Federal Environmental, Industrial and Nuclear Supervisory Service of Russia
(Rostechnadzor of Russia)

FEDERAL STANDARDS AND RULES
IN THE FIELD OF USE OF ATOMIC ENERGY

Approved by order of
Federal Environmental,
Industrial and Nuclear
Supervisory Service of Russia
No 3 of September 5, 2006

Rules for Arrangement and Safe Operation of Equipment and Piping of Nuclear Fuel Cycle Facilities
NP-070-06

EFFECTIVE since
December 1, 2005

Moscow, 2006

UDK 621.039

Rules for Arrangement and Safe Operation of Equipment and Piping of Nuclear Fuel Cycle Facilities NP-070-06.

FEDERAL ENVIRONMENTAL, INDUSTRIAL AND NUCLEAR SUPERVISORY SERVICE OF RUSSIA
Moscow, 2006

The Rules for Layout and Safe Operation of Equipment and Pipelines of Nuclear Fuel Cycle Facilities are intended for the organizations and enterprises involved in design, manufacturing and operation of equipment and pipelines of nuclear fuel cycle facilities.

The Rules establish requirements for design, manufacturing and safe operation of equipment and pipelines of nuclear fuel cycle facilities.

These Rules have been developed for the first time[*].

The document has passed a legal review in the Ministry of Justice of the Russian Federation (letter of by the Ministry No 01/8121-OH of 15 September 2006).

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ABBREVIATIONS

I&C	- Instrumentation and Controls
NFCF	- Nuclear Fuel Cycle Facility
RD	- Regulatory Documents in the field of use of atomic energy
TS	- Technical Specifications

TERMS AND DEFINITIONS

Base material shall mean the material used for making equipment and piping which are exposed to pressure or being in contact with the process medium.

Corrosive medium shall mean the medium which induces corrosion penetration to the equipment (piping) structural material at a rate of 0.1 mm per year and greater. Depending on rate, there shall be distinguished media of lower corrosiveness (a rate of not greater than 0.1 mm per year), medium corrosiveness (a rate of 0.1 mm up to 0.5 mm per year), higher corrosiveness (a rate of 0.5 mm up to 1.0 mm per year), and high corrosiveness (a rate of greater than 1.0 mm per year).

Corrosion resistant overlay shall mean the applying, by means of arc welding of corrosion-resistant metal overlay onto the weld contacting with a process medium (with the weld fusion line being overlapped); such overlay is made to improve corrosion resistance of the welded joint.

Design pressure shall mean the value of pressure used for the strength calculations of the equipment and piping.

Designated service life shall mean the duration of operation of a nuclear installation, as expressed in calendar years, established by its design; when it is achieved, further operation of the equipment and piping (or the installation as a whole) can be continued only after a special permit is obtained on the basis of carried out operational safety assessment, for example, a technical condition inspection (diagnostics).

Design temperature shall mean the value of temperature used for determining physical and mechanical characteristics, allowable metal stresses and the strength calculations.

Durability shall mean the ability of the equipment or piping to retain workability until the limiting state.

Equipment shall mean the combination of devices, tooling, instruments, mechanisms required for implementation of any works. The equipment may include vessels, reactors, and boxes.

Leading material study organization shall mean the enterprise or organization having competence in selecting materials, welding technology, quality assurance in manufacturing of the equipment and piping.

Limiting state shall mean the state of the equipment and piping where their further operation is impermissible or not expedient or restoration of its serviceable state is not possible or unreasonable.

Operating conditions shall mean the conditions regarding quantity, characteristics, serviceability and maintenance of the equipment, piping and the nuclear installation as a whole required for operation without violation of operating limits, as established by the design.

Operational limits shall mean the values of parameters and characteristics of state of the equipment and piping (and the nuclear installation as a whole) as preset by the nuclear installation design for normal operation.

Piping (pipeline) shall mean tubular assembly units and parts (headers, T-joints etc.) joint by welding and designed to transport a process medium from one vessel to other.

Producer shall mean the enterprise that manufactures equipment and piping and their assembly units and parts.

Reliability shall mean the property of an object to retain, within time and set limits, values

of all parameters that characterize the object's ability of performing designated functions within preset modes and conditions.

Repair cycle shall mean the least recurrent time intervals when certain types of repairs are carried out following a certain sequence and in accordance with the regulatory documentation.

Residual service life shall mean the service life of the equipment and piping starting from the point of time when its technical condition inspection was carried out until it enters its limiting state.

Resource of equipment shall mean a total time the equipment or piping has worked starting from its commissioning or restart after a repair until it enters its limiting state.

Service life shall mean the duration of operation of the equipment or piping starting from the commissioning or its restart from a repair until it enters the limiting state.

Serviceable state shall mean the state of the equipment and piping where all parameter values that characterize their ability to perform designated functions meet requirements prescribed in the regulatory and engineering documentation.

Template shall mean the specimen of a material intended for metallographic studies.

Vacuum gage pressure shall mean the process medium pressure that is less than atmospheric one; a magnitude of vacuum gage pressure equals a difference between atmospheric pressure and absolute pressure.

Working pressure shall mean the maximum excessive pressure of a process medium in normal operation.

1. GENERAL

1.1. Scope of application

1.1.1. The Rules for Layout and Safe Operation of Equipment and Pipelines of Nuclear Fuel Cycle Facilities (hereinafter – the Rules) are applicable to the equipment and pipelines of nuclear fuel cycle facilities regarding their layout, manufacturing, acceptance, assembling and operation intended for operation with radioactive media handled at NFCF and which are under excessive pressure or vacuum gage pressure or hydrostatic pressure.

1.1.2. These Rules cover the NFC facilities'[1] equipment and piping which are design, upgrading and operation and pertain to safety classes 1 through 3 as established in the federal standards and rules in the field of use of atomic energy (hereinafter – the federal standards and rules) applicable to NFCF.

1.1.3. These Rules do not cover the equipment and piping of the following NFCF:

production reactors, research nuclear installations, critical and subcritical facilities;

mining facilities of uranium or and mineral feed with an increased content of naturally occurring radionuclides;

facilities for hydrometallurgical processing of uranium or and mineral feed with an increased content of naturally occurring radionuclides to obtain concentrates of natural uranium and uranium tetrafluoride;

facilities which include sublimate, isotope separation and metallurgical productions.

Design, manufacturing, upgrading and operation of the equipment and piping of the said NFC facilities[2] shall be conducted in accordance with requirements of general industry standards and rules which are applicable to such facilities.

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[1] Which include the following productions: chemical-metallurgical, radiochemical reprocessing of nuclear fuel and nuclear materials, conversion of weapons materials (uranium and plutonium), fabrication of mixed oxide and other types of uranium-plutonium fuel, management of radioactive waste resulting thereof.

[2] As well as the equipment and piping pertaining to safety class 4 NFCF as stated in para. 1.1.2.

1.2. Classification of equipment and piping

1.2.1. The NFCF equipment shall be categorized by groups according to safety classes established in the federal standards and rules. Group one shall correspond to safety class one, group two – class two, group three – class three, and group four – class four.

1.2.2. Categorization of the equipment and piping by classes during design, upgrading and renovation of NFCF shall be done by the designer (engineer) organization; during NFCF operation it is to be done by the operating organization. Justification of attributing the equipment and piping to a certain group shall be done by the operating organization in the Safety Analysis Report.

1.3. Reliability

1.3.1. Reliability of the equipment and piping shall be justified by:

1) the strength calculations. In case the computer-aided calculations and programs are used, only those certified in accordance with the established procedures shall be applied;

2) the correct choice of the structural and welding materials;

3) the quality assurance programs for design, manufacturing, assembly and repair;

4) regulating nomenclature and permissible values of reliability indicators.

1.3.2. The designated service life shall be established for the equipment and piping pertaining to groups 1 through 3.

1.3.3. When setting a designated service life for the equipment and piping which host known process media and/or designated for processes used earlier, their state at the moment of technical inspection and operating experience of the equipment and piping made of the same structural materials and operated under the same conditions shall be taken into account.

1.3.4. For the vessels (apparatuses) and piping that host process media not used previously and/or those designated for processes not trialed earlier a designated service life shall be determined on the basis of experiments and rig testing and refined on the basis of pilot commercial operation.

1.3.5. For conditions that induce pitting corrosion or characterized by an increased aging a designated service life shall be determined on the basis of witness-specimen inspection results; such witness-specimens shall be placed in the vessel (apparatus) in question and subjected to a visual inspection not less than once a year. In case of high corrosion the designated service life shall be refined accordingly to the in-service inspection data.

1.3.6. Reliability indicators shall be selected in accordance with requirements of reliability standards taking account of design features, operating conditions, reliability of domestic and foreign similar equipment and piping, their component parts etc. Quantitative reliability indicators shall be verified by calculations in the course of design, confirmed by test results of the items and assembly units of the equipment and piping (as necessary) and then refined during operation.

1.3.7. Quality control programs shall be implemented at all stages of the equipment and piping lifespan, as developed in accordance with requirements of federal standards and rules.

2. DESIGN AND ENGINEERING

2.1. General provisions

2.1.1. The equipment and piping shall be reliable, maintainable, safe for the personnel and environment and remain serviceable during the designated service life.

2.1.2. Designated service life of the equipment and pipeline holding highly corrosive media shall be not less than 5 years.

2.1.3 The Terms of Reference for design of the equipment and piping shall indicate:

1) a group of the equipment, operating parameters of process media (pressure, temperature, etc.);

2) a corrosion rate in the process media (including those used for decontamination and washing) and/or their chemical composition;

3) a degree of hazard (radiation, fire, toxic, etc.) of process media and their classification in accordance with the appropriate regulatory documentation;

4) a lifetime depending on the operating conditions;

5) a need in corrosion resistant overlaying on welded joints, in additional ways of corrosion

protection (such as lining, insulation, spray-coating, etc.);

6) requirements for process monitoring;

7) input data for strength calculations regarding cyclic or seismic impacts, including those regarding residual stresses due to design features, manufacturing technology and/or assembling;

8) parameters of roughness of inner surfaces being in contact with the process medium and data on the use/non-use of etching outer surfaces;

9) data on installing the devices and instruments for in-service corrosion monitoring with the use of witness-specimens and/or other means of diagnostics;

10) information on getting required agreements;

11) an acceptance procedure;

12) information on permissible values of reliability quantitative indicators;

13) information on quality assurance programs;

14) information on amounts of process media (including those for decontamination and washing) which are not subject for draining; this shall include completely drained amounts;

15) information on used return flanges, fasteners, gaskets and component parts installed at the place of assembly.

2.1.4. Nominal sizes and tolerances of the equipment shall be determined considering nuclear safety ensurance in accordance with the Rules of Nuclear Safety for Nuclear Fuel Cycle Facilities.

2.1.5. The effects of vibration, fatigue and temperature loads shall be taken into account in designing the equipment and piping.

2.1.6. In the process of design of the equipment the following shall be provided:

1) maximum accessibility for periodic visual examination or monitoring of the state of structure components;

2) capabilities of decontamination, washing and complete draining of decontaminating solutions.

2.1.7. Cut-off and safety devises shall be boundaries between the equipment and piping pertaining to different groups. Such devices shall pertain to a group having higher safety requirements. Boundaries between the equipment and piping could also be welds joining them.

In systems with pumps fed from vessels (tanks) operating under atmospheric pressure, the boundaries shall be cut-off devices installed at pump suctions or (where cut-off devices are absent) welds of suction nozzles between a pump and piping.

2.2. Design requirements

2.2.1. The equipment of groups 1 and 2 shall not have detachable joints. It is allowed to provide detachable joints for installation of I&C and remotely replaceable parts of the equipment provided that leaktightness of such connections can be inspected during the operation. The equipment of groups 1 and 2 shall be emptied using siphon drain under the effect of excessive or vacuum gage pressure.

2.2.2. Vessels (apparatuses) shall be provided with an adequate number of manholes and inspection holes. Vessels (apparatuses) are permitted to manufacture without manholes and inspection holes if their design provides for removable parts allowing for the internal inspection.

2.2.3. When designing the equipment holding process media that are capable of inducing pitting corrosion the following shall be envisaged: design features providing for complete draining (absence of stale quantities), absence of stagnant zones, a device for removing deposits from bottoms and cones and removing condensate from lid during operation of the vessel (apparatus), as well as for mixing during storage and hold up in vessels (apparatuses).

2.2.4. For the equipment and piping subject to vibration there shall be fixtures that compensate for vibration loads (e.g., sliding supports).

2.2.5. If it is impossible to carry out a visual examination or pressure test on the equipment and piping, the procedures for assembling, operation and repair shall refer to methodologies, frequency and scope of non-destructive testing and other technical diagnostics techniques which will ensure timely detection and elimination of defects.

2.2.6. The equipment that is not characterized by sufficient stability to tilting shall be provided with features preventing tilting.

2.2.7. The equipment shall be designed with strapping devices that meet the transportation,

assembly and dismantling requirements. The design documentation shall contain a strapping scheme and center of gravity.

2.2.8. Vessels (apparatuses) shall be designed to maximum transportable sizes and load capacity of a vehicle.

2.2.9. Vessels (apparatuses) shall have appropriate pipe connections for installing required I&C providing for safe operation of the equipment and piping.

2.2.10. The equipment and piping having outer wall surface temperatures higher than 55^{o}C shall have arrangements for fixing heat insulation in places accessible by the maintenance personnel.

3. MATERIALS

3.1. Base materials

3.1.1. Grades and assortment of base materials for the equipment and piping shall be selected considering their operating conditions, physical and mechanical properties and technological characteristics to ensure the NFCF equipment and piping workability during their service life.

3.1.2. Physical and mechanical properties of the materials and semi-finished products and their quality shall meet RD requirements (that regulate these characteristics) and specifications; they also shall be confirmed certificates issued by producers.

3.1.3. It is allowed to use imported grades of steel (analogues to domestic grades) in accordance with requirements of federal standards and rules.

3.1.4. Specifications for manufacturing of the equipment and piping where sheet and profiled rolled metal items are used shall indicate additional requirements for the manufacturing technology, inspection and testing of the material.

3.1.5. All materials and semi-finished products (sheets, profiled rolled metal, pipes, forged and pressed items) received by the producer shall be subjected to a visual examination.

3.1.6. If the base material is received unprocessed, it heat treatment shall be made by the producer as confirmed by mechanical and resistance to intergranular corrosion testing results.

In case the certificate is not available or any data are missing in the certificate, it is allowed to confirm the material properties at the equipment manufacturer's place by means of the respective testing and control activities.

3.1.7. Before producing, chemical composition for the equipment pertaining to groups 1-3 shall be performed, irrespectively of availability or unavailability of the certificate, by a spectral or chemical analysis with regard to carbon and main alloying elements that determine the grade of the material.

3.1.8. Conditions for storage and transport of materials at producers’ shall exclude unallowable defects and shall ensure matching of their marking with the certificate data.

3.2. Welding materials

3.2.1. Welding and corrosion-resistance overlaying shall use welding materials indicated in RDs which cover NFCF. Welding materials shall comply with specifications requirements and have a certificate issued by the producer that confirms material quality and characteristics.

3.2.2. Welding materials shall be subjected to tests before putting to the production process.

3.2.3. Requirements for storage, accounting and release of welding materials shall be compliant to technical documentation provisions in effect at the producers’.

3.3. New materials

3.3.1. New materials include:

base materials not indicated in RD (that regulate grades and physical and technical, technological and corrosion characteristics of materials used for manufacturing of the equipment and piping) which cover NFCF;

base materials indicated in RD if used under temperatures exceeding maximum permissible values;

welding and overlaying materials not indicated by RDs.

3.3.2. To use new materials for manufacturing of the equipment and piping the organizations interested in their application shall test these materials. A report with new materials test and study results shall be agreed upon with the leading material study organization.

3.3.3. It is permitted to use new materials for manufacturing specific equipment and piping items as jointly decided by the engineering (designer) organization, leading material study organization and producer (assembling organization) and agreed upon by the operating organization. The said decision shall be attached with the documentation for semi-finished products and (or) welding and overlaying materials and information on physical and chemical, technological and corrosion-resistant characteristics of the base metal and (or) its welded joints (overlaid metal) which demonstrate that it is possible to use them for manufacturing of the equipment and piping of required performance. Scope and list of information to be submitted shall be determined by organizations which have drafted and concurred the terms of reference, depending on specific operating conditions of the equipment or piping.

4. MANUFACTURING, ASSEMBLING AND TESTING

4.1. General provisions

4.1.1. The equipment and piping shall be manufactured in accordance with the process documentation (process procedures, process flow diagrams etc.) which regulates content and procedure of all process and monitoring/control operations. The process documentation shall be written by the producer (assembling organization) with observance of requirements of these Rules and other regulations that cover NFCF equipment and piping, as well as drawings and product specifications. The process documentation for assembly of lead specimens of the equipment and piping as well as changes being made to it (including those for series-made specimens that will follow) shall be agreed upon with the designer (engineering) organization.

4.1.2. The process documentation for melting and teeming of metal, heat cutting, shaping, welding, overlaying, and heat treatment shall be agreed upon with the leading material study organization. In case of the defect elimination in metal of parts (including in welds and overlays) by welding only type process guides regulating elimination technology for most frequent (standard) defects shall be agreed upon with the leading material study organization.

4.1.3. In the course of the equipment and piping assembling the producer (assembling organization) shall conduct the technical follow-up which results shall meet requirements of these Rules.

4.1.4. Physical and mechanical properties of metal parts and assembly units that were subjected to heat treatment shall be inspected using specimens cut out of excess material or reference samples. After heat treatment the metal shall be inspected for its resistance for intergranular corrosion. The designer (engineering) organization shall determine the necessity of inspection of mechanical characteristics of metal and it shall be indicated in the engineering (design and engineering) documentation.

4.1.5. Parts and assembly units of the equipment shall be subjected to stabilizing annealing if they are intended for the use with media inducing corrosion cracking as well as under temperatures over 350^{o}C with media inducing intergranular corrosion. Heat treatment shall be carried out after welding and elimination of all defects.

4.1.6. Vessels (apparatuses) which cannot be transported because of their sizes or weight which exceeds load capacity of a vehicle shall be manufactured in parts. After assembling a vessel (apparatus) shall be subjected to the pressure or pneumatic tests. Requirements for the pressure (or pneumatic) test shall be determined and justified in the engineering documentation. The producer shall carry out test assembling of connectable parts and apply assembling marking. Instead of test assembling it is permitted to carry out a test check of sizes of the connectable parts to ensure that the item can be assembled on site without adjustment. Upon agreement with the operating organization the producer is permitted to assembly internals and test non-transportable vessels (apparatuses) on the assembly pad after they have been placed in design positions and fixed on the foundation.

4.2. Welding

4.2.1. General

4.2.1.1. The producer (assembly organization) shall use only qualified welding (overlaying) techniques.

4.2.1.2. Welding and corrosion-resistant overlaying during manufacturing, assembling, upgrading and repair of the equipment and piping shall be carried out in accordance with the process documentation and engineering guidance.

4.2.1.3. Elimination of defects in the equipment and piping (including in welds and corrosion-resistant overlays) using welding shall be carried out in accordance with the process documentation.

4.2.1.4. The use of new welding techniques or new base and welding metal is permitted only on the basis of an agreement with the leading material study organization. The subject to agreement shall be specifications or standards for semi-finished items, welding materials and information on physical and mechanical characteristics, process and corrosion-related properties of base metal and welds, which determine whether it is possible to use them to manufacture items of required performance.

4.2.1.5. Welds and corrosion-resistant overlays shall be marked in accordance with the process documentation.

4.2.2. Welding techniques

4.2.2.1. Welded joints required during manufacturing, assembly, upgrading and repair of equipment and piping shall be fabricated using the following welding techniques:

- manual arc welding with coated electrodes;
- manual argon-arc continuous welding with non-consumable electrode (with or without welding rods);
- manual pulsed argon-arc non-consumable electrode welding;
- continuous feed argon-arc non-consumable electrode welding;
- continuous feed pulsed argon-arc non-consumable electrode welding;
- continuous feed argon-arc welding by autopressing;
- continuous feed argon-arc welding by successive penetration;
- machine arc gas-shielded consumable electrode welding;
- continuous feed hidden arc welding;
- combined welding techniques;
- welding by explosion.

4.2.3. Welding equipment

4.2.3.1. Welding of steels and alloys in the course of manufacturing, assembly, upgrading and repair of equipment and piping shall be performed using the welding equipment found in the serial production or special-purpose welding equipment and tools which allow to provide the specified conditions of welding and reliable operation.

4.2.3.2. Welding equipment shall be provided with standard instrumentation that allow to monitor the specified conditions of welding. Accuracy of instrumentation reading shall be systematically checked.

4.2.3.3. Each station of machine welding shall be connected to an independent source of DC power supply to the arc.

4.2.3.4. The welding equipment shall periodically subjected to performance checks as per the process documentation in use at the producer’s.

4.2.4 Requirements to the personnel

4.2.4.1. The activities on welding, overlaying, inspection, heat treatment of welded joints shall be managed by the personnel who have been qualified for performance of the corresponding operations.

4.2.4.2. The welding activities (including making of overlaying and temporary welds) shall be performed by qualified welders.

4.2.5. Preparing and assembling parts for welding

4.2.5.1. Parts (assembly units) shall be prepared and assembled before welding in accordance with process documentation.

4.2.5.2. The structural elements and sizes of welds shall be determined in accordance with the engineering documentation.

4.2.5.3. The process documentation on pre-welding assembly the following requirements are prescribed for:

- parts and tubes edge preparation;
- the use of special tools providing the correct mutual positioning of parts during welding;
- the use of temporary process fixing.

4.2.6. Welding

4.2.6.1. Parts shall be welded in accordance with the process documentation which specifies:

- types of welded joints;
- welding techniques;
- welding materials;
- welding equipment;
- welding conditions;
- techniques and conditions for preliminary or accompanying heating during welding;
- ways to protect surface of metal adjacent to the weld from spatter;
- procedures for making beads and layers of welds;
- techniques and scopes of welding process monitoring;
- other requirements to ensure high-quality welding.

A list of specific requirements to be included into the process documentation on welding shall be developed by the producer and agreed upon with the operating organization.

4.2.6.2. It is allowed to combine two or more welding techniques for one welded joint (combined techniques of welding).

4.2.6.3. Welding shall be performed in the conditions which ensure protection of the place of welding from any impacts deteriorating quality of welding (atmospheric precipitation, currents of air, dust content, etc).

4.2.6.4. Parts made of corrosion-resistant steel grades and nickel-based alloys shall be welded at ambient temperature not lower than minus 5°C. Parts made of corrosion-resistant steel grades shall be welded in the assembly conditions at temperature not lower than minus 15 °C.

4.2.6.5. Corrosion-resistant steel grades and alloys and nickel-based alloys shall be welded in compliance with the technology that provides corrosion resistance of welds in the operating media similar to corrosion resistance of base metal.

4.2.7. Corrosion-resistant overlaying

4.2.7.1. A decision on fabricating a corrosion-resistant overlay at the equipment and piping shall be made by the engineering (designer) organization and indicated in the engineering documentation for the item.

4.2.7.2. Corrosion-resistant overlaying shall be made in the process of manufacturing of the equipment and piping by argon-arc nonconsumable electrode welding with the use of serial production welding equipment and tools. It is allowed to use manual arc coated electrode welding.

4.2.7.3. Corrosion-resistant overlays shall be fabricated in accordance with the process documentation requirements.

4.2.8. Reclamation of weld defects

4.2.8.1. All defects in welded joints and overlays revealed by non-destructive testing and are

unallowable as per RD requirements applicable to NFCF shall be reclaimed.

4.2.8.2. Defects in welded joints and overlays shall be removed only by machining (cutting, use of abrasive tools, etc.); it preferable to re-weld defects by manual argon-arc (or manual arc welding techniques using coated electrodes).

4.3. Inspection of welded joints

4.3.1. General provisions

4.3.1.1. Techniques and scopes of welded joint inspection shall be specified and justified in the engineering documentation.

4.3.1.2. Welded joints shall be inspected in accordance with requirements for relevant inspection techniques.

4.3.1.3. Quality control of welded joints involves the following types of inspection:

- preliminary inspection;
- inspection during welding, overlaying and heat treatment;
- acceptance inspection of welded joints and overlays.

4.3.1.4. Requirements for inspection of the corrosion-resistant overlay shall comply with standards established for the welded joint being overlaid.

4.3.1.5. The criteria for quality assessment of welded joints and overlays are as follows:

- inspection of butt welded joints of the same thickness – nominal thickness of base metal in the zones adjacent to weld (neglecting tolerances);
- inspection of butt welded joints of various thickness – nominal thickness of a thinner part;
- inspection of corner and T-type welded joints - design height of corner weld;
- inspection of tube welding to tube sheets – nominal thickness of tube wall;
- radiographic inspection of welded joints in tubes or other cylindrical parts through two wall – nominal thickness of one wall;
- inspection of welded joints with pre-welding or post-welding machining – nominal wall thickness;
- inspection of edge welded joints – doubled nominal thickness of a thinner of welded parts.

4.3.1.6. The results of each type of inspection shall be documented as prescribed by the producer carrying out the inspection.

4.3.2. Classification of welded joints

4.3.2.1. Welded joints shall be classified into four categories.

4.3.2.2. Categories of welded joints of equipment and piping shall be set by the engineering (design) organization in accordance with Table 1.

Table 1. Categories of welded joints in equipment and pipelines depending on operating conditions

Environment which impacts the welded joint during the process	Group of equipment and piping	Design pressure, MPa	Category of welded joint depending on its type		
			Type of welded joint		
			Butt welded joint	Corner, T-type, edge welded joint	Lap welded joint
Explosive or flammable, corrosive (the rate of corrosion more than 0.5 mm/year)	1,2	Irrespectively of pressure value	I	II	Not allowed
Corrosive (the rate of corrosion from 0.1 to 0.5 mm/year)	1, 2	The same	I	II	The same
	3		II	II	
Corrosive (the rate of corrosion from 0.01 to 0.1 mm/year)	1, 2	The same	II	II	The same
	3	> 0.5			
		≤ 0.5	III	III	IV
Corrosive (the rate of corrosion less than 0.01 mm/year)	1, 2	> 0.5	I	II	Not allowed
	3		II	III	IV
	1, 2	From 0.07 up to 0.5 inclusive	II	III	IV
	3		III	III	IV
	1, 2	<0.07	II	III	IV
	3		III	IV	IV

Note. Categories of welded joints not included in the Table shall be assigned by the engineering organization.

4.3.2.3. Categories of welded joints shall be assigned by the design organization and specified in DD. For some welded joints designed for higher loads or located in places difficult to access for repair the design organization can assign the higher categories or specify the additional techniques of inspection.

4.3.3. Preliminary inspection

4.3.3.1. Preliminary inspection shall include the checkup of:

- availability of the permit for using welding (overlaying);
- qualification of the welders;
- process trial welded joints (overlays);
- qualification of the personnel responsible for inspection and quality assessment of welded joints (overlays);
- qualification of the engineering and maintenance personnel in charge of assembly, welding and inspection activities;
- state of the equipment for welding (overlaying), heat treatment and inspection;
- quality of welding materials and materials for flaw detection;
- quality of pre-welding treatment of parts and assembly units.

4.3.3.2. In-process trial welded joints shall be made to test physical and mechanical characteristics of metal in the in-process trial welded joints of the equipment and piping pertaining to groups 1 through 3 as specified in the engineering documentation.

4.3.3.3. Quality of in-process trial welded joints shall be 100% inspected by non-destructive testing techniques specified for in-process welded joints. Quality shall meet the standards identified for in-process welded joint of a higher category of the item.

4.3.3.4. Quality control of in-process trial welded joints shall involve the following activities:

- visual examination;
- mechanical testing;
- metallographic investigations;
- testing for resistance to intergranular corrosion;
- flaw detection;
- other techniques as envisaged and justified in the engineering documentation.

4.3.3.5. Inspection of welding and heating equipment shall include the checkup of their compliance with the certificate data as well as serviceability of the instrumentation, tools and cables.

4.3.3.6. Metrological support to the instrumentation shall be arranged for.

4.3.3.7. Quality control and acceptance of welding materials incoming the enterprise shall include the checkup of availability of the certificates and compliance of the data given therein with the requirements of the technical specifications for delivery.

4.3.3.8. Each batch of materials for flaw detection (powders, penetrants, films, reagents, etc.) shall be checked for:

- availability at each packing (pack, box, tank) of labels (certificates, etc.)
- completeness of data therein, and their compliance with the requirements to the inspected materials;
- absence of damages to packing or the materials themselves;
- validity of the useful life;
- compliance of material quality to the requirements of the methodological documentation on a given inspection technique.

4.3.3.9. Prior to welding the following shall be checked:

- cleanness and conditions in the room for its compliance with the process documentation in use at the enterprise;
- lack of defects at edges to be welded;
- correctness of edge preparation for welding;
- sizes of inner diameters of pipes for butt joints and correctness of pipe end sizing if sizing is required in the engineering documentation;
- cleanness of butt edge surface.

The following shall be checked after butts have been assembled for welding:

- gaps in the joints and sizes of an item;
- alignment, no inflection of axes and displacement of edges;
- correct assembly of parts and their fixing in the assembly tools;
- quality of temporary welds by means of visual inspection and correctness of their fabrication;
- availability of the coating to protect from splatter as required in the process documentation.

4.3.4. Monitoring during welding, overlaying and heat treatment

4.3.4.1. Monitoring in the process of welding, overlaying and heat treatment shall include the following operations:

- monitoring of compliance to the production process of welding and overlaying;
- monitoring of shielding gas quality by color of the weld surface;
- monitoring of heat treatment of welded joints and overlaid items.

The monitoring is carried out in accordance with the process documentation.

4.3.4.2. Quality control of welds at the intermediate stages of their fabrication shall include:

- in-process inspection and implementation of inspection activities;
- taking up (cleaning) of weld roots before applying back-up welds;
- making and quality control of in-process trial welded joints;

- checkup of cleanness in the room and ambient temperature;

- keeping of “Welding Control Log” and entering therein the information on marking and stamping the welded joints, developing the scheme for welded joints inspection.

- layer-by-layer inspection of the weld filling where X-ray inspection is unavailable;

- control of correctness of marking, marking and recording of weld sections for subsequent in-process and acceptance non-destructive testing in the corresponding logs;

- fabrication and inspection of reference welds;

- recording of quality control results and results of inspection of in-process and reference welds in corresponding logs.

4.3.4.3. In the event of departures from the production process and poor quality of welded joints the welding activities shall be terminated until the causes are eliminated.

4.3.4.4. Upon completion of welding it is required to check whether markings on welded joints and overlays are in place and correct.

4.3.5. Acceptance inspection of welded joints and overlays

4.3.5.1. The techniques and scopes of inspection of production welded joints shall be identified and justified in the engineering documentation.

4.3.5.2. Inspection shall be performed in accordance with qualified type methodologies. Welded joints shall be considered as passed the examination if inspection using the specified techniques does not reveal any defects larger than the values limited by regulatory documents applicable to NFCF and the results of inspection of production trial welded joints are positive.

4.3.5.3. In case welded joints are made without subsequent heat treatment, overlaying and other types of treatment the acceptance inspection shall be performed in the following sequence:

- visual and instrumental inspection;
- styloscoping of weld metal;
- running of metal ball;
- radiographic inspection;
- hydraulic tests;
- tightness tests[3];
- capillary testing;
- other types of non-destructive testing.

4.3.5.4. For welded joints with corrosion-resistant overlays the overlay shall be fabricated after radiographic inspection and reclamation of weld defects, except for overlaying to be done on the inner surfaces with the single side access. Further on, the acceptance inspection shall be done in the following sequence: visual and instrumental inspection; styloscoping of overlay metal; hydraulic tests, other types of non-destructive testing.

4.3.5.5. If a welded joint is subject to heat treatment, machining and deformation, the acceptance inspection shall be performed after completion of these operations excluding styloscoping of weld metal which shall be made before these operations.

4.3.5.6. The need for radiographic inspection prior to heat treatment or deformation shall be identified by the process documentation. It is allowed to make radiographic inspection before machining of welded joints. In this case sensitivity of the inspection shall comply with sensitivity of the wall thickness inspection after machining.

4.3.5.7. If luminescent technique is used for capillary inspection, it shall be performed before radiographic inspection.

4.3.5.8. Visual and instrumental inspection shall be carried out in accordance with provisions of type methodologies for visual and instrumental inspections of base materials (semi-finished products), welded joints and overlays of the equipment and piping.

4.3.5.9. Styloscoping of welded joints and overlays shall be performed as directed by the

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[3] If the tightness testing is not carried out, the capillary testing shall be carried before the radiographic inspection.

engineering documentation. Styloscoping is used to determine the class of overlaid metal as based on the main constituting elements in the chemical composition, i.e. the content of chromium, nickel, molybdenum, titanium and niobium. Styloscoping is permitted on reference specimens fabricated simultaneously with the welded joint. It is permitted to determine a class of the overlaid metal using other, more precise techniques, if their application is justified.

4.3.5.10. Inspection by running of metal ball shall be performed for welded joints as directed by the engineering documentation for welds of tubes having a diameter of up to 76 mm.

4.3.5.11. Radiographic inspection shall be carried out in accordance with provisions of type methodologies for radiographic inspections of base materials (semi-finished products), welded joints and overlays of the equipment and piping to reveal internal defects in weld and heat treatment zone.

4.3.5.12. Hydraulic or pneumatic tests shall be performed in accordance with the test program included in the package of the engineering documentation. Hydraulic tests are mandatory for all welded joints of the structures operating under pressure.

4.3.5.13. Tightness tests shall be carried out in accordance with provisions of type methodologies for tightness inspections of base materials (semi-finished products), welded joints and overlays of the equipment and piping to reveal through defects. Tests are mandatory for welded joints of categories I and II if metal thickness is up to 8 mm inclusive and welded joints of categories III - IV if metal thickness is above 8 mm; tests shall be carried out in accordance with directives of the engineering documentation. Class of tightness and test technique shall be identified and justified in the engineering documentation.

4.3.5.14. Capillary inspection shall be performed in order to reveal non-integrities which are open to the surfaces (such as cracks, pores, etc.) in compliance with provisions of type methodologies for capillary inspections of base materials (semi-finished products), welded joints and overlays of the equipment and piping. Surfaces to be subjected to this type of inspection shall be identified and justified in the engineering documentation.

Inspection is mandatory for 100% of welded joints and corrosion-resistant overlays made with welding materials susceptible for cracking and tube weld-ins to tube grids (plates). In the latter case the inner surface adjacent to the edge shall be inspected in addition to the edges of welded-in tubes.

4.3.6. Quality control of production trial welded joints (overlays)

4.3.6.1. Destructive testing shall use specimens made of production trial welded joints (overlays) or their excess material.

4.3.6.2. Before cutting all production trial welded joints shall be inspected by means of radiography and shall meet requirements of the engineering documentation for the reference weld.

4.3.6.3. The scope of testing of production trial welded joints shall be set and justified in the engineering documentation. For vessels and piping operating under pressure above 0.07 MPa the mechanical characteristics shall be tested for butt joints of all categories. Metallographic investigations shall be performed for all production reference welded joints, including corrosion-resistant overlays made of base and welding materials susceptible for cracking. Tests for resistance to intergranular corrosion are mandatory for butt joints of categories 1 and 2 and for corrosion-resistant overlays.

4.3.6.4. The following mechanical tests shall be performed:

- static tension with determining yield stress and unit elongation;
- static bending if the specimen thickness is up 50 mm inclusive or flattening for tubes with a diameter of up to 38 mm inclusive;
- impact bending at 20°C for the structures with a wall thickness of 12 mm and greater designed for operation under pressure of above 5.0 MPa or at a temperature of above 450°C.

The values of ultimate strength of a welded joint shall be not lower than the requirements for base metal or correspond to the technical specifications for the item. The bending angle shall be at least 100°, excluding chromium-nickel-based alloys. For such alloys the bending angle shall be no less than 30°.

In the flattening tests of tubular welded joints the clearance between tube walls shall not exceed the limits specified in the technical specifications for tubes of the same range of products and grades of material.

4.3.6.5. Results of static bending and flattening tests shall be regarded satisfactory if upon achieving the required limits the tensioned side and edges of the specimen have no cracks longer than 20 % of the specimen width at its width of up to 25 mm inclusive and no more than 5 mm crack at the specimen width of greater than 25 mm.

4.3.6.6. Metallographic investigations shall be carried out using two templates and 4 templates cut at 90° if tubes are welded in fixed positions.

Metallographic microsections from the specimens of tubes welded-in to tube plates shall be cut in perpendicular to the tube plate surface from the lapped sections at the end and in the beginning of the weld-in.

Quality of welded joints and overlays shall be regarded as unsatisfactory if the microsections have cracks, lack of fusion and other discontinuities (pores, slag inclusions, etc.) larger in size than the limits prescribed in RDs.

4.3.6.7. Testing methods shall be defined in the engineering documentation and selected depending on grades of materials to be welded.

4.3.6.8. Monitoring of the ferrite phase content shall be conducted as directed by the engineering documentation. In structures made of austenitic steel grades the ferrite phase content in overlaid metal shall meet requirements of RDs applicable to NFCF.

4.3.7. Inspection after reclamation of impermissible defects

4.3.7.1. All impermissible defects revealed during non-destructive testing shall be subject to reclamation.

4.3.7.2. In the process of re-claiming the impermissible defects of welded joints the following shall be controlled:

- techniques and completeness of defects removal;
- smoothness of transitions in the places of recovery;
- wall thickness in the place of the deepest recovery (if defects are re-claimed without welding);
- shape, size and quality of surface of the recovered placed treated for welding;
- welding techniques and welding materials used for welding of the recovered places;
- welding conditions and, if required, temperature of heating during welding of the recovered places;
- procedures and possibility for re-claiming the defects after repeated reclamation of defects in the same welded joint (overlaid item).

4.3.7.3. The recovered places are subject to visual inspection. The recovered places in welded joints after reclamation of such defects as cracks, lack of fusion and surface defects revealed during capillary inspection shall be subject to the repeat capillary inspection (it is permitted to use etching inspection).

The need for radiographic inspection in the recovered zone shall be identified by the enterprise which reclaims the defects.

4.37.4. Inspection techniques and the norms of quality assessment after reclamation of defects shall comply with inspection techniques and the norms of quality assessment for welded joints of the respective category.

Defects at the same section of a welded joint of pertaining to category I or II shall be re-claimed no more than 2 times and no more than 4 times for a welded joint of category III or IV.

4.4. Marking, packing and shipping

4.4.1. Each item shall have a nameplate where the following data shall be indicated:

- name of the producer or its trademark;
- item name;
- seial number;
- year of manufacturing;
- mass;
- stamp of a technical control unit.

4.4.2. Nameplates of pressure vessels (apparatuses) shall include the additional data:

- operating pressure;
- design pressure;
- hydraulic test pressure;
- allowable maximum or minimum operating temperature at the wall.

Pressure and temperature shall be indicated separately for each cavity for vessels (apparatuses) with cavities where the values of pressure and temperature are different.

4.4.3. The engineering documentation may define additional data to include in marking.

4.4.4. Packing shall be performed in accordance with the technical documentation for specific equipment. This documentation shall define a type of packing.

4.4.5. If necessary, the internal devices and rotating mechanisms shall be fixed to avoid deformation under the effect of their own weight and dynamic loads during shipment.

4.4.6. All holes, connections, couplings shall be plugged or covered with caps to protect them from fouling and damage to sealing surfaces. Plugs and caps shall be fixed to prevent their losing.

4.4.7. Assembly units, parts or spare parts transported separately shall be packed in boxes or bags. A type of packing shall to be chosen by the producer if the technical documentation does not contain other directives.

4.4.8. The engineering documentation shall indicate a mode of transport and anchoring requirements for shipment of the equipment and piping.

4.5. Assembling

4.5.1. The equipment shall be installed so as to allow its inspection, washing, cleaning from outside and inside.

4.5.2. Assembling shall be preceded by a visual examination of the equipment (assembly units, piping) that includes checkup of the following:

- availability of all parts of equipment;
- equipment compliance to the drawings;
- undamaged state;
- availability and completeness of the technical documentation.

If any damage is revealed, it is required to perform preassembly repair.

4.5.3. During assembling and other operations it is not permitted to weld any platforms to the equipment, including any devices for fixing thermal insulation, and other metal structures not specified in the engineering documentation.

4.5.4. After assembling the equipment (pipeline) shall be subjected to strength and tightness tests; their results shall be documented as a test record.

4.5.5. Assembling defects revealed by the tests shall be reclaimed by the assembling organization.

4.6. Testing of strapping

4.6.1. The strapping fixtures (lifting bolts, cant hooks etc.) shall be subjected to strength tests as to their construction and welds by lifting and holdup lifted for 5 minutes with mass of the equipment being increased by 25%.

4.6.2. After the load has been relieved, the strapping welds shall be subjected to the capillary inspection and welds of their connection to vessel shall be subjected to the capillary inspection and tightness test.

4.7. Hydraulic (pneumatic) tests

4.7.1. Before the hydraulic (pneumatic) tests of the equipment and piping, the producer shall draw out a test program (or such tests shall be carried out following the process procedure or production regulations).

4.7.2. The strength inspection of pressurized equipment and piping shall include hydraulic (pneumatic) tests to be carried out after their manufacturing. The strength inspection of the equipment and piping intended for operation at low pressure or vacuum (e.g., up to 100 mmH_2O as

gas clean-up equipment) shall be specified by the designer organization depending on operating conditions.

4.7.3. Vessels (apparatuses) operating under hydrostatic pressure shall be tested by filling with water up to their upper trim of the equipment and exposed to it for 4 hours or by air pressure not higher than 0.01 MPa followed by inspection. Other testing techniques can be used, provided they are defined and justified by the engineering documentation.

4.7.4. Vessels (apparatuses) operating under vacuum gage pressure shall be tested for strength at hydraulic pressure P_{test} of 0.125 MPa; their stability shall be tested at operating pressure; and their tightness shall be tested in accordance directives of the engineering documentation. A class of tightness shall be identified by the designer organization.

Vessels (apparatuses) operating under pressure less than 0.07 MPa shall be tested by pressure of P_{test} equal to 0.2 MPa, if the engineering documentation requirements specify otherwise.

4.7.5. Vessels (apparatuses) and their component parts operating under pressure of 0.07 MPa and higher shall be tested at pressure P_{test} to be determined by formulas given and justified in the engineering documentation.

4.7.6. Hydraulic tests of equipment installed vertically can be performed in the horizontal position provided strength of its casing is ensured. To this end, the engineering organization shall perform a strength analysis with account for the adopted positioning for the hydraulic test. In this case the value of P_{test} shall be increased by the value of hydrostatic pressure equal to pressure of the operating fluid column.

4.7.7. In case of testing the equipment with two and more working cavities designed to withstand different pressure, each cavity shall be tested by P_{test} to be determined depending on the design pressure in a given cavity. The procedures for applying P_{test} value shall be specified in the engineering documentation.

4.7.8. Time of exposure to P_{test} value during the hydraulic test shall be at least 10 min in case the wall thickness is under 50 mm and at least 20 min in all other cases, if there are no other requirements in the engineering documentation. After such exposure of the item, it is required to reduce pressure down to the design value and carry out a visual inspection of the equipment casing, welded and detachable joints. It is recommended in addition to use acoustic emission technique during exposure period in the course of hydraulic tests.

4.7.9. During hydraulic test water shall have temperature in the range from 5°C to 40°C, if there are no different specifications in the engineering documentation. The difference of temperatures on the vessel (apparatus) walls and in the ambient air during tests shall not cause sweating on surfaces of the walls. Air shall be deaerated from the cavities during filling with water.

4.7.10. Hydraulic test pressure shall be applied to each pipe if the certificate contains no data on hydraulic test results. A value of P_{test} shall be at least 1.5 times higher than design pressure for the equipment to be manufactured, exposure time to pressure at least 5 min. Water temperature during tests shall vary from 5°C to 40°C.

4.7.11. If it is specified in the design documentation, it is permitted to carry out pneumatic tests instead of hydraulic tests in cases where latter are not possible.

The pneumatic tests can use either compressed air or inert gas. Test pressure shall be equal to P_{test}. Temperature of both testing medium and the environment shall not be below 5°C. Time of equipment and pipeline exposure to test pressure is to be determined by the designer organization but in all cases it shall not be shorter than 5 min. After the exposure, pressure shall be reduced and equipment and piping shall be inspected where accessible within the required time period. An inspection shall be conducted at pressure to be determined judging by the safety conditions but not higher than $0.8P_{test}$.

4.7.12. The equipment shall be qualified as passed the tests if the following defects are not detected:

pressure drop by the readings of manometers;

leaks of testing medium (leaks, sweating, bubbles of air or gas) in welded joints and on base metal;

cracks, signs of rupture;

leaks through detachable joints;

visible residual strain;

measurements of acoustic emission do not register the signals which correspond in terms of

their amplitude and intensity to the signals obtained on cracks with the parameters in excess of maximum permissible parameters.

4.7.13. After completion of hydraulic tests the inner cavities shall be dewatered, conditioned with compressed air and cleaned.

4.7.14. The need for tests for leaktightness, class of leaktightness and test substance pressure shall be specified and justified in the engineering documentation. Inspection of tightness of tube fastening in connections of tube-to-tube plate type where the media are not allowed to mix (fluid overflow) shall be done using helium (haloid) or luminescent-hydraulic techniques.

Hydraulic pressure during the tests for tightness of pressure equipment shall be equal to the design pressure. Test pressure and duration of tests are to be specified and justified in the engineering documentation.

4.8. Corrosion-resistance testing

4.8.1. When selecting materials for manufacturing of parts and assembly units of the equipment (piping) which operates with chemically corrosive media, and its repair, the corrosion-resistance tests shall be mandatory and carried out using techniques indicated in RDs applicable to NFCF. It is permitted to use other testing techniques provided they have been approved by the leading material study organization.

4.8.2. When selecting new materials or introduction of new processes or changes to parameters of existing technologies special laboratory investigation and tests for corrosion resistance shall be carried out; such tests shall be carried out at maximum concentrations of corrosive components and temperature values possible to occur in the process. New materials shall be subjected, along with the gravimetric corrosion tests, to electrochemical investigations. In media where steel passivity is possible (presence of haloids, reducing agents) potential raise curves after a short cathode polarization shall be obtained.

4.8.3. A time period when corrosion rate is determined by the controlled potential technique shall correspond to sensitivity of the gravimetric method and shall be not less than 3 hours for each value of potential. In media where steel passivity is possible (presence of haloids, reducing agents) potential raise curves after a short cathode polarization shall be obtained.

4.8.4. In all cases solution components' stability shall be considered and possible nature of corrosion shall be projected basing on theoretical assumptions.

4.8.5. Test specimens shall simulate various zones of metal, including those of the most unfavorable in terms of corrosion (welded joints, heat treatment zones, openings, strained zones etc.), depending on a projected type of corrosion.

4.9. Acceptance

4.9.1. The equipment being delivered to the place of assembling in parts shall undergo tests at the producer's site in as large assembled units as possible, subjected to the control assembling and bear required marking. Results shall be formalized as a record attached with an assembling marking scheme and then attached to the certificate. The equipment as a whole shall be tested after completion of assembling.

4.9.2. Quality of surfaces shall be inspected visually without the use of magnifying tools if the engineering documentation does not specify to use instrumentation.

4.9.3. Sequence of all tests and acceptance activities by the technical control unit shall be described in the process documentation.

4.9.4. Results of measurements of nuclear safety-relevant sizes, the record on trial assembly including the scheme of marking for in-field assembling of the vessels (apparatuses) to be delivered in parts, the record on testing of strapping, the records of strength, tightness results, the results of testing by programs shall be included in the equipment certificate.

4.10. Documentation

4.10.1. The engineering (design) organization shall indicate in the general layout drawings of the equipment or assembly drawings, as well as on piping drawings, the pertinence of the equipment and piping to a corresponding group.

4.10.2. All changes to the engineering (design) documentation, which are necessitated in the course of manufacturing, assembling and operation of the equipment and piping shall be made in accordance with procedures established by the state regulatory authority for nuclear and radiation safety in the uses of atomic energy. The changes being made shall be reflected in the engineering (design) documentation and the documentation which is transferred to the operating organization by the producer and assembling organization, including in certificates for the equipment and piping.

4.10.3. The equipment delivered by the producer shall be provided with the following documents:

- certificate;
- strength analysis added to the certificate for equipment designed for operation at 0.07 MPa and higher, for the remaining equipment – if required in the engineering documentation;
- specifications;
- assembly drawing of the item;
- drawings of the assembly units (if required by the customer);
- the operating instructions and procedures on assembly, startup, regulation and trial operation of the item;
- list of purchased parts (if available);
- list of spare parts, instruments and accessories (if available);
- record of trial assembly or trial marking;
- three sets of the assembly drawings for equipment delivered in parts;
- a set of the engineering documentation (if required by the operating organization).

If the equipment is fitted with safety devices, the certificate for safety devices and their through capacity calculations shall be attached in addition to the above said documents.

4.10.4. The equipment certificate shall contain the following information:

- main technical data and characteristics of the vessel (apparatus) and its main parts;
- data on connections, flanges, lids and fixing parts;
- list of delivery and a list of attached documentation;
- list of deviations from drawings after manufacturing;
- list of base material data;
- information about welding, welders and reference specimens test results;
- heat treatment modes;
- data on welded joints inspection;
- acceptance test record;
- information about valves, I&C and safety features;
- information on mothballing and packing;
- manufacturing quality certificate;
- warranty;
- information on the vessel (apparatus) location;
- information on a person responsible for orderly state;
- information on replacements and repair;
- information on inspection and registration.

Types and scopes of information to be included in the certificate shall be determined in the specification for the item.

4.10.5. The assembling organization shall formalize an assembling quality certificate which is attached to the equipment certificate. The certificate shall be signed by heads of the assembling and operating organizations and stamped.

The certificate shall contain the following information:

1) name of the assembling organization;

2) name of the operating organization and the equipment serial number;

3) information on materials used by the assembling organization;

4) information on welding, including type of welding, type and mark of electrode, heat treatment mode;

5) names of persons who carried out welding and heat treatment and numbers of their certificates;

6) results of tests of reference butt welds (specimens) as well as results of butt weld flaw detection;

7) statement on compliance of the carried out assembling works to the design, specifications, assembling procedure and operating procedure.

4.10.6. The pipeline certificate which is generated by the operating organization is the main document that confirms the pipeline characteristics, manufacturing and assembling quality, workability during operation and compliance with the process documentation.

Certificates shall be issued for transit and intershop pipelines with a conditional diameter of greater than 50 mm which transport:

- explosion and fire hazardous substances;
- toxic substances of classes 1 and 2 as per classification of a relevant regulatory document;
- substances under pressure greater than 10 MPa;
- substances under temperatures $\leq$ - 40^{o}C;
- substances under pressure less than $\geq$ 2.5 MPa and temperature $\geq$ 250^{o}C;
- substances inducing corrosion of the piping metal at a rate of more than 0.5 mm/year.

4.10.7. Documents that shall be submitted along with the pipeline certificate are:

1) a set of schemes and drawings which shall give an opportunity for inspecting the pipeline for conformance with requirements of the design, its equipping with valves and I&C, and locations of welded joints and supports;

2) manufacturing certificate for assembly units of the pipeline which is to be issued by the producer;

3) certificate of assembling of the piping which is to be issued by the assembling organization;

4) certificates for the piping fittings;

5) strength calculations or its extract with the calculation identification;

6) quality inspection tables of welded joints and base materials;

7) documentation on deviations from the engineering documentation.

4.10.8. The equipment and piping certificates, along with attachments and their inspection results, shall be kept by the operating organization during the entire period of operation.

5. REQUIREMENTS FOR FITTING THE EQUIPMENT AND PIPING WITH VALVES AND INSTRUMENTATION AND CONTROLS

5.1. General requirements

5.1.1. Number, type, installation locations and other requirements for valves and I&C of the equipment and piping shall be determined by the engineering (designer) organization proceeding from the specific conditions of operation and requirements of these Rules.

5.1.2. Redundancy of valves and I&C shall be arranged for in accordance with requirements of the federal standards and rules.

5.1.3. Valves and I&C shall be installed so to provide their maintenance, inspection, repair and replacement.

5.1.4. The producer shall supply valves along with certificates and operating manuals.

5.1.5. Valves which opening and closing require force of more than 295 N (30 kgf) or are controlled remotely shall be equipped with a mechanized drive.

5.1.6. The use of control valves as cut-off valves and otherwise shall not be permitted.

5.1.7. Cut-off units of valves of the equipment and piping of groups 1 and 2 which inadvertent movement could lead to consequences affecting NFCF safety shall be fitted with locking devices and indication of the cut-off units' positions. The necessity of installing the locking devices and indicators shall be determined by the engineering (designer) organization.

5.2. Safety devices and alarms

5.2.1. Safety devices shall be installed on equipment and piping where pressure can exceed the value of working pressure due to both chemical and physical processes taking place in them and external sources of overpressure.

If pressure in equipment and piping cannot exceed working pressure, installation of safety devices is not required. Waiver to install safety devices shall be justified in the design.

5.2.2. Number of safety devices, their through capacity and settings for opening (closure) shall be defined by the engineering organization so that pressure in the protected equipment and pipeline does not exceed a value of 15 % more than working pressure and does not result in inadmissible dynamic impacts on safety valves.

For systems with possible short-term local pressure increase it is permitted to have a local pressure increase under which safety devices shall be actuated. Such a possibility shall be provided by the design and justified by strength analysis.

5.2.3. Pressure increase for not more than 0.05 MPa is allowed in equipment and piping with working pressure of up to 0.3 MPa. A possibility of the pressure increase by the said value shall be justified by strength analysis of the corresponding equipment and piping.

5.2.4. If a safety device protects a number of equipment items connected to each other it shall be selected and set up based on the lowest working pressure for each of those equipment items.

5.2.5. Design of safety devices shall ensure their closure after actuation in case of pressure reaching a value not less than 0.9 of working pressure used for selection of setting for actuation of these safety devices.

5.2.6. Number of safety devices and (or) safety membranes with forced rupture installed to protect equipment and pipelines of groups 1 and 2 groups shall be higher than the number defined according to item 5.2.2 by not less than one.

5.2.7. Through capacity and number of safety devices shall be selected taking into account a total capacity of all possible pressure sources and analysis of design basis accidents capable of leading to an increased pressure.

Through capacity of safety devices shall be checked in the corresponding tests of this design prototype carried out by the producer of safety valves.

5.2.8. It is not allowed to install cut-off valves between a safety device and equipment and pipeline protected by it, as well as on lateral and drain pipelines.

5.2.9. Change in setting for spring and other alignment elements in safety devices shall be impossible. Springs of spring safety valves and impulse valves shall be protected against direct impact of media and overheating.

5.2.10. Safety device design shall provide a possibility to check correctness of its performance by its opening manually or from the control panel. For impulse safety devices this requirements is applied to the impulse valve. Force of manual opening shall not exceed 196 *N* (20 kgf).

If it is impossible to check performance of safety devices during operation of equipment (piping), switching devices installed before them and allowing examination of each safety device with their disconnection from the equipment (piping) shall be used.

Switching devices shall be such as to provide connection of the required number of safety devices (necessary to ensure compliance with requirements of item 5.2.2) with equipment and pipelines under any state of those switching devices.

5.2.11. Safety devices shall be installed on branches and pipelines directly attached to equipment. It is allowed to install safety devices on branches attached to pipelines.

5.2.12. Flow coefficient and size of the minimal orifice flow of the seat shall be indicated in the certificate on safety devices for the completely opened valve.

5.2.13. Equipment working under pressure that is less than the source pressure shall have automatic reducer (pressure governor downflow) installed on the supply pipeline with pressure gage and safety devices installed on the lower pressure side.

Installation of a single automatic reducer with pressure gage and safety devices installed on one main line before the first branching is allowed for the whole group of equipment working under the same pressure and from the same supply source. In cases when it is not possible due to process reasons or not required to maintain constant pressure after the reducer the unregulated reducing devices (washers, throttles, etc.) can be installed on pipelines coming from the supply source.

5.2.14. If a pipeline along the section from automatic reducer up to equipment is designed to sustain the maximum pressure of the supply source and a safety device is installed on the equipment, installation of a safety device on the pipeline after the reducer is not required.

5.2.15. If the design pressure of equipment is equal to or more than pressure of the supplying source and there is no a possibility to increase pressure in the equipment due to external

and internal power sources, installation of safety devices is not necessary.

5.2.16. Safety devices of equipment and pipelines shall be installed at places accessible for maintenance and repair.

5.2.17. Examination of operability of safety devices including control circuits with release of the working medium shall be carried out before the first start up of equipment with working parameters and before the further scheduled start ups but not less than once per twelve months. If defects or failures of the device or control circuit actuation are revealed repair work shall be done followed additional examination.

5.2.18. Alignment of safety devices should be checked after mounting, after repair of devices or control circuits affecting alignment but not less than once per twelve months. Such examination is carried out by pressure buildup in the equipment using arrangements being a part of the delivery set of these devices or by testing at the stationary test bench. After alignment of safety devices for actuation the alignment unit shall be sealed. Data on alignment shall be registered in the operating and repair log of safety devices.

5.2.19. Examination of operability and alignment of systems protecting equipment and pipelines against pressure or temperature excess shall be carried out in terms specified in paras 5.2.17 and 5.2.18.

5.2.20. Installation of alarms on the equipment and piping, which operate in the event of an accident shall be determined and justified in the engineering (design) documentation.

5.3. Instrumentation and controls

5.3.1. Equipment and piping shall be fitted with I&C to measure pressure, temperature, flow rate and level of working medium, as well as instrumentation for measuring substance pressure, temperature, accumulation and concentration.

5.3.2. Layout of installation of I&C shall provide for a possibility for periodic examination of correctness of their functioning in the laboratory and (or) in the place of their installation. Operating procedures for the equipment and piping shall specify a procedure and terms of examination.

5.3.3. Scope of control according to para. 5.3.1, places of installation of detectors and sampling devices, methods of control, accuracy and limits of safe operation shall be determined by the engineering (designer) organization and indicated in the engineering (design) documentation.

5.3.4. Accuracy class of I&C used for monitoring of the equipment and piping parameters shall not be lower than 1.5. The required accuracy of measurements of control parameters shall be indicated in the engineering (design) documentation.

6. REGISTRATION AND TECHNICAL EXAMINATION

6.1. Registration

6.1.1. Before commencing their operation, the equipment and piping of groups 1, 2 and 3 shall be registered in the state regulatory authority for nuclear and radiation safety in the uses of atomic energy.

6.1.2. The following is not subject to registration in the state regulatory authority for nuclear and radiation safety in the uses of atomic energy:

- group 3 equipment which wall temperature during operation does not exceed 200^{o}C and a product of capacity, expressed in cubic meters, and pressure, expressed in MPa, is not greater that 1;
- group 3 equipment under vacuum gage pressure;
- group 3 piping.

This equipment and piping shall be registered with the operating organization.

6.2. Technical examination

6.2.1. Equipment and piping shall be subject to technical examination after assembly, during the operation on a periodical basis and off-the-schedule as necessary.

6.2.2. The scope, techniques and frequency of technical examination shall be specified by

the operating organization with account of the operating conditions.

6.2.3. Technical examination of the equipment and piping subject to registration with the state regulatory authority for nuclear and radiation safety at the uses of atomic energy shall be carried out by the Technical Examination Commission set by the operating organization. The state safety regulatory authority shall be informed on dates of the technical examination of the equipment and piping.

6.2.4. For technical examination of the equipment and piping where low and intermediate corrosive media are used a statement on conditions of the vessels (apparatuses) used for the same purpose and operating conditions shall be issued on the basis of diagnostics data of a vessel (apparatus) or pipeline operating in more severe conditions. Other vessels (apparatuses) and pipeline of such series may be examined without opening (by witness-specimens or by visual inspection of I&C removable tubs).

6.2.5. If the process is changed in one of vessels (apparatuses) the technical personnel of the operating organization shall verify that technical indicators of the vessel (apparatus), which characterize its corrosion resistance, comply with this process and revise the vessel (apparatus) assigned service life, as necessary.

6.2.6. When trial runs using agents with higher corrosiveness are carried out at separate vessels (apparatuses) or a process section, an off-the-schedule examination of all vessels (apparatuses) involved in the trial runs shall be carried out upon completion of such operations.

6.2.7. Results of the technical examination done and a statement of further operation containing permitted parameter values for examined equipment (piping) and dates of the next examination shall be input to the equipment (piping) certificate.

Information on the technical examination along with dates of the next external and internal visual inspections and hydraulic test shall be put on the shell of the vessel (apparatus) or a special plate to be placed clearly seen near it.

For the equipment and piping subject to registration with the state regulatory authority for nuclear and radiation safety at the uses of atomic energy a copy of the technical examination statement shall be submitted to the state safety regulatory authority not later than 5 days after the examination.

7. OPERATION

7.1. General provisions

7.1.1. The enterprise that operates equipment and piping shall, basing on the engineering (design) documentation, develop and approve in accordance with the established procedure the operating documentation (operating procedures for the equipment and piping, their examination, metal condition monitoring etc.).

7.1.2. Contamination of the environment with radioactive gases and aerosols and initiation of self-sustained chain fission reaction shall be ruled out during operation of the equipment and piping.

7.1.3. The equipment and piping shall be operated using the process media in conditions prescribed by the design terms of reference. If it is necessary to operate the equipment and piping in conditions different from those specified in the design the changes in operational modes shall be agreed upon with the engineering (designer) organization.

7.1.4. The maintenance personnel shall check on workability of valves, I&C and automated features, and safety valves within timeframes specified in technical regulations with the checkup results being entered to the Shift Hand-over Log.

7.1.5. To keep the equipment and piping serviceable the preventive maintenance shall be conducted in a timely manner to include visual examinations, detection and recording of deviations from normal operation parameters, compilation of records of defective item examinations, and development of defect removal measures.

7.1.6. Repairs shall be carried out in accordance with the technology developed by the repair (operating) organization. The repair organization and conduct procedure, including frequency, labor intensity and implementation sequence shall be established in accordance with the technical documentation. Repair scope shall be determined based on the repair list compiled during visual

inspection of the equipment (piping).

7.1.7. The equipment subject to repair shall be drained; its inner sections shall be washed before and after disassembly.

7.1.8. During repair it is permitted to use the hydraulic test to checkup leaktightness.

7.1.9. Repair results shall be entered to the equipment (piping) certificate.

7.1.10. After the assigned service life of the equipment (piping) has exhausted, the equipment (piping) shall be subjected to a comprehensive examination in accordance with requirements of the federal standards and rules. Basing on the said examination a decision shall be made regarding its life extension or termination of its operation.

7.2. Requirements for personnel

The personnel qualified to perform relevant works is permitted to operate the equipment and piping (including their examination, monitoring of metal conditions, repair etc.).

7.3. Technical diagnostics

7.3.1. If it is not possible to apply radiographic and capillary techniques due to radiation fields the main diagnostic means of periodic technical examination of the equipment and piping shall be visual inspection (inner and outer visual inspection, corrosion visual inspection) which reveal changes in technical conditions due to corrosion-induced wear. All other methods of diagnostics shall be supplemental or qualifying where these or other corrosion-induced defects are detected during visual inspection except for process media and operating conditions which induce cracks.

7.3.2. Specialists conducting the visual inspection shall be provided with the following documents and information:

- vessel (apparatus) certificate with a drawing and strength calculations of the shell components or detailed layout of welded joints and main structural elements;
- information on previous repairs and conditions of the equipment and piping basing on previous visual inspection data;
- information on operating modes over the preceding period of time, modes and duration of desorption washing.

The information of the equipment conditions basing on the previous visual inspection data, data on the process medium and operating conditions shall be entered to the Corrosion Status Chart.

7.3.3. Portable light, viewing device, video camera, endoscope, remote inspection equipment (if necessary) etc. shall be prepared for the visual inspection. A list of instruments required shall be compiled by the inspection commission.

7.3.4. During visual inspection the safety precautions shall be implemented as prescribed occupational, industrial and radiation safety procedures.

7.3.5. During visual inspection, including the pre-startup examination and proceeding from the operating conditions, the necessity for the corrosion monitoring using witness-specimens (or by other techniques) shall be determined for the next assigned service life.

7.3.6. The following inspection sequence shall be followed during the visual inspection:

General visual inspection to detect damages (dents, deformities of surface and changes of geometry, structural components' integrity); visual inspection of the bottom section of the vessel (apparatus) (bottom, cone, steam jacket zone).

Depending on the process media and its corrosiveness, a special focus shall be on presence of:

- total corrosion of the surface (intergranular corrosion with shedding of metal beads), knife-line corrosion and structure-specific corrosion of welds and heat-affected zone, corrosion-induced depressions (notches) in the heat-affected zone;
- pitting damages to the base metal and welded joints;
- cracks and pitting damages to bottoms and cracks in the jacket welding zone. With that, the capillary testing is reasonable;
- pitting zones and separate pitting spots in the phase division zone and upper section of the vessel (apparatus);

- cracks in anchoring of bubblers and other equipment (piping) susceptible to vibration;

- intergranular corrosion of welds of tubes in tube plates of heat exchangers when tube bends inside vessels (apparatuses) are inspected, welded joints and tube edges.

7.3.7. If corrosion-induced damages have been detected, their depth in metal shall be assessed. Where sufficient experience is available it can be assessed without measurement instruments (this related to determining depth and diameter of corrosion-induced pits, knife-line corrosion depth, pipe wall thickness on edges). When assessing depth of even intergranular corrosion one shall be guided by the state of machined and grinded parts and state of the surface typical of rolled items. If such signs are present there are no grounds to consider a corrosion degree significant. If the sheet metal surfaced etched severely or looks loose with beads fallen out and there are no reference signs of initial thickness as mentioned above, the ultrasonic thickness measurements shall be taken in zones with said signs.

7.3.8. In case of periodic technical inspection the following instrumental monitoring techniques shall be used:

- ultrasonic thickness measurement if visual determining of corrosion depth is impossible;

- ultrasonic or capillary flaw detection in heat-affected zones of welds of vessels (apparatuses) operated in process media inducing corrosion cracking (two-phase compounds with organic chlorine phase) as well as angle and T-joints of steam-water jackets if leaks are detected by hydraulic tests;

- random radiography of butt welds and base metal piping operated in severely oxidized process media (eg., nitric acid-based solutions of concentration greater than 5 mol/l and temperature over 70^{o}C; nitric acid-based solutions of any concentrations but with high oxidizing agents; nitric acid-based solutions used for evaporation and rectification at temperature over 70^{o}C);

- random radiography of butt welds of piping operated in highly oxidized media and base metal of piping in possible stagnant zones in case of media inducing pitting corrosion (two-phase compounds with organic chlorine phase).

Inspection locations shall be identified by the designer organization or agreed upon with it.

7.4. Diagnostics using witness-specimens

7.4.1. The diagnostics using witness specimens shall be provided for the conditions that induce pitting corrosion or higher parameters and operational intensity as compared to adopted previously, as well as in vessels (apparatuses) inaccessible for visual inspection.

7.4.2. Specimens shall be made of steel (alloy) grade as used for the vessel (apparatus); it is desirable that they are of the same thickness as milled down to 5 to 6 mm. It is desirable to remove weld enforcement of the welded joint specimens to ensure corrosion effects on the less corrosion-resistant zones of the weld.

7.4.3. In parallel, it is recommended to test also other materials which application is promising for making vessels (apparatuses) to be holding the given process media. The shape and sizes of specimens are not regulated.

7.4.4. Specimen placement locations shall be identified depending on design features of the vessel (apparatus) and corrosiveness of the media in different axial zones.

7.4.5. A corrosion rate shall be assessed by a loss of a part of specimens' mass and measurements of depth of local corrosion-affected spots (pits, knife-line and dendrite corrosion).

7.5. Ways to ensure and enhance equipment operational reliability

7.5.1. To enhance the equipment operational reliability the following techniques to improve corrosion resistance shall be provided for: the use of a corrosion-resistant overlay, selection of heat treatment and welding modes.

7.5.2. Corrosion-resistant overlays

To prevent knife-line and structural corrosion of welds, sheet metal edges, pipes and shaped items the corrosion-resistant overlays of welds shall be envisaged for vessels (apparatuses) operated in highly corrosive media and made of 08H18N10T and 12H18N10T steel grades. The following structural components are recommended to overlay:

butt welds inside vessels (apparatuses);

weld-ins of pipes and hatches to the vessel;

welds of pipe and other parts fixation to the vessel and each other;

boxing welds and tube edges in tube grids (plates) (if there is no a projected part over the tube plate) or in case of a projected part of less than 2 mm;

weld edge cut of annular apparatuses inaccessible for welding from inside;

cuts made to a part of the sheet thickness of whetted bottoms of annular apparatuses;

tube plates of heat exchange chambers (before cutting out holes for tubes or after their boxing);

bottoms of vessels (apparatuses) holding process media inducing pitting corrosion.

Recommended materials for making corrosion-resistant overlays and overlay corrosion testing techniques shall be selected in accordance with RDs applied to NFCF. When making overlays the argon arc overlaying by non-consumable electrode is recommended.

7.5.3. Heat treatment

7.5.3.1. Heat treatment of austenitic stainless steel grades is always reducing strength as compared to their as-supplied state and shall be done only to ensure maximum corrosion resistance or remove stresses as combined with higher resistance to intergranular corrosion.

7.5.3.2. Heat treatment of parts and assembly units of the equipment shall be done for:

a) vessel (apparatus) bottoms manufactured by hot forging or press forming;

b) small-size parts (included welded) after hot forging or press forming (with an excess material retained for specimen-making). If test results are unsatisfactory, additional heat treatment shall be carried out followed by re-test for stability to intergranular corrosion.

7.5.3.3. Section iron items shall be subjected to heat treatment followed by specimen tests for stability to intergranular corrosion.

Fittings (angles, crosspieces, tees), ball-cone-type seals of cut-off valves, whetted parts of extractor mixers made of 12H18N10T steel grades shall be subjected to heat treatment irrespectively of the process medium.

7.5.3.4. Heat treatment modes of parts and assembly units of the equipment indicated in paras 7.5.3.2 and 7.5.3.3 shall be determined as per the process documentation taking account of operating conditions and experience of the specific equipment.

7.5.3.5. Any items which material does not demonstrate resistance to intergranular corrosion, as test results show, shall be subjected to heat treatment until positive results are obtained of corrosion tests using an assigned technique.

7.5.3.6. Heat treatment of the equipment parts and assembly units not indicated in paras 7.5.3.2 and 7.5.3.3 is not normally conducted.

7.5.4. Welding process features

7.5.4.1. Manual argon arc non-consumable electrode welding is the main welding technique which ensures at maximum degree reliability, faultness and durability of the equipment operation. When repairing vessels (apparatuses) it is allowed to use manual argon arc coated electrode welding. To repair vessels (apparatuses) with a structural components thickness of more than 10 mm the manual argon arc welding is permitted; with that, for vessels (apparatuses) operating with media of high corrosiveness the mandatory requirement shall be making layers by the argon-arc technique while the layers being on the corrosive side and to be welded last, or a corrosion-resistant welding.

If it is not possible to weld from the side of the corrosive medium due to design features (small-diameter vessels (apparatuses), annular apparatuses, pipelines), the outer cut of the weld shall be done with the weld root mandatory done by argon arc welding. In case of process media of high corrosiveness the pre-overlaying shall be made on inner surface of edges. When fabricating vessels (apparatuses) to hold these media, the back side of the weld shall be mandatory shielded with an inert gas supply. For piping butt welds it is recommended to use welding on profiled bottom spacing rings.

7.5.4.2. Welding can be done only after acceptance of assembly and preparation work by a checker in accordance with the established procedure and issuing a relevant record on control and acceptance.

7.5.4.3. The arc ignition at the base metal and strike directing to the base metal shall not occur. The weld strikes shall be thoroughly welded.

7.5.4.4. Welding shall be carried out with minimum heat input (maximum possible welding

pace taking account of adequate fusion at a preset welding current and minimum welding current possible). The weld shall be cooled down to 100°C and lower after each pass.

7.5.4.5. In vessels (apparatuses) holding intermediate corrosive media there it is permitted not to make a corrosive-resistant overlay.

7.5.4.6. In case of manual arc welding of vessels (apparatuses) for process media of high corrosiveness measures shall be taken to protect the surface facing the media against melt metal splatter, irrespectively of material grades in use.

7.5.4.7. Machining of defects (before welding or overlaying) induced by corrosion damages shall be done irrespectively of defect depth.

7.4.5.8. Main requirements for welding of steel and alloys susceptible to cracking[4] are given in the relevant technical documentation. Welding equipment applied to welding of such materials shall ensure smooth arc extinguishing to provide for the strike welding.

Before welding of steel and alloys susceptible to cracking the welder shall trial welding modes by using specimens to be subjects to 100% inspection and diagnostics.

7.5.4.9. Reliability of the welded equipment made of titanium and its alloys provided it has been correctly designated for specific process media shall be primarily determined by protectiveness degree of the welding bath and heat-affected zones from air, moisture, dust and other contaminants.

7.5.4.10. Other requirements and measures to improve titanium welded joints reliability include;

a) the use of welding burners with nozzles. Nozzles shall be made individually for each shape of materials to be welded; in case of welding of pipes the nozzle curvature shall fit the pipe diameter;

b) to protect the back side of the weld and adjacent sections the molding groove support rings and set of holes to supply an inert gas shall be arranged for;

c) when welding small items having closed volume, the weld back side shall be protected by filling this volume with an inert gas after pre-welding four- or five-time blowing. The welding gas flow rate shall be selected during the trial welding using specimens. After welding has been completed the blowing shall be terminated when the metal temperature approaches 100°C or less.

7.6. Periodic technical diagnostics and result recording

7.6.1. For the purposes of the technical diagnostics a Technical Diagnostics Commission shall be set up. Its members shall be identified by the operating organization. The commission shall include specialists in corrosion, destructive and non-destructive testing.

7.6.2. The inspection results shall be entered to the Corrosion Status Charts and the Technical Diagnostics Record. The record shall indicate diagnostics results, including visual and instrumental examination; it shall also identify the repair scope, a possibility of repair without disassembling of the equipment and piping along with replacement of the vessel (apparatus), a possibility of further operation without repair. The record shall be attached with records of the instrumental inspection done on the basis of the thickness measurement and non-destructive testing results.

7.6.3. A List of Deficiencies shall be compiled upon the technical diagnostics results.

7.6.4. A repair technology that uses welding and overlaying shall be selected considering para. 7.5.4 and recorded in the process flow-sheet.

7.6.5. In case of small thickness of the backing pass the main reliability indicators shall be absence of surface flaws and hydraulic test results. In this case it is permitted to confirm quality of welding materials in use by chemical analysis or steeloscoping of the metal overlaid on the reference welded joint made with the same welding materials.

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[4] These materials include nickel and nickel-based highly alloyed alloys (46HNM, 38HNM, HN58V, HN70U) as well as alloys 03HN28MDT and 06HN28MDT, niobium-alloyed steel grades and low-carbon steel grades without titanium.

7.6.6. Quality of the repair being done by welding shall be controlled by a person responsible for welding operations and with involvement of specialists in visual and instrumental inspection and, as necessary, specialists in non-destructive inspection. The control results shall be input to the process flow-sheet.

7.6.7. Basing of the certificate, process regulation and corrosion wear (taking account of repairs) data indicated in the Technical Diagnostics Records, the operating organization specialists shall calculate a residual service life of the vessel (apparatus) or pipeline.

7.6.8. Upon results of the diagnostics and repair done a certificate on repair quality and assigned and residual service life shall be compiled; its copy shall be submitted within 5 days to the state regulatory authority for nuclear and radiation safety in the uses of atomic energy.