



## **Chilled Cast Iron Camshafts**

### **1 Introduction**

**Note:** Nothing in this standard supercedes applicable laws and regulations.

**Note:** In the event of conflict between the English and domestic language, the English language shall take precedence.

**1.1 Purpose.** This specification defines the requirements and test conditions for finish machined chilled cast iron camshafts in three material types.

**1.2 Applicability.** For finish machined, ready-to-install chilled cast iron camshafts.

### **2 References**

**Note:** Only the latest approved standards are applicable unless otherwise specified.

#### **2.1 External Standards/Specifications.**

ISO 945

#### **2.2 GM Standards/Specifications.**

GMW4

GMW3059

GMW16331

### **3 Test Preparation and Evaluation**

#### **3.1 Resources.**

**3.1.1 Facilities.** Conforming to the relevant test procedure.

**3.1.1.1 Calibration.** The test facilities and equipment shall be in good working order and shall have a valid calibration label.

**3.1.1.2 Alternatives.** Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

**3.1.2 Equipment.** Conforming to the relevant test procedure.

**3.1.3 Test Vehicle/Test Piece.** Not applicable.

#### **3.1.4 Test Time.**

Calendar time: 0 d

Test time: 2 h

Coordination time: 2 h

**3.1.5 Test Required Information.** Not applicable.

**3.1.6 Personnel/Skills.** Not applicable.

#### **3.2 Preparation.**

**3.2.1 Test Samples.** Conforming to the relevant test procedure.

**3.3 Conditions.** Conforming to the relevant test procedure.

**3.3.1 Environmental Conditions.** Not applicable.

**3.3.2 Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

**3.4 Instructions.** Not applicable.

**3.5 Data.** Not applicable.

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**3.6 Safety.** This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

**3.7 Documentation.** Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

**3.7.1 Test Results.** The results of the tests shall be summarized in a test report.

**3.7.2 Deviations from Test Procedure.** Deviations from the requirements of the test procedures shall be agreed upon between the supplier and the purchaser. Such requirements shall be specified on component drawings, test certificates, reports etc.

## 4 Requirements and Procedure

### 4.1 Material.

- **Type A:** Unalloyed cast iron.
- **Type B and C:** Alloyed cast iron which forms a ledeburitic skin in the chilled area next to the casting mold.

The composition selection results in a high degree of abrasion resistance by adding alloying elements such as chromium, nickel and molybdenum.

### 4.2 Chemical Composition.

**4.2.1 Chemical Composition in Percent by Mass.** See Table 1.

Table 1: Chemical Composition

| Element    | Unit      | Type A                   | Type B       |              | Type C       |
|------------|-----------|--------------------------|--------------|--------------|--------------|
|            |           | GMW4M-IR-C-G250 modified | Alloy 1      | Alloy 2      |              |
| Carbon     | % by mass | 3.00 to 3.40             | 3.10 to 3.50 | 3.40 to 3.80 | 3.10 to 3.60 |
| Silicon    | % by mass | 1.90 to 2.40             | 1.80 to 2.50 | 1.50 to 2.20 | 1.70 to 2.20 |
| Manganese  | % by mass | 0.60 to 0.90             | 0.50 to 0.80 | 0.60 to 0.90 | 0.60 to 1.10 |
| Phosphorus | % by mass | 0.20 max.                | 0.20 max.    | 0.20 max.    | 0.20 max.    |
| Sulfur     | % by mass | 0.12 max.                | 0.15 max.    | 0.05 max.    | 0.15 max.    |
| Chrome     | % by mass | not defined              | 0.50 to 0.90 | 0.70 to 1.00 | 0.35 max.    |
| Molybdenum | % by mass | not defined              | 0.15 to 0.25 | 0.15 to 0.25 | 1.0 max.     |
| Nickel     | % by mass | not defined              | 0.15 to 0.25 | 0.40 to 0.70 | 1.0 max.     |
| Copper     | % by mass | not defined              | not defined  | not defined  | 0.50 max.    |
| Tin        | % by mass | not defined              | not defined  | not defined  | 0.12 max.    |

max. = maximum

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**4.2.2** If Alloy Type A is specified, Type B Alloy 1 or 2 may also be used.

**4.2.3** If Alloy Type B is specified, Types 1 or 2 may be used interchangeably.

**4.2.4** The microstructure of these materials is dependent on the chemical composition and the chilling speed of the castings. The chemical composition values listed in 4.2.1 are intended as guidelines and, unless otherwise agreed upon, are left to the discretion of the cast iron supplier. Hardness and microstructure are the primary requirements for this specification. Chemical composition is secondary.

**4.3 Hardness on the Finish Ground Surface.** All hardness measurements shall be taken on the equivalent finish ground surface.

**4.3.1** Bearing journals and the front face, (200 to 285) HBW 5/750.

**4.3.2 Lobe Surface Hardness.** Nose: HRC 48 minimum; Base Circle: HRC 40 minimum.

Because of the possibility of isolated pearlite spots on the cam lobe surface, sporadic hardness values may be below the specification limit. Figure A1 through Figure A3 in Appendix A define the hardness readings for the nose and base circle of the lobes. Reference it for details on sample preparation and for referee hardness measurements criteria.

**4.4 Microstructure of the Finish Lobe Surface.** Microstructure shall be evaluated at the equivalent finish machined surface.

#### **4.4.1 Camshaft Lobe.**

**4.4.1.1** The depth of chill over the entire lobe contour shall be 5 mm minimum.

**4.4.1.2** The microstructure in the chill zone shall consist of a ledeburitic skin of 1 mm. Total sided graphite and pearlite separations are not permissible. Concentrated pearlite separations are allowed in the following areas per Figure 1, for Area "A" and "B" a 5% maximum pearlite separation is allowed. For Area "C" a maximum pearlite separation of 10% is allowed.

**4.4.1.3** The macrostructure in the chilled zone shall consist of the following: 50/50 ("light-dark" border) = 50% surface proportion Ledeburite (light = "white") + 50% surface proportion Pearlite level (dark = "grey").

**4.4.2 Bearings and Core Zone.** Gray cast iron.

The evaluation shall be done with the rating charts for cast iron according to ISO 945.

**4.4.2.1** Chilling is possible and acceptable in the transition zone of the cam bearing to the cam lobe. In the core zone carbide separations are permissible, however they are not permissible in the areas of machining (e.g., tapped hole).

**4.4.2.2 Graphite Formation.** Graphite form I (fine lamellar) per ISO 945 Figure 1. Graphite distribution of Type A, B, D and E per ISO 945 Figure 2. Graphite size of 5 to 8 with isolated areas of size 4 per ISO 945 Figure 3.

**4.4.2.3 Pearlite Formation.** Uniform, predominantly dense lamellar Pearlite, no Ledeburite.

**4.4.2.4 Ferrite Proportion.** Free ferrite only in isolated instances.

**4.5 General Characteristics.** The camshafts shall be free of fissures, macroporosity (bubbles), gas bubbles, slag, impurity inclusions, and machining defects such as breakout, damage from grinding the flash, grinding burns, etc.

**4.6 Surface Finish.** Bearings and lobes are ground and microfinished. In addition, bearings are lapped to the peak-to-valley height specified in the corresponding drawing.

**4.6.1 Surface Quality.** On cam lobes the following deviations regarding the surface quality are possible.

**4.6.1.1 Cam Lobe.** See Figure 1 and Table 2.