeline parameters shall be considered:

specified pipeline weight per unit length;

specified insulating coating weight per unit length;

specified weight of transported media;

ballasting (if any), which is considered as distributed or concentrated load depending on its type;

buoyancy in water working upon the pipeline, which is considered as resultant distributed load.

In case the subsea pipelines subject to repair are operated for 10 years and more it is recommended to take into account average factors reflecting possible changes of metal properties depending on operation period. The values of factors taken into account shall be agreed with the Register.

4.2.3.5 When developing process procedure for post-trenching, it is necessary to justify:

determination of required horizontal location and elevation of the pipeline to guarantee reliable operation during the planned period;

detection of actual stress state and elevation of the pipeline;

determination of sequencing and value for additional burial of pipeline sections to obtain planned horizontal location and elevation without exceeding allowable pipeline stresses.

Sequencing for post-trenching of pipeline sections, length of area to be stripped, depth of post-trenching for one run of pipe-burying machines shall be designed depending on calculated both pre-repair stresses and stresses in pipelines during post-trenching.

4.2.3.6 Underwater soil excavation (wash-out) by hydraulic monitors involves soil washing out by jet from the central nozzle of hydraulic monitor head, soil loosening and evacuation beyond the trench using side nozzles.

When the underwater soil is excavated by suction dredgers (eductors), soil suction is carried out by water-jet or pneumatic suction dredgers with simultaneous loosening of soil by hydraulic monitor jet.

4.2.3.7 The most effective method to excavate underwater soil is defined considering its physical properties (e.g. refer to 10.2 of the SP Recommendations). For example, underwater excavation by dredgers equipped with soil gathering devices of different types including soil breaking by hydraulic erosion dredgers and using mechanical cutting devices, is the most effective method in case of hard sand or clayish soils.

4.2.3.8 Filling washouts (voids) under pipelines with stones or crushed rocks, leveling of berm and slopes are carried out by means of submerging loose materials via chutes or pipes with subsequent ramming. Gabions may be additionally applied in case of large volumes of works.

4.2.3.9 Free spans are eliminated by divers by means of laying bags with cement-sand mixture under the pipeline on its both sides. The bags are linked together using reinforcement bars, thus creating supports to divide the spans, as a general rule, into sections with the length not more than 20 m. The length and width of supports for each diameter shall be determined separately in the Method Statement.

The Register shall approve calculations of allowable values of free spans carried out based on Appendix 2 of the SP Guidelines, Appendix 2, Section 4 of the SP Recommendations and Appendix 5 of the SP Rules, national and/or international standards and standards adopted by firms. If necessary, the calculations shall consider operation and hydraulic test modes.

4.2.4 Cutting and replacement of defective section (by lifting pipe string to surface and under water).

4.2.4.1 Defective SP sections that do not allow restoring serviceability of the pipeline to the necessary reliability level by means of repair without section cutting are subject to repair by cutting the defective section and subsequent replacement with defect-free pipes.

4.2.4.2 Joint repair of SP by means of section replacement and installation of any repair device within one defective section is not allowed (general repair method (section replacement) shall be assigned).

4.2.4.3 To provide an uninterruptable transfer during section replacement, a bypass line with special fittings (e.g. Hot Tap type) and shut-off devices may be arranged.

4.2.4.4 Methods and extent for inspection of quality of the repair by means of section replacement (including need for hydraulic and pneumatic testing), as well as scope of as-built documentation drawn up during repair are determined in the design documentation.

4.2.4.5 Repair by means of section replacement can be carried out:

with lifting SP defective section to surface;

under water by using special equipment and appliances.

4.2.4.6 To cut and replace a defective section of the subsea pipeline buried in the seabed soil, the soil in the respective area shall be excavated (washed out) according to 4.2.3.6 and 4.2.3.7. The length of washout area shall be determined based on the Register approved calculations depending on lifting diagram, pipeline parameters indicated in 4.2.3.5, residual wall thickness, water area depth and maximum permissible environmental conditions.

4.2.4.7 Prior to above-water repair by replacement of defective section the following shall be submitted to the Register for approval:

procedure for pipeline string handling;

technological procedure for cutting of defective section, assembly and welding of spool;

strength calculations for pipeline string while handling;

calculations for reactions in anchor lines and movement of watercraft used for pipeline string handling and spool tie-in.

4.2.4.8 When carrying out welding and assembly operations all requirements of the repair execution design approved by the Register and requirements specified in Section 5, Part I "Subsea Pipelines" of the SP Rules shall be met. The material of tied-in spool shall comply with the material of pipe subject to post-trenching as regards weldability.

4.2.4.9 Welding shall be performed by welders who received special training in welding technique and passed qualification tests specified in 5.3.5, Part I "Subsea Pipelines" of the SP Rules. Welding procedures shall be approved by the Register.

4.2.4.10 Distance between spool welds and girth butt joints shall not be less than the pipe diameter, and spool length shall not be less than two pipe diameters.

4.2.4.11 Joints are assembled by means of external line-up clamps and davits. Edges shall be aligned in such a way that the displacement after assembly does not exceed 25 % of pipe wall thickness (but not more than 3,0 mm) along a maximum of 1/4 of the joint circumference.

4.2.4.12 Quality of welded joints is inspected according to 5.4, Part I "Subsea Pipelines" of the SP Rules as follows:

step-by-step inspection carried out during assembly and welding of joints;

visual examination and measurement;

100 % non-destructive examination.

4.2.4.13 Repair of welding joint where impermissible defects have been found shall be carried out according to the schedule approved by the Register, which comprises methods for defect elimination and a defective section welding. The repair is followed by a repeated welding quality check by visual examination and measurement, and non-destructive testing. Repeated repair of the welding joint is not allowed.

4.2.4.14 The repair of subsea pipeline by section replacement using special mechanical two-side connecting clamps or mechanical connecting flanged clamps to which the ends of new defect-free pipeline section are fastened (welding is not required during assembly) is subject to special consideration by the Register.

4.2.5 Repair under water without replacement of defective section.

4.2.5.1 General.

4.2.5.1.1 Repair devices installed above the defective SP sections under water allow restoring serviceability of the pipeline to the necessary and adequate reliability level without expensive repair operations involving section replacement, hydraulic or pneumatic testing and without SP operation shutdown. Taking into account advantages of clamps installation as regards prompt restoration of serviceability of the defective section and economic efficiency as compared to replacement repair method, this method is the preferred one to repair defects in cases that do not require section replacement.

4.2.5.1.2 Based on the service life, the repair devices (clamps, bandings) are divided into devices for permanent repair, which allow operating the section until the end of the SP service life, and temporary devices necessary to maintain SP serviceability until repair, for example, to recategorize an emergency defect repair as an urgent one or an urgent repair as a scheduled one.

4.2.5.1.3 Depending on application, clamps are divided into two types:

fully ready-to-install factory-made items;

banding structures made of rolled composite materials or semi-products, forming clamps on pipe surface.

Depending on material, the clamps are divided into steel, composite and combination-type clamps.

4.2.5.1.4 The following is required for using clamps or banding structures for repairs of steel pipelines:

the clamps or banding structures shall be approved by the Register, and the requirements for type approval shall comply with 2.6.1.3, 2.6.1.5, 2.6.1.6 and 2.6.1.7 of these Guidelines;

the Register shall approve strength calculation, including fatigue strength, of the defective pipeline section with the clamp under actual operating conditions of the subsea pipeline and design forecast of the pipeline service life with the clamp fitted;

the Register shall approve procedures for clamps fitting including preparation of the pipeline for its installation, application of adhesive and creation of squeeze forces as well as monitoring of technical state of the pipeline with repair clamps fitted.

4.2.5.2 Composite reinforcing clamps for pipelines.

4.2.5.2.1 Composite reinforcing clamps are designed to repair the majority of defects of base metal and welded joints on straight pipeline sections for the remaining service life of the pipeline. The repair is carried out under water on the active pipeline without stopping media transfer.

4.2.5.2.2 The reinforcing clamps shall be fitted onto the SP defective section to decrease (relieve) the hoop stresses of the pipe wall due to internal pressure in defective area which shall result in termination of the defect further propagation. The clamp shall overlap the defective area by at least 50 mm to each of its edges.

4.2.5.2.3 The reinforcing clamps are generally fitted during underwater engineering works. The reinforcing clamps are usually fitted with application of additional corrosion-protection coating or adhesive (compound) allowing underwater application.

4.2.5.2.4 Upon agreement with the Register, the clamps may be fitted onto SP under pressure with the value determined for particular defect based on the inspection results. During repairs by means of clamps, lifting/lowering of SP string is not permitted.

4.2.5.2.5 Provided that the requirements 4.2.5.2.1 to 4.2.5.2.4 are observed, the SP with the following defects may be repaired:

mechanical damages (pits, scores, etc.) of the pipe external surface;

corrosion damages (total corrosive wear, cavities, pittings, etc.) of the pipe external surface;

corrosion damages (pits, rill damages, etc.) of the pipe internal surface;

dents on the pipe surface;

delaminations in the pipe body;

defects of butt girth welds and factory longitudinal welds including corrosion damages.

Maximum permissible extension of defective areas with regard to defect depths shall be determined according to the RS-approved design procedure of acceptability of repairs by clamps.

4.2.5.2.6 The magnetic marker shall be installed at the repair location, generally upstream of the clamps in the direction of medium flow with subsequent recording of its GPS/GLONASS position.

4.2.5.2.7 The composite materials applied in clamps including metal embedments and fastenings shall comply with the RS-approved technical documentation. External surface of the composite material shall be covered with coating preventing impact of sea water on the material.

4.2.5.2.8 If not otherwise specified in the Register approved documentation, the clamps shall be manufactured from composite materials with the following characteristics:

tensile strength of at least 800 MPa;

bending fracture strength of at least 200 MPa;

modulus of elasticity in the circumferential direction of at least $3{,}0 \times 10^4$ MPa;

water saturation of not more than 0,2 %.

The specified parameters of composites shall be confirmed based on the results of sea water tests according to the procedure as agreed upon with the Register. The materials shall be selected with regard to possible limitations for their maximum operating temperature caused by transportation of heated media through subsea pipelines.

4.2.5.2.9 The type approval (periodical) tests of reinforcing composite clamps shall be aimed as a minimum at confirmation of material parameters (parameters of composite materials as specified in 4.2.5.2.8).

4.2.5.2.10 As required by the Register the following tests may be carried out according to the RS-approved programmes including specimens with artificial defects:

hydraulic tests for strength and tightness of both clamp body and seals (if any);

cyclic stress tests;

breaking load tests.

4.2.5.2.11 Check (production) tests shall include at least the following:

strength test by tightening the clamp on the bench with forces (tightening torques) equal to 150 % of design ones;

check of overall, installation and connection dimensions of the clamp;

check of surface quality as per the RS-approved documentation including holiday detection;

thickness check (unless otherwise provided in the RS-approved documentation, with tolerance of +20 % of nominal thickness).

4.2.5.2.12 The metal embedments and fasteners shall be generally manufactured from stainless steel of strength class of at least 10,9.

4.2.5.2.13 All mounting works and bolt tightening operations shall be completed within 120 minutes from the start of adhesive compound mixture. Bolt connection tightening shall be carried out by means of torque wrench with step-by-step increase of torque and in sequence specified in the detailed design documentation.

4.2.5.2.14 Application of reinforcing clamps shall be confirmed by strength calculation of pipeline defective section considering actual operating conditions of the subsea pipeline.

4.2.5.3 Steel non-welded clamps.

4.2.5.3.1 Steel non-welded clamps are designed to eliminate possible leaks and to restore serviceability of pipeline defective sections. The clamps are divided into reinforcing ones that take loads from the pipeline wall on its body and wrapping ones that form a repair device together with hardening filler.

4.2.5.3.2 Steel non-welded clamps for SP repair are made as two halves of a cylinder shell with longitudinal plate flanges with seals for mechanical connection after mounting on the pipeline. The non-welded clamps can be equipped with accessories used to provide necessary pressing of seals and to prevent longitudinal displacement when sealing a defective SP section.

4.2.5.3.3 Requirements for type approval and acceptance tests shall comply with the applicable requirements of 4.2.5.2.9 to 4.2.5.2.11. In case of wrapping devices, filling of internal spaces of a type specimen and quality of filler shall be additionally checked.

4.2.5.3.4 When carrying out SP repair at considerable depths, work class ROVs shall be used for clamp fitting and clamps shall be specially adapted for fitting by means of ROVs (so called ROV-friendly technology). In this case application of steel reinforcing non-welded clamps to repair subsea pipelines defects is subject to special consideration by the Register taking into account defect type.

4.2.5.3.5 Requirements for fitting of steel non-welded clamps:

fitting of more than two clamps on one section is not allowed;

it is not allowed to use both cutting and clamp fitting repair methods within one defective section; in such case general repair method (cutting) shall be assigned;

distance between nearest ends of clamps depends on the design of applied clamps and shall provide unobstructed fitting;

it is not allowed to fit clamps on the sections with pipe cross-section geometry defects in excess of internal clamp diameter as well as on bent sections with broken pipe axis alignment;

length of defect (group of defects) shall not exceed distance between internal ring seals of the clamp;

it is not allowed to install the clamp on fractured or centerline deformed SP sections. Prior to clamp fitting the repaired section geometry shall be mandatorily measured using special callipers;

all clamps shall have documents confirming their compliance with the requirements for technical devices applied on Hazardous Production Facilities established in accordance with the federal legislation.

4.2.5.4 Repair of deformed sections of pipeline by banding without metal loss.

4.2.5.4.1 Steel non-welded wrapping clamps with hardening filler (clamp-protectors) are designed to repair geometry defects, out-of-roundness, dents, bends, corrosion defects including areal ones with maximum depth of 20 % of pipe wall thickness.

4.2.5.4.2 Such clamps consist at least of two half shelves connected on the pipeline under repair using fasteners. When assembled the clamp shall be a closed-space section (module) with its ends tightly fitted to the external surface of the pipeline by means of sealing gaskets. The inside of the sections provides free filling with fixing grout.

4.2.5.4.3 To fill the inside with fixing grout (concrete), filler supply and drain connections with shut-off valves shall be provided.

Unless otherwise is specified in the RS-approved documentation, polymer concrete grout with strength not less than 4.0 MPa (which shall be confirmed by specimen testing) after hardening shall be used as a filler.

4.2.5.4.4 Modular approach is recommended for making sections so that they can be interconnected along the pipeline and used for repair of both straight and curved sections of subsea pipelines.

4.2.5.4.5 These clamps can be applied to repair concrete coated pipelines without concrete removal as well as in combination with reinforcing clamps.

4.2.5.4.6 The requirements for type approval and acceptance tests shall comply with the applicable requirements of 4.2.5.2.9 to 4.2.5.2.11, and internal space filling and quality of filler (concrete) shall be additionally checked.

4.2.6 Steel pre-welded and welded clamps.

4.2.6.1 Steel pre-welded and welded clamps are permanent repair devices. Due to the necessity of dry welding, this type of SP repair can be applied on shore crossings and on temporally flooded route sections.

4.2.6.2 The following is required for using pre-welded and welded clamps for repairs of steel pipelines:

the clamps shall be approved by the Register and the requirements for type approval shall comply with 2.6.1.3, 2.6.1.5, 2.6.1.6 and 2.6.1.7 of these Guidelines;

the Register shall approve strength calculation, including fatigue strength, of the defective pipeline section with the clamp under acting operation conditions of the subsea pipeline and design forecast of the pipeline service life with the clamp installed;

the Register shall approve procedure for clamp fitting including preparation of the pipeline for its installation as well as monitoring of technical state of the pipeline with repair clamp fitted.

4.2.6.3 The following requirements shall be met when assigning repair of individual defects, groups of defects and defective sections using steel pre-welded and welded clamps:

fitting of more than two clamps on one section is not allowed except for the cases when two clamps are fitted on the welded joints of the section and one clamp is fitted on the pipe body;

it is not allowed to use both cutting and clamp fitting repair methods within one defective section; in such case general repair method (cutting) shall be assigned;

handling of the subsea pipeline string under repair using clamps is not allowed;

distance between nearest ends of clamps shall not be less than 150 mm;

it is not allowed to fit clamp on the sections with pipe cross-section geometry defects in excess of internal clamp diameter;

it is not allowed to fit the clamps on the curved SP sections;

it is not allowed to mount add-on rings on the girth welds of the pipeline and corrugations. The distance from the end of the add-on ring of the clamp to the girth weld outside the clamp shall not be less than four (4) times the pipe wall thickness;

distance from the clamp-to-pipe weld to the edge of the defect subjected to repair using welded clamp shall not be less than 100 mm;

area of the defect under repair shall be overlapped by at least 1,65*DN* in longitudinal direction;

all welds during installation of steel pre-welded and welded clamps shall be carried out by dry welding;

all repair devices shall have documents confirming their compliance with the requirements for technical devices used on Hazardous Production Facilities established in accordance with the federal legislation.

4.2.6.4 This type of repair by using steel pre-welded clamps is carried out on the acting subsea pipeline without stopping product transfer. To increase relieving effect of the repair clamps and in order to carry out safe welding, the pressure in the pipeline shall be decreased down to 20 to 30 % of the operating one.

4.2.6.5 When carrying out welding and assembly operations all requirements of the repair execution design approved by the Register and requirements specified in Section 5, Part I "Subsea Pipelines" of the SP Rules shall be met.

4.2.6.6 Welding shall be performed by welders who received special training in welding technique and passed qualification tests specified in 5.3.5, Part I "Subsea Pipelines" of the SP Rules. Welding procedures shall be approved by the Register.

4.2.7 Repair of insulation.

4.2.7.1 Corrosion protection repair systems.

4.2.7.1.1 Repair of insulation shall be carried out by using corrosion protection banding repair systems (e.g. Sea Shield type), which include:

primer;

petrolatum tape;

outer cover.

Placement of protective covering includes the following stages: preparation of the surface, application of primer, application of tape and installation of cover.

4.2.7.1.2 Corrosion protection repair systems shall be type approved by the Register according to 2.7.1.1. Scope of type approval testing shall comply with 2.7.1.3.2.1, 2.7.1.3.2.4, 2.7.1.3.2.5 and 2.7.1.3.2.6.

4.2.7.1.3 Prior to placement of protective covering, corrosion, old insulation coating and other impurities shall be removed from the surface (to at least grade 3 as per GOST 9.402).

4.2.7.1.4 It is prohibited to apply insulation on the pipes with surfaces containing corrosion residues. It is not allowed to make deep (more than 10 % of rated thickness of pipe walls) scratches, notches, chips on base metal and to remove weld reinforcement below base metal.

4.2.7.1.5 The petrolatum-based primer shall have high adhesion to the metal surface and shall contain water displacement agents (to ensure its application under water), corrosion inhibitors and biocides. The primer shall be applied not later than 24 hours after cleaning the pipeline surface.

4.2.7.1.6 The reinforced petrolatum tape is wrapped in two layers. To restore the insulation coating on long sections, the tape shall be applied using wrapping devices ensuring necessary tape tension and layer-by-layer overlap of 50 %.

4.2.7.1.7 The wrapped petrolatum tape shall be protected against environmental loads by the outer cover.

4.2.7.1.8 Similar corrosion protection banding systems comprising epoxy primers and fiber glass, kevlar, carbon fiber, etc. tapes may be applied; the outer cover is not required for such systems.

4.2.7.2 Insulating composite clamps.

4.2.7.2.1 Insulating composite clamps shall have fiber-glass protective cover with at least one joint into which an insert (liner) is installed on the protected pipe surface using epoxy adhesive containing water displacement agents ensuring its application under water.

4.2.7.2.2 Prior to installing insulating clamp, corrosion, old insulation coating and other impurities shall be removed from the surface of the pipeline including welds.

4.2.7.2.3 The insert with adhesive applied on the internal surface shall be placed on the prepared protected surface. Protective cover shall be fitted above the insert and the fastenings shall be tightened.

4.2.7.2.4 Insulating composite clamps shall be type approved by the Register according to 2.7.1.1. Scope of type approval testing shall comply with 4.2.7.1.2 and the tests according to 2.7.1.3.2.2 and 2.7.1.3.2.11 shall be additionally conducted.

4.2.8 Repair of surface defects of steel pipes by grinding.

4.2.8.1 Grinding method is used to repair corrosion defects, notches, delaminations on surfaces, small cracks. Maximum depth of ground section shall not be more than 20 % of rated thickness of pipe wall. The grinding shall restore smoothness of the surface to reduce tension concentration at the defect area.

4.2.8.2 Prior to grinding, the pressure in SP shall be reduced to the value given in the Method Statement.

4.2.8.3 After grinding, the pipe section shall be checked for residual thickness of the wall. If the thickness of SP wall after grinding does not fall outside the negative tolerance specified by the relevant normative documents for pipes or pipeline components, insulation shall be repaired in accordance with 4.2.8. If SP wall thickness does fall outside the negative tolerance, reinforcing clamps shall be fitted in accordance with 4.2.6.

4.2.8.4 Repair by grinding is carried out by a diving team using specialized appliances as well as by work class remote controlled vehicles.

4.2.9 Typical subsea pipeline repair methods.

4.2.9.1 Typical repair method to eliminate the defects detected during diagnostic examination of subsea pipelines considering technical state of the pipeline according to 9.2.2.11 and 9.2.3, Part I "Subsea Pipelines" of the SP Rules can be selected in accordance with Table 4.2.9.1.

Table 4.2.9.1

Matrix for selection of typical subsea pipeline repair method

Pipeline defects/repair methods	Technical state of pipeline	Repair methods/scope of repair works					
		Underwater excavation works	Repair of external coatings	Grinding of pipe wall	Fitting of reinforcing clamp	Fitting of wrapping clamp	Replacement of defective section
Global defects							
Bending and/or deviation from design route	Up state Level I						
	Up state Level II						
	Limiting state						
Stripping and/or sagging	Up state Level I						
	Up state Level II						
	Limiting state						
Cross-section defects							
Dent or corrugation	Up state Level I						
	Up state Level II						
	Limiting state						
Out-of-roundness	Up state Level I						
	Up state Level II						
	Limiting state						
Defects of pipe wall and welds							
External metal loss	Up state Level I						
	Up state Level II						
	Limiting state						
Internal metal loss	Up state Level I						
	Up state Level II						
	Limiting state						

Table 4.2.9.1 — continued

Pipeline defects/repair methods	Technical state of pipeline	Repair methods/scope of repair works					
		Underwater excavation works	Repair of external coatings	Grinding of pipe wall	Fitting of reinforcing clamp	Fitting of wrapping clamp	Replacement of defective section
Mark, score on external surface	Up state Level I						
	Up state Level II						
	Limiting state						
Crack on external surface	Up state Level I						
	Up state Level II						
	Limiting state						
Cracks on internal surface	Up state Level I						
	Up state Level II						
	Limiting state						
Delamination	Up state Level I						
	Up state Level II						
	Limiting state						
Delamination reaching external surface	Up state Level I						
	Up state Level II						
	Limiting state						
Delamination reaching internal surface	Up state Level I						
	Up state Level II						
	Limiting state						
Weld defect	Up state Level I						
	Up state Level II						
	Limiting state						
External coating defects							
Insulation defect	Up state Level I						
	Up state Level II						
	Limiting state						

Table 4.2.9.1 — continued

Pipeline defects/repair methods	Technical state of pipeline	Repair methods/scope of repair works					
		Underwater excavation works	Repair of external coatings	Grinding of pipe wall	Fitting of reinforcing clamp	Fitting of wrapping clamp	Replacement of defective section
Deterioration of concrete coating	Up state Level I						
	Up state Level II						
	Limiting state						

— repair methods (main working repair operations);

— auxiliary working operations.

4.2.10 Technical supervision of subsea pipelines repair.

4.2.10.1 In accordance with 1.3.11 of the SP Guidelines in order to specify types and scope of the Register surveys during technical supervision of SP repair it is recommended to use Inspection and Test Plans developed by the firms (contractors) and agreed by the Register.

4.2.10.2 Tables 4.2.10.2-1 to 4.2.10.2-7 contain recommended typical inspection and test plans for RS technical supervision of SP repair.

4.2.10.3 When conducting a set of repair works for a specific item, Inspection and Test Plans reviewed by the Register as part of technical documentation (refer to 4.2.2) may comprise combinations of the typical Inspection and Test Plans above depending on utilized repair types and procedures.

Table 4.2.10.2-1

Typical inspection and test plan for defect repair by grinding

Performed works	Equipment, appliances, materials	RS technical supervision	Notes
1 Review of MS and technical documentation	—	R	
2 Receipt of written notice from customer on pressure decrease in SP to allowable value and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
4 Soil wash-out on all sides of pipeline near defect location (if necessary for buried SP)	Hydraulic monitor, pontoon suction dredger	M	According to Inspection and Test Plan for underwater excavation
5 Specification of defect location	Set for visual examination and measurement	M	Unambiguous defect location shall be provided
6 Cleaning of defect location from insulation, corrosion and adjacent 100 mm area	Grinder	—	
7 Additional diagnostic analysis of defect (visual examination and measurement, ultrasonic testing) and adjacent 100 mm area	Devices for visual examination and measurement, ultrasonic testing	M	In accordance with technological flow charts for additional diagnostic analysis
8 Grinding of defect till complete elimination of corrosion, micro-cracks etc. with smooth transition to base metal	Grinder	M	
9 Visual examination and measurement, ultrasonic testing of ground section to detect defects, check of residual pipeline wall thickness	Ultrasonic thickness gauge	W	Following the results of measurement of residual pipeline wall thickness
10 Restoration of coatings and ballasting, coating quality inspection	—	W	In accordance with requirements of Sections 6 and 7, Part I of SP Rules
11 Pipeline backfilling	Hydraulic monitor, suction dredger	M	According to Inspection and Test Plan for underwater excavation
12 Diver ascending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
13 Drawing up of as-built documentation	—	H	

Table 4.2.10.2-2

Inspection and test plan for defect repair by fitting reinforcing clamps

Performed works	Equipment, appliances, materials	RS technical supervision	Note
1 Review of MS and technical documentation, checking availability of RMRS certificates, material incoming inspection	—	R	
2 Receipt of written notice from customer on pressure decrease in SP to allowable value and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
4 Soil wash-out/backfilling on all sides of pipeline near defect location (if necessary for buried SP)	Hydraulic monitor, pontoon suction dredger	M	According to Inspection and Test Plan for underwater excavation
5 Specification of defect location and preparation of place for clamp fitting	—	W	Unambiguous defect location shall be provided
6 Clamp fitting			
6.1 Preparation of repair compound and filling defects of pipe surface	—	M	
6.2 Preparation of adhesive compound and installation of clamp insert onto pipe surface	—	M	Weld reinforcement shall be located in insert break
6.3 Fitting clamp onto pipeline	Marine winch	M	
6.4 Bolt tightening	Torque wrenches	M	
7 Diver ascending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
8 Drawing up of as-built documentation	—	H	

Table 4.2.10.2-3

Inspection and test plan for defect repair by fitting insulating clamps

Performed works	Equipment, appliances, materials	RS technical supervision	Notes
1 Review of MS and technical documentation, checking availability of RMRS certificates, material incoming inspection	—	R	
2 Receipt of written notice from customer on pressure decrease in SP to allowable value and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
4 Soil wash-out/backfilling on all sides of pipeline near defect location (if necessary for buried SP)	Hydraulic monitor, pontoon suction dredger	M	According to Inspection and Test Plan for underwater excavation
5 Specification of defect location and preparation of place for clamp fitting	—	W	Unambiguous defect location shall be provided
6 Clamp fitting			
6.1 Preparation of adhesive compound and installation of clamp insert onto pipe surface	—	M	Weld reinforcement shall be located in insert break
6.2 Clamp lowering from ship and fitting onto pipeline	Marine winch	M	
6.3 Bolt tightening	Torque wrenches	M	Torque in accordance with the requirements of manufacturer′s installation instruction
6.4 Clamp joint shall be filled with plasticine provided	—	M	
7 Diver ascending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
8 Drawing up of as-built documentation	—	H	

Table 4.2.10.2-4

Inspection and test plan for defect repair by fitting clamps for banding

Performed works	Equipment, appliances, materials	RS technical supervision	Notes
1 Review of MS and technical documentation, checking availability of RMRS certificates, material incoming inspection	—	R	
2 Receipt of written notice from customer on pressure decrease in SP to allowable value and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV and supply of fixing grout	—	In compliance with requirements of document RD 31.84.01-90
4 Soil wash-out/backfilling on all sides of pipeline near defect location (if necessary for buried SP)	Hydraulic monitor, pontoon suction dredger	M	According to Inspection and Test Plan for underwater excavation
5 Specification of defect location and preparation of place for clamp fitting, specification of clamp geometry	—	W	Unambiguous defect location shall be provided
6 Clamp fitting			
6.1 Clamp lowering from ship and fitting onto pipeline	Marine winch	M	
6.2 Mounting of clamp parts on pipeline	—	W	
6.3 Clamp bolt tightening	Torque wrenches	M	Torque in accordance with the requirements of manufacturer's installation instruction
6.4 Opening of drain and concrete supply valves, connection of supply hose	—	M	
6.5 Supply of fixing grout into clamp cavity	Concrete pump	M	Monitoring of clamp joint surface, bolt retightening in case of leaks
6.6 Monitoring of clamp cavity filling by grout discharge from drain points, shut-off of leak and drain valves	—	W	Shut-off after clamp filling
7 Diver ascending	Ship with diver station and underwater CCTV and supply of fixing grout	—	In compliance with requirements of document RD 31.84.01-90
8 Drawing up of as-built documentation	—	H	

Table 4.2.10.2-5

Inspection and test plan for underwater excavation works

Performed works	Equipment, appliances, materials	RS technical supervision	Notes
1 Review of MS and technical documentation, material incoming inspection	—	R	
2 Receipt of written notice from customer on pressure decrease in SP to allowable value and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
4 Underwater excavation works			
4.1 Specification of work location, marking of work area, placement of hoses	Marine winch	M	
4.2 Soil washout/backfilling	Hydraulic monitor, pontoon suction dredger	M	
4.3 Monitoring of SP position during post-trenching	—	W	
4.4 SP covering with specially supplied soil (if necessary)	Dredger pontoon/barge	M	Bags with sand-cement mixture or flexible concrete mats may be used
5 Diver ascending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
6 Drawing up of as-built documentation	—	H	

Table 4.2.10.2-6

Inspection and test plan for underwater elimination of free spans

Performed works	Equipment, appliances, materials	RS technical supervision	Notes
1 Review of MS and technical documentation, material incoming inspection	—	R	
2 Receipt of written notice from customer on pressure decrease in SP to allowable value and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
4 Underwater works			
4.1 Specification of work location, marking of work area	Marine winch	M	
4.2 Arrangement of intermediate supports made of bags with sand-cement mixture (if necessary)	—	W	
4.3 Soil wash-out/backfilling	Hydraulic monitor, pontoon suction dredger	M	
4.4 Elimination of sagging by supplied soil (if necessary)	Dredger pontoon/barge	M	
5 Diver ascending	Ship with diver station	—	In compliance with requirements of document RD 31.84.01-90
6 Drawing up of as-built documentation	—	H	

Table 4.2.10.2-7

Inspection and test plan for repair by lifting and replacement of defective section

Performed works	Equipment, appliances, materials	RS technical supervision	Notes
1 Review of MS and technical documentation, checking availability of RMRS certificates, material incoming inspection	—	R	
2 Receipt of written notice from customer on pressure decrease, SP cleaning and permission for work	—	R	
3 Diver descending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
4 Soil wash-out/backfilling on all sides of pipeline near defect location (if necessary for buried SP)	Hydraulic monitor, pontoon suction dredger	M	According to Inspection and Test Plan for underwater excavation
5 Specification of defect location and cutting of defective section (if necessary)	Underwater cutter (oxy-electric, exothermic, etc.)	W	Unambiguous defect location shall be provided
6 Slinging of pipeline string with installation of buoyancy components	Specialized watercraft with davits to lift SP string	M	
7 Lifting of SP string(s) to specialized watercraft, cutting of defective section (if necessary), preparation of string edges	Specialized watercraft with davits to lift SP string	M	
8 Manufacture of spool for tie-in	—	W	In accordance with requirements of Sections 4 and 5, Part I of the SP Rules
9 Assembly and welding of spool, inspection of welded joints quality	Line-up clamp, welding station, NDT aids	W	In accordance with requirements of Sections 4 and 5, Part I of the SP Rules
10 Applying insulation and ballast coating on spool, coating quality inspection	—	W	In accordance with requirements of Sections 6 and 7, Part I of the SP Rules
11 Lowering and placing of repaired SP section	Specialized watercraft with davits to lift SP string	M	
12 Restoration of protective soil layer on SP (if necessary)	Hydraulic monitor, pontoon suction dredger	M	According to Inspection and Test Plan for underwater excavation
13 Diver ascending	Ship with diver station and underwater CCTV	—	In compliance with requirements of document RD 31.84.01-90
14 Hydraulic testing (if necessary)	—	W	
15 Drawing up of as-built documentation	—	H	

APPENDIX 1

ASSESSMENT OF ACCEPTABILITY OF STEEL SP DEVIATION FROM ORIGINAL ROUTE

The acceptability of a steel SP deviation from an original route is determined as follows:

1. following the examination results, the coordinates of points (x_i, z_i) on the pipeline section with deviations from the design (original) route are determined. The points are recommended to be spaced at least 100 m apart (refer to Fig. 1);

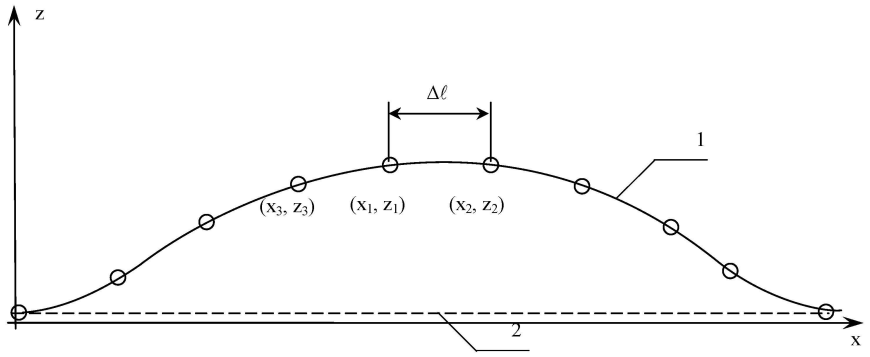

Fig. 1:
1 — actual SP route; *2* — initial (design) SP route

2. a radius of SP curvature is calculated for each point with coordinates (x_1, z_1), in m:

$$R_{l1} = \sqrt{(x_1 - x_0)^2 + (z_1 - z_0)^2}$$

where $x_0 = \Delta_x/\Delta$; $z_0 = \Delta_z/\Delta$;

$$\Delta_x = \frac{1}{2}\left\{\left[(x_2^2 - x_1^2) + (z_2^2 - z_1^2)\right]\cdot(z_3 - z_1) - \left[(x_3^2 - x_1^2) + (z_3^2 - z_1^2)\right]\cdot(z_2 - z_1)\right\};$$

$$\Delta_z = \frac{1}{2}\left\{\left[(x_3^2 - x_1^2) + (z_3^2 - z_1^2)\right]\cdot(x_2 - x_1) - \left[(x_2^2 - x_1^2) + (z_2^2 - z_1^2)\right]\cdot(x_3 - x_1)\right\};$$

$$\Delta = (x_2 - x_1)\cdot(z_3 - {}_1) - (x_3 - x_1)\cdot(z_2 - z_1);$$

(x_2, z_2) and (x_3, z_3) — coordinates of the previous and the next point, accordingly, in m;

3. the pipeline deviation is acceptable if for each *i*-th point

$$\frac{D_0 \cdot 10^{-3}}{R_{li}} \leqslant 0{,}001,$$

where D_0 = nominal external diameter of a pipe, in mm.

APPENDIX 2

ASSESSMENT OF ACCEPTABILITY OF FREE SPAN STEEL SP SECTION

The acceptability of a free span steel SP section shall be validated by strength calculation to determine quasistatic bending stresses (refer to Section 1 — 3) and verification of the absence of the SP resonance transverse oscillations under variable hydrodynamic loads (refer to Section 4).

1. the length of the free span section l, in m (refer to Fig. 1) is determined by visual examination;

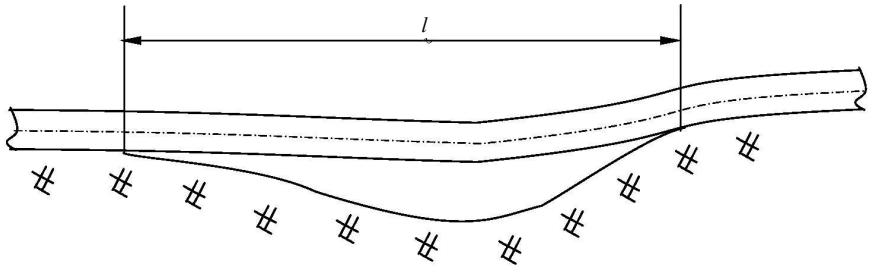

Fig. 1
Free span SP section

2. The maximum bending moment within the free span section, in Nm:

$$M_{\max} = \frac{ql^2}{24} \frac{2l}{l + \frac{2}{\alpha_s}}, \text{ when } l > \frac{6}{\alpha_s};$$

$$M_{\max} = \frac{ql^2}{24} \frac{l + \frac{6}{\alpha_s}}{l + \frac{2}{\alpha_s}}, \text{ when } l < \frac{6}{\alpha_s},$$

where $\alpha_s = \sqrt[4]{\frac{k}{4EI}}$;

k = linear stiffness of interaction between the pipe and seabed soil, in N/m^2;
E = Young's modulus of the pipe material, in Pa;

$I = \frac{\pi}{64} [D^4 - (D - 2t)^4] \cdot 10^{-12}$ = inertia moment of the pipe cross-section, in m^4, determined by the formula

D = nominal external diameter of a metal pipe, in mm;
t = actual wall thickness of the pipe, in mm;
q = vertical linear load due to pipe weight with regard to insulation weight, weight coating, transported medium and total vertical component of current (refer to 2.5.1, Part I "'Subsea Pipelines" of the SP Rules) and waves action (refer to 2.6.4, Part I "Subsea Pipelines" of the SP Rules), in N/m.

.3 the value of quasistatic bending stresses of the pipeline a σ_{bend}, in MPa:

$$\sigma_{bend} = \frac{M_{\max}}{W} \cdot 10^{-6},$$

where W = section modulus, in m^3, determined by the formula

$$W = \frac{\pi}{32} \left[D^3 - (D-2t)^4/D\right] \cdot 10^{-9}.$$

The defect of a free span section of the pipeline shall be assumed permissible provided that the strength condition specified in 3.2.6, Part I "Subsea Pipelines" of the SP Rules is met in the absence of excess internal pressure (i.e., during laying) at the working and test pressure.

4. The free spans calculations under variable hydrodynamic loads shall be carried out providing that the span length l, in m (refer to Fig. 1) does not exceed the critical value L_{cr}, in m, at which resonance of the transverse pipeline oscillations occur due to the combined exposure of currents and waves.

4.1 In accordance with 2.3 of Appendix 5 of the SP rules the reduced velocity of the initial transverse oscillations $V_{R,\ onset}^{CF}$ shall be determined depending on correction factors with regard to the seabed proximity and trench availability (refer to Formulae (2.3-1) – (2.3-3), Appendix 5 of the SP Rules. In such case, D_0, in mm, shall be taken as the pipe external diameter based on the available weight and/or insulation coatings).

4.2 The critical value of free span L_{cr}, in m, and the absence of the SP transverse oscillations for the span of l, in m, in length, identified during in-water survey, shall be determined by the following formula:

$$L_{cr} = \sqrt{\frac{CV_{R,\ onset}^{CF} D_0}{(V_c+V_w)\gamma_{CF}} \sqrt{EI/m}} > l, \qquad (4.2\text{-}1)$$

where V_c = current velocity, in m/s, according to 2.5, Part I "Subsea Pipelines" of the SP Rules;
V_w = maximum velocity close to seabed induced by wave forces, in m/s, according to 2.6, Part I "Subsea Pipelines" of the SP Rules;
γ_{CF} = safety factor taken equal to 1,4;
EI = bending stiffness of free span, in $N \cdot m^2$ as determined for a metal pipe (refer to Section 2);
m = linear pipeline weight calculated according to formula (only if the concrete weight coating is available);

$$m = \frac{\pi}{4}((D^2-(D-2t)^2)\rho_s+(D_0^2-D^2)\rho_{concr}+(D-2t)^2\rho_m+D_0^2\rho), \text{ kg/m}, \qquad (4.2\text{-}2)$$

where D = external diameter of a metal pipe, in m;
D_0 = external diameter of a concrete coated pipe, in m;
ρ_s = steel density, in kg/m^3;
ρ_{concr} = concrete weight coating density, in kg/m^3;
ρ_m = transported medium density, in kg/m^3;
ρ = sea water density, in kg/m^3;
t = actual wall thickness of the pipe, in m;
C = factor considering the boundary conditions at the ends of the pipeline free span, shall be taken equal to 1,54 in case of sliding supports at the ends and 3,56 in case of end restraints.

APPENDIX 3

ASSESSMENT OF ACCEPTABILITY OF SP STEEL PIPE DENT

The acceptability of the dent on a pipeline wall is determined as follows:

1. the maximum deformations in way of the dent are obtained from the formula

$$\varepsilon_{max} = 1{,}15 \cdot \sqrt{\varepsilon_y^2 + \varepsilon_x^2 + \varepsilon_y \varepsilon_x},$$

where $\varepsilon_y = \frac{20 h_0 t}{B_0^2}$,

$\varepsilon_x = \frac{20 h_0 t}{L_0^2}$;

h_0, B_0, L_0 = maximum residual deflection, width and length of the dent, respectively, determined according to fault detection results, in mm;

t = actual wall thickness of the pipe, in mm.

2. the dent shall be assumed permissible if $\varepsilon_{max} < 0{,}02$.

APPENDIX 4

ASSESSMENT OF ACCEPTABILITY OF SURFACE CORROSION FOR STEEL SP PIPE

1. The permissible maximum value of corrosive wear allowance Δt, in mm, measured during the fault detection for the isolated/single corrosive damage shall meet the following condition:

$$\Delta t = \min[0{,}5t_0,\ Mt_0], \tag{1-1}$$

where factor M is determined by the formula

$$M = \frac{0{,}9R_e - p\left(\frac{D}{2t_0} - 1\right)}{0{,}9R_e - \frac{p}{Q}\left(\frac{D}{2t_0} - 1\right)}, \tag{1-2}$$

where t_0 = initial (as-built) wall thickness, in mm;
D = external diameter of a metal pipe, in mm;
R_e = yield strength of the pipe material, in MPa;
$p = p_i - p_{g\min}$;
p_i = pipeline working pressure, in MPa;
$p_{g\min}$ = minimum external hydrostatic pressure on the pipeline determined by formula (2.2.2), Part I "Subsea Pipelines" of the SP Rules, in MPa;
Q = correction function (Folias correction factor) allowing for the maximum extension of the damage along the pipe, determined by the formula

$$Q = \sqrt{1 + 0{,}31\left(\frac{l}{\sqrt{Dt_0}}\right)}, \tag{1-3}$$

l = maximum extension of the defect along the pipe, in mm.

The defect shall be assumed isolated if no other corrosive damages are detected at a distance equal to l from its edge.

2. For two or several corrosive damages which cannot be assumed as isolated (distances between their edges are less than the maximum dimension of the largest adjacent defect along the pipe), the maximum permissible value of the corrosive wear shall be determined according to para 1 when the total extension of the corrosive damage (without subtraction of sections between defects) is used in formula (1-3) instead of value l.

3. To account for possible increase of the corrosive wear for the period before the next inspection, the value Δt shall be increased with regard to the actual depth of the corrosive wear on the basis of 0,5 mm per year.

APPENDIX 5

ASSESSMENT OF ACCEPTABILITY OF (PIT) PITTING CORROSION FOR STEEL SP PIPE

1. The acceptability of pit (pitting) corrosion h is determined by the criterion

$h \leqslant \min[h_1, h_2]$

where h_1 = permissible defect depth determined according to Appendix 4 as for the defect of metal loss type;
h_2 = permissible defect depth determined according to Appendix 6 as for the crack-like defect.

2. To account for possible increase in the corrosion depth for the period before the next inspection, the value h shall be increased with regard to the actual depth on the basis of 0,5 mm per year.

APPENDIX 6

ASSESSMENT OF ACCEPTABILITY OF SCORES, NOTCHES, DELAMINATIONS, CRACKS AND CRACK-LIKE DEFECTS FOR STEEL SP PIPES

1. Crack-like defects detected during fault detection are divided into surface (refer to Fig. 1-1) and subsurface (refer to Fig.1-2).

The geometric parameters *a* and *b* of the crack in Fig. 1-1 and 1-2 are determined during SP inspection (it is assumed that $a > b$), *t* — actual thickness of the pipe wall.

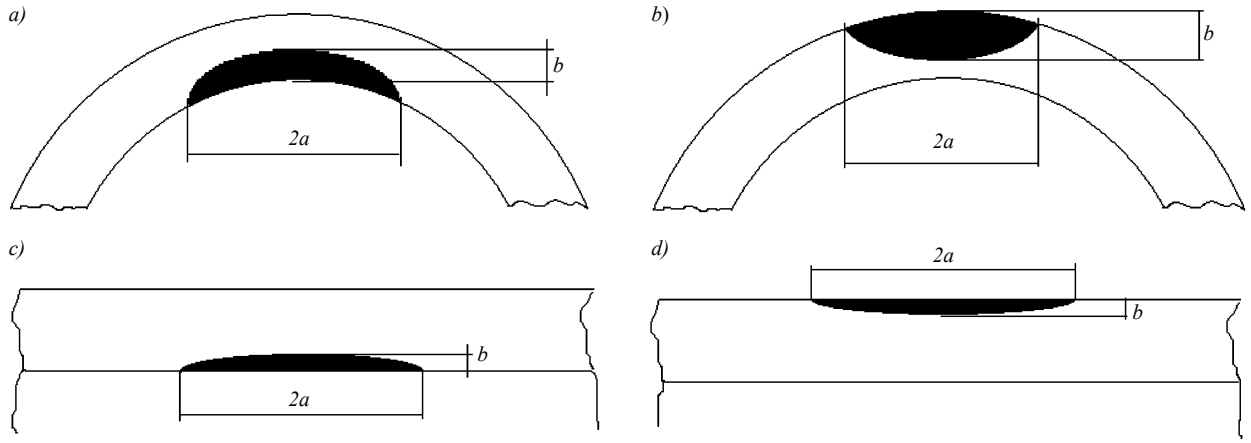

Fig.1-1
Classification of surface cracks:
a) — transversal internal; *b*) — transversal external; *c*) — longitudinal internal; *d*) — longitudinal external

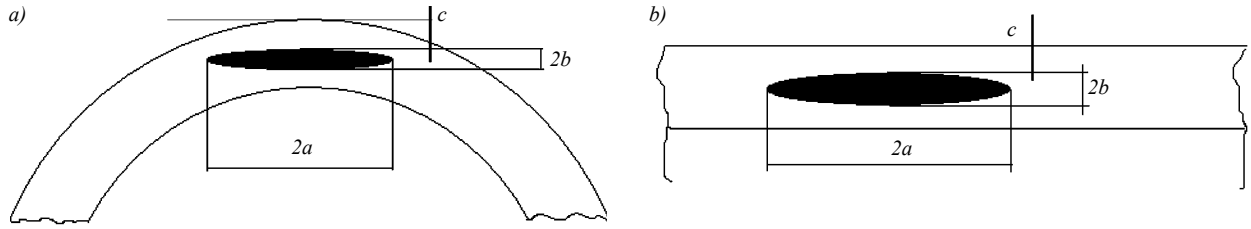

Fig.1-2
Classification of subsurface cracks:
a) — transversal; *b*) — longitudinal

2. The initial data for the defect acceptability assessment are as follows:

stress σ perpendicular to the defect surface (refer to para 3);

data allowing for assessment of material crack resistance parameter K_c (refer to para 4) and permissible value of critical stress intensity factor [*K*] (refer to para 5);

location of the defect relative to the weld: the defect is considered as a base metal defect if the distance between the defect surface and weld is more than the pipe thickness *t*. Otherwise, the assessment accounts for the residual welding stresses (refer to para 8). If the defect is located within the weld, the assessment accounts for the necessity of crack resistance parameter assessment for the weld joint metal (refer to para 4).

3. Stresses σ shall be determined by the following formulae:
for defects located along the pipe, in MPa,

$$\sigma = p\left(\frac{D}{2t} - 1\right); \tag{3-1}$$

for transverse defects, in MPa,

$$\sigma = \frac{ED}{R_i}10^{-3} + \alpha\Delta TE + \mu p\left(\frac{D}{2t} - 1\right), \tag{3-2}$$

where D = external diameter of a metal pipe, in mm;
t = actual wall thickness of the pipe, in mm;
$p = p_i - p_{gmin}$;
p_i = working pressure within the SP, in MPa;
p_{gmin} = minimum external hydrostatic pressure on the pipeline determined by formula (2.2.2), Part I "Subsea Pipelines" of the SP Rules, in MPa;
E = modulus of elasticity, in MPa;
μμ = Poisson's ratio;
R_i = radius of SP curvature during laying, in m;
α = linear expansion coefficient of pipe metal, 1/deg.;
ΔT = design temperature difference, in °C.

4. The crack resistance parameter K_c is determined based on the following data.

4.1 Based on results of tests carried out according to the RS approved procedures when receiving the Recognition Certificate for Manufacturer for pipe products used during SP construction. In this case, the crack tip opening displacement (CTOD) is determined for base metal and metal of field longitudinal weld. The value K_c shall be determined by the following formula:

$$K_c = \sqrt{\frac{2R_e\delta_{cr}E}{(1-\mu^2)}10^{-3}}, \tag{4.1}$$

where δ_{cr} = critical crack opening, in mm;
R_e = guaranteed yield strength of pipe material, in MPa;
K_c = critical stress intensity factor, in MPa$\sqrt{\text{m}}$.

4.2 Based on results of tests carried out according to the RS approved procedures during qualification of welding procedures used for welding of field butt welds. When determining CTOD, the value K_c for the field weld metal is determined by formula (4.1).

4.3 Based on special tests carried out for determining the SP operational reliability. Upon the calculation results of *J*-integral critical value, J_c the value K_c may be also determined by the following formula:

$$K_c = \sqrt{\frac{J_cE}{(1-\mu^2)}\ 10^{-9}}, \tag{4.3}$$

where J_c = critical value of *J*-integral, in N/mm.

4.4 When data on crack resistance is not available, the value K_c may be calculated based on impact energy guaranteed by the normative and technical documentation for the pipes during Charpy *V* impact tests.

$$K_c = 16\sqrt{KV}, \tag{4.4}$$

where KV = impact energy, in J.

4.5 The test temperature for determination of crack resistance parameters shall not exceed the design operating temperature for SP. The following is taken for the characteristic of K_c:

for tests of three specimens — minimum value from the obtained results;

for tests of four and more specimens — the second to last from the obtained values or mean of the obtained values minus one standard deviation.

5. The permissible value of stress intensity factor [K] shall be determined by the formula

$$[K] = K_c/n, \tag{5}$$

where n = safety factor.

The value n is equal to 1,4 when using the actual values of material crack resistance or 1,75 when correlation specified in 4.4 is used.

6. The defect shall be assumed permissible when the following inequations are met:

$$\sigma_s \leqslant R_e; \tag{6-1}$$

$$K_s = \frac{K_d + K_{res}}{[K]} f \leqslant 1, \tag{6-2}$$

where σ_s = stresses in the net section of the pipe wall determined with regard to defect, in MPa;
K_d = design value of stress intensity factor for the defect under operating stresses as defined according to para 3, in MPa$\sqrt{\text{m}}$;
K_{res} = design value of stress intensity factor for the defect under residual welding stresses, in MPa$\sqrt{\text{m}}$;
f = function considering ratio σ_s/R_e.

7. The value K_d is determined by the following formula:

$$K_d = Y\sigma\sqrt{\pi b 10^{-3}}, \tag{7}$$

where Y = dimensionless parameter determined by Tables 7-1 to 7-24 depending on location of the crack/crack-like defect (refer to Fig. 1-1 and 1-2), its relative dimensions and ratio R/t. For intermediate values b/t, b/a, c/t and R/t, parameter Y is determined by linear interpolation.

Table 7-1

Longitudinal internal crack, values $Y(R/t = 10)$

b/t / b/a	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,29	1,35	1,55	1,87	2,36	3,16	4,50	7,08	13,3
0,1	1,24	1,27	1,35	1,49	1,70	1,99	2,41	2,92	4,07
0,2	1,18	1,19	1,23	1,31	1,41	1,54	1,69	1,84	1,99
0,3	1,12	1,12	1,15	1,21	1,28	1,36	1,46	1,55	1,64
0,4	1,06	1,06	1,08	1,12	1,17	1,23	1,29	1,36	1,41
0,5	0,99	0,99	1,01	1,03	1,07	1,11	1,16	1,21	1,24
0,6	0,93	0,93	0,94	0,96	0,99	1,02	1,05	1,08	1,11
0,7	0,88	0,88	0,88	0,90	0,91	0,94	0,96	0,98	1,00
0,8	0,82	0,82	0,83	0,84	0,85	0,87	0,88	0,90	0,91
0,9	0,78	0,78	0,78	0,78	0,79	0,80	0,82	0,83	0,84
1,0	0,73	0,73	0,73	0,74	0,74	0,75	0,76	0,76	0,77

Table 7-2

Longitudinal internal crack, values $Y(R/t = 20)$

b/t / b/a	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,2	1,27	1,46	1,76	2,24	2,99	4,27	6,73	12,6
0,1	1,15	1,19	1,27	1,40	1,61	1,87	2,29	2,77	3,87
0,2	1,10	1,11	1,16	1,23	1,34	1,46	1,60	1,74	1,89
0,3	1,05	1,05	1,09	1,14	1,21	1,29	1,38	1,47	1,56
0,4	0,99	0,99	1,02	1,05	1,10	1,16	1,22	1,29	1,34
0,5	0,93	0,93	0,95	0,98	1,01	1,05	1,10	1,14	1,18
0,6	0,88	0,88	0,89	0,91	0,93	0,96	1,00	1,03	1,06
0,7	0,82	0,82	0,83	0,85	0,86	0,89	0,91	0,93	0,95
0,8	0,77	0,77	0,78	0,79	0,80	0,82	0,84	0,85	0,87
0,9	0,73	0,73	0,73	0,74	0,75	0,76	0,77	0,76	0,79
1,0	0,69	0,69	0,69	0,69	0,70	0,71	0,72	0,73	0,73

Table 7-3

Longitudinal internal crack, values *Y*(*R*/*t* = 30)

b/t / *b/a*	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,18	1,24	1,43	1,73	2,19	2,94	4,19	6,61	12,4
0,1	1,13	1,16	1,24	1,38	1,57	1,81	2,17	2,72	3,80
0,2	1,08	1,09	1,14	1,21	1,31	1,43	1,57	1,72	1,86
0,3	1,03	1,03	1,06	1,12	1,18	1,27	1,36	1,45	1,53
0,4	0,97	0,97	0,99	1,03	1,08	1,14	1,20	1,27	1,32
0,5	0,91	0,91	0,93	0,96	0,99	1,04	1,08	1,13	1,16
0,6	0,86	0,86	0,87	0,89	0,92	0,95	0,98	1,01	1,04
0,7	0,81	0,81	0,81	0,83	0,85	0,87	0,89	0,92	0,94
0,8	0,76	0,76	0,76	0,77	0,79	0,80	0,82	0,84	0,85
0,9	0,71	0,71	0,72	0,72	0,74	0,75	0,76	0,77	0,78
1,0	0,67	0,67	0,68	0,68	0,69	0,70	0,70	0,71	0,72

Table 7-4

Longitudinal internal crack, values *Y*(*R*/*t* = 40)

b/t / *b/a*	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,16	1,23	1,41	1,71	2,17	2,83	4,15	6,55	12,3
0,1	1,11	1,15	1,23	1,36	1,56	1,82	2,23	2,70	3,77
0,2	1,07	1,08	1,12	1,20	1,30	1,42	1,56	1,70	1,84
0,3	1,01	1,02	1,05	1,10	1,17	1,26	1,35	1,44	1,52
0,4	0,96	0,96	0,98	1,02	1,07	1,13	1,19	1,25	1,31
0,5	0,90	0,90	0,92	0,95	0,98	1,03	1,07	1,11	1,15
0,6	0,85	0,85	0,86	0,88	0,91	0,94	0,97	1,00	1,03
0,7	0,80	0,80	0,81	0,82	0,84	0,86	0,89	0,91	0,93
0,8	0,75	0,75	0,76	0,77	0,78	0,80	0,81	0,83	0,85
0,9	0,71	0,71	0,71	0,72	0,73	0,74	0,75	0,76	0,77
1,0	0,67	0,67	0,67	0,67	0,68	0,69	0,70	0,71	0,71

Table 7-5

Longitudinal external crack, values *Y*(*R*/*t* = 10)

b/t / *b/a*	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,17	1,23	1,43	1,74	2,22	3,01	4,32	6,87	13,04
0,1	1,12	1,16	1,25	1,39	1,60	1,90	2,32	2,83	3,99
0,2	1,06	1,09	1,14	1,22	1,33	1,47	1,62	1,78	1,95
0,3	1,01	1,02	1,06	1,12	1,20	1,29	1,39	1,50	1,60
0,4	0,96	0,96	1,00	1,04	1,10	1,17	1,25	1,32	1,40
0,5	0,91	0,91	0,93	0,97	1,01	1,06	1,12	1,17	1,21
0,6	0,86	0,86	0,87	0,90	0,93	0,97	1,00	1,05	1,09
0,7	0,81	0,81	0,81	0,84	0,86	0,89	0,92	0,96	0,99
0,8	0,76	0,76	0,76	0,78	0,80	0,83	0,86	0,87	0,88
0,9	0,71	0,71	0,72	0,73	0,74	0,76	0,78	0,80	0,82
1,0	0,66	0,66	0,68	0,69	0,70	0,71	0,73	0,74	0,75

Table 7-6

Longitudinal external crack, values *Y*(*R*/*t* = 20)

b/t / *b/a*	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,14	1,21	1,40	1,70	2,17	2,92	4,19	6,63	12,47
0,1	1,09	1,14	1,22	1,35	1,56	1,84	2,24	2,73	3,83
0,2	1,04	1,07	1,12	1,19	1,30	1,43	1,57	1,73	1,87
0,3	0,99	1,01	1,04	1,10	1,17	1,25	1,34	1,45	1,53
0,4	0,94	0,95	0,98	1,02	1,07	1,14	1,21	1,27	1,34
0,5	0,89	0,89	0,91	0,94	0,98	1,03	1,08	1,12	1,16
0,6	0,84	0,84	0,85	0,88	0,90	0,94	0,97	1,01	1,04
0,7	0,79	0,79	0,80	0,82	0,84	0,86	0,89	0,92	0,96
0,8	0,74	0,74	0,75	0,76	0,78	0,80	0,83	0,84	0,85
0,9	0,70	0,70	0,71	0,71	0,73	0,74	0,75	0,77	0,79
1,0	0,65	0,66	0,66	0,67	0,68	0,69	0,70	0,71	0,72

Table 7-7

Longitudinal external crack, values *Y*(*R*/*t* = 30)

b/t / *b/a*	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,15	1,20	1,39	1,69	2,15	2,89	4,13	6,54	12,3
0,1	1,09	1,13	1,21	1,34	1,54	1,78	2,14	2,69	3,77
0,2	1,04	1,06	1,11	1,18	1,29	1,41	1,55	1,70	1,85
0,3	0,99	1,00	1,03	1,09	1,16	1,25	1,34	1,43	1,51
0,4	0,93	0,94	0,97	1,01	1,06	1,12	1,19	1,26	1,33
0,5	0,88	0,89	0,91	0,94	0,97	1,02	1,06	1,11	1,14
0,6	0,83	0,84	0,85	0,87	0,90	0,93	0,97	1,00	1,03
0,7	0,79	0,79	0,79	0,81	0,83	0,86	0,89	0,91	0,94
0,8	0,74	0,74	0,74	0,76	0,77	0,79	0,81	0,83	0,84
0,9	0,69	0,69	0,70	0,71	0,72	0,74	0,75	0,77	0,78
1,0	0,65	0,65	0,66	0,66	0,67	0,69	0,69	0,71	0,71

Table 7-8

Longitudinal external crack, values *Y*(*R*/*t* = 40)

b/t / *b/a*	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8
0	1,13	1,20	1,38	1,68	2,14	2,79	4,11	6,50	12,24
0,1	1,08	1,13	1,21	1,34	1,54	1,80	2,21	2,68	3,75
0,2	1,03	1,06	1,10	1,18	1,28	1,41	1,55	1,69	1,83
0,3	0,98	1,00	1,03	1,08	1,15	1,23	1,32	1,42	1,50
0,4	0,93	0,94	0,97	1,01	1,06	1,12	1,19	1,25	1,32
0,5	0,89	0,89	0,90	0,93	0,97	1,01	1,06	1,10	1,14
0,6	0,84	0,84	0,84	0,86	0,89	0,92	0,95	0,99	1,02
0,7	0,79	0,79	0,79	0,81	0,83	0,85	0,88	0,90	0,94
0,8	0,74	0,74	0,74	0,75	0,77	0,79	0,81	0,81	0,83
0,9	0,69	0,69	0,70	0,70	0,72	0,73	0,74	0,75	0,77
1,0	0,64	0,65	0,66	0,66	0,67	0,68	0,69	0,69	0,71

Table 7-9

Transversal internal crack, values *Y*(*R*/*t* = 10)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,25	1,38	1,58	1,78	2,02	2,31	2,61
0,1	1,19	1,26	1,37	1,53	1,73	1,92	2,08
0,2	1,11	1,17	1,25	1,36	1,47	1,56	1,63
0,3	1,03	1,07	1,13	1,20	1,27	1,33	1,38
0,4	0,97	0,99	1,04	1,09	1,13	1,17	1,21
0,5	0,91	0,92	0,94	0,98	1,01	1,04	1,08
0,6	0,85	0,86	0,88	0,89	0,92	0,95	0,99
0,7	0,79	0,80	0,82	0,83	0,85	0,89	0,93
0,8	0,74	0,75	0,76	0,77	0,79	0,82	0,85
0,9	0,70	0,70	0,71	0,71	0,72	0,74	0,77
1,0	0,66	0,66	0,66	0,67	0,68	0,69	0,71

Table 7-10

Transversal internal crack, values *Y*(*R*/*t* = 20)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,37	1,66	2,12	2,83	4,05	6,37	12,02
0,1	1,20	1,32	1,47	1,65	1,85	2,03	2,19
0,2	1,11	1,19	1,28	1,38	1,49	1,59	1,67
0,3	1,03	1,09	1,15	1,23	1,30	1,35	1,39
0,4	0,97	1,02	1,05	1,11	1,16	1,19	1,22
0,5	0,91	0,94	0,96	1,01	1,04	1,07	1,10
0,6	0,85	0,87	0,89	0,92	0,95	0,97	1,01
0,7	0,79	0,81	0,82	0,84	0,86	0,89	0,93
0,8	0,75	0,76	0,77	0,78	0,79	0,82	0,85
0,9	0,70	0,71	0,71	0,72	0,73	0,74	0,77
1,0	0,66	0,67	0,67	0,68	0,68	0,69	0,72

Table 7-11

Transversal internal crack, values *Y*(*R*/*t* = 30)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,37	1,66	2,12	2,83	4,05	6,37	12,02
0,1	1,20	1,33	1,50	1,71	1,92	2,11	2,25
0,2	1,11	1,19	1,29	1,41	1,53	1,62	1,69
0,3	1,04	1,09	1,16	1,25	1,32	1,37	1,40
0,4	0,97	1,02	1,06	1,12	1,17	1,20	1,23
0,5	0,91	0,94	0,97	1,01	1,05	1,08	1,10
0,6	0,85	0,87	0,89	0,93	0,96	0,98	1,01
0,7	0,80	0,81	0,83	0,86	0,88	0,90	0,93
0,8	0,75	0,76	0,77	0,79	0,81	0,83	0,86
0,9	0,70	0,71	0,71	0,73	0,75	0,77	0,80
1,0	0,66	0,67	0,67	0,69	0,69	0,70	0,73

Table 7-12

Transversal internal crack, values *Y*(*R*/*t* = 40)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,37	1,66	2,12	2,83	4,05	6,37	12,02
0,1	1,20	1,33	1,51	1,73	1,96	2,16	2,30
0,2	1,11	1,19	1,30	1,43	1,55	1,65	1,71
0,3	1,04	1,09	1,16	1,25	1,32	1,37	1,41
0,4	0,97	1,02	1,06	1,13	1,18	1,21	1,23
0,5	0,91	0,94	0,97	1,01	1,06	1,08	1,11
0,6	0,85	0,87	0,89	0,93	0,96	0,98	1,01
0,7	0,80	0,81	0,83	0,86	0,88	0,91	0,94
0,8	0,75	0,76	0,77	0,80	0,82	0,85	0,88
0,9	0,70	0,71	0,72	0,74	0,75	0,78	0,81
1,0	0,66	0,67	0,67	0,69	0,70	0,72	0,74

Table 7-13

Transversal external crack, values *Y*(*R*/*t* = 10)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,25	1,35	1,63	1,88	2,16	2,52	2,97
0,1	1,20	1,33	1,52	1,75	2,02	2,29	2,52
0,2	1,12	1,21	1,32	1,46	1,61	1,76	1,89
0,3	1,05	1,12	1,18	1,29	1,38	1,45	1,51
0,4	0,98	1,04	1,07	1,15	1,22	1,28	1,32
0,5	0,92	0,96	0,99	1,04	1,10	1,13	1,16
0,6	0,86	0,89	0,91	0,95	1,00	1,02	1,04
0,7	0,80	0,83	0,84	0,88	0,91	0,93	0,96
0,8	0,75	0,78	0,79	0,81	0,84	0,86	0,89
0,9	0,71	0,73	0,74	0,75	0,77	0,79	0,81
1,0	0,67	0,68	0,69	0,70	0,72	0,74	0,76

Table 7-14

Transversal external crack, values *Y*(*R*/*t* = 20)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,37	1,66	2,12	2,83	4,05	6,37	12,02
0,1	1,21	1,35	1,56	1,83	2,14	2,43	2,63
0,2	1,12	1,21	1,33	1,48	1,63	1,76	1,88
0,3	1,04	1,11	1,18	1,29	1,38	1,45	1,50
0,4	0,98	1,03	1,07	1,15	1,21	1,25	1,28
0,5	0,92	0,95	0,98	1,04	1,09	1,12	1,14
0,6	0,86	0,89	0,90	0,95	1,00	1,01	1,03
0,7	0,80	0,83	0,84	0,88	0,91	0,93	0,94
0,8	0,75	0,77	0,78	0,81	0,85	0,87	0,88
0,9	0,71	0,72	0,72	0,75	0,77	0,79	0,82
1,0	0,67	0,68	0,68	0,70	0,72	0,74	0,76

Table 7-15

Transversal external crack, values *Y*(*R*/*t* = 30)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,37	1,66	2,12	2,83	4,05	6,37	12,02
0,1	1,21	1,35	1,56	1,83	2,14	2,43	2,63
0,2	1,12	1,21	1,33	1,48	1,63	1,76	1,88
0,3	1,04	1,11	1,18	1,29	1,38	1,45	1,50
0,4	0,98	1,03	1,07	1,14	1,21	1,25	1,28
0,5	0,92	0,95	0,98	1,03	1,09	1,12	1,14
0,6	0,86	0,89	0,90	0,95	0,99	1,01	1,03
0,7	0,80	0,83	0,84	0,88	0,91	0,93	0,94
0,8	0,75	0,77	0,78	0,80	0,84	0,86	0,88
0,9	0,71	0,72	0,72	0,74	0,77	0,80	0,82
1,0	0,67	0,68	0,68	0,70	0,71	0,73	0,76

Table 7-16

Transversal external crack, values *Y*(*R*/*t* = 40)

b/t / *b/a*	0,2	0,3	0,4	0,5	0,6	0,7	0,8
Ring	1,37	1,66	2,12	2,83	4,05	6,37	12,02
0,1	1,21	1,35	1,56	1,83	2,14	2,43	2,63
0,2	1,12	1,21	1,33	1,48	1,63	1,76	1,88
0,3	1,04	1,11	1,18	1,29	1,38	1,45	1,50
0,4	0,98	1,03	1,07	1,15	1,21	1,25	1,28
0,5	0,92	0,95	0,98	1,04	1,09	1,12	1,14
0,6	0,86	0,89	0,90	0,95	1,00	1,01	1,03
0,7	0,80	0,83	0,84	0,88	0,91	0,93	0,94
0,8	0,75	0,77	0,78	0,81	0,85	0,87	0,88
0,9	0,71	0,72	0,72	0,75	0,77	0,79	0,82
1,0	0,67	0,68	0,68	0,70	0,72	0,74	0,76

Table 7-17

Subsurface longitudinal crack, values *Y*(*b*/*t* = 0,1)

c/t / *b/a*	0,4 and amidst	0,35	0,3	0,25	0,2	0,15	0,1	0,075	0,05	0,025	surface crack	
											internal	external
extended crack	1,03	1,03	1,04	1,05	1,07	1,10	1,15	1,21	1,31	1,50	1,67	1,53
0,1	1,00	1,00	1,01	1,01	1,02	1,04	1,08	1,12	1,21	1,37	1,23	1,14
0,2	0,97	0,97	0,97	0,97	0,97	0,98	1,01	1,04	1,12	1,26	1,05	0,97
0,3	0,92	0,92	0,92	0,92	0,93	0,93	0,96	0,98	1,04	1,16	0,90	0,83
0,4	0,88	0,88	0,88	0,88	0,88	0,89	0,90	0,93	0,97	1,08	0,78	0,72
0,5	0,83	0,83	0,83	0,83	0,83	0,84	0,85	0,87	0,91	1,00	0,78	0,72
0,6	0,79	0,79	0,79	0,79	0,79	0,79	0,80	0,82	0,85	0,93	0,78	0,72
0,7	0,75	0,75	0,75	0,75	0,75	0,75	0,76	0,77	0,80	0,86	0,78	0,72
0,8	0,71	0,71	0,71	0,71	0,71	0,71	0,71	0,73	0,75	0,80	0,78	0,72
0,9	0,67	0,67	0,67	0,67	0,67	0,67	0,68	0,69	0,71	0,75	0,78	0,72
1,0	0,64	0,64	0,64	0,64	0,64	0,64	0,65	0,65	0,67	0,71	0,78	0,72

Table 7-18

Subsurface longitudinal crack, values *Y*(*b*/*t* = 0,2)

c/t / *b/a*	0,3 and amidst	0,25	0,2	0,175	0,15	0,125	0,1	0,075	0,05	surface crack	
										internal	external
extended crack	1,11	1,14	1,19	1,22	1,25	1,31	1,40	1,52	1,74	2,71	2,56
0,1	1,06	1,07	1,10	1,12	1,15	1,19	1,25	1,34	1,48	1,50	1,37
0,2	1,00	1,01	1,03	1,05	1,06	1,09	1,14	1,20	1,30	1,15	1,09
0,3	0,95	0,96	0,97	0,98	0,99	1,01	1,05	1,10	1,17	0,97	0,89
0,4	0,90	0,90	0,91	0,92	0,93	0,95	0,98	1,02	1,08	0,82	0,75
0,5	0,85	0,85	0,86	0,86	0,88	0,89	0,91	0,95	1,00	0,82	0,75
0,6	0,80	0,80	0,81	0,81	0,82	0,83	0,85	0,88	0,93	0,82	0,75
0,7	0,75	0,75	0,76	0,76	0,77	0,78	0,80	0,82	0,86	0,82	0,75
0,8	0,71	0,71	0,72	0,72	0,73	0,74	0,75	0,77	0,80	0,82	0,75
0,9	0,67	0,68	0,68	0,68	0,69	0,70	0,71	0,73	0,75	0,82	0,75
1,0	0,64	0,64	0,65	0,65	0,65	0,66	0,67	0,69	0,71	0,82	0,75

Table 7-19

Subsurface longitudinal crack, values *Y*(*b*/*t* = 0,3)

c/t / *b/a*	0,2 and amidst	0,175	0,15	0,125	0,1	0,075	surface crack	
							internal	external
extended crack	1,31	1,35	1,41	1,49	1,62	1,83	6,24	6,04
0,1	1,21	1,24	1,28	1,33	1,41	1,54	1,74	1,68
0,2	1,12	1,14	1,17	1,20	1,26	1,34	1,27	1,23
0,3	1,04	1,05	1,07	1,10	1,14	1,19	1,00	0,97
0,4	0,97	0,98	1,00	1,02	1,06	1,1	0,83	0,80
0,5	0,90	0,91	0,93	0,95	0,98	1,02	0,83	0,80
0,6	0,84	0,85	0,86	0,88	0,91	0,94	0,83	0,80
0,7	0,79	0,80	0,81	0,82	0,84	0,87	0,83	0,80
0,8	0,74	0,74	0,75	0,77	0,78	0,81	0,83	0,80
0,9	0,70	0,70	0,71	0,72	0,74	0,76	0,83	0,80
1,0	0,66	0,67	0,68	0,68	0,70	0,72	0,83	0,80

Table 7-20

Subsurface longitudinal crack, values *Y*(*b*/*t* = 0,4)

c/t / *b/a*	0,1 and amidst	After initial crack exposure
extended crack	1,83	∞
0,1	1,59	5,56
0,2	1,40	2,80
0,3	1,26	2,05
0,4	1,15	1,70
0,5	1,05	1,70
0,6	0,97	1,70
0,7	0,89	1,70
0,8	0,82	1,70
0,9	0,77	1,70
1,0	0,73	1,70

Table 7-21

Subsurface transversal crack, values *Y*(*b*/*t* = 0,1)

c/*t* / *b*/*a*	0,4 and amidst	0,35	0,3	0,25	0,2	0,15	0,1	0,075	0,05	0,025	surface crack	
											internal	external
0,1	1,00	1,00	1,01	1,01	1,02	1,04	1,08	1,12	1,21	1,37	1,11	1,12
0,2	0,97	0,97	0,97	0,97	0,97	0,98	1,01	1,04	1,12	1,26	0,95	0,95
0,3	0,92	0,92	0,92	0,92	0,93	0,93	0,96	0,98	1,04	1,16	0,82	0,82
0,4	0,88	0,88	0,88	0,88	0,88	0,89	0,90	0,93	0,97	1,08	0,70	0,71
0,5	0,83	0,83	0,83	0,83	0,83	0,84	0,85	0,87	0,91	1,00	0,70	0,71
0,6	0,79	0,79	0,79	0,79	0,79	0,79	0,80	0,82	0,85	0,93	0,70	0,71
0,7	0,75	0,75	0,75	0,75	0,75	0,75	0,76	0,77	0,80	0,86	0,70	0,71
0,8	0,71	0,71	0,71	0,71	0,71	0,71	0,71	0,73	0,75	0,80	0,70	0,71
0,9	0,67	0,67	0,67	0,67	0,67	0,67	0,68	0,69	0,71	0,75	0,70	0,71
1,0	0,64	0,64	0,64	0,64	0,64	0,64	0,65	0,65	0,67	0,71	0,70	0,71

Table 7-22

Subsurface transversal crack, values *Y*(*b*/*t* = 0,2)

c/*t* / *b*/*a*	0,3 and amidst	0,25	0,2	0,175	0,15	0,125	0,1	0,075	0,05	surface crack	
										internal	external
0,1	1,06	1,07	1,10	1,12	1,15	1,19	1,25	1,34	1,48	1,33	1,37
0,2	1,00	1,01	1,03	1,05	1,06	1,09	1,14	1,20	1,30	1,04	1,06
0,3	0,95	0,96	0,97	0,98	0,99	1,01	1,05	1,10	1,17	0,86	0,88
0,4	0,90	0,90	0,91	0,92	0,93	0,95	0,98	1,02	1,08	0,73	0,74
0,5	0,85	0,85	0,86	0,86	0,88	0,89	0,91	0,95	1,00	0,73	0,74
0,6	0,80	0,80	0,81	0,81	0,82	0,83	0,85	0,88	0,93	0,73	0,74
0,7	0,75	0,75	0,76	0,76	0,77	0,78	0,80	0,82	0,86	0,73	0,74
0,8	0,71	0,71	0,72	0,72	0,73	0,74	0,75	0,77	0,80	0,73	0,74
0,9	0,67	0,68	0,68	0,68	0,69	0,70	0,71	0,73	0,75	0,73	0,74
1,0	0,64	0,64	0,65	0,65	0,65	0,66	0,67	0,69	0,71	0,73	0,74

Table 7-23

Subsurface transversal crack, values *Y*(*b*/*t* = 0,3)

c/*t* / *b*/*a*	0,2 and amidst	0,175	0,15	0,125	0,1	0,075	surface crack	
							internal	external
0,1	1,21	1,24	1,28	1,33	1,41	1,54	1,56	1,66
0,2	1,12	1,14	1,17	1,20	1,26	1,34	1,14	1,18
0,3	1,04	1,05	1,07	1,10	1,14	1,19	0,92	0,95
0,4	0,97	0,98	1,00	1,02	1,06	1,1	0,77	0,79
0,5	0,90	0,91	0,93	0,95	0,98	1,02	0,77	0,79
0,6	0,84	0,85	0,86	0,88	0,91	0,94	0,77	0,79
0,7	0,79	0,80	0,81	0,82	0,84	0,87	0,77	0,79
0,8	0,74	0,74	0,75	0,77	0,78	0,81	0,77	0,79
0,9	0,70	0,70	0,71	0,72	0,74	0,76	0,77	0,79
1,0	0,66	0,67	0,68	0,68	0,70	0,72	0,77	0,79

Table 7-24

Subsurface transversal crack, values *Y*(*b*/*t* = 0,4)

c/*t* / *b*/*a*	0,1 and amidst	After initial crack exposure
0,2	1,40	2,36
0,3	1,26	1,87
0,4	1,15	1,61
0,5	1,05	1,61
0,6	0,97	1,61
0,7	0,89	1,61
0,8	0,82	1,61
0,9	0,77	1,61
1,0	0,73	1,61

8. For the defect located within the welded joint (para 2), the value K_{res} shall be determined by the following formula:

$$K_{res} = 1{,}05R_e\sqrt{t10^{-3}}\left[\left(\frac{t-b}{t}\right)^2 - \exp\left(-\frac{9b}{t}\right)\right] \times [1 + 4{,}6(b/2a)^{1{,}65}]^{0{,}5}. \quad (8)$$

In other cases, K_{res} shall be taken to 0.

Stresses σ_s are determined by the following formulae:

for surface internal or external longitudinal defect

$$\sigma_s = 1{,}2\,\frac{1-b/(tM)}{1-b/t}\,\sigma, \quad (9\text{-}1)$$

where $$M = \sqrt{1 + 1{,}6\,\frac{2a^2}{Dt}}\,; \quad (9\text{-}2)$$

for surface internal or external transversal defect

$$\sigma_s = \frac{\pi(1-b/t) + 2(b/t)\sin(2a/D)}{(1-b/t)(\pi - \frac{2a}{D}\frac{b}{t})}\,\sigma; \quad (9\text{-}3)$$

for internal longitudinal or transversal defect

$$\sigma_s = \frac{3\sigma\alpha + \left[(3\sigma\alpha)^2 + 9\sigma^2\left\{(1-\alpha)^2 + 4\,\frac{c\alpha}{t}\right\}\right]^{0{,}5}}{3\left[(1-\alpha)^2 + 4\,\frac{c\alpha}{t}\right]}, \quad (9\text{-}4)$$

where $\alpha = (2b/t)/(1 + t/a)$;

c = distance between the defect edge to the nearest surface, in mm.

10. Correction function f shall be determined by the following formula:

$$f = (1-0{,}14L^2)[0{,}3 + 0{,}7\exp(-0{,}65L^6)], \quad (10)$$

where $L = \sigma_s/R_e$.

11. The acceptability assessment of defect development within the period before the next survey under variable component of operating stresses shall be determined by the following formula:

$$(b+\Delta b) = [b^{(-m/2+1)} - (-m/2 + 1)NCY^m\Delta\sigma^m\,\pi^{m/2}]^{1/(1-m/2)}, \quad (11\text{-}1)$$

where N = expected number of load cycles;

C, m = parameters of variation of crack growth rate da/dN with the range of stress intensity factor in the load cycle;

$\Delta\sigma$ = range of operating stresses in the cycle (difference between maximum and minimum stresses), in MPa;

Δb = increase in the defect depth within the operating period concerned, in mm.

Upon agreement with the Register, the following values of factors may be taken for assessment: $C = 4.9\cdot10^{-11}$, $m = 2{,}71$ for dimensions da/dN, in m/cycle; ΔK, in MPa$\sqrt{\text{m}}$. With dimensions $\Delta\sigma$, in MPa; b, in mm, the calculation shall be obtained from the following formula:

$$(b + \Delta b) = 10^3[11{,}6b^{-0{,}355} - 1{,}906\cdot10^{-11}N(Y\Delta\sigma)^{2{,}71}]^{-2{,}81}. \quad (11\text{-}2)$$

The value Y shall be determined for the initial dimension of the defect based on tables specified in para 7.

When the assessment result is $(b + \Delta b) > 1{,}5b$, the defect is assumed impermissible.

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