

RC 911.09

Manual of Testing

CALIBRATION OF A DRYING OVEN

1. SCOPE

This method describes the procedure for calibrating a drying oven which has a 105-110°C operating range, using the method given in AS 1289.0. Appendix B describes the procedure for calibrating a low temperature drying oven Ref. AS 1289.1.1.

2. DEFINITION

The working space of the oven, within which the samples are placed, is defined as the space not closer than 50mm from the walls, ceiling, floor and inside the door.

3. PRECAUTIONS

- (a) Thermocouples: It is essential that the thermocouple wires are not kinked. Contrary to popular belief the emf in a thermocouple is not generated at the hot junction. The thermoelectric effect is a bulk property of the metals; and the output does not agree with the tabulated values if there are any significant stresses or inhomogeneities, in the wires, in regions of steep temperature gradient.
- (b) Maximum Thermometers: It is essential that maximum thermometers be read hot, and vertical (bulb down). If they are left to cool down, before reading, the reading will drop by more than 2°C; and if they are not read bulb down the mercury can, and will, move depending on the thermometer inclination.
- (c) Oven thermometers: If an oven thermometer is used in a protective metal sheath, it must not be used at the minimum insertion depth, as the thermally conducting sheath can reduce the apparent temperature. ie If using a thermometer with a metal sheath make sure that it protrudes well into the oven, preferably to the maximum possible distance.

4 APPARATUS

- (a) Balance, with a limit of performance not exceeding $\pm 0.5g$.
- (b) Petri dishes, 100mm diameter, about 50mm high.

- (c) Covers for Petri dishes.
- (d) Thermometer readable to 0.5°C.
- (e) YEW Portable Hybrid Recorder. Model 3087. and 10 Copper Constantan thermocouples; or
- (f) Nine calibrated maximum thermometers

5 PROCEDURE

Perform the following measurements after a minimum of 12 hours continuous operation with the door closed, the vent open as far as possible consistent with the attainment of the temperature requirements, and forced ventilation operating, if fitted.

- (a) Temperature Range Test
 - (i) Preheat the empty oven with the thermostat set so that the indicated temperature remains between 105°C and 110°C, for a minimum of 12 hours.
 - (ii) The thermometer reading shall then be recorded five times at 1 hourly intervals, without adjustment of the thermostat to obtain five readings.
- (b) Maximum Temperature Test - Thermocouples

With the oven empty, place a thermocouple at each of the four corners of the top and bottom shelves of the preheated oven and at the centre of the middle shelf (Total 9). Place one thermocouple at the top, rear of the chart recorder to measure the ambient temperature. Note the above precautions and place the thermocouples carefully i.e. do not kink around door seals - put in through vent if door likely to cause kink/s. Tie, or peg, lightly in position on shelves - **do not** twist thermocouples to hold in place.

Confirm the recorder's chart scaling prior to the calibration. With the power on, and the **KEY LOCK** switch set to left, press the list button. The results should read as follows:

CHART SPEED = 50 mm/h

CH	RANGE	LEFT END	RIGHT END
01	Type T	95.0°C	115.0°C
02	Type T	95.0°C	115.0°C
03	Type T	95.0°C	115.0°C
04	Type T	95.0°C	115.0°C
05	Type T	95.0°C	115.0°C
06	Type T	95.0°C	115.0°C
07	Type T	95.0°C	115.0°C
08	Type T	95.0°C	115.0°C
09	Type T	95.0°C	115.0°C
10	Type T	10.0°C	30.0°C
11	SKIP		
12	SKIP		
13	SKIP		

Select the **PRINT** function key to start the calibration, then slide the **KEY LOCK** switch to the right.

After at least 12 hours, inspect the chart of the temperature readings and record the maximum temperatures, and the corresponding thermocouple numbers. If necessary apply corrections to the thermocouple readings, from the recorder/ thermocouple calibration report.

If any channel exceeds the 110°C limit then either the oven has a localised problem, that must be further investigated or the controller may need to be reset and the calibration repeated.

If all nine channels cannot be readily distinguished, on the chart, it may be necessary to run the test for some time longer with the chart speed increased (up to 900mm/hour), to help distinguish the individual channels. If some channels cannot be individually distinguished and all channels are under 110°C then the best approach is to quote the maximum temperature of the hottest location (channel) and perhaps use the tabulated temperature outputs to determine the other channels. If one or more locations are significantly lower in temperature than the others then it would be advisable to recheck the evaporation rate - at least for the suspect locations, but preferably for the whole oven.

(c) Maximum Temperature Test - Maximum Thermometers

With the oven empty, place a maximum thermometer at each of the four corners of the top and bottom shelves of the preheated oven and at the centre of the middle shelf (Total 9).

After at least 12 hours, remove each maximum thermometer and read while still hot and record the maximum temperatures, and the corresponding thermometer numbers. If necessary apply corrections to the thermometer readings, from the thermometer calibration report.

If any location exceeds the 110°C limit then either the oven has a localised problem, that must be further investigated or the controller may need to be reset and the calibration repeated.

If one or more locations are significantly lower in temperature than the others then it would be advisable to recheck the evaporation rate - at least for the suspect locations, but preferably for the whole oven.

(d) Evaporation Test:

This test is required when the oven is (a) new, (b) repaired or (c) suspected of having a problem.

- (i) Label the Petri Dishes and corresponding covers and determine the mass of each dish plus cover.
- (ii) Add 200g of water at 20 ± 2°C to each dish and record total mass of dish plus cover plus water.
- (iii) For ovens of about 0.15m³ volume, place a Petri Dish without cover near each of the four corners of the top and bottom shelves on the edges of the working space of the oven.

For ovens of 0.28m³ volume, place four dishes on the centre shelf as well.

For ovens of 0.47 m³ volume, place seven Petri Dishes on each of the three shelves, one in each corner, one centre rear, one centre front and one centre.

For ovens other than those specified above of greater or less volume than 0.15m³, increase or reduce the number of Petri dishes by one for each 0.03m³ greater or less than 0.15m³ and arrange the dishes as evenly as possible in the working space of the oven.

- (iv) Record the time the door of the oven is closed, at the commencement of the test and continue heating for 4 hours without adjustment of the thermostat setting.
- (v) After 4 hours remove the Petri Dishes from the oven, cover and allow to cool. Determine the mass of each Petri Dish plus water plus cover.
- (vi) For each Petri dish calculate the rate of evaporation in grams/hour. If all the water evaporates from a dish, assume that the rate of evaporation from that dish was 50g/hr.
- (vii) Calculate the average rate of evaporation.

6. REPORT

Report the following:

- (a) identification of oven
- (b) date/s of calibration
- (c) the five temperature range readings to the nearest 0.5°C.
- (d) maximum temperature to the nearest 0.5°C
- (e) evaporation rate at each point measured in g/hr
- (f) average evaporation rate in g/hr.
- (g) the number of vents; and whether they are open, part open or closed.

APPENDIX A REQUIREMENTS

1. High Temperature (105-110°C)

(a) General Requirements

The purpose of a high temperature soil drying oven is to dry a sample of soil to a constant mass in accordance with Australian Standard 1289.0 "Methods of testing soils for engineering purposes - Apparatus Drying Ovens".

(b) Specific Requirements

Drying ovens shall meet the following requirements:

- (i) Be provided with a thermometer whose sensing element is located in the air stream moving towards the vents of the cabinet, and not less than 50mm below the ceiling of the cabinet. The thermometer shall be located so that it can be observed from the working space in front of the cabinet. (In the case of modern ovens with digital temperature indication (and no hole in the top for a mercury in glass thermometer) the digital readout shall be taken as a replacement for the above thermometer, and hereafter when thermometer is mentioned it shall be taken to also include the digital readout (Note. Not the control setting).

- (ii) Be fitted with an automatic control device for maintaining the oven temperature within the range 105-110°C when empty and with the vents open. The oven temperature shall be measured with a thermometer (Refer (i) above).

- (iii) Be adequately vented to permit the escape of moisture laden air; so that the oven complies with the specified evaporation rate.

- (iv) The maximum temperature at any point within the working space shall not exceed the upper limit 110°C.

- (v) An oven of satisfactory efficiency should have a minimum average evaporation rate of 15 g/hr and a minimum of 10 g/hr for any individual dish.

2. Low Temperature

Requirement

Thermostatically controlled drying oven capable of maintaining a temperature of 45°C to 50°C (optional).

APPENDIX B

CALIBRATION PROCEDURE FOR LOW TEMPERATURE OVEN

1 SCOPE

This appendix describes the procedure for calibrating a soil drying oven which has a 45°C to 50°C operating range.

Confirm the Recorder's chart scaling prior to the calibration. With the power on, and the **KEY LOCK** switch set to left, press the list button. The results should read as follows:

2 DEFINITION

The working space of the oven, within which the samples are placed, is defined as the space not closer than 50mm from the walls, ceiling, floor and inside the door.

CHART SPEED = 50 mm/h

CH	RANGE	LEFT END	RIGHT END
01	Type T	35.0°C	55.0°C
02	Type T	35.0°C	55.0°C
03	Type T	35.0°C	55.0°C
04	Type T	35.0°C	55.0°C
05	Type T	35.0°C	55.0°C
06	Type T	35.0°C	55.0°C
07	Type T	35.0°C	55.0°C
08	Type T	35.0°C	55.0°C
09	Type T	35.0°C	55.0°C
10	Type T	10.0°C	30.0°C
11	SKIP		
12	SKIP		
13	SKIP		

3 APPARATUS

- (a) Thermometer readable to 0.5°C.
- (b) YEW Portable Hybrid Recorder. Model 3087. and 10 Copper Constantan thermocouples; or
- (c) Nine calibrated maximum thermometers.

4 PROCEDURE

All the following measurements shall be taken after a minimum of 4 hours continuous operation with the door closed, the vent open as far as possible consistent with the attainment of the temperature requirements, and forced ventilation operating, if fitted.

Select the **PRINT** function key to start the calibration, then slide the **KEY LOCK** switch to the right.

- (a) Temperature Range Test.
 - (i) Preheat the empty oven with the thermostat set so that the indicated temperature remains between 45°C and 50°C, for a minimum of 4 hours.
 - (ii) The thermometer reading shall then be recorded five times at 1 hourly intervals, without adjustment of the thermostat.

At the end of the 4 hour test, the chart of the temperature readings shall be inspected and the maximum temperatures, and the corresponding thermocouple numbers recorded on the report form. If necessary apply corrections to the thermocouple readings, from the recorder/thermocouple calibration report on the oven report form.

- (b) Maximum Temperature Test. - Thermocouple

If any channel exceeds the 50°C limit then either the oven has a localised problem, that must be further investigated or the controller may need to be reset and the calibration repeated.

With the oven empty, maximum temperatures shall then be determined by placing a thermocouple at each corner of the working space of the preheated oven and at the centre of the middle shelf (Total 9). Place one thermocouple at the top, rear of the chart recorder to measure the ambient temperature. Run the test for a minimum of 4 hours. Note the above precautions and place the thermocouples carefully i.e. do not kink around door seals - put in through vent if door likely to cause kink/s. Tie, or peg, lightly in position on shelves - **do not** twist thermocouples to hold in place.

If all nine channels cannot be readily distinguished, on the chart, it may be necessary to run the test for some time longer with the chart speed increased (up to 900mm/hour), to help distinguish the individual channels. If some channels cannot be individually distinguished and all channels are under 50°C then the best approach is to quote the maximum temperature of the hottest location (channel) and perhaps use the tabulated temperature outputs to determine the other channels.

(c) Maximum Temperature Test. - Maximum Thermometer

With the oven empty, place a maximum thermometer at each of the four corners of the top and bottom shelves of the preheated oven and at the centre of the middle shelf (Total 9).

The test shall run for a minimum of 4 hours. Note the above precautions.

At the end of the 4 hour test, read the maximum thermometers, while still hot; record the maximum temperatures, and the corresponding thermometer numbers on the report form. If necessary apply corrections to the thermometer readings, from the maximum thermometer calibration report on the oven report form.

If any location exceeds the 50°C limit then either the oven has a localised problem, that must be further investigated; or the controller may need to be reset and the calibration repeated.