



Internal information

Instruction

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KTS011-Nodular Cast Iron EN 1563 Insert

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1. Purpose

Cast iron inserts are essential canisters components. This technical specification, KTS011, defines the technical requirements and documentation for nodular cast iron inserts.

2. Requirements

2.1 Quality plan

A quality plan¹ shall be established by the producer and accepted by SKB prior to production of nodular cast iron inserts.

2.2 Chemical composition

The chemical composition given as information in SS 14 07 17² may be adjusted. Experience is being collected to determine if any change of the specification is required.

Additional requirement

An additional requirement is that the copper content should not exceed 0,05 %.

2.3 Mechanical properties

The material for nodular cast iron inserts shall in principle fulfil the requirements in EN 1563³ grade EN-GJS-400-15U (Number EN-JS1072, SS 07 17-00) regarding mechanical properties.

Cast-on samples

The specified mechanical properties for dimension $60 < t \leq 200$ mm (R_m min 370 N/mm², $R_{p0,2}$ min 240 N/mm², A min 11%) shall apply for cast-on samples (a sample may be used for one or more test pieces).

At least two cast-on samples are to be taken, one from the lower part and one from the upper part of the casting. The sample size shall be representative for the casting. At least one tensile test pieces shall be taken from each sample. Retest, see 6.2.

Samples from insert

From the insert normally 6 test pieces shall be taken according to the Annexes A and B. The following requirements shall be fulfilled:

- At least five values of $R_{p0,2}$ shall reach min 240N/mm²(reported in units.
- At least five values of R_m shall reach min 370 N/mm²(reported in units) If these requirements for $R_{p0,2}$ and R_m are not fulfilled It is allowed to take out one new piece for retest according to marked positions in Annex A and B. The values of this retest shall be used.
- The average elongation value among the five highest values (rounded to the nearest 0,5 %) shall exceed 7 %. If one or two elongation values are below 4 % one new piece for retest must be taken out according to marked positions in Annex A or B. This new value shall be used. If a retest due to low $R_{p0,2}$ and R_m values is made the elongation value from that test shall be used. If two or more test pieces then fail to exceed 4 % the insert is not accepted.

About retest for other reasons, see §10.1 En 1563:1997³. Pieces for such retests must also be taken out from the marked positions in Annex A and B.

2.4 Microstructure

At all positions of the casting, the microstructure shall correspond, to a minimum of 80 %, to forms V and VI in EN ISO 945⁴. The magnification used shall be minimum 50x and recorded.

The microstructure shall nowhere be as illustrated by forms I and II.

2.5 Macroscopic discontinuities

Experience is being collected to determine permissible types, positions and extent of discontinuities such as non-metallic and other types of inclusions, cold flows, gas porosities, shrinkage cavities and shrinkage cracks.

2.6 Size and shape

Size and shape of inserts shall be as stated in drawings according to applicable SKB order. Sufficient machining allowance should be added to the cast insert diameter. See 6.3 for corresponding inspection requirements.

2.7 Identification marking

Each cast insert shall be uniquely marked and the identification shall be maintained throughout the manufacture, including the machining stages. At delivery the insert shall be marked in accordance with requirements in the SKB order and applicable procedure⁵. The traceability to the casting shall be maintained.

3. Steel section cassette⁶

The cassette shall be stored under dry conditions to prevent rusting and the hollow sections shall, if necessary, be shot blasted inside and outside to remove oxide. Any shot blasting shall be done as closely in time as possible prior to casting. The steel section cassette shall be filled with a suitable filler to prevent distortion during casting.

4. Casting

The casting process shall be controlled to ensure an acceptable microstructure. This shall include specifying and recording of melting parameters such as tapping temperature, temperature for Mg addition and inoculation, time elapsed between Mg addition and pouring, pouring temperature and time. This shall be described in an internal work instruction, available at the melt shop.

Samples for chemical analysis shall be taken after Mg treatment in accordance with normal melt shop practice.

5. Machining

5.1 Cutting of ends and test disk

Cutting of insert ends, including any test disk, shall be performed by suitable means, e.g. bandsaw cutting. It is recognised that cooling liquids have to be used, efforts shall be taken, however, to minimise exposure of insert surfaces, in particular the top end of cassette sections to water or any other liquid.

5.2 Rough machining and cleaning from filler medium, e.g. sand

Cleaning the channel surfaces from remainder of the filler medium, e.g. sintered sand particles can be performed by adding tumbling media in the channels during the rough turning operation. Afterwards the channels shall be properly cleaned from dust etc. Rough machining of the insert circumference, top end and the recess for steel lid shall be done without any cooling liquid.

6. Inspection and testing

6.1 Chemical analysis

The analysis shall be performed in accordance with industry practice by an accredited laboratory or by a laboratory meeting ISO 9001⁷ requirements with exclusion of clause 7.3 of the standard, if this clause is not applicable. Laboratory reference material shall be traceable to accredited sources and its identity and use for the analysis shall be recorded.

6.2 Mechanical testing and microstructure evaluation

Sampling

Test pieces for tensile and hardness testing and for microstructure examination shall be taken as specified in 2.3 or in the SKB order. A sketch of the actual sample size and position(s) shall be provided.

Tensile testing

Tensile testing shall be performed in accordance with EN 10002-1⁸ and EN 1563:1997³ by an accredited laboratory or by a laboratory meeting ISO 9001 requirements with exclusion of clause 7.3, if this clause is not applicable.

Results from each test piece shall be recorded and provided in the certificate, see 11.4. Requirements for mechanical properties and possible retests shall be as specified in 2.3.

In case a test result from a cast-on sample is not accepted, one retest (one test piece) representing the insert may be performed. The result of the retest shall be used.

Hardness testing

Hardness testing – HB according to EN ISO 6506-1⁹, preferably using 10 mm ball –shall be performed on the test pieces from cast-on samples and the result shall be recorded.

Microstructure

Microstructure evaluation shall be performed on the test pieces from cast-on samples and on the two specimens with the highest and lowest elongation values from the insert. The structure shall be documented in micrographs at minimum 50x magnification.

6.3 Size and shape inspection

The insert shall be measured to check its conformity with the specified size after machining.

Channel shape

1. BWR

For BWR fuel canister inserts with cassettes made from square sections (VKR or KKR) 180 x 180 x 10 mm (outer size x thickness) the straightness of the channels

shall be sufficient to permit a 152 x 152 mm square profile test-gauge in accordance with applicable SKB drawing to freely move down the entire channel.

In case the 152 x 152 mm test-gauge does not pass down the entire channel, i.e. the result is not acceptable, the following shall be done in order to collect experience:

- a) the distance that the test-gauge can be freely moved down is to be measured for various diminishing sizes from 152 x 152 mm,
- b) the largest size that will pass the entire channel is to be determined.

2. PWR

For PWR fuel canister inserts with cassette sections 250 x 250 x 10 mm the corresponding test-gauge size is 224 x 224 mm (provisional requirement). Corresponding testing, measurement and recording shall be performed.

Channel length

1. BWR

The *shortest* acceptable channel length from any *channel bottom* to the *cut and machined surface at the insert top end* is 4515 mm (before the 50 mm top end recess for the steel lid is machined), if not otherwise prescribed in the applicable SKB drawing. After top end machining, the length of each channel shall be measured from the top end of the insert and recorded. The difference in length among the channels should not exceed 15 mm.

2. PWR

The corresponding shortest channel length is 4480 mm before machining of the 50 mm steel lid recess, and the maximum permissible variation in channel length is 15 mm. Each channel length shall be recorded.

Records

The result of the shape and size measurement shall be documented on a separate form¹⁰.

Eccentricity

Maximum permissible eccentricity of the machined insert shall be 5 mm. The eccentricity will be defined as the distance between centre of the cassette and the centre of the casting at the same height, measured as well at the bottom end as at the top end of the insert. The methods of measurement and the results are to be recorded.

6.4 Non-destructive testing

The casting shall be ultrasonically tested according to EN 12680-3¹¹ from the outside with regard to inner discontinuities such as non-metallic inclusions and other inhomogeneities. Provisionally, the 30 mm rim zone of total surface area shall be tested. The reference defect shall be a 5 mm flat bottom hole. Experience is being collected to determine suitable acceptance criteria.

The structure is to be checked using measurement of ultrasonic damping and speed of sound to collect experience of the possibility to determine the homogeneity.

7. Final machining

Final machining shall be done in accordance with applicable SKB drawing. The machining shall be done in the dry condition, i.e. without any cooling liquid.

8. Nonconformities

Any deviation, e.g. from specified shape or size or any other significant deviation from requirements shall immediately be reported in accordance with the manufacturer's quality management system. This party shall consult with SKB for decision about suitable action.

9. Request for concession

Any request for concession¹² shall be documented on SKB form¹³ or similar and sent to SKB.

10. Transport and storage protection

To prevent exposure to snow, water, dust, dirt etc. during any outdoor transport and storage the insert and in particular the channel ends shall be suitably protected, e.g. by plastic wrapping or cover. However, rust preventive liquids are not permitted. Long range transports shall be performed on covered trucks, lorries, railway trucks etc. See also a separate procedure ¹⁴.

11. Manufacturer's documentation

11.1 Quality plan

The quality plan ¹ according to 2.1 shall be completed and sent to SKB.

11.2 Photographic documentation

The production sequence shall be photographically documented when required by SKB. The extent is to be agreed with SKB from case to case.

11.3 Process documentation

Information regarding the casting process in accordance with clause 4 shall be documented by the manufacturer.

11.4 Certification

A certificate according to EN 10204 3.1.B 15 shall be issued by the manufacturer stating as a minimum:

- the manufacturer's name and address,
- SKB order number,
- SKB drawing number,
- insert number,
- casting date,
- cast or heat number,
- chemical composition,
- results of tensile testing, hardness testing and micro structure evaluation,
- result of size and shape inspection,
- result of non-destructive testing,
- a declaration that the material has been produced in accordance with the company's current quality system and quality plan, both to be accepted by SKB.

11.5 Submission of documents and information

The documentation according to 6, 9, 11.4 and request for delivery permit ¹⁶ shall be sent to SKB for authorisation prior to delivery.

SKB shall be informed when the shipping takes place.

The supplier shall, without delay, give complete information to SKB on all observations and other circumstances in connection with the production which may influence the design and properties of the insert. SKB shall have the right to use this information without any restriction.

11.6 Retention of documentation

Project engineer, PE, is responsible for the retention of documentation according to sections 6, 9 and 11 described in a separate procedure ¹⁷.

The manufacturer shall retain the documentation according to sections 4, 6, 9 and 11 for (at present) at least 10 years under suitable security. If any records are stored on electronic/magnetic media the readability shall be ensured for this time period.

12. Retention of test samples

SKB shall retain samples for determination of chemical composition, microstructure and tensile properties for (at present) minimum 10 years, under suitable conditions. The identification of samples shall be maintained.

13. Document control

QASK is responsible for document control, including distribution, of this technical specification¹⁸.

Revision record

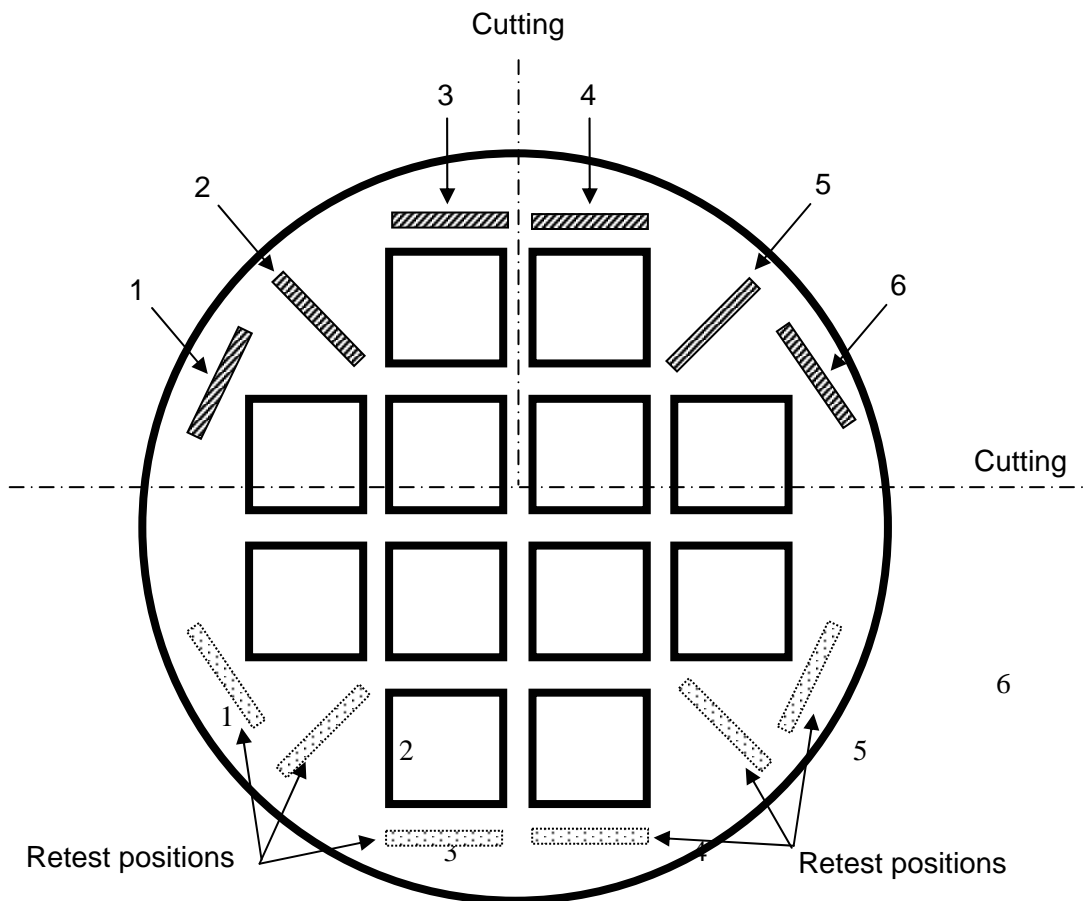
Revision	Date	Revision includes	Author	Reviewed	Approved
5.0	2006-03-05		CGA	JH	NLe
6.0	2007-08-21	PE-ansvar för redovisande dokumentation. SKB-ansvar för arkivering av teststycken.	GH	Se SKBdoc	
7.0	2007-09-27	Tilläggskrav. Cu-innehåll får ej gå över 0,05 %. Se protokoll Teknikmöte 2, 2007. SKBdoc: 1082825	GH	Se SKBdoc	

Footnotes

1. SKB Procedure KT0704, Requirements on 1) Quality plan, 2) Manufacturing and inspection plan
2. SS 14 07 17:1981, Segjärn – SS-gjutjärn 0717 (Spheroidal graphite iron)
3. EN 1563:1997, Founding – Spheroidal graphite cast iron
4. EN ISO 945:1994, Cast iron – Designation of microstructure
5. SKB Procedure KT0705, Identification of canister components and assembled canisters
6. SKB Technical Specification KTS021, Steel section cassette
7. ISO 9001:2000, Quality management systems – Requirements
8. EN 10002-1:2001, Metallic materials – Tensile testing
9. EN ISO 6506-1:2006, Metallic materials – Brinell hardness test – Part 1: Test method
10. SKB Forms KTS001F-1, KTS001F-2, KTS001F-3 or similar
11. EN 12680-3 Founding – Ultrasonic examination Part 3: Spheroidal graphite cast iron castings
12. SKB Procedure KT1102, Request for concession
13. SKB Form KTF11-1, Supplier's request for concession
14. SKB Procedure KT0702, Handling, storage, packing and transport of canister components and assembled canisters
15. EN 10204:1995, Metallic products - Types of inspection documents
16. SKB Form KTF07-07 (Eng) or KTF07-08 (Sv) or similar
17. SKB Procedure KT1002, Retention of quality documents and records
18. SKB Procedure KT1001, Establishing and control of SKB technical specifications, procedures and forms

Annex A – Test piece positions, BWR

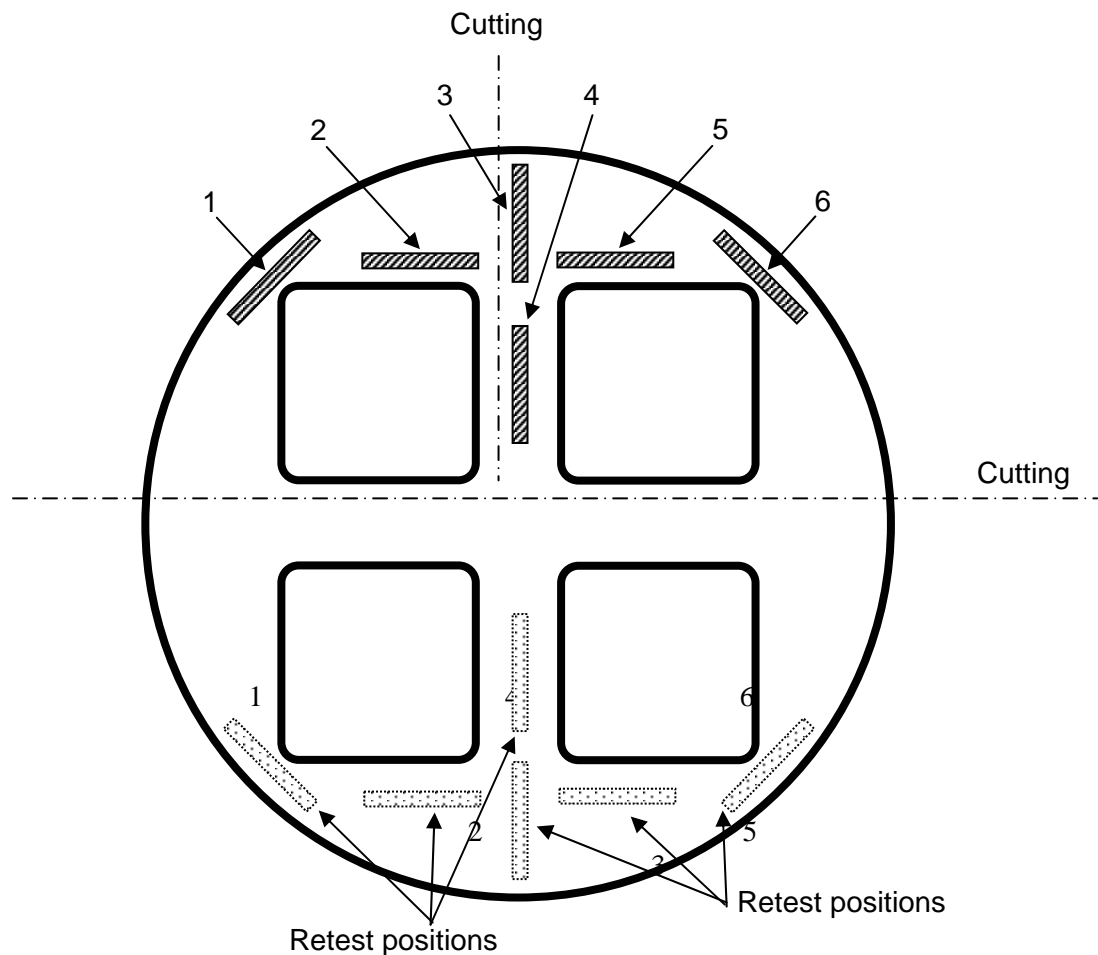
The sketch shows the positions of the regular series of six test pieces, when tensile testing is to be carried out on a nodular cast iron BWR insert itself (and not on cast-on samples). It also shows retest positions.



Results can be recorded on SKB form KTF07-15.

Annex B – Test piece positions, PWR

The sketch shows the positions of the regular series of six test pieces, when tensile testing is to be carried out on a nodular cast iron PWR insert itself (and not on cast-on samples). It also shows retest positions.



Results can be recorded on SKB form KTF07-16.