SAFETY GUIDE

CONDITION MONITORING AND SERVICE LIFE EVALUATION FOR SODA RECOVERY BOILERS OPERATED AT THE ENTERPRISES OF ILIM GROUP JSC

RB-SRK-2018

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Safety Guide *Condition Monitoring and Service Life Evaluation for Soda Recovery Boilers Operated at the Enterprises of Ilim Group JSC* contains explanations of individual industrial safety requirements and recommendations for their use in the manufacture, installation, maintenance, reconstruction (modernization), repair, and industrial safety expertise of steam soda recovery boilers operating under excessive steam pressure up to 10.0 MPa in order to prevent accidents, incidents, and workplace injuries.

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TABLE OF CONTENTS

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I.GENERAL PROVISIONS

1. Safety Guide *Condition Monitoring and Service Life Evaluation for Soda Recovery Boilers Operated at the Enterprises of Ilim Group JSC* (hereinafter, RB-SRK-2018 or the Guide) has been developed to integrate the requirements of:

– Federal rules and regulations in the field of industrial safety *Regulations of Industrial Safety for Hazardous Facilities Using Equipment Working Under Excess Pressure* approved by the Order of the Federal Environmental, Industrial, and Nuclear Supervision Service (Rostechnadzor) dated March 25, 2014 No. 116, registered by the Ministry of Justice of Russia on May 19, 2014, Registration No. 32326;

– Federal rules and regulations in the field of industrial safety *Rules for Audit of Industrial Safety* approved by the Order of Rostechnadzor dated November 14, 2013 No. 538 registered by the Ministry of Justice of Russia on December 26, 2013, Registration No. 30855;

– TR CU 032/2013 Technical Regulation of the Customs Union *On the Safety of Equipment Operating Under Excessive Pressure*;

– SO 153-34.17.469-2003 *Instructions on Extending Safe Operation Life of Steam Boilers with Operating Pressures up to 4.0 MPa Inclusive, and Hot Water Boilers with Water Temperatures Above 115°C*;

– other regulatory documentation (hereinafter, RD) in the field of boiler elements metal control;

– the Orange Book of the International Paper Company;

– production system of the Ilim Group (GMS) of the sub-element Enterprise Safety.

2. The Safety Guide applies to soda recovery steam boilers (hereinafter, the SRB or boiler) operating under excess steam pressure up to 10.0 MPa at the enterprises of Ilim Group JSC.

3. A soda recovery boiler is understood as an industrial power boiler, the main task of which is highly efficient regeneration of chemicals – pulp cooking products, black liquor burning and steam generation. When burning black liquor, highly corrosive gases are generated containing alkali and organic acids, which leads to increased corrosion of heating surfaces and other elements of the boiler.

4. Condition monitoring and service life evaluation for SRB elements are carried out to ensure their reliable operation until the next inspection or replacement.

The result of this work is the confirmation (or nonconfirmation) of the possibility and conditions of further operation of the equipment and the establishment of an additional specified service life therefor (for boilers the estimated (specified) service life of which has expired). If necessary, recommendations can be developed to ensure continued reliable operation of the equipment for a limited period.

5. Condition monitoring and service life evaluation for SRB elements is carried out in compliance with both the regulatory documents in the field of industrial safety in force in the Russian Federation and the requirements of the Orange Book of the International Paper Company.

II.TERMS AND DEFINITIONS

6. The Guide uses terms and definitions specified in the federal rules and regulations in the field of industrial safety *Regulations of Industrial Safety for Hazardous Facilities Using Equipment Working Under Excess Pressure* approved by the Order of the Federal Environmental, Industrial, and Nuclear Supervision Service (Rostechnadzor) dated March 25, 2014 No. 116, registered by the Ministry of Justice of Russia on May 19, 2014, Registration No. 32326.

In addition, for the purposes of this Guide, the terms and their definitions specified in Appendix No. 1 are used.

III.PROVISIONS FOR ORGANIZING THE CONDITION MONITORING AND SERVICE LIFE EVALUATION FOR SRB

7. Organization of the works on condition monitoring and service life evaluation for SRB shall be carried out by the enterprise owning the boiler.

8. Federal rules and regulations depending on the stage of the equipment life cycle, provide for:

a) monitoring during installation, repair, reconstruction, including input, operational, and acceptance control;

b) control in the scope of technical diagnosis within the estimated service life (resource);

c) monitoring upon expiration of the estimated or specified service life during the expert review of industrial safety;

d) extraordinary control.

9. It is recommended to organize the SRB condition monitoring as monitoring of the operating conditions of the boiler and the state of its elements.

10. Monitoring of operating conditions provides for an analysis of the service life of the boiler and its elements, the number of starts, the steam and

technological (by liquor) boiler performance, steam parameters, composition and types of fuel burned, the quality of feed and boiler water, conservation conditions, etc.

11. Condition monitoring is carried out in order to obtain initial data to determine the technical condition and evaluate the service life of the SRB elements.

12. To identify the condition of the SRB elements, the following types of monitoring are used:

a) visual inspection (VI);

b) dimensional inspection (DI);

c) magnetic particle test (MPT) or liquid penetrant test (LPT);

d) ultrasonic testing (UST);

e) ultrasonic wall thickness testing (USTT);

f) radiographic testing (RT);

g) metal ball rolling;

h) hardness measurement by portable devices (HM);

i) replica method (RM);

j) metal clippings study (MCS).

13. All types of monitoring of heating surfaces are performed on the fire side. The exception is:

a) VI and DI of the boiler elements at the input control;

b) elements that are monitored outside the boiler when insulation is removed (elements from which the insulation should be removed for monitoring are specified in Cl. 33 and 34 of this SG and Appendices 3 and 4 to this SG).

14. USTT of the pipes of the combustion chamber is carried out at three points along the pipe sections: left, right and center of the pipe (see diagram No. 1).

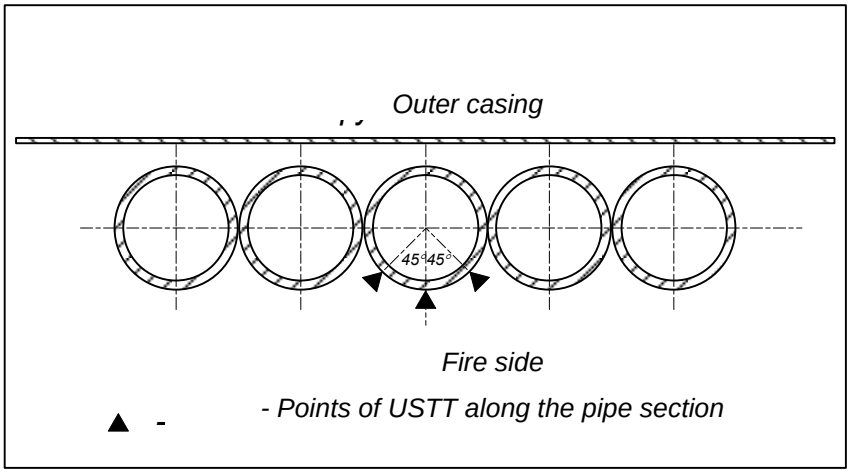

Diagram No. 1

15. When examining metal clippings, it is recommended to determine the size and chemical composition of internal deposits.

16. Visual and measuring inspection, elements metal control using nondestructive and destructive methods, research, calculations, and extension of the safe operation life of SRB are carried out in accordance with the applicable RD for the specified types of works in the prescribed manner.

17. Based on the results of visual, measuring, destructive and nondestructive testing, laboratory studies of metal and calculations of boiler elements in accordance with the RD requirements for certain types of monitoring and research, the organization performing these works shall compile primary documentation in the form of reports, opinions, protocols, forms, tables, diagrams, figures, photographs, etc.

18. Based on the primary documentation for visual and measuring inspection, certain types of destructive and nondestructive testing, the results of laboratory tests, calculations, hydraulic testing with test pressure, the organization performing works on the condition monitoring and extension of the safe operation life of the boiler shall develop a final opinion on its condition,

capabilities, operating parameters and the period for further safe operation with specification of metal control measures for the extended period.

19. The final opinion in the established form on the possibility of extending the safe operation life of the boiler shall be approved by the head of the organization that carried out works on the condition monitoring and service life evaluation and shall be transferred to the owner of the boiler.

20. If unacceptable defects are identified during the monitoring process, the decision on the need for additional control and its scope shall be taken by the organization conducting works on the SRB condition monitoring, together with the operating organization.

In any case of identification of deviations of the element condition from the requirements of the regulatory documentation, the reasons of such deviations shall be established and measures to eliminate such reasons shall be coordinated with the operating organization.

IV.MONITORING OF SRB ELEMENTS IN THE PROCESS OF MANUFACTURE, INSTALLATION, REPAIR, AND RECONSTRUCTION

21. In the process of manufacture, installation, repair, and reconstruction of SRB in accordance with the requirements of RD, a systematic quality control test of welding and welded, expansion and demountable joints shall be carried out – preliminary control (including input control), operational and acceptance control of welded, expansion and demountable joints.

22. New equipment shall be subject to input control, as well as elements used for installation on operating equipment.

23. The input control of the equipment shall be carried out with the aim of:

a) checking the conformity of the product to the requirements of the project, delivery, and regulatory documentation;

b) obtaining the initial data for a comparative assessment of the condition of the elements during subsequent monitoring (determination of check points).

24. The scope and methods of input control of the SRB elements are specified in Appendix No. 2.

It is recommended to include welding materials control in the scope of the input control in the volume of RD requirements.

V.SRB ELEMENTS CONDITION MONITORING WITHIN THE ESTIMATED SERVICE LIFE

25. The work to monitor the condition of the SRB within the estimated service life shall be organized by the organization owning the boiler represented by the person responsible for good condition and safe operation.

26. The main method of the SRB condition monitoring within the service life is the visual inspection of all critical components of the SRB carried out as part of a technical inspection. During the technical inspection, other methods of

nondestructive testing required to determine the technical condition of the SRB shall be determined.

27. Technical inspection of the SRB elements shall be carried out at least once every 12 months.

28. Technical inspection of the SRB elements shall be carried out by a group of specialists which shall include:

a) a specialist responsible for good condition and safe operation of the SRB;

b) a specialist responsible for the implementation of production control at the enterprise;

c) a specialist of an expert organization certified in the prescribed manner (during the technical inspection of the boiler in accordance with the requirements of [1]);

d) a specialist for boiler water treatment.

29. In order to conduct a technical inspection, the examined surfaces of the SRB elements shall be properly washed from deposits and cleaned of impurities, individual parts of the surface shall be cleaned for nondestructive testing.

30. Visual inspection of the SRB critical components as part of the technical inspection shall be carried out to identify and measure the detected defects (surface cracks of all types and directions, corrosion damage, erosion, delamination, dents, bulges, or mechanical damage) formed during operation, at the stage of installation or repair the development of which can lead to the destruction of damaged elements of the boiler.

31. The parent metal, welded and expansion joints on the outer and inner (if access is possible) sides of the SRB elements shall be subject to visual inspection.

Visual inspection results shall be documented.

32. During the VI, special attention shall be paid to the presence of defects in the following areas:

a) routing of wall tubes for smelt spouts, routing of wall tubes for primary, secondary and tertiary blast tuyeres, routing of wall tubes for alkali and fuel nozzles, routing of wall tubes for sootblowers, including places for sealing parts welding;

b) wall tubes at the “normal” (design) level of the melt, as well as in the strip 200 mm above and below the “normal” (design) level of the melt;

c) wall tubes outside the furnace in places of possible water ingress when washing the boiler, under soot blowers, under primary, secondary and tertiary air channels, fuel and alkali nozzles;

d) sections of pipes of the boiler bank at a length of 80 mm from the outer surface of the mud drum;

e) sections of pipes of the curtain walls in the passages of soot blowers;

f) areas around the smelt spouts

33. In order to conduct the VI according to Cl. 33 c), it is necessary to remove the outer insulation on several square sections of 0.4 m^2;

34. When conducting an inspection to examine the condition of the boiler bank pipes, it is recommended to use a fiberscope.

If the sections of the wall tubes of the lower part of the furnace have been replaced, it is necessary to analyze the scale inside; in particular, determine the weight and composition of the scale. Using a fiberscope on the pipe sections available for monitoring along the length above and below the cut, the presence of scale shall be checked.

35. The main steam valve, feed water shutoff valve, and feed water control valve shall be disassembled and inspected every five years. The results of the inspection of the specified shut-off and control valves shall be documented.

36. The feed water pipeline from the control valve to the boiler and from the economizer to the steam drum shall be checked every five years by the USTT method to control the walls thinning due to corrosion.

37. Spray attemperator shall be monitored at least once every five years.

Attemperator control results shall be documented.

38. Revision and adjustment of safety valves shall be carried out within the time periods specified in the documentation of the manufacturer and design documentation, but at least once every three years.

The results of the inspection of safety valves shall be documented.

39. Nondestructive testing of the SRB elements within the estimated service life shall be carried out in accordance with the technical documentation of the manufacturer. In addition to the scope of nondestructive testing of the SRB elements specified in the manufacturer's technical documentation and if the manufacturer's technical documentation does not contain the terms, volumes and methods of operational control within the estimated service life, the periodic nondestructive testing and determination of the technical condition (technical diagnostics) of the SRB elements are required. The frequency, volume, and methods of nondestructive testing are specified in Appendix No. 3.

The results of the testing (technical diagnosis) shall be documented.

40. The nondestructive testing of the SRB elements can be carried out by the operating organization on its own or by involved ones, including expert organizations.

41. An organization conducting nondestructive testing shall be provided with a detailed list of all testing requirements. The application for works shall contain the requirements for certification of operating staff, characteristics of radiographic equipment, methods and volumes of works, regulatory documentation for control, and schematic drawings indicating the areas and sections of control.

42. The results of technical inspections and nondestructive testing of the SRB elements for each boiler shall be analyzed as part of monitoring and compared with the results of previous inspections.

Reports and other documents drawn up based on the results of technical inspections and nondestructive testing shall be stored along with the boiler certificate throughout the entire period of its operation.

VI. CONDITION MONITORING OF SRB ELEMENTS WITH OPERATING PRESSURE UP TO 4.0 MPa ON EXPIRATION OF THE ESTIMATED OR SPECIFIED SERVICE LIFE

43. The work to monitor the condition of the SRB upon the expiration of the estimated or specified service life shall be organized by the organization owning the boiler represented by the person responsible for good condition and safe operation.

44. According to the requirements of Article 7 of the Federal Law No. 116-FZ *On Industrial Safety of Hazardous Production Facilities*, and the federal rules and regulations in the field of industrial safety *Regulations of Industrial Safety for Hazardous Facilities Using Equipment Working under Excess Pressure*, an expert examination of industrial safety shall be carried out upon expiration of the estimated service life of the SRB.

Monitoring of the technical condition, carried out according to the scheme specified in section V RB-SRK-2018, shall be supplemented by the monitoring of the SRB elements carried out during technical diagnostics as part of the expert examination of the industrial safety of the boiler. At the same time, the condition monitoring during the technical inspection of the SRB elements described in section V hereof can be both combined with the technical diagnostics as part of the expert examination of the industrial safety and carried out independently.

The framework program for the SRB elements monitoring upon expiration of the estimated service life during technical diagnostics as part of the expert examination of the industrial safety of the boiler is given in Appendix No. 4.

The monitoring program for a specific boiler shall be developed on the basis of the framework program, taking into account the following:

a) design features of the boiler;

b) information on damage, repair, replacement or reconstruction of the main elements for the entire period of operation;

c) operating conditions;

d) results of the previous SRB elements monitoring.

45. Individual monitoring programs shall be developed by an expert organization based on the requirements of regulatory documentation in force in the Russian Federation and shall be agreed upon by the operating organization.

VI.1. PREPARATION FOR TECHNICAL DIAGNOSTICS

46. The SRB to be diagnosed shall be stopped, cooled, drained and reliably isolated by shut-off valves or plugs from the neighboring SRB, existing pipelines and other supply lines (steam, water, gas ducts, and fuel); insulation that impedes monitoring shall be partially or completely removed; scaffolds shall be constructed.

47. To provide access to the SRB elements for inspection and monitoring, the internal devices in the drums shall be partially or completely dismantled.

48. The outer and inner surfaces of the boiler elements shall be washed from impurities, deposits, and solidified melt; individual parts of the surface shall be cleaned for nondestructive testing. Zones and scope of monitoring shall be determined by the framework program (Appendix No. 4) hereof, and the quality of surface preparation for monitoring shall be determined by the RD for the applied monitoring methods.

49. The organization owning the SRB shall provide the organization carrying out works on the technical diagnosis and extension of service life of the SRB with the following:

a) boiler certificate;

b) repair log;

c) water treatment log;

d) instruction acts of the inspector of the local territorial body of Rostechnadzor;

e) opinions (reports, protocols, acts, etc.) drawn up based on the results of previous monitoring and examinations of the SRB elements;

f) materials containing data on the boiler design, operating conditions, repairs, reconstructions, and elements replacements;

g) information on accidents, incidents, cases of deviations from the normal operating mode throughout the period of the SRB operation, and other information related to the SRB operation (information on the number of starts/stops, loading modes, etc.).

VI.2. TECHNICAL DOCUMENTATION ANALYSIS

50. An analysis of the technical (design, engineering, operational, and repair) documentation shall be carried out to familiarize themselves with the design features, materials, manufacturing technology and operating conditions of the boiler, as well as to identify places and possible causes of defects in the metal of the elements as a result of operation.

51. The technical documentation analysis includes:

a) checking the compliance of the actual operating modes with the design ones in terms of temperature, pressure, number of starts, shutdowns, quality of the liquor burned, and quality of the feed water;

b) analysis of certificate data to identify cases of deviations in the initial mechanical properties of the metal or its chemical composition;

c) analysis of data on damage, repairs, replacements, reconstructions, technical inspections (including without fail on technical inspections carried out as part of section V hereof), cleaning, washing of boiler elements, results of technical inspections, and hydraulic tests;

d) identification of domestic equivalents of foreign steel grades used in the manufacture of the SRB elements;

e) establishment and determination of the SRB operation duration in abnormal conditions; analysis of the circumstances and causes of emergency shutdowns and determination of zones of elements that could be exposed to negative impact; obtaining information on the presence of defects, the intensity of their development, as well as on possible changes in the mechanical characteristics and structure of the metal elements during the operation.

52. The results of the analysis of technical documentation shall be used to adjust the framework monitoring program (Appendix No. 4).

VI.3. VISUAL AND DIMENSIONAL INSPECTION

53. VI and DI shall be carried out to identify and measure the detected defects (surface cracks of all types and directions, corrosion damage, erosion, delamination, dents, bulges, and mechanical damage) formed during operation, at the stage of installation or repair the development of which can lead to the destruction of damaged critical elements of the SRB.

54. The results of VI and DI shall be used to adjust the framework monitoring program (Appendix No. 4) in terms of the application of monitoring methods and their scopes.

55. The parent metal, welded, and expansion joints on the outer and inner sides of the elements shall be subject to VI and DI.

56. When conducting VI, special attention shall be paid to:

a) the presence of defects in the areas specified in Cl. 33 of Section V hereof;

b) the presence of cracks in butt welds along the fusion line, heat affected zones and in the weld metal across (less commonly along) the weld;

c) the presence of cracks and other defects on the edges of tube sheet holes and on the surface around them or inside the downtake and passage pipes, feed water and chemicals supply pipes;

d) the presence of corrosion damage in the following areas:

- on the inner surface of the lower part of the drums and collectors;

- in places of violation of thermal insulation and possible ingress of water on the outer surface of the drums and collectors.

57. If cracks, corrosion-erosion damages or deformed sections are detected in the SRB elements, the defective zones shall also be examined from the opposite side (if access is possible).

58. Defects identified as a result of VI shall be applied to schemes with a detailed description of their shape, linear dimensions, and location.

59. In cases of dents and bulges in the walls of the SRB elements, their maximum lengths in mutually perpendicular directions (L×b) and their maximum depth (h) shall be measured. In this case, the depth of the dent, bulge shall be measured from the generatrix of the undeformed element.

Based on the measurements taken, the relative deflection of the element in percent shall be calculated:

$$\frac{h}{L} \times 100 \qquad (1)$$

$$\frac{h}{b} \times 100 \qquad (2)$$

60. For drums the following actions shall be made:

a) measuring of the maximum (D_{max}) and minimum (D_{min}) internal diameters in the control sections located along the entire length of the drum. According to

the results of measuring of the diameters, the ovality a (in percent) shall be calculated by the formula

$$a = \frac{2(D_{max} - D_{min})}{(D_{max} + D_{min})} \qquad (3)$$

b) control of the straightness of the generatrix by measuring distances from the lower generatrix to a metal string stretched from the annular seams of the welding of the bottoms to the drum shells;

c) control of the straightness of the collectors according to measurements from their outer surface;

d) measurement of local deviations from straightness or normal curvature using templates.

61. The following measurements shall be performed on individual pipes of the heating surfaces specified in the framework monitoring program:

a) of the outer diameter of the pipes;

b) of the deflection of pipes if during VI their warping, sagging and other deviations from their initial location are detected;

g) of the height and wall thickness of the “bells” in expansion joints.

62. On the unheated pipes of the SRB, the largest and smallest outside diameters of the pipes shall be measured at the bends.

Based on the results of measurements of the diameters, the ovality of the pipes in the places of bends shall be determined by the formula (3) of Clause 61 hereof.

63. The results of VI and DI shall be recorded in reports. Identified defects with a detailed description of their shape, linear dimensions, and location shall be applied to the monitoring schemes and/or photographed.

VI.4. MONITORING OF THE OUTER AND INNER SURFACES OF THE SRB ELEMENTS BY METHODS OF DYE PENETRATION AND MAGNETIC PARTICLE INSPECTION

64. The monitoring is carried out in accordance with applicable RD with the aim of identifying and determining the dimensions and configuration of surface and subsurface cracks, as well as defects of corrosion origin.

65. Zones (sections) and monitoring volumes are specified in the framework program (Appendix No. 4) hereof.

66. The monitoring shall be carried out based on the results of inspections of those sections of the surface where crack formation is expected, or in places of samples of corrosion pits, cracks, and other defects, or in places of repair weldings, as well as in test areas of elements specified in the framework program.

67. The results of the LPT (MPT) shall be documented by opinions. Identified defects with a detailed description of their shape, linear dimensions, and location shall be applied to the schemes and/or photographed.

VI.5. ULTRASONIC WALL THICKNESS TESTING

68. USTT shall be carried out in accordance with the requirements of existing RD in order to determine the quantitative characteristics of the thinning of the SRB elements wall during its operation.

69. Based on the results of USTT:

a) the rate of corrosion-erosion wear of the elements wall shall be determined;

b) the deadlines for the replacement of worn elements shall be established;

c) the deadlines for repair or replacement of critical elements (in particular, heating surfaces) shall be established.

70. USTT zones and volumes are specified in the framework program (Appendix No. 4) hereof.

71. The results of measurements of the wall thickness of the elements shall be documented by protocols with tables. The location of the points of measurement of the elements wall thickness with reference to the main dimensions of the boiler elements shall be applied to the monitoring scheme.

VI.6. ULTRASONIC TESTING OF THE PARENT METAL, WELDED JOINTS, AND BENDS

72. Ultrasonic testing shall be carried out in accordance with the requirements of the RD applicable to this method in order to identify internal defects in welded joints, in the parent metal and on bends.

73. UST zones and volumes are specified in the framework program (Appendix No. 4) hereof.

74. The results of the UST shall be documented by opinions. The location of the control points with reference to the main dimensions of the boiler elements is applied to the monitoring scheme.

VI.7. METAL BALL ROLLING

75. The metal ball rolling control is carried out in order to verify the provision of a given nominal bore in the welded joints of the pipes of the heating surfaces of the boilers.

76. Metal ball rolling control shall be carried out according to the technology described in the technical guidelines developed for the installation of a specific type of boiler.

VI.7. DETERMINATION OF MECHANICAL PROPERTIES, CHEMICAL COMPOSITION, AND METAL STRUCTURE

77. Studies of the mechanical properties, chemical composition, and microstructure of the metal are carried out to establish their compliance with the requirements of existing RD and to identify changes that have arisen due to violation of normal working conditions or due to long-term operation.

78. Studies of the mechanical properties, chemical composition, and metal structure shall be carried out by nondestructive testing methods; if necessary, on samples made from metal cuttings of drums and pipes of heating surfaces of the SRB.

79. Studies of the mechanical properties, chemical composition and structure of the parent metal or/and the welded joint on the sample cuttings from boiler elements shall be carried out in case of:

a) unsatisfactory results of measuring of the hardness of the metal with a portable device;

b) detection of abnormal changes in the microstructure of the metal according to metallographic analysis on chips or replicas;

c) the need to establish the causes of metal defects that affect the performance of the element;

d) violation of operating modes due to which changes in the structure and properties of the metal, deformation and destruction of elements, or the appearance of other unacceptable defects are possible.

When examining metal by cuttings from pipes on the heating surfaces of the SRB, it is recommended to determine the size and chemical composition of internal deposits.

80. The chemical composition shall be determined by the methods of analytical or spectral analysis. For this purpose, either chips from the parent metal or the weld shall be sampled with the subsequent determination of the chemical

composition by the method of analytical analysis, or a sample shall be cut out for spectral analysis.

81. Hardness measurements shall be performed using portable devices. For a rough estimate of the temporary resistance or conditional yield strength, formulas shall be used to convert the hardness values into the strength characteristics of the metal.

82. The mechanical properties of the parent metal and welded joints on the cuts shall be determined by samples tension and toughness testing.

83. The study of the microstructure (including assessment of the graphitization degree) of the parent metal, the heat-affected zone and butt welded joints of elements, including superheater headers with an operational temperature of more than 400°C, shall be carried out on replicas or/and chips.

It is recommended to investigate the microstructure at 100- and 500-fold magnification.

84. The results of determining the chemical composition, mechanical properties shall be recorded in protocols and tables; the microstructure shall be photographed accompanied by a description of its condition.

VI.8. BOILER HYDROSTATIC TEST

85. Hydrostatic test is the final operation of the SRB elements metal monitoring carried out in order to verify the density and strength of all the elements working under pressure.

86. A hydrostatic test shall be carried out in case of positive monitoring results and after elimination of the detected defects in accordance with [2] and subject to the following additional conditions:

a) the water temperature shall be at least 20°C;

b) the time of exposure to the test pressure shall be at least 20 minutes;

If necessary, it is allowed to use the value of the test pressure above the minimum value recommended [2]. The value of the established test pressure is justified by the calculation of strength according to [5].

87. The boiler shall be considered to have passed the hydrostatic test if the conditions of Clause 182 [2] are met.

VI.9. MONITORING RESULTS ANALYSIS AND STRENGTH CALCULATION

88. The obtained factual data on the geometric dimensions, shapes, and properties of the metal of the elements shall be compared with the initial ones, and the dimensions of the defects detected shall be compared with the quality assessment standards of Section IX hereof.

89. Should the dimensions of the detected defects deviate from the conditions of the norms of Section IX hereof, the strength calculation shall be performed taking into account the actual dimensions of the wall thickness, metal properties, and the presence of defects in the elements obtained during monitoring.

When calculating the strength of pipes of boiler heating surfaces, it is recommended to:

a) take the pressure of the opening of the safety valve as the design pressure;

b) apply to the calculation results the coefficient $\gamma = 0.95$ that takes into account factors affecting the reliability of the control.

90. If local or general residual deformations that change the shape of the boiler element within unacceptable limits are detected, a verification calculation for strength shall be performed with an assessment of the operability and residual durability of the defective element.

91. For drums, a fatigue strength check calculation shall be performed if the number of pressure change cycles for the entire service life of the boiler exceeds 1,000. The number of boiler starts / stops, hydrostatic tests and transient

pressure cycles shall be taken into account if the amplitude of the pressure fluctuations exceeds 15% of the nominal value.

92. For superheater collectors, bends, and tees made of carbon or/and manganese-silicon steels that have been in operation for 40 years or more with a design temperature of more than 380°C, strength calculation shall be performed in accordance with [5], taking into account the actual dimensions of these elements and operating parameters in order to determine the possibility and duration of their safe operation.

93. For bends of unheated pipes with an outer diameter of 57 mm or more operated at temperatures up to 380°C inclusive, strength calculations shall be performed taking into account the actual measurement data of ovality and wall thickness in the following cases:

a) the measured values of ovality of bends exceed 8%;

b) the service life of the boiler exceeds 30 years and during this period the bends of this standard size were not completely replaced;

c) if during operation of the boiler there was at least one case of destruction of the bends of this standard size.

The calculation shall be carried out in accordance with the existing RD to assess the static strength and durability of bends by the permissible number of starts.

94. In case of intensive corrosion (corrosion-erosion) wear of SRB elements (average wear rate exceeds 0.15 mm/year), strength shall be calculated according to [5] by the minimum actual wall thickness taking into account its subsequent weakening at the end of the planned service life.

VII. EXTRAORDINARY CONDITION MONITORING OF SRB ELEMENTS

95. Extraordinary monitoring of the boiler elements shall be carried out:

a) in case of failure of the SRB due to damage to the element;

b) in case of detection of unacceptable defects during technical inspection (Section 5 hereof) or repair;

c) in case of overtemperature above levels that are maximum permissible by the manufacturer's technical documentation or production operating instruction;

d) after the boiler idle period of more than 12 months;

e) to confirm, if necessary, the possibility of transferring equipment to higher (compared with the currently installed) operating parameters;

f) to confirm, if necessary, the possibility of shifting the recommended period of replacement of equipment items;

g) after an accident or incident which entailed damage to the boiler elements;

h) as prescribed by the Rostechnadzor authorities.

96. Depending on the specific situation, there may be other reasons and purposes for conducting extraordinary monitoring.

97. For extraordinary monitoring, a program of such monitoring shall be developed, taking into account its specific purposes and objectives.

98. The program shall be developed by an expert organization and agreed upon by the operating organization.

VIII.NORMS AND CRITERIA OF QUALITY ASSESSMENT OF SRB ELEMENTS METAL

99. The geometrical dimensions that determine the strength of the SRB elements shall correspond to those calculated according to [5], taking into account operational increments and the minimum allowable wall thickness according to [5].

100. The mechanical properties of the metal of the boilers elements specified in the certificate data shall comply with the requirements of RD for this material.

101. The offset, the mismatch of the edges of the joined sheets must comply with the tolerances established by RD for the product.

102. Single corrosion pits and/or erosion damage up to 15% depth of the nominal wall thickness of the drums and collectors found during VI can be omitted. Corrosion and/or erosion damage to metal of greater depth, as well as chains of pits, clumps of corrosion pits with a depth of more than 1.0 mm and a maximum size on the surface of an element of more than $\sqrt{D_{\text{av}} \times S}$ (where D_{av} is the average diameter of the element; S is the nominal wall thickness) shall be removed with an abrasive tool with smooth rounding of the edges of the samples. Sample locations shall be checked for cracks by LPT or MPT methods.

103. All cracks detected during the inspection shall be removed with an abrasive tool. The completeness of the removal shall be controlled by the LPT and MPT methods.

Samples of cracks and/or other unacceptable defects of metal comprising 35% (or more) of the nominal value of the element wall thickness shall be welded regardless of the results of strength calculation. The welding places shall be checked for cracks by the LPT or MPT methods.

Based on the results of VI of pipes, longitudinal grooves (from the use of an abrasive tool) with a depth of 1 mm on the outer surface of the pipes of the heating surfaces are allowed provided that they do not bring the wall thickness of the pipe to the minimum allowable specified in Clause 116 hereof.

104. If it is impossible to remove samples (they are inaccessible) (see Cl. 101 and 102 hereof) of corrosion-erosion damage and/or metal cracks (for example, in the tube sheet holes of drums, collectors and other elements), defective elements shall be allowed for temporary operation on the basis of strength calculation performed taking into account the presence of the specified damage in the elements.

105. The outer diameter of the pipes of the heating surfaces shall not exceed 3.5% of the nominal diameter for carbon steels and 2.5% for alloy steels.

106. The deviation of the average diameter (not less than two measurements at an angle of 90°) of the drum from the nominal value upward shall not exceed 1%.

107. The ovality of the SRB drums shall not exceed 1.0%.

Ovality is calculated by the formula (3) of Cl. 61 hereof.

The permissible operation of the SRB drums in case of excess of 1.0% ovality shall be determined based on strength calculations taking into account local stresses in the metal.

108. The maximum value of the ovality of pipe bends of unheated pipelines shall not exceed 10%.

109. The maximum value of the ovality of the pipes bends of the heating surfaces shall not exceed 12%.

110. The deviation from the straightness of the generatrix for the drums shall not exceed 0.3% of the entire length of the cylinder course, as well as in any section 5 m long.

111. The deflection of horizontal collectors shall not exceed 50 mm along the entire length of the collector.

112. The exit of pipes of heating surfaces from the plane of the row due to deflection, warping, sagging, and other deviations from their initial location shall not exceed the diameter of the pipe.

For boiler elements consisting of pipes interconnected by welded parts (close-coupled screens, superheater platen and economizer screens, etc.), smooth convexity, concavity or warping with an arrow of not more than 100 mm on an area of at least 1 m^2 are allowed.

113. The following defects of the flared pipe ends are not allowed in expansion joints of pipes with drums:

a) delamination, blisters, cracks at the ends of pipes;

b) ruptures of flared pipe sections;

c) undercuts or overlaps at the transition of the milling belt into a “bell”;

d) dents, scratches on the inner surface of the pipe;

e) noncontinuous adjoining of the pipe to the pipe hole within the milling belt;

f) deviation of the flanging angle in one direction by more than 10°.

The length of the protruding ends of the pipes in the expansion joints shall be at least 3 mm.

The decrease in the wall thickness of the end of the flanged pipe in the expansion joints shall not exceed 50% of the nominal thickness.

114. Single cracks and corrosion pits on the end surface of flared pipes may be removed with an abrasive tool. The use of a repaired pipe is allowed if the distance to the wall of the pipe wall is at least 3 mm. It is allowed not to remove defects up to 1.0 mm deep.

115. The thinning of the wall of hull products made of sheets, as well as pipe elements shall not exceed 15% of their nominal thickness.

116. Thinning of the wall on the outer contour of pipe bends of unheated pipelines and pipes of heating surfaces with a relative bend radius (R/D_{nom}) of more than 3.5 shall not exceed 15%, and with a relative bend radius of 3.5 or less, it shall not exceed 20%. For bends of unheated carbon steel pipes operating at a temperature of more than 380°C, the actual minimum wall thickness on the outer contour of the bend shall meet the requirements [5].

117. For heating surfaces, the defect of the pipes of which can lead to water getting into the SRB furnace (furnace screens, superheater tube guards, boiler bank and evaporating surfaces of the rotary gas duct), the maximum allowable wall thickness of straight pipe sections detected by ultrasonic or other control methods shall be not less than

a) 2.2 mm for pipes with an outer diameter of up to 51 mm (inclusive);

b) 2.6 mm for pipes with an outer diameter of 52–70 mm;

c) 3.0 mm for pipes with an outer diameter of more than 70 mm.

118. The permissible thinning of the wall of straight sections of pipes of other heating surfaces shall be established according to the results of strength calculation according to [5].

119. Local thinning of anchor ties up to 20% of the nominal diameter is allowed.

120. All butt welded joints of the tubes of the furnace screens, the superheater tube guards, the boiler bank, and the evaporating surfaces of the rotary gas duct shall pass radiographic inspection when replacing them.

121. The quality of welded joints must comply with the requirements established by the RD for welding and inspection of welded joints.

122. If, based on the results of ultrasonic testing, defects are detected in the welded joints that exceed the norms established by the applicable RD, the decision on admitting the boiler to further operation shall be taken on the basis of strength calculations.

123. The maximum permissible value of internal deposits on the surface of the furnace screens, superheater tube guards, boiler bank, and evaporating surfaces of the rotary gas duct determined by the cutouts shall not exceed:

a) 300 g/m^2 for SRB with a working vapor pressure of up to 5.0 MPa.

b) 500 g/m^2 for SRB with a working pressure of more than 5.0 MPa.

124. The metal structure according to the results of metallographic examination on clippings, chips, and replicas shall not have anomalous changes in comparison with the requirements to the initial condition.

125. The degree of graphitization of the metal shall not exceed two points according to the applicable RD.

126. The values of the hardness of the metal elements according to measurements by portable devices shall be within the following limits:

a) for carbon and molybdenum steel (domestic steels of type 20, 20K, 22K, 15M, 16M or their imported equivalents) – 120–180 HB;

b) for alloyed steel (domestic steels of the type 16GNM, 16GNMA or their imported equivalents) – 130–200 HB.

In case of unsatisfactory results of measuring the hardness of the metal of the elements with portable devices, metal examinations on cuttings shall be performed.

127. The mechanical properties determined at room temperature on samples obtained from metal cuttings of boiler elements shall meet the following requirements:

a) the strength characteristics of the metal (temporary resistance or conditional yield strength) shall not differ by more than 5% downward from the values regulated by applicable RD;

b) the ratio of the conditional yield strength to the temporary resistance of the metal shall not exceed 0.75 for carbon steels and 0.80 for alloy steels;

c) the relative elongation shall not be less than 16%;

d) the impact resistance on samples with a sharp notch shall be at least 25 J/m^2 for elements with a wall thickness of more than 16 mm and at least 20 J/m^2 for elements with a wall thickness of less than 16 mm.

128. Based on the opinion of an expert organization, the following is allowed:

a) a change in the geometric dimensions that determine the strength of the elements, but not more than 25%;

b) a decrease in the safety factors of individual elements in the design and/or manufacture;

c) the use of elements and repair technologies not included in the list of recommended materials;

d) further (temporary or after repair (replacement) of elements) operation:

- drums and collectors with corrosion-erosion and other defects specified in Clauses 101 and 102 hereof if it is impossible to select them (if there is no access for their selection);

- drums and collectors with ovality and deflection that do not meet the standards of Clauses 106, 109, and 110 hereof;

- bends of unheated pipelines with an ovality of more than 10% and bends of pipes of heating surfaces with an ovality of more than 12%;

- SRB with a working pressure of up to 4.0 MPa and being in operation 40 years or more, as well as SRB that have crashed (with the establishment of conditions and operating parameters).

IX. DETERMINATION OF OPPORTUNITIES, PARAMETERS, CONDITIONS, AND SERVICE LIFE OF SRB

129. The opportunities, parameters, conditions, and the term of further safe operation of the boiler, the designated service life of which has expired, shall be determined based on the results of the industrial safety examination conducted in accordance with the industrial safety RD in force in the Russian Federation.

The expert opinion contains one of the following conclusions on the compliance of the expert review object (SRB) with the industrial safety requirements:

1) the expert review object (SRB) complies with the requirements of industrial safety;

2) the expert review object (SRB) does not fully comply with the requirements of industrial safety and can be applied provided that appropriate changes are made to the documentation or appropriate measures are taken in relation to the boiler (the opinion shall specify the changes after which the documentation will comply with the requirements of industrial safety, or measures after which the SRB will comply with the industrial safety requirements);

3) the expert review object (SRB) does not comply with the requirements of industrial safety.

130. Based on the results of the SRB expert review, the expert review opinion shall additionally contain the estimated and analytical procedures for assessing and forecasting the technical condition of the SRB, including determining the residual life (service life) reflecting in the conclusions of the expert opinion the established period for further safe operation of the expert review object, indicating the conditions for further safe operation.

The extension of the service life depending on the actual state of the SRB elements can be performed repeatedly; with each next extension, a new additionally settled service life of the equipment shall be established.

It is recommended to choose the additionally settled boiler service life as a multiple of the period between regular technical inspections of the boiler (one year, two years, four years, eight years, etc.). Upon the expiration of the additionally settled service life, a regular expert review of the industrial safety of the SRB shall be carried out.

131. The residual life of the boiler element can be calculated according to the formula:

$$T_{rl} = (S_{min} - S_e)/a_{max}\ , \qquad (4)$$

where S_{min} and S_e are respectively the minimum actual and estimated wall thickness determined during the last diagnosis

a_{max} is the maximum rate of corrosion (corrosion-erosion) wear of the element for the period between measurements of the wall thickness of the element of one operation cycle.

132. SRB complies with the requirements of industrial safety and is allowed for further operation on the design parameters:

a) if the elements of the boiler comply with the strength conditions established in [5];

b) when fulfilling the requirements of Section VIII hereof;

c) after repair (reconstruction), during which all deviations from industrial safety requirements were eliminated;

d) after replacing elements that did not satisfy the strength conditions with new ones;

e) in case of positive results of hydrostatic testing of the boiler by test pressure.

133. SRB does not fully comply with the requirements of industrial safety if during the expert review minor deviations from the requirements of industrial safety are detected that do not affect the possibility of further safe operation. In this case, the SRB is allowed for further operation provided that:

a) changes are introduced to the documentation after which the documentation complies with the industrial safety requirements;

b) the measures in respect of the boiler are taken within the time period agreed upon with the expert organization after which the SRB complies with industrial safety requirements

134. If the SRB does not comply with the requirements of industrial safety, the extension of the service life of the SRB is not allowed; it must be decommissioned or reconditioned. This solution can apply both to the entire object as a whole and to its individual elements.

Appendix No. 1

TERMS AND DEFINITIONS

ADDITIONALLY USED FOR THE PURPOSES OF THE GUIDE

Specified service life – the service life of the boiler established in the opinion of the industrial safety expert review.

Expert organization – a specialized organization having a license to conduct industrial safety expert reviews issued by Rostechnadzor.

Monitoring – specially organized, systematic observation of the condition of the SRB elements for the purpose of their assessment, control, and forecast.

Regulatory document – national standards, construction standards and regulations, industry standards, other documents containing specific requirements for ensuring industrial safety of steam boilers and approved in the prescribed manner.

Complete technical inspection (technical inspection) – control of SRB elements carried out within the framework of the requirements established in The Orange Book of The International Paper Company

Appendix No. 2
(recommended)

SCOPE AND METHODS OF INPUT CONTROL OF THE SRB ELEMENTS

Item No.	*Boiler element*	*Control area*	*Control method*	*Control scope*
1.	All boiler elements	Technical documentation	VI	100%
		Inner and outer surface	VI	100%
			DI	To be established based on the results of VI
2.	Drums and collectors	Repair welds, defect samples (and adjacent area 30 mm wide)	MPT (LPT) and UST	100%
3.	Furnace screens, vertical sections	Pipes at the “normal” (design) level of melt	USTT	20%, every fifth pipe
		Tuyere pipes of the 1st blast: - pipes at a distance of 250 mm from the “normal” level of melt	USTT	20%, every fifth pipe
		- pipes at a distance of 500 mm from the “normal” level of melt		Control groups of three pipes for every 30 pipes
		Pipes between tuyeres of the 1st and 2nd blast with intervals of height of 500 mm	USTT	Control groups of three pipes for every 40 pipes
		Pipes between tuyeres of the 2nd and 3rd blast with intervals of height of 600–900 mm	USTT	Control groups of three pipes for every 40 pipes
		Pipes above the 3rd blast at intervals of height of 2,000 mm	USTT	Control groups of three pipes for every 40 pipes
		Pipe routing for smelt spouts	USTT of the lower generatrix	100%
			MPT (LPT) of welding of mechanical gaskets	100%
		Pipe routing for tuyere of the 1st blast	USTT	Five routings of each screen
		Pipes routing for soot blowers	USTT	Three routings of each screen
4.	Furnace screens,	Upper pinch bends	USTT	50%, every even pipe

	aerodynamic pinch	Lower pinch bends	USTT	50%, every uneven pipe
		Pipes of the lower slope of the pinch at a distance of 900 mm from the bend	USTT	50%, every even pipe
Item No.	***Boiler element***	***Control area***	***Control method***	***Control scope***
5.	Furnace hearth	Three pipes adjacent to the side screens: - straight sections with an interval of 2,000 mm - bends	USTT	100%
6.	Furnace ceiling	Two pipes adjacent to the side screens: - straight sections with an interval of 2,000 mm - bends	USTT	100%
7.	Screens of the rotary gas duct	The first structurally free pipes along the way of flue gases at a height of 1,000 mm from the lower mark of the gas inlet to the gas duct	USTT	One control group of three pipes on each screen
8.	Protective beam of superheater, horizontal part of the panel	Upper pipe at a distance of 100 mm from the front and rear screens	USTT	50%, even panels
		Lower pipe: - at a distance of 100 mm from the front and rear screens and with an interval of 2,000 mm in length	USTT	50%, uneven panels
		- bends located in the furnace	USTT and MPT (LPT)	100%
			DI (ovality)	30%
9.	Superheater platens, exhaust stage	Lower bends and pipe section between them	USTT, DI (ovality)	20% of platens
10.	Boiler bank of a double-drum boiler	Lower bends of the first two rows along the way of gases	USTT (of the stretched part)	20%
			DI (ovality)	
		Pipes of the first two rows along the way of gases at a distance of 1,000 mm and 400 mm from the lower drum	USTT	20% at four diametrically opposite points

11.	Boiler bank of a single-drum boiler (panel)	The first pipes of the panels along the way of the gases at a height of 100–500 mm from the lower mark of the gas inlet to the gas duct	USTT	20%

Appendix No. 3

FREQUENCY, VOLUME AND METHODS OF NONDESTRUCTIVE TESTING OF SRB ELEMENTS WITHIN THE ESTIMATED SERVICE LIFE

Item No.	***Boiler element***	***Control area***	***Control method***	***Monitoring frequency***	***Control scope***	***Note***
1.	All boiler elements	Inner and outer surfaces	VI	Annual	100%	
2.	Drums and collectors	Repair welds, defect samples (and adjacent area 30 mm wide)	MPT (LPT) and UST	Annual	100% available for monitoring	In the presence of repair welding, defect samples
		The ends of the pipes of the expansion joints (“bells”) in the lower drum	DI (height, wall thickness)	Once every four years	Every tenth circular row of pipes	
3.	Hearth pipes	Outer surface of pipes	VI	Annual	100%	Integrity of the fire-resistant insulation is checked.
			USTT	Once every five years	100% of the pipes with an interval between the measurement belts 2,000 mm	For inspection, the fire-resistance insulation shall be completely removed
4.	Furnace screens, vertical sections	Pipes at the level of melt	VI, USTT	Annual	100%	
		Pipes from the melt level to the tuyeres of the 1st blast	VI, USTT	Annual	100% of the pipes with an interval between the measurement belts in height 250 mm	
		Pipes between the tuyeres of the 1st and 2nd blast	VI, USTT	Annual		
		Pipes between the tuyeres of the 2nd and 3rd blasts	VI, USTT	Annual	100% of the pipes with an interval between the measurement belts in height 500 mm	

Item No.	*Boiler element*	*Control area*	*Control method*	*Monitoring frequency*	*Control scope*	*Note*
		Pipes above tuyeres of the 3rd blast	VI, USTT	Annual	Every sixth pipe with an interval between the measurement belts in height 2,000 mm	
		Pipe routing for smelt spouts	VI, USTT of the lower generatrix	Annual	100% of spouts	
			MPT (LPT) of welding of mechanical gaskets	Annual	100% of spouts	Is carried out on routings where there is no mounted spout
		Pipe routing for tuyere of the 1st, 2nd and 3rd blast	VI, USTT	Annual	100% of routing at three levels at the height of routing	It is carried out during USTT of vertical sections of screens
		Pipes routing for manholes, peepholes, and alkaline and fuel oil nozzles	VI, USTT	Annual	100% of routing at three levels at the height of routing	
		Pipes routing for soot blowers	VI, USTT	Annual	100% of routings at the same level (in the center of routing)	
		Pipes of screens outside the furnace	VI	Once every four years	Pipes of screens on the insulation side in places of possible water ingress when washing the boiler, under sootblowers, under the tuyeres of the 1st, 2nd and 3rd blast, fuel oil and alkali nozzles	To conduct VI, it is necessary to remove the outer insulation on square sections of 0.4 m^2. The monitoring areas shall be determined by the operating organization.

Item No.	***Boiler element***	***Control area***	***Control method***	***Monitoring frequency***	***Control scope***	***Note***
		Pipes of furnace screens	RT (for detecting corrosion fatigue)	Once every three years (for close-coupled screens). Once every five years (for non-close-coupled screens)	According to the requirements of Section 1.10.8S of Chapter 1.10S of the Orange Book of the International Paper Company	On boilers: - in the course of previous inspections of which signs of corrosion fatigue were revealed; - in which leaks of pipes of heating surfaces through welded joints were detected; - having failures in relation to boiler water quality Pipe corrosion fatigue testing shall be carried out at each technical inspection in accordance with Clause 29 hereof.
5.	Furnace screens, aerodynamic pinch	Pipes forming an aerodynamic pinch along the front of the arc	VI, USTT	Once every three years	100% of the pipes with an interval between the measurement belts in height 1,000 mm	The upper pinch bend shall be taken as the starting point
6.	Ceiling screen	Pipes of the ceiling screen	VI, USTT	Once every two years	100% of the pipes with an interval between the measurement belts in the furnace depth 2,000 mm	The inner radius of the bend of the front screen shall be taken as the starting point, then the measurements shall be made up to the rear screen or superheater (depending on which is located closer)

Item No.	*Boiler element*	*Control area*	*Control method*	*Monitoring frequency*	*Control scope*	*Note*
7.	Screens of the rotary gas duct	The first structurally free pipes along the way of flue gases at a height of 1,000 mm from the lower mark of the gas inlet to the gas duct	VI, USTT	Once every two years	100% of structurally free pipes	
8.	Protective beam of the superheater, horizontal (inclined) part of the panel.	Upper pipe of the panel	VI, USTT	Once every three years	100% of pipes at a distance of 100 mm from the front and rear screens	
		Upper pipe of the panel			100% of pipes at a distance of 100 mm from the front and rear screens and with an interval in length 500 mm	
		Bends located in the furnace			100% of bends of the outer pipes along the front of the arc (on the fire side)	Measurements shall be made at three points of the bend: in the most stretched part and 100 mm above and below the first point
9.	Protective beam of the superheater, pipes in a rotary gas duct (outside the furnace)	The first pipes along the way of the gases at a height of 100–500 mm from the lower mark of the gas inlet to the gas duct	VI, USTT	Once every three years	20% of pipes	

Item No.	***Boiler element***	***Control area***	***Control method***	***Monitoring frequency***	***Control scope***	***Note***
10.	Boiler bank of a double-drum boiler	Lower bends of the first two rows along the way of gases	USTT DI (ovality)	Once every two years	100% of lower bends of the first rows along the way of gases	Measurements shall be made at three points of the bend: in the most stretched part and 100 mm above and below the first point
		Vertical sections of pipes	VI, USTT	Once every four years	100% of pipes of the first two rows along the way of gases at a distance of 1,000 mm and 400 mm from the lower drum	
		Pipe sections along the sootblower passage axis	VI, USTT	Once every two years	100% of pipes in rows in contact with the passage of the sootblower	In case of wear detection, the section shall be carefully checked
		Boiler bank pipes in the lower drum area	VI, USTT	Once every two years	Every tenth circular row of pipes by continuous scanning in the area at a distance of 19 to 57 mm from the outer surface of the lower drum	It is necessary to scan the pipes around the entire circumference and record the minimum thickness in each quadrant. The decision on the possibility of further operation of the pipes shall be made by the organization conducting the survey

Item No.	*Boiler element*	*Control area*	*Control method*	*Monitoring frequency*	*Control scope*	*Note*
11.	Boiler bank of a single-drum boiler (panel)	The first pipes of the panels along the way of gases	VI, USTT	Once every two years	100% of pipes of the panels at a height of 100–500 mm from the lower mark of the gas inlet to the gas duct	
		Outer pipes of panels	VI, USTT	Once every two years	100% of panel pipes at a distance of 50–200 mm from the lower panel collector	
		Pipe sections along the sootblower passage axis	VI, USTT	Once every two years	100% of pipes in rows in contact with the passage of the sootblower	In case of wear detection, the section shall be carefully checked
12.	Superheater platens	Lower bends and straight sections of pipes adjacent to them	VI, USTT DI (ovality)	Once every two years	100% of the outer bends of the pipe coil of the platen of each step on the fire side	The measures shall be made at three points: in the maximum stretched part of the bend and 100–1,000 mm above and below the first point (depending on the design features of the SRB)
		Pipe sections along the sootblower passage axis	VI, USTT	Once every two years	100% of pipes in pipe coils in contact with the passage of the sootblower	

Item No.	*Boiler element*	*Control area*	*Control method*	*Monitoring frequency*	*Control scope*	*Note*
13.	Pipes of platen (vertical) economizer	Platen pipes on the side of incoming gases at a distance of 50–200 mm from the lower platen collector	VI, USTT	Once every three years	100% of the pipes at a distance of 50–200 mm from the lower platen collector	
		Pipe sections along the sootblower passage axis	VI, USTT	Once every three years	100% of pipes of platen pipes in contact with the passage of the sootblower	
14.	Pipes of a coil (horizontal) economizer.	Pipes of the upper row of each package and lower pipes of the inlet package	VI, USTT	Once every three years	100% of the pipes in the center of each package	
15.	Feedwater pipeline	Feedwater pipeline in the area behind the control valve	VI, USTT	Once every five years	USTT shall be carried out according to the methodology and in the scope specified in the circular Ts-02-89 (T)	
		Feedwater pipeline in the section from the economizer to the steam drum	VI, USTT	Once every five years	USTT shall be carried out in at least five cross-sections along the length of the area	
16.	Boiler structure	Hangers for heating surfaces	DI (outer diameter, checking of the nuts tightening)	Once every four years	Two hangers of each element	

Appendix No. 4

FRAMEWORK PROGRAM OF THE CONDITION MONITORING OF SRB ELEMENTS WITH OPERATING PRESSURE UP TO 4.0 MPa ON EXPIRATION OF THE ESTIMATED OR SPECIFIED SERVICE LIFE

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope[2]***	***Notes***
1. 1.1	Drums[3] Course	Thermal insulation	VI	100%	Check of the integrity of thermal insulation, detection of signs of steaming and leakage
		The outer surface structurally not covered by insulation, sections with removed insulation	VI	100% in accessible places	The insulation shall be removed in places where steaming, leakage were detected, as well as in the areas of installation of safety valves
		Inner surface	VI	100%	Pay particular attention to the "steam-water" section and the surface of the lower generatrix
			MPT (LPT)	One section of 200×200 mm in water volume on each course	
			USTT, HM	At least four sections on each course	1. In each section, measurements shall be performed: - in the upper drum – on the lower generatrix and in the "steam-water" section; - in the lower drum – on the lower and upper generatrix. 2. Measurements shall be performed at a distance of at least 50 mm from the welds

Item No.	*Boiler element*	*Control area*	*Monitoring method*	*Control scope[2]*	*Notes*
		Pipe holes in the water volume and the areas around them with a width of 30 mm	VI	100%	
			MPT (LPT)	10%	Holes for MPT (LPT) monitoring shall be selected based on the results of VI, but so that the control group includes holes of pipes of all purposes; the feed water inlet openings in the absence of a thermal jacket are subject to mandatory monitoring
		Pipe holes in the steam volume and the areas around them with a width of 30 mm	VI	100%	
			MPT (LPT)	5%	Holes for MPT (LPT) monitoring shall be selected based on the results of VI, but so that the control group includes holes of pipes of all purposes; the feed water inlet openings in the absence of a thermal jacket are subject to mandatory monitoring
		Linkages between pipe holes in the water volume	VI	100%	
			MPT (LPT)	5% boiler bank 10% – other purposes	
		Over the entire length of the drum	DI (ovality, straightness)	Every 1,000 mm along the length of the drum	

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope[2]***	***Notes***
1.2	Boiler heads	Inner surface	VI	100%	The VI applies to the edges of the manhole opening, the surface of the bores and the sealing surface of the shutter.
			MPT (LPT)	The monitoring section of 200×200 mm on each boiler head	1. The monitoring section – in the transition area from the cylindrical part to the elliptical part in the water volume 2. Each subsequent monitoring shall be carried out in areas not previously inspected
				100% of feedwater inlet openings	Monitoring shall be carried out for openings without a thermal jacket
			USTT, HM	Three measurements on each boiler head	Monitoring sections – along the lower generatrix from the cylindrical part to the manhole opening
1.3	Weld joints	Main longitudinal and transverse welds with a heat-affected zone	VI	100%	
			UST	30% of the total length, including all interlocks of joints for a length of at least 200 mm to each side from the lock	
		Seams of welding of internal drum devices fastening	VI	100%	
			MPT (LPT)	5% of the seams length	

Item No.	*Boiler element*	*Control area*	*Monitoring method*	*Control scope[2]*	*Notes*
		Corner welds of pipes (fittings) welding in water and steam volume	VI	100%	
			MPT (LPT)	10% of welds, but at least 2 pcs, of each pipe group	1. MPT (LPT) shall be carried out on the seams worst based on the results of VI 2. If unacceptable defects are detected, 100% MPT (LPT) inspection of the welds of the pipes of the same purpose shall be carried out.
		Weld seams of fastening of a manhole cover	VI	100%	
1.4	Expansion joints	Edge and surface of pipes, incl. those in the drum	VI	100%	
		Protruding ends of the pipes (bells)	DI (height, wall thickness, and diameter)	10%	Shall be carried out on the most worn pipes selected based on the results of VI
		Welding seams of expansion joints and zones around them with a width of 30 mm	VI	100%	Monitoring shall be carried out if during the repair work the seal welding of pipes of the boiler bank in the drum was performed
			MPT (LPT)	5%	
1.5	Repair welds, defects samples	Weld metal or sample and adjacent area with a width of 30 mm	VI, MPT (LPT), or UST	100%	Selection of the monitoring method shall be determined depending on the nature of the welding or sampling

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope[2]***	***Notes***
2. 2.1	Collectors Collectors of heating surfaces	The outer surface in places where water may get on the insulation	VI	100%	
		The outer surface in the places of angular and butt welds and in the linkages between the holes.	VI	One collector for each purpose	1. If there is a suspicion of defects during VI, MPT (LPT) of these sections shall be carried out and all collectors of this purpose shall be inspected 2. If a deflection is suspected, its measurement on the outer surface shall be carried out
		The inner surface along the lower generatrix and in the linkages between the holes.	VI	One of the lower collector screens	
		Outer surface	USTT, HM	In three sections on one collector of each purpose	1. Shall be carried out on collectors that have passed VI 2. Three measurements shall be taken in each cross-section
		Welded joints of bottoms with a collector, butt joints of a collector	UST	One welded joint of each purpose on one collector of each purpose	Shall be carried out on collectors that have passed VI
		Corner welds of the fittings of input of the medium	MPT (LPT)	One welded joint of each purpose on one collector of each purpose	Shall be carried out on collectors that have passed VI

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope[2]***	***Notes***
2.2	Superheater collectors with a working temperature of more than 400°C	Linkages between holes, including corner welds on the outer side	MPT (LPT)	10% of linkages	The specified monitoring shall be additional to the monitoring according to Clause 2.1
		Heat-affected zone for butt welds	RM	One welded joint of the output collector	
2.3	Spray attemperator – housing	The outer surface in the area of the nozzle of the water supply device at a length of 400 mm from the nozzle wall	VI, UST	The outer surface in the area of the nozzle of the water supply device at a length of 400 mm from the nozzle wall	
		Welded joints of the housing with the pipeline	USTT	One welded joint	Subsequent monitoring shall be carried out on another welded joint
2.4	Surface attemperator	Housing (outer or inner surface), welded, flanged, and expansion joints	VI	100%	If a deflection is suspected, its measurement shall be carried out
			USTT, HM	In three sections along the length of the housing	Three measurements shall be taken in each cross-section
2.5	Capacitor	Main longitudinal and transverse welds with a heat-affected zone	UST	30% of the total length, including all interlocks of joints for a length of 200 mm to each side from the lock	The specified monitoring shall be additional to the monitoring according to Clause 2.4
		Corner welds of pipes (fittings) welding	MPT	Two welds	

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope[2]***	***Notes***
3.	Pipes for heating surfaces				For technical diagnostics, the monitoring results obtained during the last full technical inspection (but not earlier than 182 days before the time of the technical diagnosis) can be used, as well as the data obtained directly as part of the implementation of this framework control program
3.1	Pipes of screens on the furnace side	Throughout the entire height, including the hearth and ceiling pipes	VI	100%	Reveal pipes (and their sections) with increased wear and scale formation. Pay special attention to the areas at the welds of welding parts and gaskets of pipes routing for smelt spouts, blast tuyeres, alkali and fuel oil nozzles, hatches, peepholes, and sootblowers
3.2	Hearth pipes[4]	Outer surface of pipes	VI USTT	25% of the pipes with an interval between the measurement belts 2,000 mm	USTT shall be carried out in groups of three pipes uniformly across the width of the hearth. It is obligatory to monitor three pipes adjacent to the side screens
		Welds connecting the hearth with the screens and the transverse seal of the hearth	VI	At least 30% of the length of the welds	
			MPT (UST)		Monitoring shall be carried out based on the results of VI in case of suspected cracks

Item No.	*Boiler element*	*Control area*	*Monitoring method*	*Control scope[2]*	*Notes*
3.3	Furnace screens, vertical sections	Pipes at the level of melt	VI, USTT	100%	
		Pipes from the melt level to the tuyeres of the 1st blast	VI, USTT	100% of the pipes with an interval between the measurement belts in height 250 mm	
		Pipes between the tuyeres of the 1st and 2nd blast	VI, USTT	50% of the pipes with an interval between the measurement belts in height 250 mm	
		Pipes between the tuyeres of the 2nd and 3rd blasts	VI, USTT	25% of the pipes with an interval between the measurement belts in height 500 mm	
		Pipes above tuyeres of the 3rd blast	VI, USTT	Every sixth pipe with an interval between the measurement belts in height 2,000 mm	
		Pipe routing for smelt spouts	VI, USTT of the lower generatrix	100% of spouts	
			MPT (LPT) of welding of mechanical gaskets	100% of spouts	Is carried out on routings where there is no mounted spout
		Pipe routing for tuyere	VI, USTT	100% of routing at three	It is carried out during USTT of vertical

		of the 1st, 2nd and 3rd blast		levels at the height of routing	sections of screens
Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope***[2]	***Notes***
		Pipes routing for manholes, peepholes, and alkaline and fuel oil nozzles	VI, USTT	Two routing of each purpose of each screen at three levels in height of the routing	It is carried out during USTT of vertical sections of screens
		Pipes routing for soot blowers	VI, USTT	50% of routings at the same level (in the center)	
		Pipes of screens outside the furnace	VI, USTT	Pipes of screens on the insulation side, under sootblowers, under the tuyeres of the 1st, 2nd and 3rd blast, fuel oil and alkali nozzles	To conduct VI, it is necessary to remove the outer insulation on square sections of 0.4 m^2. The monitoring areas shall be determined by the operating organization.
3.4	Furnace screens, aerodynamic pinch	Pipes forming an aerodynamic pinch along the front of the arc	VI, USTT	20% of the pipes with an interval between the measurement belts in height 1,000 mm	The upper pinch bend shall be taken as the starting point
3.5	Ceiling screen	Pipes of the ceiling screen	VI, USTT	20% of the pipes with an interval between the measurement belts in the furnace depth 2,000 mm	The inner radius of the bend of the front screen shall be taken as the starting point
3.6	Screens of the rotary gas duct	The first structurally free pipes along the way of flue gases at a height of 1,000 mm from the lower mark of the gas inlet to the gas duct	VI, USTT	20% of pipes at a height of 1,000 mm from the lower mark of the gas inlet to the gas duct	

Item No.	*Boiler element*	*Control area*	*Monitoring method*	*Control scope*[2]	*Notes*
3.7	Protective beam of the superheater, horizontal (inclined) part of the panel.	Upper pipe of the panel	VI, USTT	25% of pipes at a distance of 100 mm from the front and rear screens	
		Upper pipe of the panel		50% of pipes at a distance of 100 mm from the front and rear screens and with an interval in length 500 mm	
		Bends located in the furnace		50% of bends of the outer pipes along the front of the arc (on the fire side)	Measurements shall be made at three points of the bend: in the most stretched part and 100 mm above and below the first point
		Control clippings from the most worn out pipes	MCS (deposits)	By one clipping from two panels	According to the decision of the organization conducting technical diagnostics
3.8	Protective beam of the superheater, pipes in a rotary gas duct (outside the furnace)	The first pipes along the way of the gases at a height of 100–500 mm from the lower mark of the gas inlet to the gas duct	VI, USTT	25% of pipes at a height of 100–500 mm from the lower mark of the gas inlet to the gas duct	
3.9	Boiler bank of a double-drum	Lower bends of the first two rows along the way of gases	USTT DI (ovality)	25% of lower bends of the first rows along the way of gases	Measurements shall be made at three points of the bend: in the most stretched part and 100 mm above and below the first

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope***[2]	***Notes***
	boiler				point
		Vertical sections of pipes	VI, USTT	25% of pipes of the first two rows along the way of gases at a distance of 1,000 and 400 mm from the lower drum	
		Pipe sections along the sootblower passage axis	VI, USTT	100% of pipes in accessible places in rows in contact with the passage of the sootblower	In case of wear detection, the section shall be carefully checked
		Boiler bank pipes in the lower drum area	VI, USTT	Two central longitudinal rows in accessible places in the zone at a distance of 15 to 60 mm from the outer surface of the lower drum	Pipes shall be scanned around the entire circumference and the minimum thickness shall be recorded. The decision on the need for monitoring shall be made by the organization conducting the technical diagnostics
3.10	Boiler bank of a single-drum boiler (panel)	The first pipes of the panels along the way of gases	VI, USTT	25% of pipes of the panels at a height of 100–500 mm from the lower mark of the gas inlet to the gas duct	
		Outer pipes of panels	VI, USTT	25% of panel pipes at a distance of 50–200 mm from the lower panel collector	
		Pipe sections along the sootblower passage axis	VI, USTT	100% of pipes in accessible places in rows in contact with the passage of the sootblower	

Item No.	*Boiler element*	*Control area*	*Monitoring method*	*Control scope*[2]	*Notes*
3.11	Superheater platens	Over the entire height and in the "hot well"	VI	100%	Reveal pipes with increased wear protruded from the row plane, check the integrity of the stiffness rings ("collets")
		The lower bends and adjacent straight sections of pipes 1 m long (including pipes of primary loops of the exhaust stage)	USTT DI (ovality)	50% of the outer bends of the pipe coil of the platen of each step on the fire side	The measures shall be made at three points: in the maximum stretched part of the bend and 100–1,000 mm above and below the first point (depending on the design features of the SRB)
		Pipe sections along the sootblower passage axis	VI, USTT	100% of pipes in accessible places in coils in contact with the passage of the sootblower	
		Straight pipe sections between horizontal stiffening rings on the screens of the exhaust stage	DI (diameter)	20%	1. The monitoring shall be carried out in the platens on which the USTT was carried out 2. If pipes with a diameter of 2.5% more than nominal are detected, DI of 100% of the accessible pipes shall be carried out
		Welded joints for fastening pipes to screens (horizontal stiffening rings)	VI	100%	
		Monitoring clippings from the exhaust (hot) stage	MCS	The clipping section and the number of clippings shall be determined based on the results of VI, USTT, and DI	According to the decision of the organization conducting technical diagnostics

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope***[2]	***Notes***
3.12	Pipes of platen (vertical) economizer	Outer surface	VI	100% in accessible places	Pay special attention to pipe sections at the lower collectors, in the passages of sootblowers and welding of pipe fasteners.
		The lower bends of all platens and the adjacent inclined sections	USTT	30% of platens	
		Sections in the passages of sootblowers	USTT	100% of pipes in accessible places on the platens pipes in contact with the passage of the sootblower	
3.13	Pipes of a coil (horizontal) economizer.	Outer surface	VI	100% in accessible places	Pay special attention to pipe sections in the area of sootblowers, to the welded fins.
		Pipes of the upper row of each package and lower pipes of the inlet package	USTT	10 pipes of each package at the center of the package	Pipes to be monitored shall be selected based on the results of VI

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope***[2]	***Notes***
4. 4.1.	Pipelines Unheated pipelines (including feed pipeline) within the boiler (with an outer diameter of more than 57 mm)	Thermal insulation	VI	100%	Check of the integrity of insulation, detection of signs of steaming and leakage In places where steaming, leakage is detected, the insulation shall be removed and VI of the outer surface of the pipeline shall be carried out.
		Welded joints – butt and corner	VI, UST, and MPT (LPT)	10% of welds, but at least two pieces, pipelines of each purpose and standard size	When identifying unacceptable defects at least in one connection on the pipeline for this purpose, all joints of the same standard size shall be monitored
4.2	Bends of unheated pipelines within the boiler	Outer surface	VI, USTT, UST, MPT (LPT), and DI (ovality)	Three bends of each purpose and standard size	In case of defection of defects: cracks, ovality, wall thinning, all bends of the same purpose and standard size shall be monitored
4.3.	The section of the feed pipeline behind the control valve	Outer surface	VI and USTT	USTT shall be carried out according to the methodology and in the scope specified in the circular Ts-02-89 (T)	
5.	Fittings and cast parts operating under pressure. Valves housing, cast parts DN 100 mm or more	Outer surface	VI	100%	
5.1		Radius transitions of the outer surface	MPT (LPT)	25%	When defects are detected, all housings (parts) shall be monitored

Item No.	***Boiler element***	***Control area***	***Monitoring method***	***Control scope***[2]	***Notes***
5.2	Studs M36 and more	Threaded surface	VI, MPT (LPT), and UST	100%	If it is impossible to unscrew, a report shall be drawn up
		End surface	HM	100%	
6	Boiler structure	Columns, metal structures of the ceiling, main beams, crossbars, ties, stiffening rings, attachment points, and actually suspension elements of the boiler	VI	100%	
			USTT and DI	According to Individual program, as per RD 10-210-98	

Notes

1. The scope of monitoring specified in the framework program shall be performed at the first technical diagnosis upon the expiration of the estimated service life of the SRB. In subsequent technical diagnoses, the monitoring scope may be adjusted taking into account the results of the earlier monitoring.
2. If defects are detected, an additional scope of monitoring shall be established by decision of the organization performing the monitoring.
3. Monitoring of the drum shall be carried out with the removed intra-drum devices.
4. To monitor the hearth pipes on the furnace side, the ramming shall be removed

Appendix No. 5

REGULATORY DOCUMENTATION USED IN THE DRAWING UP OF THIS GUIDE

1. Federal Law No. 116-FZ dated July 21, 1997 *On Industrial Safety of Hazardous Production Facilities*
2. Federal rules and regulations in the field of industrial safety *Regulations of Industrial Safety for Hazardous Facilities Using Equipment Working Under Excess Pressure* approved by the order of the Federal Environmental, Industrial and Nuclear Supervision Service (Rostechnadzor) dated March 25, 2014 No. 116, registered by the Ministry of Justice of Russia on May 19, 2014, Registration No. 32326;
3. Federal rules and regulations in the field of industrial safety *Rules for Audit of Industrial Safety* approved by the order of Rostechnadzor dated November 14, 2013 No. 538, registered by the Ministry of Justice of Russia on December 26, 2013, registration No. 30855.
4. SO 153-34.17.469-2003 *Instructions on Extending Safe Operation Life of Steam Boilers with Operating Pressures up to 4.0 MPa Inclusive, and Hot Water Boilers with Water Temperatures Above 115°C*;
5. RD 10-249-98 *Codes for Calculating the Strength of Stationary Boilers and Pipelines of Steam and Hot Water* approved by the Resolution of Gosgortechnadzor of Russia No. 50 dated August 25, 1998.
6. The Orange Book of the International Paper Company.
7. RD 10-210-98 *Guidelines for the Technical Examination of the Metal Structures of Steam and Hot Water Boilers (with an amendment No. 1 RDI 10-363(210)-00)*

6. RD 24.032.01-91. *Quality Standards for Feed Water and Steam, Organization of the Water-chemical Regime and Chemical Control of Stationary Steam Recovery Boilers and Industrial Power Boilers.*

7. RD 34.17.452-98 *Methodological Instructions on the Procedure for the Works when Assessing the Residual Life of Superheaters of Boilers in Power Plants.*

8. OST 34-70-690-96 *Metal of Steam-Power Equipment of Power Plants. Methods of Metallographic Analysis in Operating Conditions.*

9. Circular Ts-02-89 (T)

10. SO 153-34.17.442-2003 *Instruction on the Procedure for Extending the Service Life of Drums of High-Pressure Boilers.*

11. SO 153.34.17.421-2003. *Typical Instructions for the Monitoring of Metal and the Extension of the Life of the Basic Elements of Boilers, Turbines, and Pipelines of Thermal Power Plants (RD 10-577-03).*

Note. State standards are not included in the list of regulatory documentation.