RUSSIAN MARITIME REGISTER OF SHIPPING

GUIDELINES

ON TECHNICAL SUPERVISION DURING CONSTRUCTION AND OPERATION OF SUBSEA PIPELINES

Saint-Petersburg
2017

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 July 2017.

These Guidelines are based on the Guidelines on Technical Supervision during Construction and Operation of Subsea Pipelines, 2016, taking into account the amendments developed immediately before publication.

On the entry into force of these Guidelines, the Guidelines on Technical Supervision during Construction and Operation of Subsea Pipelines, 2016, become void.

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

ISBN 978-5-89331-259-1

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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"), the Guidelines on Technical Supervision of Industrial Safety of Hazardous Production Facilities and Their Technical Devices, and also the standards and rules of national technical supervision bodies, as appropriate, shall be followed.

1.1.3 In compliance Federal Law No.II6-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 the 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 the Guidelines on Technical Supervision of Industrial Safety of Hazardous Production Facilities and Their Technical Devices).

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**.

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;

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.

.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.

1.6.2 The materials and products used during construction and operation of subsea pipelines under the RS technical supervision shall be supplied to

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	СИИ	C, C3	K	—	—	—
23001002	sections	P	СИИ	C, C3	K	—	—	—
23001003	bars	P	СИИ	C, C3	K	—	—	—
23001004	pipe billet	P	СИИ	C, C3	K	—	—	—
23002000	**Steel pipes[1]:**							
23002001	seamless	P	СИИ	C, C3	K	P	—	—
23002002	welded	P	СИИ	C, C3	K	P	—	—
23003000	**Steel bends and fittings[1]**	P	СИИ	C, C3	—	P	—	—
23004000	**Steel castings and forgings[1]**	P	СИИ	C, C3	—	—	—	—

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
23005000	**Flexible polymeric-metal pipes**	P	CTO	C, C3	—	P	—	—
23006000	**Valves:**							
23006001	manually controlled	P	CTO	C, C3	—	P	P	P
23006002	remotely controlled	P	CTO	C, C3	—	P	P	P
23006003	safety valves	P	CTO	C, C3	—	P	P	P
23007000	**Parts of joints:**							
23007001	flanged joints	P	CTO	C, C3	—	P	P	P
23007002	fastenings	P	CTO	C, C3	—	P	—	—
23007003	sealing gaskets	P	CTO	C, C3	—	P	—	—
23008000	Corrosion protection and thermal insulation:							
23008001	internal coatings (anti-friction and/or corrosion-protection)	P	CTO	C, C3	—	P	—	—
23008002	external corrosion-protection coatings	P	CTO	C, C3	—	P	P	—
23008003	cathodic protection system	P	CTO	C, C3	—	P	P	—
23008004	galvanic anode system	P	CTO	C, C3	—	P	P	—
23008005	thermal insulation coatings	P	CTO	C, C3	—	P	P	—
23008006	heat-shrink sleeves	P	CTO	C, C3	—	P	P	—
23009000	**Ballasting**							
23009010	Single weights:							
23009011	cast-iron	P	CTO	CTO	—	P	P	—
23009012	concrete	P	CTO	CTO	—	P	P	—
23009013	reinforced concrete	P	CTO	CTO	—	P	P	—
23009020	Continuous coatings:							
23009021	concrete	P	CTO	C, C3	—	P	P	—
23009022	reinforced concrete	P	CTO	C, C3	—	P	P	—
23009023	asphalt concrete	P	CTO	C, C3	—	P	P	—
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	COTTIC	COTTIC	—	—	—	—
23012000	Computer software (Programs for computer-aided calculations)	P	CTOП	CTOП	—	—	—	—
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.

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**);

СОСМ — 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 The recognition of the manufacturers of materials and products for subsea pipelines shall comply with the provisions of Sections **7** and **10**, Part I "General Provisions for Technical Supervision" of the Rules for Technical Supervision during Construction of Ships, and the instructions of this Section.

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 (C) (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 Computer Program (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 (C3) (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.

1.9 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 supplier includes:

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

survey of the supplier 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 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 the recognition in compliance with the requirements of the RF technical supervisory bodies in the industrial safety.

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 7, 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 **11.1.3**, 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 the RS requirements for the service providers with codes 24001001 — 24001005 (refer to **1.9**) in accordance with the works performed and the conditions of their implementation.

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 (CTO) (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 survey 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 specimens orientation;

test results;

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).

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**).

2.2.2.7 The weldability test program is aimed at manufacturer's recognition based on the requirements

Table 2.2.2.6

Scope of tests for recognition of the rolled products manufacturer

Type of tests (item in Part I "Subsea Pipelines" of the SP Rules)	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[1]	Test temperature: 0, −20, −40, −60, −80 °C depending on operating temperature

Table 2.2.2.6 — continued

Type of tests (item in Part I "Subsea Pipelines" of the SP Rules)	Position of samples and specimens cutting-out	Quantity			Notes
		casts/plates/ cast samples	specimens of a plate	Total number of specimens	
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[1]	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[2] (4.3.9.5)	From one end	2/3/1	6	12	—
Drop-weight tear test (DWTT)[3] (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}[4] (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)[4] (4.3.9.7)	From one end, transverse	2/3/3	8	48	Test to determine critical temperature
CTOD test (crack tip opening displacement)[5] (4.3.9.3, Section 2, Appendix 4)	From one end, transverse	2/3/1	9	18[1]	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]Here the number of specimens is determined based on testing at three temperature values specified in the test program approved by the Register.
[2]For pipes designed of class L2 and G2 pipelines
[3]Except pipes of class L — L2 pipelines
[4]Except pipes of class L — L2, G pipelines
[5]Except pipes of class L and G pipelines

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;

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

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 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,

Table 2.2.3.4

Scope of tests for rolled products approval

Type of tests (item in Part I "Subsea Pipelines" of the SP Rules)	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[1]
Test to determine the fracture type according to Drop-weight tear test (DWTT)[2] (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]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.

[2]Except pipes for L to L2 pipelines, as well as for any pipes with the diameter less than 500 mm.

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.

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 testing 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.

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.

2.4.1.6 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 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

Table 2.4.2.3

Scope of tests for recognition of SP pipe manufacturer

Type of tests (item in Part I "Subsea Pipelines" of the SP Rules)	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	2/10/1	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 (4.3.9.4 and Section 3, Appendix 4)	From both ends, transverse	2/10/2	2	8	Bending angle is to be determined
Impact tests to establish transition curve (4.3.3)	From one end, transverse	2/10/3	9	54[1]	Test temperature: 0, −20, −40, −60, −80 °C 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[1]	Test temperature: 0, −20, −40, −60, −80 °C 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[2] (4.3.9.5)	From one end	2/10/2	6	24	—
Drop-weight tear test (DWTT)[3] (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)[4] (4.3.9.7)	From one end, lengthwise	2/10/2	8	32	Test to determine critical temperature
CTOD test (crack tip opening displacement)[5] (4.3.9.3, Section 2, Appendix 4)	From one end, transverse	2/10/1	9	18[1]	Test temperature: 0, −20, −40, −60, −80 °C depending on operating temperature

Table 2.4.2.3 — continued

Type of tests (item in Part I "Subsea Pipelines" of the SP Rules)	Position of samples and specimens cutting-out	Quantity			Notes
		casts/plates/ cast samples	specimens of a plate	Total number of specimens	
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]Here the number of specimens is determined based on testing at three temperature values specified in the test program approved by the Register.
[2]For pipes designed of class L2 and G2 pipelines.
[3]Except pipes of L — L2 pipelines as well as for any pipes less than 500 mm in diameter.
[4]Except pipes of L — L2, G pipelines.
[5]Except pipes of L and G pipelines.

Register on the basis of the manufacturer submitted preliminary information in accordance with 2.2.2.8.

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.

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

Table 2.4.3.2

Scope of tests for steel pipes approval

Type of tests (item in Part I "Subsea Pipelines" of the SP Rules)	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	1/50/1	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[1]
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[1]
Determination of fracture type according to Drop-weight tear test (DWTT)[2] (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)	From one end, transverse	1/50/1	2	2	Normal and root-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 20 G

[1]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.
[2]Except pipes for L to L2 pipelines as well as for any pipes less than 500 mm in diameter.

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 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	

Table 2.4.2.9 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Notes
8 **Final acceptance of pipes**				
8.1 Visual examination and measurement	Weld, external and internal surface of base metal, geometrical parameters of pipes	Each pipe	R	
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 pipes	Each pipe	M	
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 Register approved documentation at the firms with the Register Type Approval Certificate (CTO) (form **6**.8.3) for the manufactured type of products.

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 result 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 not more than **2** years ago provided that the deliveries of accessories/products are identical as well as 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**.

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

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

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 weigth 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.

2.7.1.3 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 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±5) °C (for at least two pipes from the batch);

.7 test to determine adhesion to steel at temperature of +(20±5) °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.

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;

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	M	
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 2 h	R	
3 Application and quality check				
3.1 Checking the adhesive and impact strength	Adhesion and impact strength at temperature of +20°C	2 pipes per shift	R	
3.2 Continuity test	Coating continuity	Each pipe	W	
3.3 Remanent magnetization	Remanent magnetization	Each pipe from both ends	R	
3.4 Appearance	Coating appearance	Each pipe	R	
3.5 Coating thickness	Coating thickness	2 pipes per shift	R	
3.6 Coating repair	Coating appearance	Each pipe repaired	R	
3.7 Marking the pipe coatings	Marking	Each pipe	M	
4 Issue of Firm's (Manufacturer's) Certificate		Each batch	R	
5 Issue of the RS Certificate/endorsement of the Firm's Manufacturer's Certificate		Each batch	H	

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

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 sacrificial 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 2.7.3.2.

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 sacrificial 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 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 sacrificial 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 aluminium alloy galvanic anodes:

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

longitudinal cracks more than 0,5 mm wide, with length more than 20 % anode length, transverse cracks more than 0,5 mm wide, with length more than 50 % anode internal diameter, with depth more than 50 % thickness of anode material covering the reinforcement cage.

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-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 shall be properly roughened in some manner according to the RS-approved documentation to ensure better adhesion with the applied concrete coating.

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).

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

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	When using the procedure as specified in 2.8.1.6.2 and 2.8.1.6.3
Deviation between centrelines of steel pipe and mantle pipe	Each pipe	
Concrete compression strength	One pipe from the batch	
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	
Location of sacrificial anode	Each pipe with sacrificial anode	For pipes with sacrificial anode fitted
Resistivity of pipe insulation coating after application of concrete coating and fitting of sacrificial anode	Each pipe with sacrificial anode	For pipes with sacrificial anode fitted
Breaking test for the repaired insulation coating in the area where cathodic protection cable is welded to the pipe	Each pipe with sacrificial anode	For pipes with sacrificial anode fitted
Absence of contact between sacrificial anode and steel wire mesh	Each pipe with sacrificial anode	For pipes with sacrificial anode fitted
Electric resistance between steel pipe and sacrificial anode	Each pipe with sacrificial anode	For pipes with sacrificial anode fitted

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.

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

Table 2.8.4.11 — continue

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
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
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 sacrificial anode	R	
10.2 Fitting of galvanic anode	As per detailed design documentation	Each pipe with sacrificial anode	R	
10.3 Welding of cable including insulation of welding area	As per detailed design documentation, normative and technical documentation	Each pipe with sacrificial anode	M	
10.4 Checking for proper fitting of galvanic anode	Geometrical parameters and resistance measurements	Each pipe with sacrificial 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 COATING

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.

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 plastic or galvanized steel strip helically wound with or without corrosion-protection coating may be used for mantle pipes.

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.

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.

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 centrelines of steel pipe and mantle pipe	Each pipe	
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	

2.11.2 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 considerung 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 0,010 %.

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.

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**.

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).

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.

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 ⩽ 2 %, CLR ⩽ 15 %, CTR ⩽ 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 2 mm
100% ultrasonic testing	T, S	T, S	T, S	As accepted for linear pipes. For requirements of level 2, delamination area is limited to 100 mm^2
Ultrasonic or radiographic testing welds	M	M	M	As for linear pipes for SP
100% ultrasonic testing of weld area 15 mm wide for welds made by automated submerged arc welding (delaminations)	M	M	M	Length up to 6 mm, three per 1 m length
Repair	M	M	M	As per specifications
Internal diameter at flange ends	M	M	M	Not more than 1,5 %
Deviation from the round shape at flange ends	M	M	M	As per specifications
Dimensions according to specifications	M	M	M	As per specifications
Treatment of flange ends	M	M	M	As per specifications
Surface condition	T	T	T	With no cracks, tears and visible distortions, test pressure as per design documentation
Hydraulic tests				

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).

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 — ±0,02 % C, ±0,03 C_{eq} and/or ±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	±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: ±15 °C, heating and cooling rates shall be agreed

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

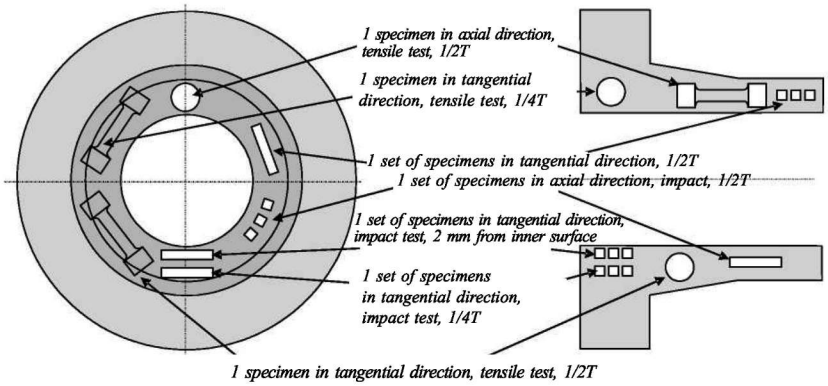

Fig. 2.11.4.6-1 Position of specimens during tensile and impact tests, neck flange with section thickness $T > 50$ mm

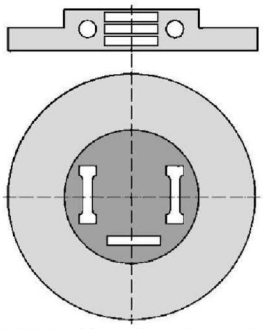

Fig. 2.11.4.6-2 Position of specimens during tensile and impact tests, blind flange

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 (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.

2.12.1.5 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.

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.

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 above 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	—	CSR ⩽2 %, CLR ⩽15 %, CTR ⩽ 5 %
Stress-corrosion tests	—	T	—	Absence of cracks and tears on the extended surface
Drop weight tests at wall thickness above 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 of weld area 15 mm wide for welds made by automated submerged arc welding (delaminations)	—	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
Repairs	M	M	M	As per specifications
Wall thickness	T, M	T, M	T, M	Minimum thickness without tolerance, maximum as per specifications
Diameter of bend body	M	M	M	As per specifications, to be checked by calliper
Diameter at ends	M	M	M	As per specifications
Deviation from the round shape of ends	M	M	M	Not more than 1,5 %
Deviation from the round shape of body	M	M	M	Not more than 3 %, for bending radius ⩾5D — not more than 2,5 %
Linear dimensions	M	M	M	Within ±30 mm
Angle	M	M	M	Within ±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	S	S	S	Tolerance of ±1% but not exceeding ±10 mm
Squareness of ends to pipe axis	M	M	M	Not more than 3 mm
Planar position of bend ends	M	M	M	±0,5°, max. 3 mm
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

Symbols:
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).

Table 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 — ±0,02 % C, ±0,03 C_{eq} and/or ±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	±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	±2,5 mm/min
Casting temperature	±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	±5 % in steady mode (for seamless pipes to be agreed upon with the Register)
Induction heating frequency	±20 %
Cooling liquid, number and size of cooling metal tubes	Without deviations
Flow rate/pressure of cooling liquid	Without deviations (±10% upon agreement)
Cooling liquid temperature	±15 °C
Weld position relative to bending plane	±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.

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**).

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 requirem by the Register

[4]For requirements of level 2 only

[5]Spiral-welded pipes are subject to additional tests as required by the Register

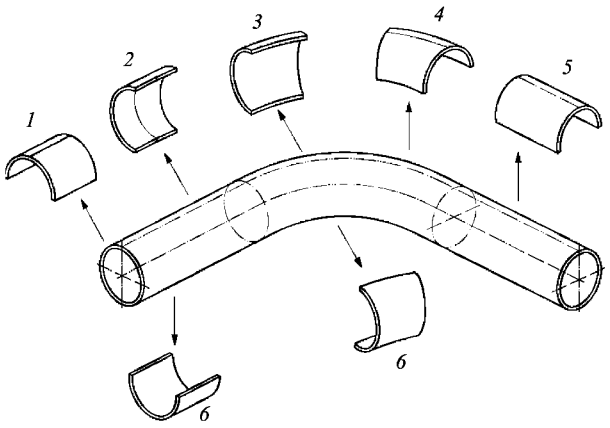

Fig. 2.12.4.6 Cutting-out specimens locations of bends:
1 — weld of the straight end,
2 — metal of transient area (start and end heating areas),
3 — metal of external side of the bend, 4 — bent weld,
5 — weld of transient area (start and end),
6 — metal of internal side of the bend,
7 — base metal of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

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 (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.

2.13.1.5 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 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	—	CSR ⩽ 2 %, CLR ⩽ 15 %, CTR ⩽ 5 %
Stress-corrosion tests	—	T	—	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 of weld area 15 mm wide for welds made by automated submerged arc welding (delaminations)	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
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.

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 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**).

2.14.1.3 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 **2.7.3.2**.

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;

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 37 mm – one set, for thickness of 37 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.

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.

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.

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 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).

3.5.2 In cases specified in 8.2.8, 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.

3.5.3 The following shall be separately surveyed by the Register:

the 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 8.2.12, Part I "Subsea Pipelines" of the SP Rules.

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;

stations for coating process to field welds (butts);

stations for fitting anodes and/or ballast weights.

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 the 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 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.

3.7 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 (СОПС)	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 (СЛЛ)		H	
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	

Table 3.7.1.1 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
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 (СОТПС)	Each pipe	M	
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	
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 sacrificial anode	M	
11.2 Fitting of welded-on strips	Compliance with detailed design documentation	Each pipe with sacrificial anode	R	

Table 3.7.1.1 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
11.3 Non-destructive testing of weld of welded-on strips	Compliance with detailed design documentation	Each pipe with sacrificial anode	R	
11.4 Fitting of galvanic anodes	Compliance with detailed design documentation	Each pipe with sacrificial anode	M	
11.5 Welding of galvanic anode contacts	Compliance with detailed design documentation	Each pipe with sacrificial anode	R	
11.6 Non-destructive testing of the weld of galvanic anode contacts	Compliance with detailed design documentation	Each pipe with sacrificial 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	
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	

Table 3.7.1.1 — continued

Process or check procedure	Parameter to be checked	Test/inspection intervals	Type of inspection[1]	Note
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 The same part of a weld (field joint) may not be repaired more than once.

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.

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 8.2.12, Part I "Subsea Pipelines" of the SP Rules.

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 flexible SP.

3.7.3.1 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.

3.7.3.2 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.

3.7.3.3 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).

3.7.3.4 The fasteners for joining FPMP end fittings shall meet the requirements of 2.5.3.

3.7.3.5 In other cases, the technical supervision during installation and laying of flexible subsea pipelines shall be subject to special consideration by the Register.

3.7.4 Steel SP pressure testing.

3.7.4.1 Instructions on SP pressure testing are specified in 8.6, Part I "Subsea Pipelines" of the SP Rules.

3.7.4.2 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.

3.7.4.3 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.

3.7.4.4 Prior to test procedure, the Register shall survey the for testing instrumentation and equipment in accordance with 8.6.7.2, Part I "Subsea Pipelines" of the SP Rules.

3.7.4.5 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.

3.7.4.6 The pressure during leak testing shall be at least 110 % of the SP design pressure.

3.7.4.7 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 The RS documents issued according to the results of technical supervision during SP construction.

3.7.5.1 Based on satisfactory results of all the surveys specified by the List of items of the technical supervision of the subsea pipeline, the RS Branch Office that has carried out the technical supervision during SP construction and will be carrying out technical supervision in operation shall perform the following:

registration of the SP with a register number assigned;

issue of Report on Survey of Subsea Pipeline (SP) after construction (form 9.9.1);

issue of Classification Certificate of Subsea Pipeline (SP) (form 9.9.2).

3.7.5.2 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.

3.7.5.3 The SP record keeping by the RS Branch Office shall be executed in compliance with the valid internal RS procedure.

3.7.5.4 Based on satisfactory results of all surveys provided by the List of items of the technical supervision for SP, the RS Branch Office issues Report on Survey of Subsea Pipeline (SP) after construction (form 9.9.1). The Report shall specify the dates of periodical surveys of the SP.

3.7.5.5 Based on Report on Survey of Subsea Pipeline (SP) after construction, the RS Branch Office shall issue Classification Certificate of Subsea Pipeline (SP) (form 9.9.2).

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 equlations of SP technical operation 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.

4.1.2 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 operatinal 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 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 echosounders;

side-scan sonars;

single beam echosounders;

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 $0,3 \times 0,3 \times 0,3$ 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 echosounders with angular resolution of not more than **1,5°** and operating frequency at least 300 kHz shall be used. In such case, multibeam echosounder 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 min. 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**,

[1]Besides/instead of using ROVs, diver's examinations with the appropriate equipment may be carried out.

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.

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 echosounder 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/ egulatory 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 ±0,05 m for reliability of 0,8. The tolerance for measuring distance between markers by odometry system shall be not more than ±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.

The defects measured manually, generally is 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.

The defects measured manually, generally is 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 – corrosion damages characterized by the definite affected depth and affected area: extension both along the pipeline length and in the circumferential direction;

continuity defects – delaminations, pitting damages, scores, marks, 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 (temporaral 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** 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.

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**),

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[5]E	O	OM[6]E	O	O	OM[5]E	O	OM[6]E	O	O	OM[6]E	O	OM[5]E	O	O	OM[6]E	O	OM[5]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[5]E	C	CM[8]E	C	C	OM[8]E	C	CM[8]E	C	C	CM[8]E	C	OM[8]E	C	C	CM[8]E	C	OM[5]E
2.3 Insulating coating	O	O	CM[9]E	O	CM[9]E	O	O	CM[9]E	O	CM[9]E	O	O	CM[9]E	O	OM[5]E	O	O	CM[9]E	O	OM[5]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[5]E	O	OM[6]E	O	O	OM[5]E	O	OM[6]E	O	O	OM[6]E	O	OM[5]E	O	O	OM[6]E	O	OM[5]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.

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 SP repairs shall comply with the provisions of 9.2, Part I "Subsea Pipelines" of the SP Rules.

4.2.1.3 The repair works at SP items specified in **4.2.1.1** shall be performed by the firms verified by the Register according to the requirements of 1.11 and/or recognized by the Register for rendering such services in accordance with requirements specified in 1.9.

4.2.1.4 The SP repair works are planned with due regard to nature and hazard degree of the defects detected during the RS surveys and for the conclusion on the technical condition of the SP in the documents specified in **4.1.5.1**.

4.2.1.5 The SP routine repair is generally carried out by its owner in combination with the pipeline maintenance according to the approved schedule as agreed with the Register.

4.2.2 Repairs using reinforcing clamps.

4.2.2.1 General.

4.2.2.1.1 The reinforcing clamps shall be fitted onto the SP defective section to decrease the hoop stresses (unload) the pipe wall from internal pressure in defective area which shall result in termination of the defect further propagation.

4.2.2.1.2 The reinforcing clamps are generally fitted during underwater engineering works. The reinforcing clamps are generally fitted with application of additional corrosion-protection coating or adhesive (compound) allowing underwater application.

4.2.2.1.3 Upon agreement with the Register, the clamps may be fitted onto SP under pressure with the value determined for the defect based on the inspection results. During repairs by collars, lifting/lowering of SP string is not permitted.

4.2.2.1.4 The following is required for using reinforcing clamps for repairs of steel subsea pipelines:

the clamps shall be of Register approved type;

the Register shall approve calculation on strength including fatigue strength, strength of SP defective section with the clamps under actual operating conditions of SP and design forecast of the SP service life;

the Register shall approve the procedure for clamps fitting including preparation of SP for its installation and creation of squeeze forces as well as monitoring of SP technical condition with repair clamps fitted.

4.2.2.1.5 The steel or composite reinforcing clamps may be applied. In such cases, the defective area shall be overlapped by the clamps by at least 50 mm up to each edge.

4.2.2.1.6 The repair by reinforcing clamps with respect to SP under the RS technical supervision shall be performed by firms audited by the Register according to 1.11 and having the Certificate of Firm Conformity (ССП) (form 7.1.27) (code **24003000**).

4.2.2.1.7 Provided that the requirements **4.2.2.1.1** to **4.2.2.1.5** are observed, the SP with the following defects may be repaired:

mechanical damages (pits, scores, etc.) of the outer pipe surface;

corrosion damages (total corrosive wear, cavities, pittings, etc) of the pipe external surface;

corrosion damages (pits, rill damages, etc.) of the pipe inner surface;

dents on the pipe surface;

delaminations in the pipe body;

defects of butt girth welds and field 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.

4.2.2.1.8 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.

4.2.2.2 Composite reinforcing clamps.

4.2.2.2.1 The composite (glass/carbon reinforced) clamps reinforced by the appropriate roving and moulded by epoxy bonds shall be type approved by the Register and manufactured under the RS technical supervision.

4.2.2.2.2 Requirements to 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 (form 6.8.3), the specimens of clamps shall be subject to tests according to the requirements of **4.2.2.2.5** and **4.2.2.2.6**.

4.2.2.2.3 The materials applied in the composite clamps including metal embedments and fastenings shall comply with the RS approved technical documentation.

4.2.2.2.4 The clamps shall be manufactured from 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.

4.2.2.2.5 The type approval (periodical) tests of reinforcing composite clamps shall be aimed as a minimum at confirmation of material parameters as specified in **4.2.2.2.4**. 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 the RS-recognized classification/supervisory body) testing laboratory not more than **2** years ago provided that the deliveries of accessories/products are identical as well as process procedures and structural design remain unchanged.

4.2.2.2.6 Check (production) tests shall include the following:

strength test of by tightening it on the bench with torques equal to 150 % 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).

4.2.2.2.7 The metal embedments and fasteners shall be generally manufactured from stainless steel of strength class of at least 10,9.

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);

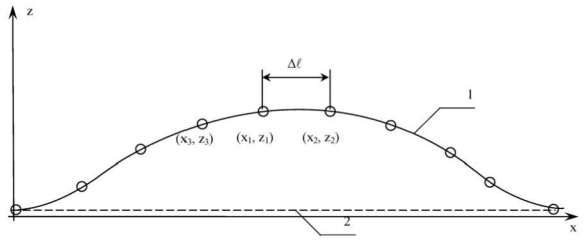

Fig. 1:
1 — actual SP route;
2 — initial (design) SP route

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 DUE TO SEABED SOIL EROSION

The acceptability of a free span steel SP section due to seabed soil erosion is determined as follows:

1. the length of the free span section *l*, in m (refer to Fig. 1) is determined by visual examination;

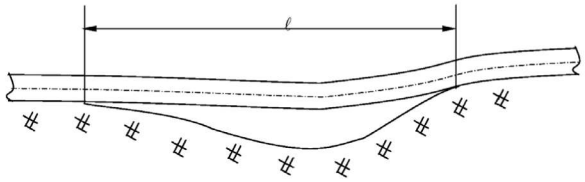

Fig. 1 Free span SP section

2. The maximum bending moment within the free span section, in Nm:

$$M_{max} = \frac{ql^2}{24}\cdot\frac{2l}{l + \frac{2}{\alpha_s}} \quad \text{when } l > \frac{6}{\alpha_s}$$

$$M_{max} = \frac{ql^2}{24}\cdot\frac{l + \frac{6}{\alpha_s}}{l + \frac{2}{\alpha_s}} \quad \text{when } l < \frac{6}{\alpha_s}$$

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;
$I = \frac{\pi}{64}[D_0^4 - (D_0 - 2t)^4]\cdot 10^{-12}$ = inertia moment of the pipe cross-section, in m^4, determined by the formula
D_0 = nominal external diameter of a 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

$$W = \frac{\pi}{32} \left[D_0^3 - (D_0 - 2t)^4 / D_0\right] \cdot 10^{-9}$$

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;

4. the free spans calculations under variable hydrodynamic loads shall be calculated according to 2.7 and 3.6, Part I "Subsea Pipelines" of the SP Rules or according to the procedure agreed with the Register.

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:

$$\Delta t = \min[0{,}5 t_0, M t_0] \qquad (1\text{-}1)$$

where factor M is determined by the formula

$$M = \frac{0{,}9 R_e - p\left(\frac{D_0}{2t_0} - 1\right)}{0{,}9 R_e - \frac{p}{Q}\left(\frac{D_0}{2t_0} - 1\right)} \qquad (1\text{-}2)$$

where t_0 = initial (as-built) wall thickness, in mm;

D_0 = nominal external diameter of a 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

$$Q = \sqrt{1 + 0{,}31\left(\frac{l}{\sqrt{D_0 t_0}}\right)} \qquad (1\text{-}3)$$

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).

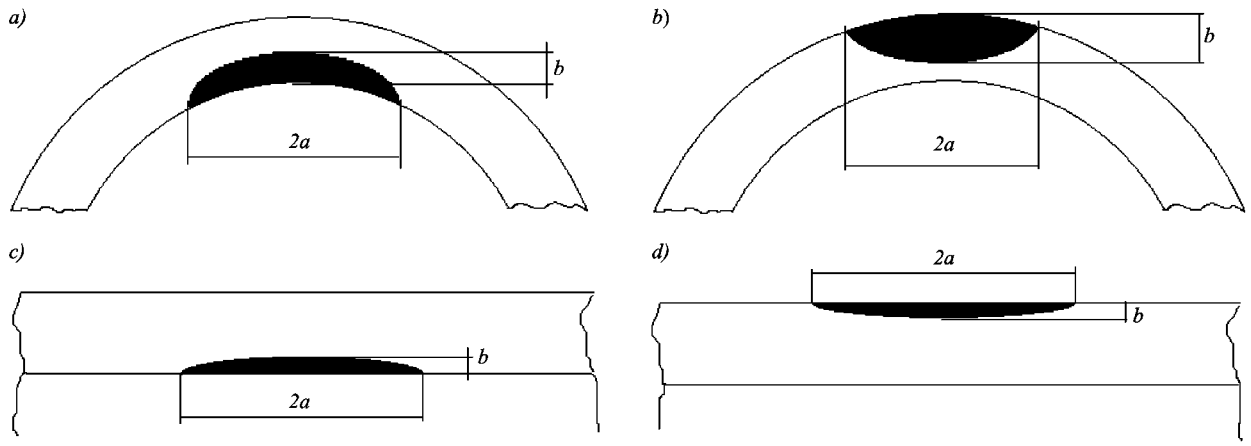

Fig.1-1 Classification of surface cracks:
a) — transversal internal; *b*) — transversal external; *c*) — longitudinal internal; *d*) — longitudinal external

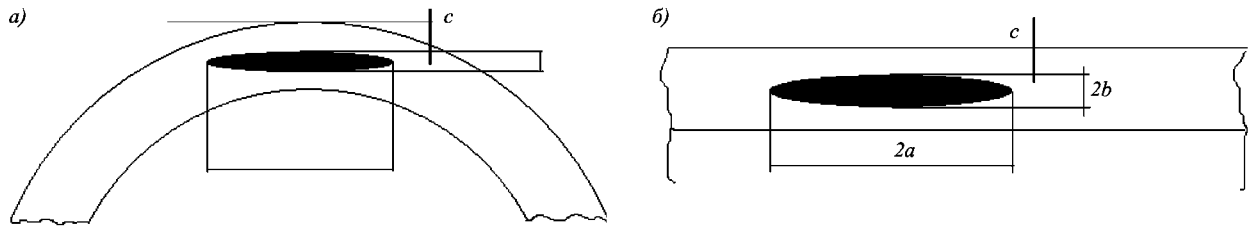

Fig.1-2 Classification of subsurface cracks:
a) — transversal internal; *b*) — transversal external; *c*) — longitudinal internal; *d*) — longitudinal external

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.

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).

Stresses σ shall be determined by the following formulae:

for defects located along the pipe, in MPa,

$$\sigma = p\left(\frac{D}{2t} - 1\right); \qquad (3\text{-}1)$$

for transverse defects, in MPa,

$$\sigma = \frac{ED}{R_i}10^{-3} + \alpha\Delta TE + \mu p\left(\frac{D}{2t} - 1\right) \qquad (3\text{-}2)$$

where D = external pipe diameter, 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;
μ = 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:

$$K_c = \sqrt{\frac{2R_e\delta_{cr}E}{(1-\mu^2)}10^{-3}} \qquad (4.1)$$

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:

$$K_c = \sqrt{\frac{J_cE}{(1-\mu^2)}10^{-9}} \qquad (4.3)$$

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.

$$K_c = 16\sqrt{KV} \qquad (4.4)$$

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

$$[K] = K_c/n \quad (5)$$

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:

$$\sigma_s \leqslant R_e; \quad (6\text{-}1)$$

$$K_s = \frac{K_d + K_{res}}{[K]} f \leqslant 1 \quad (6\text{-}2)$$

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 defact 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:

$$K_d = Y\sigma\sqrt{\pi b 10^{-3}} \quad (7)$$

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/a \ b/t	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 7-4

Longitudinal internal crack, values $Y(R/t = 40)$

b/a \ b/t	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/a \ b/t	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	1,15	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 7-7

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	1,33	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 7-11

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:

$$K_{res} = 1{,}05R_e\sqrt{t10^{-3}}\left[\left(\frac{t-b}{t}\right)^2 - \exp\left(-\frac{9b}{t}\right)\right] \times$$

$$\times [1 + 4{,}6(b/2a)^{1{,}65}]^{0{,}5}. \quad (8)$$

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 $M = \sqrt{1 + 1{,}6\,\frac{2a^2}{Dt}}$; (9-2)

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.

Российский морской регистр судоходства

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Russian Maritime Register of Shipping

Guidelines on Technical Supervision During Construction and Operation of Subsea Pipelines

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