



Standard Specification for Gravity Convection and Forced Ventilation Incubators¹

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1. Scope

1.1 This specification covers the performance requirements for general purpose air incubators ordinarily used for incubating procedures, which have an incubating chamber up to 0.6 m³ (25 ft³) in volume. It is applicable to gravity and forced ventilation incubators designed to operate over all or part of the temperature range from 5°C above ambient to 75°C.

1.2 This specification does not include any requirements for the safe handling of harmful or disease bearing organisms.

1.3 The following precautionary caveat pertains only to the test method portions, Sections 4, 5, and 6, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Types

2.1 This specification covers the following four types of air incubators:

2.1.1 *Type 1A*—An incubator ventilated by gravity convection having a uniformity of temperature within 3 % of the differential between incubator and ambient temperature,

2.1.2 *Type 1B*—An incubator ventilated by gravity convection having a uniformity of temperature within 6 % of the differential between incubator and ambient temperature,

2.1.3 *Type 2A*—An incubator ventilated by forced ventilation having a uniformity of temperature within 2 % of the differential between incubator and ambient temperature,

2.1.4 *Type 2B*—An incubator ventilated by forced ventilation having a uniformity of temperature within 5 % of the differential between incubator and ambient temperature.

3. Performance Requirements

3.1 The temperature within the incubating chamber shall be controlled by an automatic device, and shall be uniform within the tolerances given in **Table 1**, when tested in accordance with Section 4.

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3.2 The rate of ventilation of the incubating chamber shall conform to the requirements specified in **Table 1** for the particular type of incubator when measured in accordance with the procedure given in Section 5.

3.3 The recovery time of the incubating chamber shall conform to the requirements specified in **Table 1** for the particular type of incubator, when tested in accordance with the procedure specified in Section 6.

4. Test Methods

4.1 Temperature Uniformity:

4.1.1 Place nine calibrated thermocouples (**Note 1**) made from iron-constantan or copper-constantan wires approximately 0.5 mm in diameter (No. 24 gauge) and having a junction size of not more than 2 mm (0.08 in.) in the empty incubating chamber with shelves in place, and vents open. Locate one thermocouple in each of the eight corners of the incubator approximately 5 cm (2 in.) from each wall, and place the ninth thermocouple within 2.5 cm (1 in.) of the geometric center of the chamber. A minimum length of 30 cm (12 in.) of wire for each thermocouple shall be inside the incubator to minimize the conduction of heat from the thermocouple.

NOTE 1—If calibrated thermocouples are not available, nine thermocouples made from the same spool of wire may be used, provided they give the same value for temperature when placed adjacent to one another in the incubating chamber at the temperature of the test.

4.1.2 Bring the incubator to the specified temperature and allow it to reach a steady state (**Note 2**). Record the temperature of the nine thermocouples for a period of at least 12 h and determine from the record the maximum deviation of each point from the desired temperature. The ambient room temperature shall vary by not more than a total of 5°C and the line voltage shall not vary by more than a total of 5 % during the test.

NOTE 2—Some incubators may require as much as 12 h to reach a steady state. If a steady state does not exist, there is a drift in the temperature toward the steady state condition.

5. Rate of Ventilation

5.1 Seal the ventilation ports, doors, and all apertures of the incubator with adhesive tape, or by other means to prevent any air from passing through the incubator (**Note 3**). Connect a Wh meter with the smallest division reading in 0.01 Wh in the electrical supply line to the incubator.

TABLE 1 Performance Requirements for Incubators

Characteristic	Type 1A	Type 1B	Type 2A	Type 2B
Deviation from specified temperature of test throughout incubating chamber during the 12 h period. Maximum percent of the differential between ambient and test temperature. Numbers in parentheses are for chamber temperature of 37°C and ambient of 25°C	3 (0.4°C)	6 (0.7°C)	2 (0.25°C)	5 (0.6°C)
Rate of Ventilation in Air Changes per H				
min	1	1	2	2
max	3	3	5	5
Recovery Time in Min, max	12	16	5	9

NOTE 3—In forced circulation incubators, the space around the motor shaft where it enters the incubator must be closed, but the motor speed must not be affected by the closure.

5.2 Heat the incubator to its maximum rated temperature, and while at this temperature measure the electrical energy consumption for a period of at least 4 h. Start and stop the test at corresponding points of the off-on cycle.

5.3 Then remove the seals, open the ventilation ports, and measure the consumption of electrical energy in the same manner as in 5.2. The ambient room temperature measured at a point approximately 2 m (6 ft) from the incubator approximately level with its base and at least 0.6 m (2 ft) from any solid object must be the same within 0.2°C during the two tests.

5.4 Calculate the number of changes per h of the air in the incubating chamber from the following equation:

$$N = 3590(X - Y)/VD\Delta T \quad (1)$$

where:

- N = number of air changes per h,
- X = average power consumption during ventilation, obtained by dividing the energy consumption determined from the Wh meter reading by the duration of the test in hours,

Y = average power consumption with no ventilation, computed in the same manner as X .

V = volume of the incubating chamber in cm^3 ,

D = density of the ambient room air during the test in g/cm^3 , and

ΔT = difference in temperature between the incubating chamber and the ambient room air in degrees Celsius.

6. Recovery Time

6.1 Place one thermocouple made from iron-constantan or copper-constantan wires approximately 0.5 mm in diameter (No. 24 gauge) and having a junction size of not more than 2 mm (0.08 in.) in the empty chamber with shelves in place, and vents open. Locate the thermocouple within 2.5 cm (1 in.) of the geometric center of the chamber.

6.2 Bring the incubator to 37°C and allow it to reach a steady state (Note 2). Record the temperature for ½ h. Open the outer and inner doors for 30 ± 1 s. Close the doors and measure the time required for the chamber to come back within the uniformity band for the type of incubator being tested, at 37°C.

7. Keywords

7.1 convection; forced; gravity; incubators; ventilation

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