Hermetically-sealed glazing: laboratory testing procedures

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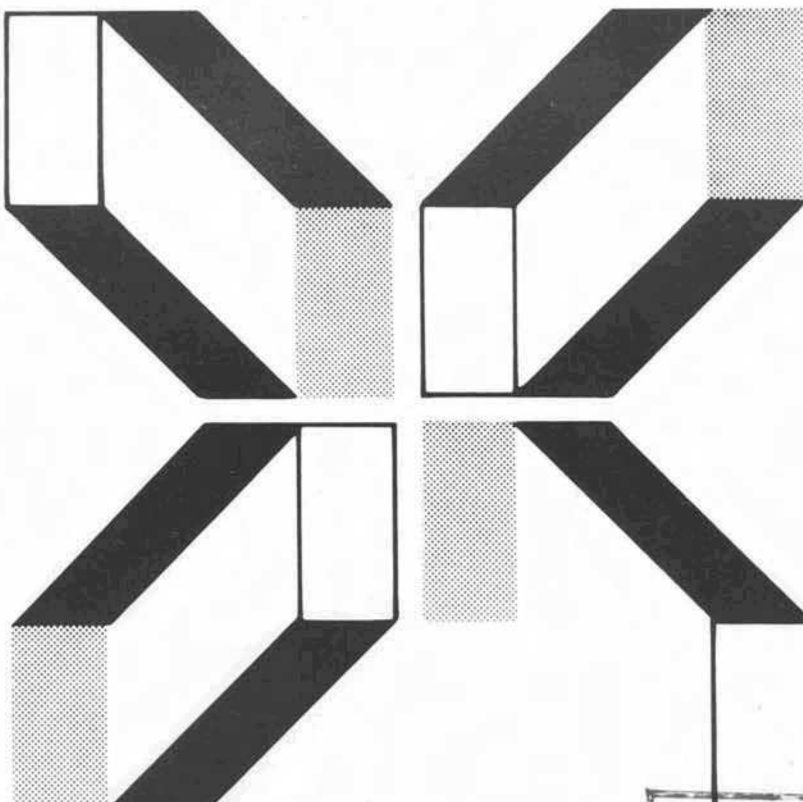

Canada

HERMETICALLY-SEALED GLAZING: LABORATORY TESTING PROCEDURES

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R.P. Bowen and R.G. Perrault

ABSTRACT

Until 1986, the Institute for Research in Construction (IRC) ran the only independent test facility in Canada capable of testing sealed glazing units to the Canadian standard CAN2-12.8 "Insulating Glass Units". Since private laboratories have expressed an interest in conducting these tests for the industry, the laboratory procedures used at IRC have been summarized in this Note to aid in setting up and operating similar test facilities. Details on the dew-point determination, initial seal, weather-cycling, high-humidity cycling, and ultraviolet-exposure tests are given.

RÉSUMÉ

Jusqu'en 1986, l'Institut de recherche en construction (IRC) possédait la seule installation canadienne permettant de réaliser des essais commerciaux sur des panneaux à vitres étanches pour conformité à la norme canadienne CAN2-12.8 "Panneaux isolants en verre". Les laboratoires privés s'étant montrés intéressés à effectuer ces essais pour l'industrie, l'IRC a bien voulu résumer à son intention, dans cette Note, ses méthodes d'essai en laboratoire afin d'aider le secteur privé à mettre sur pied et à exploiter des installations d'essai semblables. On donne ici des précisions concernant la détermination du point de rosée ainsi que les essais d'étanchéité initiale et d'exposition aux cycles d'intempéries, aux cycles à taux d'humidité élevé et aux rayons ultraviolets.

INTRODUCTION

Sealed glazing units have been widely used in Canada for over twenty years. When they were first used, there were no standards, and some products exhibited poor field performance. The test procedures developed by the Institute for Research in Construction (IRC), National Research Council of Canada, to assess sealed glazing units form the basis of the present Canadian standard CAN2-12.8-M76 "Insulating Glass Units", as well as other standards around the world. Until 1986, DBR ran the only independent test facility in Canada capable of testing to the standard. Since private laboratories have expressed interest in conducting these tests, this Note describes the laboratory procedures used at IRC to assist in setting up similar facilities.

The standard CAN2-12.8-M76 is a performance-based standard requiring the assessment of a number of samples submitted by the applicant. Briefly, the procedures consist of determining the dew point of the air within the sealed space and assessing for initial seal leaks in 18 of 20 submitted samples. From the 18 samples, 2 are selected for exposure in an ultraviolet (UV) chamber, 4 in a weather-cycling apparatus, and 8 in a high-humidity chamber. Lastly, the final dew point of each of the 12 units exposed to the weather and high-humidity cycles is determined.

An outline of each test is provided in the following sections. Readers are, however, referred to the standard in place at time of testing for details and current revisions.

GENERAL INSTRUCTIONS

Twenty 355 × 510 mm hermetically-sealed glazing units (double or triple) are received from the manufacturer for tests, in accordance with the standard. After the units have been individually removed from the shipping crates and inspected for damage or flaws, they are placed on a window cart which holds the units in a vertical position (Figure 1). This cart should be designed so that an equal load on each lite of the unit is maintained, to prevent any shifting that may occur if the weight of the unit is borne by one lite only (Figure 2). The principle of equal support on all lites of a unit should be observed during all stages of testing and storage.

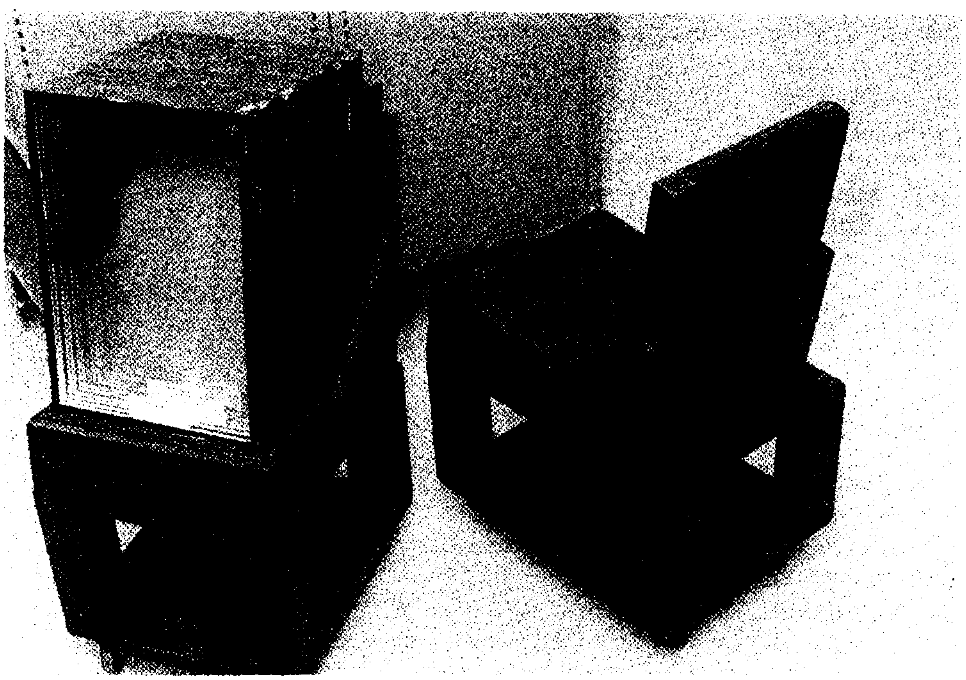

Figure 1. Window carts

The temporary edge channels or caps, put on the glazing units for handling, may be left on while the units are handled in the laboratory. They should, however, be removed before the units are installed in the weather-cycling, high-humidity and UV-exposure apparatuses.

To ensure that all the stages of testing are in accordance with the standard, temperatures are monitored and recorded for each apparatus by means of a multi-point data recorder.

SAMPLE SELECTION AND IDENTIFICATION

After selecting at random 18 units in good condition from the set supplied by the applicant, sequentially number them with a permanent water-resistant marker. For triple units, the side with the number is considered as side 1. Record any information on attached labels from inspection agencies, as well as flaws or damage observed during the initial inspection. At this stage, check the test application and the cross-section drawings of the units to ensure that all required items have been provided and that the proper units have been received for testing.

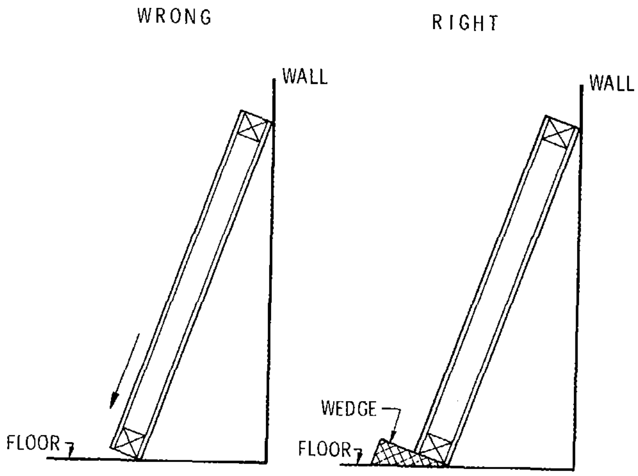

Figure 2. Sealed unit edge support

INITIAL SEAL TEST

The 18 units are placed, in order of their identification number, in the seal-leakage vacuum chamber (Figure 3) where they are exposed to a vacuum of 10 kPa for $2\frac{1}{2}$ hours. The glass deflection is measured once the vacuum has been reached, again after $2\frac{1}{2}$ hours, and again after the vacuum has been released. The deflection measurements before and after testing are compared with the criteria in the standard to determine whether the units have passed or failed.

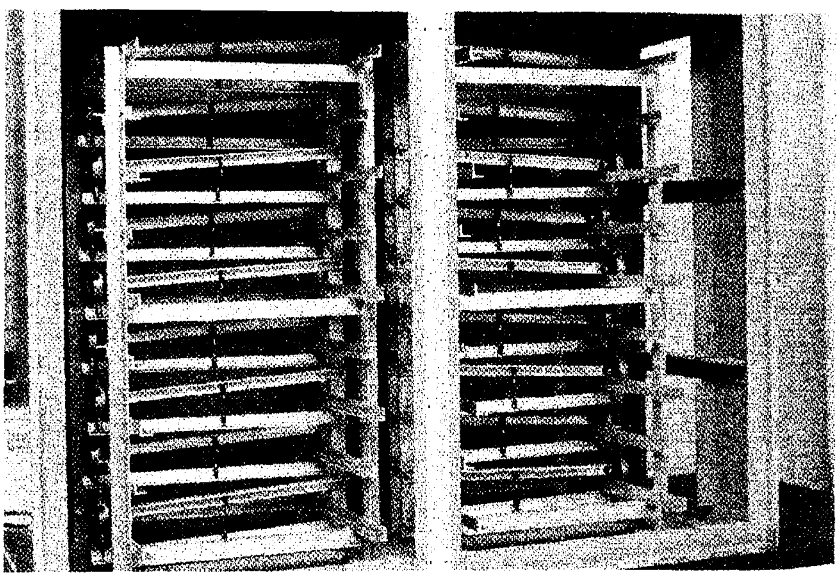

Figure 3. Seal leakage vacuum chamber

To install the units in the chamber, separate the two arms holding the dial indicators with one hand while sliding each unit into place with the other. Gently release the arms so that the contact pins land smoothly. After all the units are in place, adjust the dial indicators used to measure glass deflections to the same setting. The dial setting, which depends on the thickness of the unit, should allow for deflection of at least 5 mm in either direction. Record this setting as the initial reading (see Table 1 for sample record sheet). Then tape the access panel into place, and start the vacuum pump. Note the start time. Once the low pressure has been reached, note the readings on the dials and record them (column 1 of record sheet). After 2½ hours, read and record the deflection (column 2). Then turn off the vacuum pump and allow the chamber to return to atmospheric pressure without removing the access panel or opening the bleed-off valve. Once the chamber is back to atmospheric pressure, take a final set of readings and record them (final). Lastly, remove the units from the chamber.

This test is conducted at a laboratory temperature of 22°C. A thermocouple to monitor laboratory air temperature is centrally located in the laboratory, freely hanging 300 mm from the ceiling.

INITIAL DEW-POINT TEMPERATURE TEST

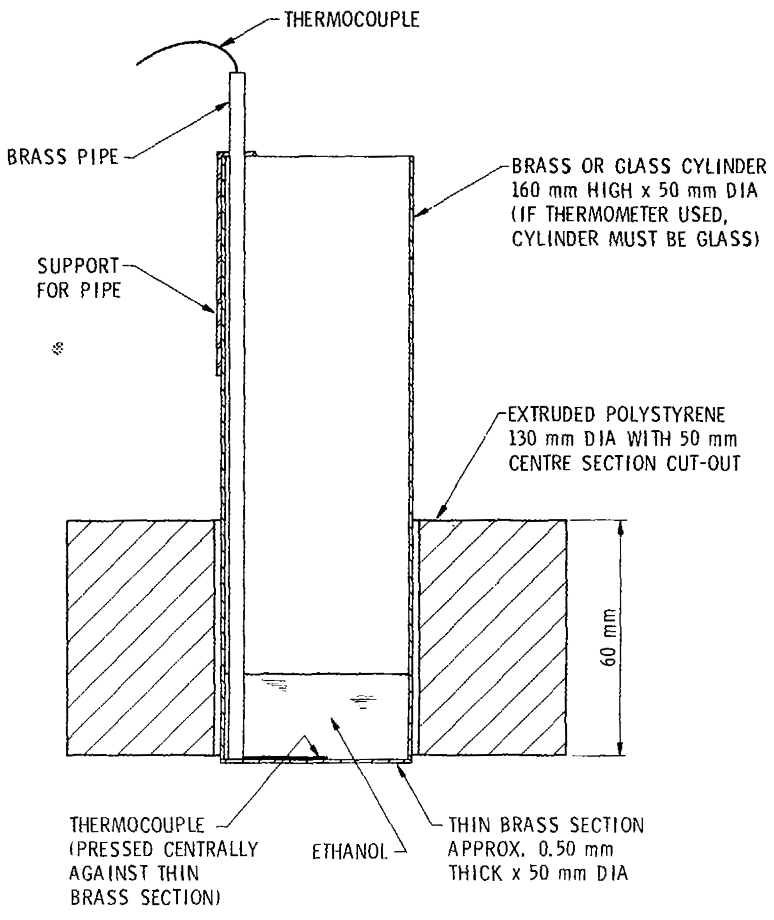

Figure 4. Dew-point apparatus

The dew point is a condition that relates to the amount of moisture in the air of the sealed space. The colder the dew point, the less the amount of moisture present in the air. The dew point of the 18 units is determined by using a Dew Point Apparatus (DPA) (Figure 4). By adding dry ice and alcohol to the DPA, the temperature of the brass bottom can be lowered to the desired level. A lighting box (Figure 5) is used for observing the moisture deposit following removal of the DPA.

To begin the test, place approximately 75 ml of ethanol into the DPA together with enough dry ice to cool the ethanol to the desired temperature. Place a unit on the lighting box, which is positioned with

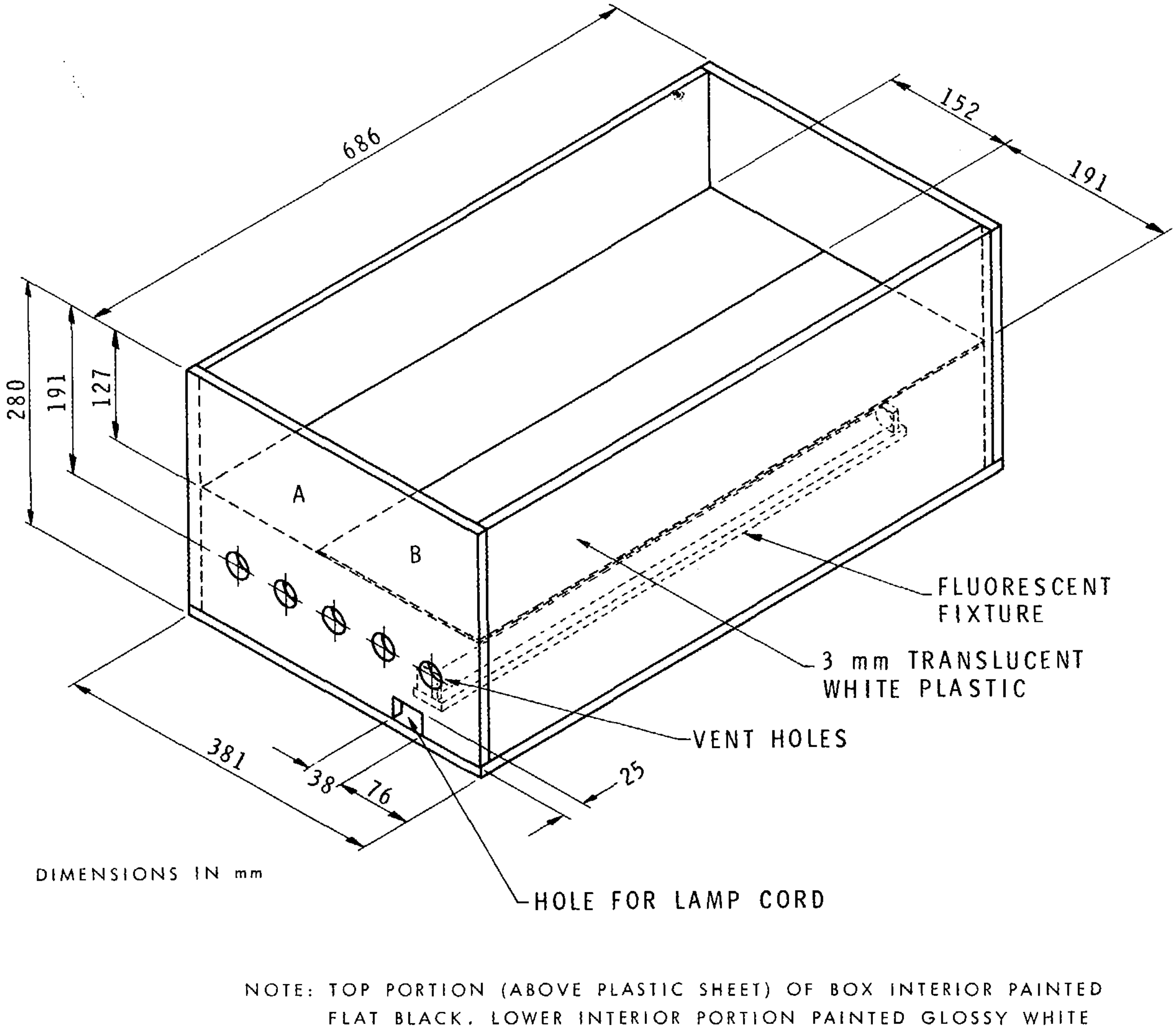

Figure 5. Light box for dew-point test

the translucent plastic side closest to the operator. (If two DPAs are available, two units can be placed on the box at once.) Apply a thin film of alcohol to the face of the unit directly above the lighted portion of the box and rest the DPA against the unit for 3 minutes. Note the amount of deposit immediately after removing the DPA. The surface will have to be wiped with a small brush or cloth wetted with alcohol to remove outer surface condensation and facilitate viewing the deposit. The black portion of the viewing box can be used as a background for making the observation.

Determining a dew point close to the pass/fail criteria may require several attempts. Test first at the coldest state possible. If no frost or moisture deposit occurs, record it as such (NF). If there is a deposit, raise the temperature of the DPA and repeat the procedure. Before determining a second dew point, reheat the glass to near room temperature. This reheating can be made easier by placing a flat piece of metal (preferably aluminum due to its high conductance), equal to or greater than the area of the DPA. To reduce the possibility of an erroneous reading, locate the next dew point at least 175 mm away from the previous one. Ideally, when the dew point temperature is reached, only faint condensation should be visible.

The device to measure the temperature of the dry ice and ethanol solution should be recalibrated annually at a reliable physics calibration centre.

After the initial dew point has been determined, units are selected for the UV-exposure, weather-cycling and high-humidity-cycling tests.

UV-EXPOSURE TEST

Two of the eighteen units are exposed to UV radiation and heat in a UV-exposure box (Figure 6). The air in the box is maintained at 60°C. A cold plate, maintained at 22°C, is mounted on the upper lite of each test unit. During the test, organic vapours are driven from the sealant and any other component parts by the high temperature and UV exposure. These vapours, if not absorbed by the desiccant in the unit, are condensed on the surface of the glass by the cold plate. Following a 7-day exposure, each unit is placed in a viewing box (Figure 7) and observed for evidence of a deposit on the inside surface of the glass lite adjacent to the cold plate.

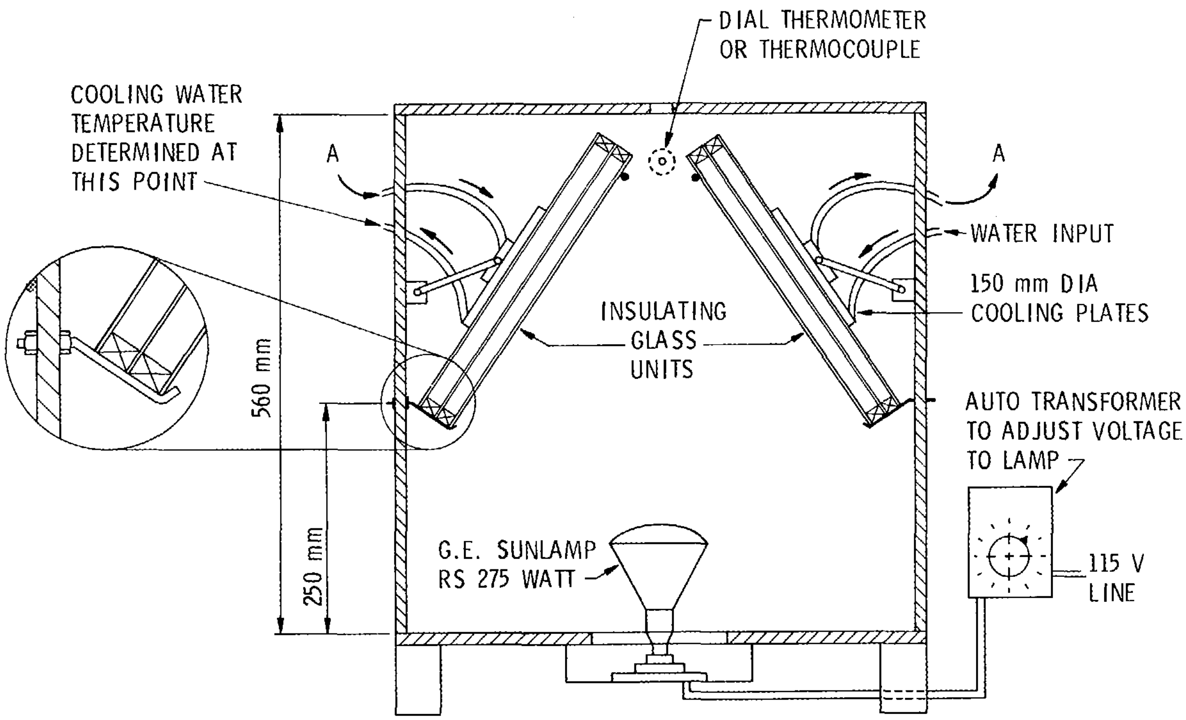

Figure 6. Ultraviolet exposure box

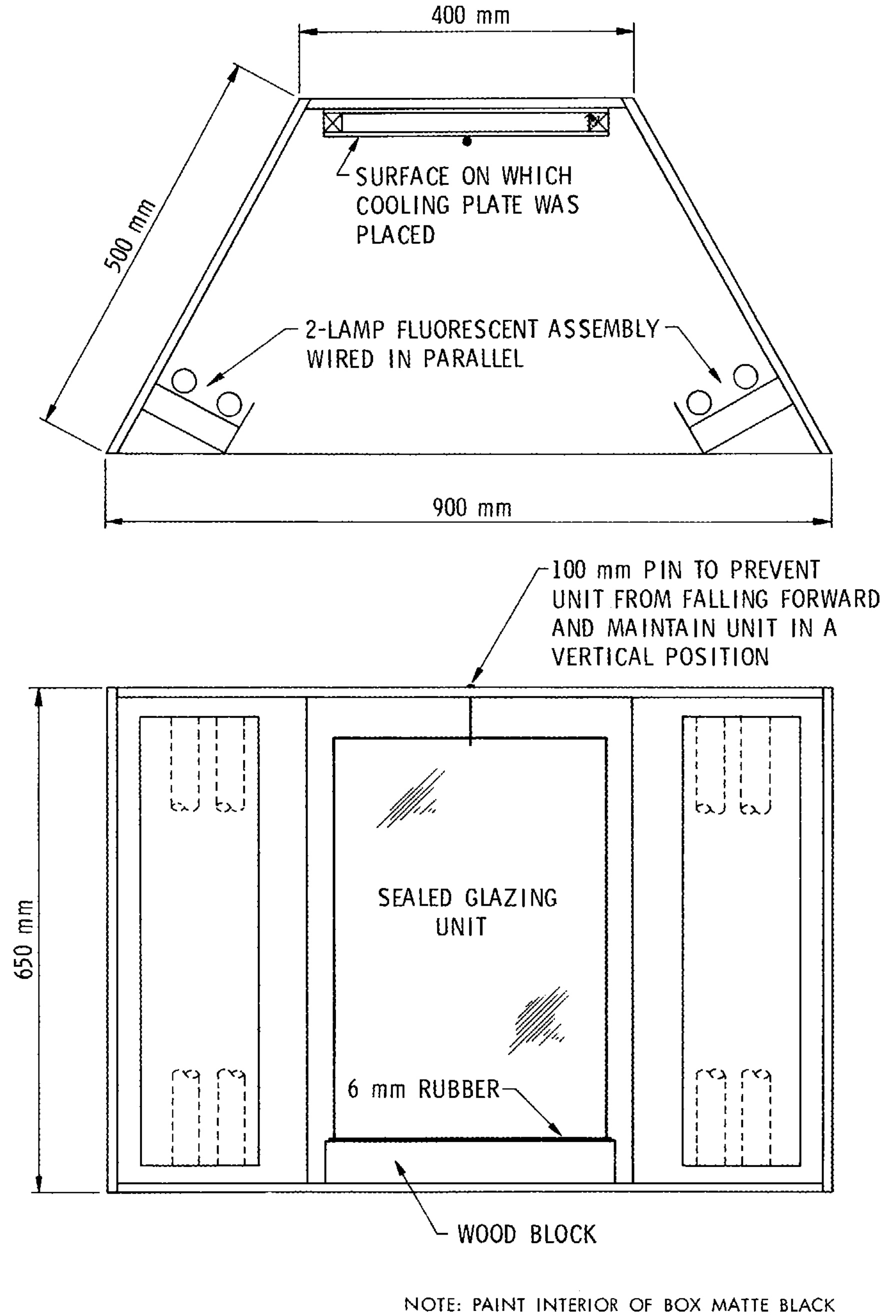

Figure 7. Viewing box for ultraviolet exposure test

The UV-exposure box is made of plywood and lined with aluminum foil. The UV and heat source is a G.E. Sunlamp (RS275W) mounted in the bottom of the box and powered through a variac. The two test units are placed in the box and supported at an angle of about 45° above the lamp. The cold plates are supplied with a mixture of hot and cold water to maintain a temperature of 22°C. The lid of the box contains a 30 mm × 60 mm adjustment hole which can be progressively uncovered to make fine adjustments to the air temperature in the box.

To begin the procedure, select 2 units from the set of 18. Clean the units on both faces with glass cleaner and install them in the UV-exposure box. Then place the cold plate on the upper lite of each unit. The cold plate must rest flatly on the centre of the unit, and all lites of the unit should rest equally on the supports. Turn on the lamp and adjust the variac to provide the specified UV intensity and approximate temperature. Fine temperature adjustments can be made by changing the area of the hole in the lid. Once the temperature has been reached, measure the UV intensity with a UV-intensity meter through the opening in the lid to ensure that it complies with the standard. Adjust the temperature of the water running through the cold plates to maintain 22°C throughout the test.

After the two units have been exposed for 7 days, switch off the UV lamp and remove the units once they are cool enough to handle. Immediately following removal, clean each unit with glass cleaner and place it in the viewing box, in such a way that it can be viewed through the surface on which the cold plate was placed during the test. Darken the room to eliminate any glare on the unit, and turn on the viewing lamps. Standing about 2 m directly in front of the unit with an eye level at mid-height of the unit, observe it for any evidence of a deposit on the interior glass surface.

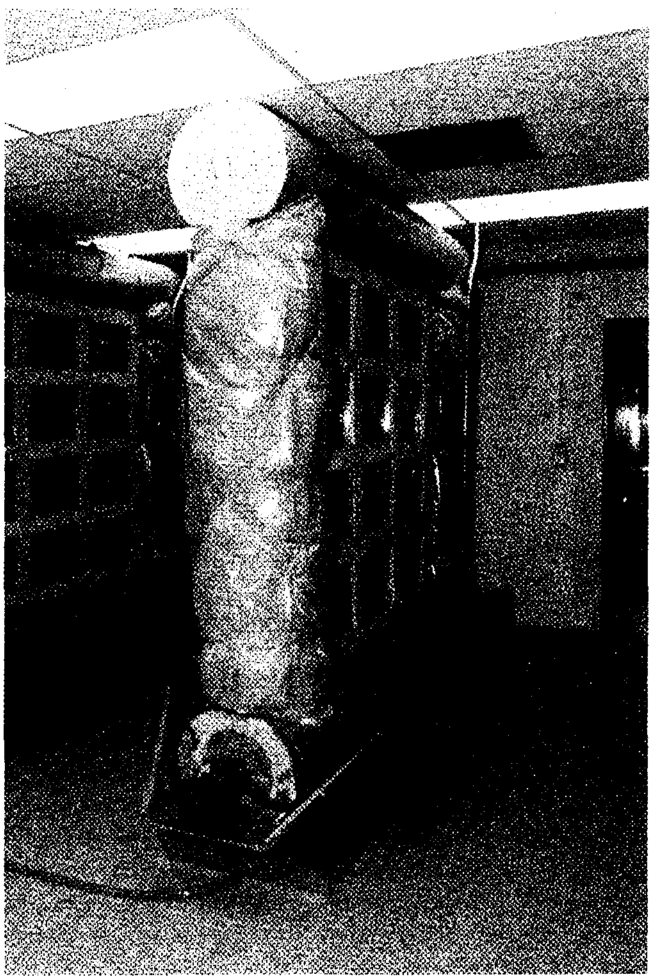

Figure 8. Weathering apparatus for insulating glass units

If one unit has a deposit, two additional units are tested. Since the test is not intended to assess glass breakage, units broken during the test are replaced and the test is repeated.

Temperature is monitored by a thermocouple suspended from a fine wire 300 mm above the centre of the sunlamp to sense inside air temperature, and a second thermocouple taped to the water outlet of the cold plate to sense the temperature of the cooling water as it goes to drain.

WEATHER-CYCLING TEST

In the weather-cycling test, four units are exposed to laboratory air on one side and to apparatus chamber air on the other side (Figure 8). The chamber air is cycled from -32°C to 52°C in a 4-hour cycle (Figure 9). On the cool-down cycle, water is sprayed on the units for 5 minutes. Except when the water spray is used,

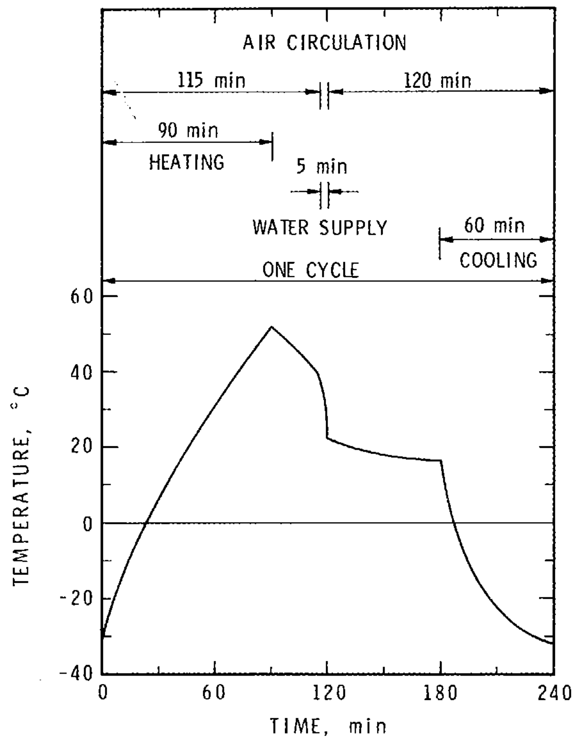

Figure 9. Weather-cycling test cycle

air is circulated in the chamber on a continuous basis. The units are exposed to 320 cycles after which their final dew points are determined.

Select 4 units from the set of 18 for this test and remove any excess dirt or foreign deposits. Measure the thickness of each unit using a depth gauge; then adjust the stops on the sample support frame so that when each unit is installed, the surface exposed to the laboratory is flush with the exterior surface of the frame. Once all four openings in the frame have been adjusted, install the units and hold them in place while covering the gaps between frame and unit with plastic film tape (suitable for temperature ranges of −40 to 60°C). As a safety precaution, start by installing the lowest unit and work up to the top of the frame. To reduce water leaks, check that all of the tape is firmly pressed flat onto the support frame, the unit, and onto itself in overlapping corners. Then place extruded polystyrene (25 mm × 100 mm) over the unit edges as shown in Figure 8.

Monitor the windows closely for the first 50 cycles (8½ days). In the event of glass breakage, replace the unit and continue the cycling (a maximum of three breaks between exposures to the weathering apparatus and the high-humidity chamber is permitted by the CAN2-12.8-M76 standard). On completion of 320 cycles (53½ days), remove the units from the apparatus and condition them in the laboratory air for one week. Then determine their final dew points as previously described.

The best time to remove the units is after the water spray portion of the cycle since, at that point, the units and the apparatus are near room temperature. New units should also be installed then to enable proper adhesion of the plastic film tape to the support frame.

Six thermocouples are used to monitor temperatures in the laboratory weathering apparatus; three located opposite the top units and three opposite the bottom units. Each thermocouple is centrally positioned between the two upper cooling coils for the unit.

HIGH-HUMIDITY CYCLING

In the high-humidity test, eight units are exposed to moist air in an enclosed cabinet (Figure 10). The air within the cabinet is kept at or near saturation by continuous water spraying; the temperature of the spray water

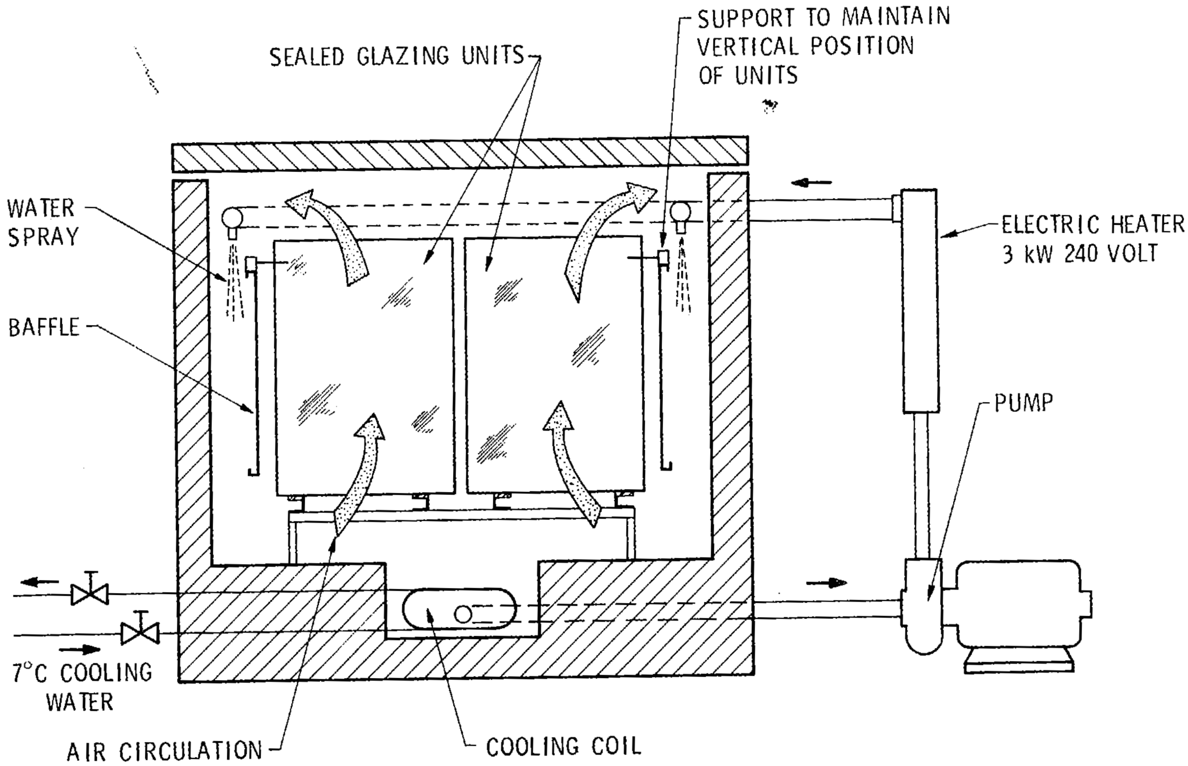

Figure 10. High-humidity cycling cabinet

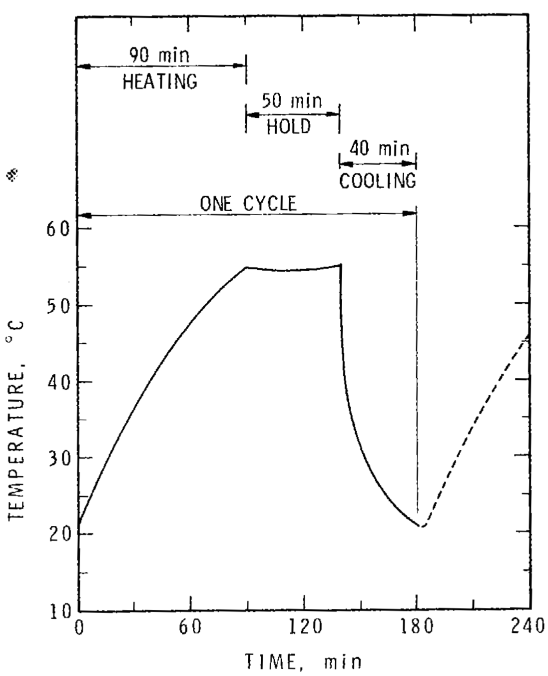

Figure 11. High-humidity test cycle

is adjusted to cycle the air temperature in the cabinet from 22°C to 55°C in a 3-hour cycle (Figure 11). The temperature in the cabinet is monitored by one thermocouple located in the cabinet air. The units are exposed to 224 cycles after which their final dew points are determined.

Select 8 units from the set of 18 for this test and clean them. Install the units vertically in the cabinet using positioning pins or spacers. A space between each unit should be provided to allow air to circulate.

Monitor the units closely for the first 50 cycles (6½ days). If a unit breaks, replace it and continue cycling. On completion of 224 cycles (28 days), remove the units from the cabinet and condition them in the laboratory air for one week. Then determine their final dew points as previously described.

The easiest time to inspect the units is when the high-humidity cabinet is turned off during the hot portion of the cycle and the lid is opened for a short time to allow the units to dry off.

To reduce particulates which could block the water-spray nozzle, the water in the high-humidity cabinet should be changed every 3 months. Care should be taken to ensure that the water level is maintained below the bottom of the units. This can be done by using a water reservoir and float system.

SUMMARY

The procedures discussed above have evolved over a number of years. They are intended to reduce handling and accidental breakage of samples. Because the dew-point determination and the UV-exposure test have subjective components which are operator-dependent, laboratory procedures must be established and rigorously followed to ensure consistency from one test to another. Actual details of the procedures may change as the standard is modified; nevertheless, the basic approach should remain similar. Due to the nature of the equipment and the test cycles, the temperature of all apparatuses should be monitored continuously to ensure compliance to the standard.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the dedicated work of K.R. Solvason and H. Egan, on which these procedures were based.

Sample Record Sheet

Laboratory Code ____________ Name of Applicant ____________ Type of Glazing ____________

Unit* No.	CMHC No.	Initial Seal Test Deflection Measurements (mm)				Dew Point Test Measurements (°C)				Notes
						Initial		Final		
		Initial	1	2	Final	Side 1	Side 2	Side 1	Side 2	
1	0001									
2	0002									
3	0003									
4	0004									
5	0005									
6	0006									
7	0007									
8	0008									
9	0009									
10	0010									
11	0011									
12	0012									
13	0013									
14	0014									
15	0015									
16	0016									
17	0017							UV:	date in ____	Results: ____
18	0018								date out ____	____
19	0019									
20	0020									

*Units 1-18 undergo initial seal and initial dew point tests.
Units 1-4 undergo weather cycling.
Units 5-12 undergo high-humidity cycling.
Units 17,18 undergo UV-exposure test.