INTERNATIONAL STANDARD

**ISO 6369**

First edition
2023-05

# Ice makers for commercial use — Classification, requirements and test conditions

*Machines à glaçons à usage commercial — Classification, exigences et conditions d'essai*

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Reference number
ISO 6369:2023(E)

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Published in Switzerland



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# Foreword

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This document was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 7, *Testing and rating of commercial refrigerated display cabinets*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 44, *Commercial and professional refrigerating appliances and systems, performance and energy consumption*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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# Ice makers for commercial use — Classification, requirements and test conditions

## 1 Scope

This document specifies methods for the measurement of energy consumption, water consumption, ice production capacity and the harvested ice characteristics of ice makers with built-in condensing units for commercial use.

This document does not apply to:

— ice makers intended to be incorporated in appliances for household use;

— ice makers with remote condensing units.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

### 3.1 Types of appliances

**3.1.1**
**ice maker**
factory-made appliance consisting of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice, also including means for storing or dispensing ice, or both

Note 1 to entry: Ice makers are intended to produce ice in irregular shapes or flakes or ribbons or wafers as well as uniformly shaped ice cubes.

Note 2 to entry: A modular-type ice maker is an ice maker without storage means.

Note 3 to entry: A self-contained ice maker is an ice-maker in which the ice-making mechanism, storage compartment and condensing unit are integrated within a cabinet.

**3.1.1.1**
**ice maker with built-in condensing unit**
appliance in which the refrigeration unit is an integral part of the cabinet

**3.1.1.2**
**ice maker with remote condensing unit**
appliance in which the compressors, condensers and liquid receivers (when required) are not supplied with the cabinet

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**3.1.1.3**
**split ice maker**
appliance in which the condenser is not integrated in the main ice making unit and the condenser and piping are made in accordance with manufacturers indications using dedicated condensers

## 3.2 Type of condenser cooling

**3.2.1**
**water-cooled ice maker**
appliance in which the condenser is cooled by use of water

**3.2.2**
**air-cooled ice maker**
appliance in which the condenser is cooled by use of air

## 3.3 Type of ice

**3.3.1**
**ice cube**
single piece of ice that can have different shapes (e.g. dice, cylinder, ball, etc.) and is produced by a batch-type ice maker

**3.3.2**
**ice flakes**
ice which contains at least 70 % flaked ice (and no more than 30 % water) which is produced by a continuous-type ice maker

## 3.4 Type of production

**3.4.1**
**batch-type ice maker**
ice maker that has alternate freezing and harvesting periods

**3.4.1.1**
**batch-type single cubes ice maker**
ice maker that produces single ice cubes

**3.4.1.2**
**batch-type multiple cubes ice maker**
ice maker that produces multiple ice cubes

**3.4.2**
**continuous-type ice maker**
ice maker that continually freezes and harvests ice flakes at the same time

**3.5**
**ice storage bin**
factory-made container (not necessarily shipped in one package with the ice-maker) that forms or is intended to form a non-refrigerated compartment for the storage of ice

Note 1 to entry: The container is equipped with additional devices (e.g. container support, carts).

**3.6**
**separate storage compartment**
non-refrigerated compartment for the storage of ice that is separate from the ice-making mechanism

**3.7**
**purge**
**blow-down**
dissipation of a certain percentage of water to control the clarity of ice or to prevent scaling

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**3.8**
**ice production**
amount of ice harvested, stated in kg/24 h in multiples of 1 kg

**3.9**
**energy consumption rate**
total energy input stated in kWh/100 kg of ice in multiples of 0,1 kWh

**3.10**
**potable water use rate**
amount of potable water used in making ice, including purging and harvesting, stated in l/100 kg of ice in multiples of 0,1 l

**3.11**
**cooling water use rate**
amount of cooling water used in making ice, stated in l/100 kg of ice in multiples of 0,1 l

## 4 Measurement of energy consumption, water consumption and ice production capacity

### 4.1 General

Unless otherwise specified, measurements shall be made under test conditions and with equipment set-up as specified in 4.2 to 4.5 and Clause 5.

### 4.2 Test room

The test room walls and ceilings shall be insulated to ensure that the temperature of both the inside walls and the ceiling surface is within 2 °C of the ambient temperature.

Fluorescent or LED lighting shall be used owing to its high light output, low surface temperature and low heat load on the test room.

The air flow shall be horizontal with a speed ≤0,25 m/s.

The measuring point of air speed shall be located, 300 mm upstream of the ice maker, in line with the front of the ice maker at a vertical height that is half the ice maker height (including ice maker feet and fixings) see Figure 1.

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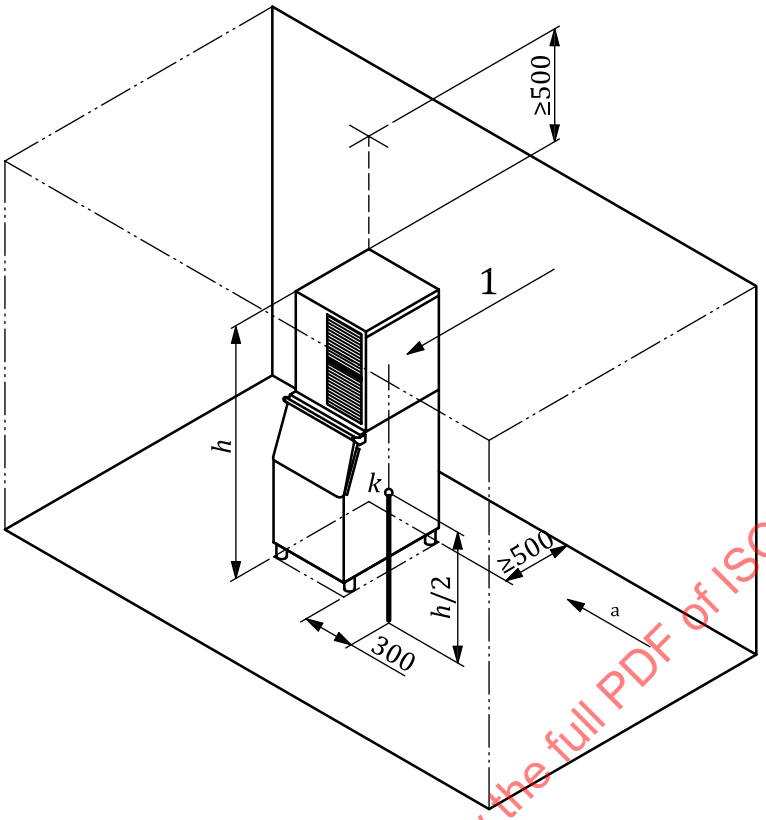
Dimensions in millimetres




**Key**

1 climate measuring point

*h* overall height of the cabinet including feet

*k* climate measuring point detecting temperature

[a] Air flow.

**Figure 1 — Test room temperature measuring point and positioning of the cabinet**

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## 4.3 Ambient temperature

The ice maker shall be tested at an ambient temperature of 32 °C ± 1 °C.

For a split ice maker, the condenser air inlet temperature shall be 32 °C ± 1 °C, with an indoor ambient temperature of 32 °C ± 1 °C.

With the ice maker switched off and the test room in operation, temperatures shall be measured in a vertical line through the climate measuring points. The vertical ambient temperature gradient in any metre of vertical distance from 50 mm above the floor or supporting platform to a height of 2 m, or to a height of 300 mm above the top of the cabinet, whichever is greater, shall not exceed 1,0 °C per metre.

Test room temperatures shall be measured by sensors, inserted in the centre of tinned solid copper or copper-zinc alloy cylinders having a mass of 25 g ± 1 g and of minimum external area (diameter = to height = to approximately 15,2 mm).

## 4.4 Water supply

The water used for the test shall have an inlet temperature of 21 °C ± 1 °C and the water pressure shall be according to the manufacturer's specifications with a tolerance of ±50 kPa.



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Whenever a pressure range is indicated, the tests are carried out at the mean of the pressure range with a tolerance of ±50 kPa.

The temperature and the pressure of the supply water used for the test shall be measured within 300 mm of the machine by inserting the temperature and the pressure -measuring sensors directly into the water stream or into a test port inserted into the water pipe.

## 4.5 Location of unit in test room

The ice maker shall be installed according to the manufacturer's instructions and shall be positioned in the test room with a minimum clearance of 0,5 m from the ceiling and the walls.

Condenser and length and section of piping of split ice makers shall be in accordance with manufacturer instructions.

## 4.6 Power supply

The ice maker shall be supplied at the voltage and frequency marked on the rating plate. In case a range of voltage or frequency are indicated, the ice maker is supplied at the conditions giving the highest energy consumption.

The tolerance on power supply shall be ±2 % for voltage and ±1 % for frequency, in relation to the nominal values given on the marking plate or otherwise stated.

## 4.7 Set-up and operation of the ice maker

### 4.7.1 Ice maker set-up

The ice maker shall be set-up, heat exchangers and other accessories shall be connected, and the ice maker shall be adjusted in accordance with the manufacturer’s instructions prior to testing.

The ice maker shall be completely assembled, with all panels, doors and lids in their normal operating positions.

Ice storage bins shall be filled approximately one-half full of ice. Ice makers that convey ice to an ice storage bin shall be tested with the minimum length of conduit that can be used.

For air-cooled ice makers with air cooling features and with air inlet(s), ambient temperature(s) shall be measured at a point centred 300 mm from each inlet. The maximum temperature difference between this temperature and the ambient room temperature(s) shall not exceed 1,0 °C. For water-cooled ice makers, not provided with air-cooling features, ambient temperature shall be measured centred 300 mm from one of the sides of the cabinet (see Figure 1).

### 4.7.2 Ice maker operation

After the set-up the ice maker is switched on. No changes to the test room shall be made during operation of the ice maker under test that would impact the vertical ambient temperature gradient or the ambient air movement according to 4.3.

## 4.8 Accuracy of measurement and instrumentation

The accuracy of measurement shall be as follows:

— temperature: ±0,8 °C;

— total energy: ±2 %;

— mass: ±2 g;

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— time: ±1 s;

— dimensions: ±2 mm.

## 4.9 Test procedure

### 4.9.1 Simultaneous tests

Tests for energy consumption, water consumption and ice production capacity shall be undertaken simultaneously.

For temperature, measurements shall be carried out at least every 3 min.

For energy consumption, measurements shall be carried out at least every 1 min.

### 4.9.2 Stabilization

The ice maker shall be considered stabilized after three consecutive ice production capacity measurements with a tolerance between each ice production of ±3 % for batch-type ice makers and after a period of not less than two hours of operation for continuous-type ice makers.

### 4.9.3 Ice sampling

#### 4.9.3.1 General

After temperature stabilization, ice samples shall be collected according to the procedures described in 4.9.3.2 and 4.9.3.3.

#### 4.9.3.2 Batch-type ice maker

The collection of ice samples for batch-type machines shall start at a preselected point in the cycle and shall end at the same point in the cycle. One cycle comprises one complete freezing period followed by one complete harvesting period. At least 5 cycles for collection of ice samples shall be performed after the 3 stabilization cycles specified in 4.9.2.

The intercepted ice sample shall be collected after each cycle in a perforated container (such that any water present is drained) that has been pre- cooled with the ice produced by the ice-maker whilst stored in the ice storage bin, which is not more than half volume full of ice. The ice sample shall be immediately transferred in a non-perforated container and the mass shall be measured according to 4.9.1.

#### 4.9.3.3 Continuous-type ice maker

The test for continuous-type machines shall start at stabilization conditions, 5 test samples batches each lasting 20 min shall be taken in a non-perforated container precooled with the ice produced by the ice-maker whilst stored in the ice storage bin (half volume full of ice) and the mass shall be measured at the end of each 20 min period.

## 4.10 Recording

### 4.10.1 General

a) Ambient temperature (°C).

b) Supply water temperature (°C).

c) Input voltage (V).

d) Input frequency (Hz).

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#### 4.10.2 Ice production capacity test

a) Mass of each sample collected (kg).

b) For batch-type appliances, time to produce each sample (s).

#### 4.10.3 Water consumption test

a) Cooling water used, if any (l).

b) Potable water used in making ice, including the purging and harvesting stages (l).

c) Duration of test period (s).

#### 4.10.4 Energy consumption test

a) Energy consumption (kWh).

b) Duration of test period (s).

### 4.11 Calculations

#### 4.11.1 Ice production capacity

The ice production capacity (kg/24 h) of the ice maker shall be calculated as given by Formula (1):

$$\left(\frac{\sum_{i=1}^{5} M_i}{\sum_{i=1}^{5} T_i}\right) \times 86\,400 \tag{1}$$

where

$M_i$ is the mass of each intercepted sample, in kg;

$T_i$ is the time to produce each intercepted sample, in s.

#### 4.11.2 Cooling water used in condenser

The cooling water (litres/100 kg ice) used in the condenser shall be calculated as given by Formula (2):

$$\left(\frac{\sum_{i=1}^{5} V_{ci}}{\sum_{i=1}^{5} M_i}\right) \times 100 \tag{2}$$

where

$V_{ci}$ is the volume of cooling water used, in l;

$M_i$ is the mass of each intercepted sample, in kg.

#### 4.11.3 Potable water used in ice-making

The potable water (litres/100 kg ice) used in making ice shall be calculated as given by Formula (3):

$$\left(\frac{\sum_{i=1}^{5} V_{pi}}{\sum_{i=1}^{5} M_i}\right) \times 100 \tag{3}$$

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where

$V_{pi}$ is the volume of water used in making ice, including the purging and harvesting stages, in l;

$M_i$ is the mass of each intercepted sample, in kg.

#### 4.11.4 Energy consumption

The energy consumption (kWh/100 kg ice) of the ice maker shall be calculated as given by Formula (4):

$$\left(\frac{E}{\sum_{i=1}^{5} M_i}\right) \times 100 \tag{4}$$

where

$E$ is the total energy consumption of 5 cycles, in kWh;

$M_i$ is the mass of ice measured, in kg.

## 5 Ice quality measurement by method of calorimetry

### 5.1 Instrumentation

— Weighing scale, accurate to ±2 g, with a range of at least 0 to 25 kg.

— Temperature-measuring instrument for water, accurate to 0,8 °C with a range of at least –1 °C to 50 °C and a resolution of at least one tenth of a degree.

— Temperature measuring instrument for room (ambient) temperature, accurate to 0,8 °C, with a range of at least –1 °C to 40 °C and a resolution of at least one tenth of a degree.

— Timer readable to the nearest second.

### 5.2 Procedure for calorimeter constant determination

The verification of the calorimeter constant of the apparatus is used to determine specific heat of fusion for the ice product. This is to correct the effects of heat transfer with ambient temperature and heating effects of stirring the contents of the calorimeter. The procedure shall be carried out in duplicate.

a) Room temperature shall be within a range of 18 °C to 24 °C during the entire procedure.

b) Weigh the empty calorimeter and record its mass.

c) Add a quantity of water that is 5 times the mass of the ice to be added as in 5.2 e), ±60 g, and that has a temperature 10 °C ± 1 °C above room temperature. Record the water temperature and the combined mass of the calorimeter and water.

d) Stir at 1 ± 0,5 revolutions per second for 15 min and record the water temperature and room temperature just prior to the addition of the ice.

e) Within 1 min, add a mass of ice that is produced over a period of 15 min for the ice maker under test. This shall be within a range of 50 % to 200 % of the rated ice production or shall be 2,5 kg ± 150 g, whichever is less. Record the mass of the ice added. The ice shall be in the form of a single block of pure ice that has been allowed to reach an equilibrium temperature measured by a thermocouple embedded in the interior of the block of 0 °C. The block shall be free of trapped water. Time shall be recorded to the nearest second when all the ice has been added.

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