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Shell Boilers -- Part 1: General Requirements

锅壳锅炉　第 1 部分：总则

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Standardization Administration Committee.

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Shell Boilers -- Part 1: General Requirements

1 Scope

1.1 This Part of GB/T 16508 specifies the general technical requirements for the material, design, fabrication, inspection, safety accessories, combustion system, installation, operation, energy-saving and environment protection of stationary shell boilers.

1.2 This Part is applicable to the stationary pressure shell boilers with water as medium, evaporating heating surface mainly arranged on shell OR boiler furnace arranged in shell which meet the following conditions:

a) Steam boiler of which the water volume at the design normal water level is greater than or equal to 30L, and the rated steam pressure is greater than or equal to 0.1MPa (gauge pressure; the same below);

b) Hot-water boiler of which the rated outflow pressure is greater than or equal to 0.1Mpa, or the rated power is greater than or equal to 0.1MW.

1.3 This Part is not applicable to the following equipment:

a) Portable boiler (e.g. marine boiler, railway locomotive traction boiler);

b) Cooling devices required for equipment and process flow cooling;

c) Boiler for military use.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the normative document (including any amendments) applies.

GB/T 1576 Water Quality for Industrial Boilers

GB/T 1921 Parameters for Industrial Steam Boilers

GB/T 3166 Parameters for Hot Water Boilers

GB/T 2900.48	Electrotechnical Terminology of Boilers
GB 8978	Integrated Wastewater Discharge Standard
GB/T 10180	Thermal Performance Test Code for Industrial Boilers
GB/T 10863	Thermal Test Method for Gas Pass Heat Recovery Boiler
GB/T 12145	Quality Criterion of Water and Steam for Generating Unit and Steam Power Equipment
GB 12348	Standard of Noise at Boundary of Industrial Enterprises
GB 13271	Emission Standard of Air Pollutants for Boiler
GB/T 16507	Water-tube Boilers
GB/T 16508.2	Shell Boilers - Part 2: Material
GB/T 16508.3	Shell Boilers - Part 3: Design and Strength Calculation
GB/T 16508.4	Shell Boilers - Part 4: Fabrication, Inspection and Acceptance
GB/T 16508.5	Shell Boilers - Part 5: Safety Appurtenances and Instruments
GB/T 16508.6	Shell Boilers - Part 6: Combustion Systems
GB/T 16508.7	Shell Boilers - Part 7: Installation
GB/T 16508.8	Shell Boilers - Part 8: Operation
GB/T 22395	Specification for Design of Boiler Steel Structures
GB 24747	Safety Technology Conditions for Heat Transfer Fluids
JB/T 6734	Strength Calculation Method for Boiler Fillet Weld
JB/T 6735	Calculation Method for Strength of Boiler Hanger Rod
NB/T 47013	Nondestructive Testing of Pressure Equipment
(JB/T 4730)	

3.5

Safety release pressure

The pressure of safety valve upon releasing, also referred to as set pressure of safety valve.

3.6

Hydrostatic test pressure

The pressure applied when conducting hydrostatic test for boiler system or pressure component (part) as required.

3.7

Rated temperature

The working fluid temperature at the outlet which shall be ensured for long-term continuous operation under specified design conditions.

3.8

Calculating temperature

The metal temperature of part set under normal operating conditions (the mean temperature along the metal section of part).

3.9

Test temperature

The metal temperature of pressure part in pressure test.

3.10

Required thickness

The thickness of pressure part determined according to theoretical calculation formula. Where necessary, thickness required by other loads shall also be calculated.

3.11

Design thickness

3.18

The highest fire line

The highest point of water-side under the erosion of flame or high-temperature flue gas on the evaporating heating surface of boiler.

3.19

Component space

It means that adequate space must be provided between adjacent parts of different wall temperatures on the tube plate so as to avoid overlarge temperature difference stress.

4 Qualification and responsibilities

4.1 Qualification

4.1.1 Organization qualification

The fabrication, inspection, testing and installation organizations of boilers shall obtain corresponding special equipment license qualification according to the requirements of "Regulations on Safety Supervision over Special Equipment".

4.1.2 Personnel qualification

4.1.2.1 The welding personnel of the boiler pressure parts shall be assessed according to the requirements of relevant safety technical codes such as "Examination Rules for Welding Operators of Special Equipment" and may be engaged in the welding work within the acceptable project scope within the period of validity after obtaining the "Special Equipment Operator Certificate".

4.1.2.2 The non-destructive inspection personnel may only undertake non-destructive testing with type and technical level corresponding to the qualification certificate after obtaining the special equipment operator qualification certificate according to the requirements of relevant technical codes.

4.1.2.3 The operation personnel of boiler using organization shall be provided with corresponding qualification required by safety technical codes.

4.2 Responsibilities

main pressure part, welding quality certificate, non-destructive testing report and hydrostatic test report, etc.);

e) Installation instructions and operating instructions of boiler;

f) Significant design change information of pressure part;

g) Water flow diagram and hydrodynamic calculation sheet of hot-water boiler (except natural-circulation shell boiler);

h) Fabrication, supervision and inspection certificate;

i) Technical information concerned with safety and energy conservation.

4.2.2.5 For the fabricated boilers within the design service life, the fabrication organization shall not only preserve the above technical information of delivery, but also properly preserve the following technical documents for future reference:

a) Boiler design detail;

b) Material utilization list;

c) Fabrication process diagram or fabrication process card;

d) Welding process document;

e) Heat treatment process document;

f) Inspection and test record during fabrication process and after completion;

g) Fabrication, supervision and inspection certificate;

h) Permissible project selection record, etc.

4.2.3 Installation Organization

The installation organization shall carry out installation construction according to relevant safety technical codes and standards as well as the boiler drawings and installation instructions provided by the boiler manufacturer, and shall be responsible for the construction safety and quality.

5 Definition of the Boiler Range

5.1 Boiler range

The range of boiler managed according to this Standard includes the boiler body, within the range, safety accessory and combustion system, which are defined

steel	M24~M48		$R^t_{eL}(R^t_{p0.2})/1.5$	
$R^t_{eL}(R^t_{p0.2})$ - the lower yield strength (or specified non-proportional elongation strength at high temperature) of steel at design temperature, Mpa.				

6.4 Design

6.4.1 Boiler structure

The boiler structure shall be determined according to parameters adopted such as boiler evaporation, thermal power, operating pressure, operating temperature, fuel characteristics and combustion mode. The selection of boiler structure shall meet the relevant requirements of GB/T 16508.3.

6.4.2 Design calculation

6.4.2.1 The boiler part shall be designed and calculated according to failure mode following appropriate design criteria and design method. Boiler design calculation mainly includes thermal calculation, flue-gas and air resistance calculation, hydrodynamic force calculation, part strength calculation, etc.

6.4.2.2 The design and calculation methods of boiler pressure parts shall meet the relevant requirements of GB/T 16508.3, the strength calculation method for boiler fillet weld shall meet the requirements of JB/T 6734, the calculation method for strength of boiler hanger rod shall meet the requirements of JB/T 6735, and design calculation of boiler steel structures shall meet the requirements of GB/T 22395.

6.4.2.3 Where the boiler structure is subject to shell-water tube composite design, the design and calculation of water tube type part shall meet the requirements of GB/T 16507.

6.4.2.4 For the pressure part of which the structural dimension cannot be determined by calculation according to GB/T 16508.3, its safety may be verified through test or other calculation methods.

6.4.3 Calculating temperature

The calculating temperature of pressure part may be determined with three methods, namely medium temperature, heat transfer calculation or measured temperature. The loaded non-pressure part is determined according to the medium temperature of calculated position and the ambient temperature.

6.4.4 Load

6.4.4.1 Calculating loads which shall be considered during pressure part design are

$$C = C_1 + C_2 + C_3 \quad \ldots\ldots (1)$$

Where,

C - the additional thickness, mm;

C_1 - the corrosion allowance, mm;

C_2 - the manufacturing thickness reduction, mm;

C_3 - the thickness tolerance of steels, mm.

6.4.6.1 The corrosion allowance is determined according to the expected service life of boiler and the corrosion rate of medium for metal material. Generally, only the corrosion at working medium side is considered, while that at smoke side shall be separately specified in order contract. Abrasion condition may be treated by reference to this article.

6.4.6.2 The manufacturing thickness reduction during manufacturing process is determined according to specific conditions, e.g. plate rolling, stamping and bending process.

6.4.6.3 The thickness tolerance of steel plate and steel tube is determined according to corresponding steel standards.

6.4.6.4 Besides the strength, the rigidity of pressure part, the limit of minimum thickness in manufacturing process, as well as the maximum thickness restricted by thermal stress shall also be considered.

6.4.7 Welded joint coefficient

6.4.7.1 The welded joint coefficient shall be determined according to the weld type of butt joint and proportion of non-destructive testing.

6.4.7.2 For butt joints by both sides welding and full penetration butt joints equivalent to two-side welding (e.g. argon arc welding bottoming double-side forming welded joints):

a) 100% non-destructive testing, φ=1.00;

b) Local non-destructive testing, φ=0.85.

6.4.7.3 Single welded butt joint (subplate available along the root of weld)

etc.; the non-destructive testing method for boiler pressure parts shall meet the requirements of NB/T 47013 (JB/T 4730).

X-ray real-time imaging for the butt joint of the tube shall be in accordance with the relevant technical requirements.

Where Ultrasonic Time-of-Flight Diffraction Technique (TOFD) is adopted, pulse echo method (PE) shall be combined for testing, and the test conclusion shall be comprehensively judged according to the results of TOFD and PE.

6.7 Hydrostatic test

6.7.1 Basic requirements

After fabrication completion of boiler pressure parts or components, hydrostatic test shall be carried out after non-destructive testing and heat treatment, and hydrostatic test pressure of the parts or components shall not be lower than that of boiler body corresponding to them; integral hydrostatic test shall be carried out on the packaged boiler and the boiler installed at construction site. Hydrostatic test shall be carried out according to the requirements of GB/T 16508.4.

6.7.2 Integral hydrostatic test

During integral hydrostatic test, test pressure is calculated according to Formula (2), and then is compared with Table 3, the higher value taken as hydrostatic test pressure and the pressure holding time is at least 20min.

$$p_T = 1.25p[\sigma]/[\sigma]^t \quad \text{..... (2)}$$

Where,

p_T - the test pressure, MPa;

p - the operating pressure, MPa;

$[\sigma]$ - the permissible stress of the pressure part material under the test temperature, MPa;

$[\sigma]^t$ - the permissible stress of the pressure part material under design temperature, MPa;

Thereinto, materials used for each pressure component (part) are different, the minimum value of the $[\sigma]/[\sigma]^t$ of each pressure component (part) material shall be taken.

σ_T - the membrane stress of pressure part under test pressure, MPa;

p_T - the test pressure, MPa;

D_n - the inside diameter of the pressure part, mm;

δ_e - the effective thickness of the pressure part, mm;

φ - the welded joint coefficient;

$R_{eL}^t(R_{p0.2}^t)$ - the lower yield strength (or specified non-proportional elongation strength) of the pressure part material under test temperature, MPa;

6.8 Safety accessories and instruments

The safety and reliability of boiler shall be ensured by configured safety accessories (safety valve, pressure gauge and water level gauge), alarm device, measuring instruments and safety protection devices etc. Economic and environmental-friendly properties of boiler shall be ensured by configured auxiliary equipment, e.g. water supply, ventilation, coal delivery and de-slagging (dedusting). Configuration of safety accessories and metering instrument shall meet the requirements of GB/T 16508.5.

6.9 Combustion system

The boiler's combustion system (including combustion equipment, fuel delivery system, air supply system, smoke exhaust system, dedusting (de-slagging) device), and all relevant control and monitoring equipment shall meet the requirements of GB/T 16508.6.

6.10 Installation

Site installation, installation process inspection, commissioning and acceptance etc. for boiler shall meet the requirements of GB/T 16508.7.

6.11 Operation

Operation and regulation of boiler shall meet the relevant requirements in GB/T 16508.8. Boiler using organization shall correctly use the boiler according to the product operation and maintenance instructions of the fabrication organization.

Appendix A

(Normative)

Declaration of Conformity and Revision for the Standard

A.1 All parts of GB/T 16508 is prepared according to the basic safety requirements specified in the safety regulations of boiler issued by the state, and its design criteria, material requirements, technical requirements of fabrication and inspection, acceptance standard, installation and operation requirements etc. conform to the corresponding requirements of "Boiler Safety Technical Supervision Administration Regulation". All parts in this Standard are harmonized, the boiler built according to requirements of all parts of this Standard may meet the basic safety requirements of "Boiler Safety Technical Supervision Administration Regulation".

A.2 Proposal and review mechanism is applied for standard revision. Any organization or individual has a right to put forward proposals for revision of this Standard. The revision proposals shall be submitted to Boiler Branch of China Standardization Committee on Boilers and Pressure Vessels according to the standard proposal/questionnaire way in Table A.1. Review for proposal revision of the received standard is carried out by Boiler Branch of China Standardization Committee on Boilers and Pressure Vessels, and the adopted technical content will be incorporated into the standard of next edition according to review result.

Table A.1 -- Standard Proposal/Questionnaire No.____

<table>
<tr><td colspan="2">☐Standard proposal ☐Standard enquiry</td><td>Standard name</td><td colspan="2"></td></tr>
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<tr><td>Tel./Fax:</td><td colspan="2"></td><td>E-mail:</td><td></td></tr>
<tr><td>Standard clause</td><td colspan="4"></td></tr>
<tr><td colspan="5">Proposal/enquiry content (on attached sheet if necessary)</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Technical basis and relevant information (on attached sheet if necessary)</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">Additional information:</td></tr>
<tr><td colspan="2">Seal of organization or signature of proposer (enquirer):</td><td colspan="3">Submitting date:</td></tr>
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