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

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Nuclear related flexible graphite sheets

核级柔性石墨板材

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Table of Contents

- 1 Scope
- 2 Normative references
- 3 Terms and definitions
- 4 Technical requirements
- 5 Test methods
- 6 Inspection rules
- 7 Marking, packaging, transport and storage

1 Scope

This document sets the technical requirements, test methods, inspection rules, marking, packaging, transport and storage for nuclear related flexible graphite sheets.

This document applies to nuclear related flexible graphite sheets made from expandable graphite, without modification and without reinforcement, for use in the nuclear industry. Non-nuclear-grade flexible graphite sheets used in the nuclear industry may be handled by reference to it.

3 Terms and definitions

No terms and definitions need to be listed in this document.

4 Technical requirements

4.1 Appearance. The surface of a nuclear related flexible graphite sheet shall be flat and clean and free from bubbles, delamination, cracks, creases, scratches, foreign matter and similar defects.

4.2 Dimensional deviation. The dimensional deviations shall meet Table 1. The length and width deviations are agreed between supplier and purchaser. The thickness deviation is stated as a percentage of the nominal thickness t and tightens as the sheet gets thicker: plus or minus 10 % of t for a nominal thickness of 0.4 mm or less, plus or minus 7 % of t for a nominal thickness above 0.4 mm and up to 1.0 mm, and plus or minus 5 % of t for a nominal thickness above 1.0 mm. The values are in millimetres.

4.3.1 Chemical composition. The chemical composition shall meet Table 2. The table sets a floor on fixed carbon content of 99.5 % and ceilings on ash of 0.5 %, on sulfur of 200 micrograms per gram, on chlorine of 30 micrograms per gram and on fluorine of 30

micrograms per gram. It also sets a ceiling of 500 micrograms per gram on the combined content of the metallic elements copper, zinc, cadmium, tin, antimony, mercury, lead and bismuth; where the purchaser requires those elements to be tested, this is to be stated in the order contract.

4.3.2 Physical properties. The physical properties shall meet Table 3. Against a nominal density of 1.0 g/cm³, the density deviation is limited to plus or minus 0.10 g/cm³ for a thickness of 0.4 mm or less and to plus or minus 0.07 g/cm³ above 0.4 mm. Tensile strength shall be at least 4.5 MPa, compressibility shall lie between 35 % and 55 %, recovery shall be at least 9 %, and loss on heating at 450 °C shall be below 0.5 %.

4.3.3 Radiation resistance. When a nuclear related flexible graphite sheet has taken a cumulative gamma dose of 1.9 million gray from a cobalt-60 radiation source, the change in tensile strength, compressibility and recovery against the values before irradiation shall not exceed plus or minus 10 %, referred to the thickness of the sheet sample used for that test.

5 Test methods

5.1 Appearance inspection. The appearance of a nuclear related flexible graphite sheet is inspected visually.

5.2.1 The length and width are measured with a gauge accurate to 1.0 mm, to the nearest 1 mm.

5.2.2 The thickness is measured with a gauge accurate to 0.01 mm, to the nearest 0.01 mm. The specimen for thickness measurement is a square of 50 mm side, at least five specimens to a set, each measured at three points spaced evenly along a diagonal, and the arithmetic mean taken.

5.3 Sample preparation. Sampling follows 2.1 and 2.2 of GB/T 33920-2017, the size and number being enough for each of the tests.

5.4.1 Fixed carbon content, ash, sulfur content, chlorine content and fluorine content are determined according to GB/T 33920-2017.

5.4.2 The contents of copper, zinc, cadmium, tin, antimony, mercury, lead and bismuth are determined according to GB/T 23942.

5.5.1.1 Take the square specimen of 50 mm plus or minus 0.1 mm side measured under 5.2.2 and measure its length and width with a gauge graduated in 0.01 mm, to the nearest 0.1 mm.

5.5.1.2 With a gauge graduated in 0.01 mm, measure the thickness at five evenly spaced points along either diagonal of the specimen, to the nearest 0.01 mm, and take the arithmetic mean as the thickness of the single specimen.

5.5.1.3 Weigh the specimen on a balance accurate to at least 1 mg, to the nearest 1 mg.

5.5.1.4 The density of a single specimen is calculated from Formula (1), in which the density in grams per cubic centimetre is the mass of the specimen in milligrams divided by the product of its length, width and thickness in millimetres.

5.5.1.5 The result is the arithmetic mean of five parallel determinations, rounded to two decimal places in accordance with GB/T 8170.

5.5.1.6 The density deviation is obtained by subtracting the nominal density of 1.0 g/cm³ from the measured density of the specimen.

5.5.2 Tensile strength. Determined by method D of GB/T 20671.7-2006.

5.5.3 Compressibility and recovery. Determined by test procedure A of GB/T 20671.2-2006.

5.5.4 Loss on heating. Determined according to GB/T 33920-2017.

5.6 Radiation resistance test. The sheet is irradiated at a qualified radiation laboratory with the radiation source and the cumulative dose given in 4.3.3, then tested for tensile strength according to 5.5.2 and for compressibility and recovery according to 5.5.3, and the results are compared with the tensile strength, compressibility and recovery measured before irradiation.

6 Inspection rules

6.1 All nuclear related flexible graphite sheets shall be inspected and shall leave the works only after passing inspection.

6.2 The release inspection items are appearance, dimensions, density deviation, tensile strength, compressibility, recovery, fixed carbon content, ash, loss on heating, sulfur content, chlorine content and fluorine content. The type inspection items are all the items set out in Clause 4. The manufacturer shall provide a document showing that the irradiation test has been passed.

6.3 Sheets produced under the same production conditions form one batch. From each batch that has passed the appearance and dimensional check, 300 kg is taken at random, or the whole lot where it is less than 300 kg, and the samples needed for each test are prepared by the method given in GB/T 33920-2017.

6.4 Where every inspection item of every sample meets the requirements, the type inspection is judged to have been passed. Where one item fails, a double sample may be taken and retested. Where the retest meets the requirements, the type inspection is judged to have been passed; where an item still fails on retest, the type inspection is judged to have failed.

7 Marking, packaging, transport and storage

7.1.1 The outer packaging shall carry the product name, the name and address of the

manufacturer, the production date or batch number, the net content, and the rain, damp and sun protection marks.

7.1.2 Each batch shall be accompanied by a certificate of conformity giving the product name, the product type and size, the batch number, the number of the standard the product is made to, the code or mark of the inspector, and the name and address of the manufacturer.

7.2.1 Sheets shall be packed by type, size and rated quantity in a packing bag and placed in a dedicated packing case.

7.2.2 The packing bag shall be dry and clean and free from oil and other foreign matter.

7.2.3 The outside of the packing case shall carry the product name, the product type and size, the batch number, the net and gross weight, the date of manufacture, the name of the manufacturer and the nuclear grade mark.

7.2.4 A packing list shall be enclosed in the case, giving the product name, the product type and size, the quantity, the batch number, the production date and the name of the manufacturer.

7.2.5 The packing case shall be given shock protection, for which sponge, foam or similar cushioning material may be used.

7.2.6 The packing case shall be protected against rain and damp.

7.3.1 Sheets shall not be exposed to rain or damp during transport and storage.

7.3.2 Sheets shall be stored in a clean, dry and ventilated indoor warehouse.

7.3.3 Where sheets have been stored for more than five years, their performance shall be retested against the requirements of this document; where they do not meet the requirements, the stored material shall not be used to make parts required to be of nuclear grade.