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34.3 AO Temperature Test Procedure 1—Stabilized Temperature with Air Velocity Measurement

1. If temperature detectors are not already installed on the winding, then install them in accordance with the applicable efficiency test standard. If it is permissible to disassemble the motor, then the preferred location for the temperature detector(s) is on the winding end coils.¹ If it is not permissible to disassemble the motor, then install the temperature detector(s) on the stator iron (i.e., where the terminal box is located).
2. Perform the temperature test in the following manner:
 - a. Run the motor at rated load with air flow provided by an external blower.
 - b. Adjust the external blower in order to increase or decrease air flow over the motor so that rated air velocity can be achieved.
 - c. Rated air velocity is achieved as follows:

- 1) Air velocity shall be the average of three measurements on the motor's frame nearest the mid-point of the stator winding core. If the stator core position is unknown, then use the mid-point of the frame. It is recommended to be taken at 3, 9, and 12 o'clock positions unless one or more of those positions is obstructed by a terminal box or other protruding accessory.
- 2) The air velocity shall be measured within 1 inch from the surface of the motor's frame (for finned motors the measurement location shall be at no greater



motor with temperature detectors in similar locations, then operate the motor at the rated air velocity until the temperature rise change of the highest temperature detector is 1°C or less over a 30 minute period. Shut the motor and blower down and determine the average winding temperature² in accordance with the average winding temperature resistance method (see IEEE 112-2004 Section 5.8.5.1³).

Exception: for a single phase motor for which it is not possible to isolate the main winding from the auxiliary winding in order to measure its resistance separately, it is permissible to use the hottest main winding temperature measured by the detector as the average winding temperature.

- 2) If a temperature test has already been performed on a duplicate motor with temperature detectors in similar locations, then operate the motor at the rated air velocity until:

¹ For single phase motors, this is the end coils of the main winding.

² Throughout this Part 34, unless otherwise specified (for example, by the use of the phrase “by detector”), the terms “average winding temperature,” “temperature rise,” and “target temperature” are determined by applying the average winding temperature method described in IEEE 112-2004 Section 5.8.5.1, IEEE 114-2010 Section 5.3.2, or CSA C390 Clause 7.2.1. For single-phase motors, this value is for the main winding.

³ or IEEE 114-2010 Section 5.3.2 or CSA C390 Clause 7.2.1

- a) For polyphase motors: the temperature of the hottest detector multiplied by the following ratio is within 10°C of the average winding temperature by resistance from the previous temperature test on a duplicate motor:

(average winding temperature by resistance from the previous temperature test on a duplicate motor) / (temperature of the detector in this same location from the previous temperature test on a duplicate motor)
- b) For single-phase motors for which the main winding can be isolated from the auxiliary winding in order to measure its resistance separately: the temperature of the hottest detector multiplied by the following ratio is within 10°C of the average main winding temperature by resistance from the previous temperature test on a duplicate motor:

(average main winding temperature by resistance from the previous temperature test on a duplicate motor) / (temperature of the detector in this same location from the previous temperature test on a duplicate motor)
- c) For single-phase motors for which the main winding cannot be isolated from the auxiliary winding in order to measure its resistance alone: the temperature of the hottest detector is within 10°C of the hottest detector from the previous temperature test on a duplicate motor.

3. Perform the load test to the applicable efficiency test method (e.g., IEEE 112 method B, and CSA C390) with the external blower configured exactly as it was at the conclusion of the temperature test. When the load test is begun, the winding temperature must still be within 10°C of the stabilized winding temperature from step 2.d.

34.4 AO Temperature Test Procedure 2—Target Temperature with Air Flow

1. Method for determining target temperature
 - a. If motor temperature rise is not otherwise indicated then:
 - 1) For polyphase motors: select the appropriate target temperature from Table 34-1⁴ based on the indicated insulation class.
 - 2) For single-phase motors: the target temperature shall be 75°C⁵
 - b. If motor temperature rise is indicated in terms of an insulation class, then select the target temperature from Table 34-1 that corresponds to the temperature rise being defined in terms of an insulation class, i.e., if indicated insulation class is class “F” and indicated temperature rise is class “B,” then select 95°C target temperature.
 - c. If motor temperature rise is indicated as a numerical value (i.e., 50°C) then the target temperature is the sum of that temperature rise (50°C) and the reference ambient of 25°C (resulting in a target temperature of 75°C in this example).

⁴This table is equivalent to Table 1 in IEEE 112-2004.

⁵This is consistent with IEEE 114-2010 Section 8.2.1 and CSA C747 Clause 6.2.

Table 34-1
Target Temperature in °C (Determined by applying the average winding temperature method described in IEEE 112-2004, Section 5.8.5.1⁶ including 25°C ambient)

Insulation Class	Target Temperature in °C
A	75
B	95
F	115
H	130

2. If temperature detectors are not already installed on the winding, then install them in accordance with the applicable efficiency test standard. If it is permissible to disassemble the motor, then the preferred location for the temperature detector(s) is on the winding end coils⁷. If it is not permissible to disassemble the motor, then install the temperature detector(s) on the stator iron (i.e., where the terminal box is located).
3. Perform the temperature test in the following manner:
 - a. Run the motor at rated load with air flow provided by an external blower.
 - b. Monitor the temperature detector(s), and if the highest of the reading(s) cannot get within the following tolerance of the target temperature defined in step 1, then it is recommended to adjust the external blower in order to increase or decrease the air velocity over the motor:
 - 1) If the temperature detector(s) are located on the winding, then the tolerance is $\pm 20^{\circ}\text{C}$.
 - 2) If the temperature detectors(s) are located on the stator iron, then the tolerance is $-10^{\circ}\text{C} / -40^{\circ}\text{C}$.
 - c. When the highest of the temperature detector reading(s) falls within an appropriate tolerance, such as that proposed in step 3.b, of the target temperature, then shut the motor and blower down and determine the average winding temperature in accordance with the average winding temperature resistance method (See IEEE-112-2004, section 5.8.5.1⁸).

Exception: for a single phase motor for which it is not possible to isolate the main winding from the auxiliary winding in order to measure its resistance separately, it is permissible to use the hottest main winding temperature measured by the detector as the average winding temperature.

 - d. If the average winding temperature is within 10°C of the target temperature defined in step 1, then:
 - 1) Make note of the ratio of (average winding temperature) to (highest of the temperature detector readings).
 - 2) With the external blower configured exactly as it was immediately prior to shutting the motor down in step 3.c, restart the motor and run at rated load until

⁶ or IEEE 114-2010 Section 5.3.2. or CSA C390 Clause 7.2.1

⁷ For single phase motors, this is the end coils of the main winding.

⁸ or IEEE 114-2010 Section 5.3.2 or CSA C390 Clause 7.2.1

the following falls within 10°C of the target temperature defined in step 1: (highest of the temperature detector readings) * (the ratio determined in step 3.d.i). This is done because the winding may have cooled outside the ±10°C tolerance while the average winding temperature was being measured.

- 3) Proceed to the load test in step 4.
- e. If the average winding temperature measured in step 3.c is not within 10°C of the target temperature defined in step 1, then:
 - 1) Make note of the ratio of (average winding temperature) to (highest of the temperature detector readings) for later use.
 - 2) Adjust the external blower's air velocity over the motor, then restart the motor and run at rated load while monitoring the temperature detectors. Continue until the highest temperature detector is such that the following value falls within 10°C of the target temperature defined in step 1:

(highest of the temperature detector readings) * (the ratio determined in step 3.e.i)
 - 3) Note: Multiple adjustments to the external blower setup and/or the length of operating time may be required to achieve an average winding temperature that is within 10°C of the target temperature.
 - 4) Proceed to the load test in step 4.
4. Perform the load test to the applicable efficiency test method (i.e., IEEE 112 method B, CSA C390, etc.) with the external blower configured exactly as it was at the conclusion of the temperature test. When the load test is begun, the average winding temperature must be within 10°C of the target temperature defined in step 1.

34.5 AO Temperature Test Procedure 3—Target Temperature without Air Flow

1. Method for determining target temperature.
 - a. If motor temperature rise is not otherwise indicated then:
 - 1) For polyphase motors: select the appropriate target temperature from Table 34-1 based on the indicated insulation class.
 - 2) For single-phase motors: the target temperature shall be 75°C
 - b. If motor temperature rise is indicated in terms of an insulation class, then select the target temperature from Table 34-1 that corresponds to the temperature rise being defined in terms of an insulation class, i.e., if indicated insulation class is class "F" and indicated temperature rise is class "B," then select 95°C target temperature.
 - c. If motor temperature rise is indicated as a numerical value (i.e., 50°C) then the target temperature is the sum of that temperature rise (50°C) and the reference ambient of 25°C (resulting in a target temperature of 75°C in this example).
2. If temperature detectors are not already installed on the winding, then install them in accordance with the applicable efficiency test standard. If it is permissible to disassemble the motor, then the preferred location for the temperature detector(s) is on the winding end coils⁹. If it is not permissible to disassemble the motor, then install the temperature detector(s) on the stator iron (i.e., where the terminal box is located).

⁹For single phase motors, this is the end coils of the main winding.

3. Begin no load temperature test without air flow.
 - a. Monitor all temperature detectors and their respective temperatures.
 - b. Operate the motor until the highest temperature detector reading is within 10°C of the target temperature in Table 34-1.
 - c. If the conditions given in 3.b cannot be satisfied then proceed to step 4.
 - d. If the conditions given in 3.b are satisfied:
 - 1) Shutdown motor
 - 2) Measure and record resistance between any two motor line leads.

Exception: For a single phase motor for which it is not possible to isolate the main winding from the auxiliary winding in order to measure its resistance separately, it is permissible to use the hottest main winding temperature measured by the detector as the average winding temperature.

 - e. If the average winding temperature determined in accordance with the average winding temperature method (See IEEE-112-2004, section 5.8.5.1¹⁰) is within 10°C of the target temperature.
 - 1) Proceed to step 5.
 - f. If the average winding temperature is not within 10°C of the target temperature:
 - 1) Determine the ratio of average winding temperature to the highest of the temperature detector readings.
 - 2) Correlate highest temperature detector reading to average winding temperature with the formula: (highest of the temperature detector readings) * (the ratio determined in step 3.f.i). Proceed with temperature testing as required to insure compliance with the ±10°C tolerance between average winding temperature and target temperature before proceeding to the load test portion of the efficiency test.
 - 3) If the correlated temperature is more than 10°C lower than the target temperature, then additional load is required. Proceed to step 4.
4. Begin loaded temperature test without air flow.
 - a. Couple the motor to a dynamometer:
 - 1) Establish a load torque that will result in the desired target temperature (Multiple load adjustments may be required to attain target temperature).
 - b. Monitor all temperature detectors and their respective temperatures.
 - c. Operate the motor until the highest temperature detector reading is within 10°C of the target temperature in Table 34-1.
 - d. If the conditions given in step 4.c are satisfied:
 - 1) Shutdown motor.
 - 2) Measure and record resistance between any two motor line leads.

¹⁰or IEEE 114-2010 Section 5.3.2 or CSA C390 Clause 7.2.1

