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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 38820-2020

Irradiation-resistant and heat-resistant steels

抗辐照耐热钢

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1 Scope

China's national standard for irradiation-resistant and heat-resistant steels. It specifies the terms and definitions, the order content, the dimensions and appearance, and the technical requirements. These are the structural steels for the inside of a nuclear reactor, where a material faces a combination of conditions that exists nowhere else. Fast neutrons displace atoms from the lattice continuously, producing point defects that harden the steel and embarrass its ductility, and transmuting some of its atoms into helium, which collects at grain boundaries and embrittles it further. All of that happens at a temperature high enough that creep matters, in a coolant that may be water at pressure or a liquid metal, over decades, in a component that cannot be inspected or replaced. The steels developed for this duty - the reduced activation ferritic-martensitic grades in particular - are designed as much for what they become under irradiation as for what they are when new.

This standard specifies the terms and definitions, order content, dimensions, shape, weight, technical requirements, test methods, inspection rules, packaging, markings and quality certificates of radiation-resistant heat-resistant steel. This standard applies to hot-rolled and forged bars (hereinafter referred to as steel bars) which has a diameter of not more than 150 mm for the nuclear industry. The designation and chemical composition as specified in this standard are also applicable to steel ingots, billets and their products.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 222 Permissible tolerances for chemical composition of steel products

GB/T 223.5 Steel and iron - Determination of acid-soluble silicon and total silicon content - Reduced molybdosilicate spectrophotometric method

GB/T 223.11 Iron, steel and alloy - Determination of chromium content - Visual titration or potentiometric titration method

GB/T 223.14 Methods for chemical analysis of iron, steel and alloy - The N-Benzoyl-N-Phenylhydroxylamine extraction photometric method for the determination of vanadium content

GB/T 223.21 Methods for chemical analysis of iron steel and alloy - The 5-CL-PADAB spectrophotometric method for the determination of cobalt content

GB/T 223.26 Iron, steel and alloy - Determination of molybdenum content - The thiocyanate spectrophotometric method

GB/T 223.86 Steel and iron - Determination of total carbon content - Infrared absorption method after combustion in an induction furnace

GB/T 226 Test method for macrostructure and defect of steel by etching

GB/T 228.1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 228.2 Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature

GB/T 229 Metallic materials - Charpy pendulum impact test method

GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test method

GB/T 351 Metallic materials - Resistivity measurement method

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 Irradiation-resistant and heat-resistant steels The steel alloy which, after being irradiated by neutrons, has good elongation after fracture and low swelling rate, maintains high enduring strength, creep resistance and good chemical stability in high temperature environment, has low activation characteristics.

Note: Low activation characteristics, that is, the radioactivity after neutron irradiation mainly comes from short-lived or medium-lived radioactive elements.

4 Order content

The contract or order for ordering according to this standard shall at least include the following contents:

- a) Number of this standard;
- b) Product name;
- d) Smelting method;
- e) Dimensions and allowable deviations (see Chapter 5);
- f) Order weight;
- g) Delivery status (if necessary, see 6.3.2);
- h) Qualified level of macrostructure (see 6.5);
- i) Qualified level of ultrasonic testing (see 6.9);
- j) Special requirements (if necessary, see 6.11). The steel bar shall be ultrasonically tested in accordance with NB/T 47013.3. Its qualification level shall be determined through negotiation between the supplier and the buyer and shall be indicated in the contract.

6.10 Surface quality

6.10.1 There shall be no visible cracks, scars, folds and inclusions on the surface of the steel bar. If the above defects exist, partial removal is allowed. The removal depth shall not exceed half the tolerance of the steel bar from the actual size of the steel bar. The removal width shall not be less than 5 times the depth. The number of positions where maximum removal depth is reached on the same section shall be not more than 1. It allows for the individual small scratches, indentations, pits and small cracks which has a depth of not more than

0.2 mm that do not exceed half of the dimensional tolerance from the actual size. The defect removal place shall be smooth and without corners.

6.10.2 The surface of the steel bar delivered in a polished or peeled state shall be clean and smooth. There shall be no cracks, folds, scars and oxide scale. If the above defects exist, local grinding is allowed, but the maximum grinding point shall ensure the minimum size of the steel bar.

6.11 Special requirements According to the requirements of the buyer, after negotiation between the supplier and the buyer and indicated in the contract, the steel bar may be tested of the physical properties (see Appendix A), non-metallic inclusions, Vickers

hardness, (pre-irradiation) impact absorption energy-temperature curve, other non-destructive testing, etc.

7 Test method

7.1 The inspection items and test methods of steel bars shall meet the requirements of Table 6.

7.2 Chemical composition analysis is usually carried out according to general methods such as GB/T 22368 and GB/T 11170. During arbitration, it shall follow the requirements of GB/T 223.5, GB/T 223.11, GB/T 223.14, GB/T 223.21, GB/T 223.26, GB/T 223.31, GB/T 223.53, GB/T 223.54, GB/T 223.60, GB/T 223.62, GB/T 223.63, GB/T 223.67, GB/T 223.75, GB/T 223.81, GB/T 223.84, GB/T 223.86 and GB/T 20127.13.

7.3 The content testing of tantalum, tungsten, antimony, silver, oxygen and nitrogen is carried out in accordance with GB/T 223.42, GB/T 223.43, GB/T 223.47, GB/T 20127.1, GB/T 11261, GB/T 20124, YB/T 4395, respectively.

Note: -Compulsory inspection items; -Inspection items negotiated between the supplier and the demander; - No such item.

8 Inspection rules

8.1 Inspection and acceptance The inspection and acceptance of steel bars are carried out by the supplier's technical supervision department. When necessary, the purchaser has the right to inspect and accept any inspection items specified in this standard or contract.

8.2 Inspection classification The inspection of steel bars is divided into type inspection and exit-factory inspection.

8.3 Type inspection

8.3.1 Type inspection shall be carried out in one of the following situations:

- a) Type finalization of new product;
- b) When the material composition and preparation process have changed significantly;
- c) When required by the contract.

8.3.2 See Table 6 for type inspection items, sampling quantity, sampling locations and test methods.

8.3.3 If all inspection results meet the requirements of Chapter 6, the type inspection is passed.

8.4 Exit-factory inspection