# IEA SHC Task 27: Accelerated Aging of IG units: North American Test Methods

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## Introduction

There exist Canadian (CAN/CGSB 12.8) and American (ASTM E773 and E774) standards that deal with the edge seal durability of insulating glass units (IGU). Those standards have been in practice for decades, with some modifications made every four to five years when they are due for revision. In recent years, efforts in Canada and USA concentrated on harmonizing the IGU standards to arrive at acceptable test methods for the durability of IGU's and for implementation in IGU certification programs in North America.

Accelerated ageing of IG units is a means to test the durability and integrity of the seal(s) of these units by subjecting them to a number of cycles in a controlled environment. The amplitude and frequency of these cycles is determined by consensus among the experts and practitioners in the field.

This paper presents a summary of the Canadian, American and the harmonized test methods used in testing the seal integrity and the determination of argon gas of IGU's.

## Summary of the CAN/CGSB 12.8 test method

The Canadian CAN/CGSB 12.8 [1] Insulating Glass Unit standard has been in use for decades. It encompasses a number of tests to examine the seal integrity of IGU's. This includes the following tests:

- Initial seal of units (optional test)
- Initial dew point (frost point)
- Initial argon gas concentration
- Failure analysis (water immersion test)
- Weather cycling
- Volatile fogging (UV)
- Dew point measurement after weather cycling
- High humidity cycling
- Final argon concentration

Complete details about all these tests are given in Reference 1.

Similarly, the ASTM E773 [2] and ASTM E774 [3] are the standard test method and specifications for the durability of IG units. However, there are some major differences in the sequence of testing and the rating of IG units. This resulted in considerable financial hardship for the glazing

manufacturers in certifying the IG units when shipping units across the boarders to meet their clients demand. Therefore, it became necessary to harmonize the IG durability tests in both countries to eliminate any trade barriers and to promote economic growth.

**Harmonization of standards:**

Representatives from IG industry, testing laboratories, researchers, users and general interest groups who are usually involved in the development of such standards from Canada and USA joined forces in arriving at a set of test methods to evaluate the durability of the edge seal of IG units. This resulted in the development of three ASTM standards: E 2188-02 [4], E 2189-02 [5] and E 2190-02 [6].

The E 2188-02 provides details of the test apparatus and procedure (weather cycling rack, high humidity chamber and dew point measurement), E 2189-02 details the resistance to fogging test procedure and E 2190-02 is the specification for the evaluation of the IG unit performance.

**Apparatus**

The test apparatus shall be capable of mounting the IG units and expose them to weather conditions (heating and cooling) on one side and to the room conditions on the other side of the IG units. Figures 1 and 2 are illustrations of the weather cycling test apparatus. The weather cycling apparatus is also equipped with ultra violet light source and the light bulbs are of the type F72T12BL/HO. The light bulbs are installed as shown in Figure 3.

The high humidity chamber is of suitable dimensions to accommodate several IG units and of maintaining 60±3 °C and 95±5% relative humidity.

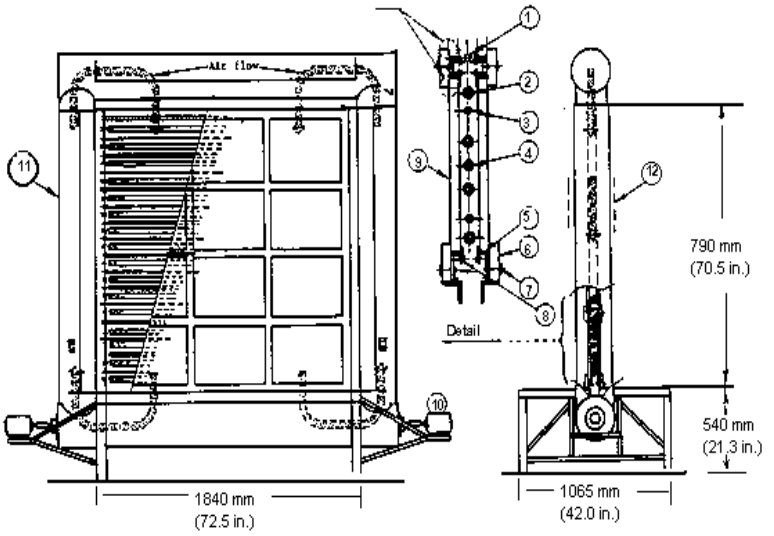
**Sample specifications**

Each test specimen measures 355 ± 6 mm by 505 ±6 mm and is composed of two or three lites of clear, tinted or coated annealed, heat-strengthened, tempered or laminated glass. The double glazed test samples are fabricated with at least one lite of clear, uncoated glass. The triple glazed test samples are fabricated with at least one outer lite of clear, uncoated glass. The other outer lite are fabricated with a glass, which allows easy viewing of the frost point.

The thickness of the glass lite shall be between nominal 3.0 mm and a maximum of 6.0 mm nominal. The airspaces for units with either two or three lites of glass shall be a minimum of 6.0 mm ± 0.8 mm. Triple pane units where the intermediate airspace divider is a plastic film are acceptable.

**Cycle description**

The weather cycle consists of heating and cooling as illustrated in Figure 4, in addition to water spray and ultra violet light exposure.




Description: 1. Fog or mist spray, 2. Cooling Coil, 3. Fluorescent black light lamp, F72T12BL/HO, 4. Heating coil, 5. Rubber pad, 6. Polystyrene insulation, 7. Rubber washer, 8. Clamping device, 9. Test specimen, 10. Fan motor, 11. Air duct, 12. Insulation.

**Fig. 2 Schematic drawing of Typical Accelerated Weathering Apparatus**

Fig. 1 Illustration of the weather cycling apparatus

Fig. 2 Weather cycling test apparatus.

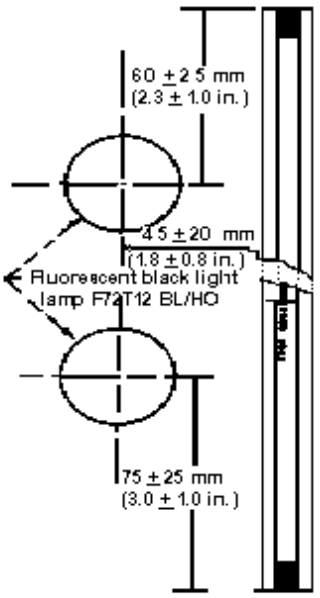
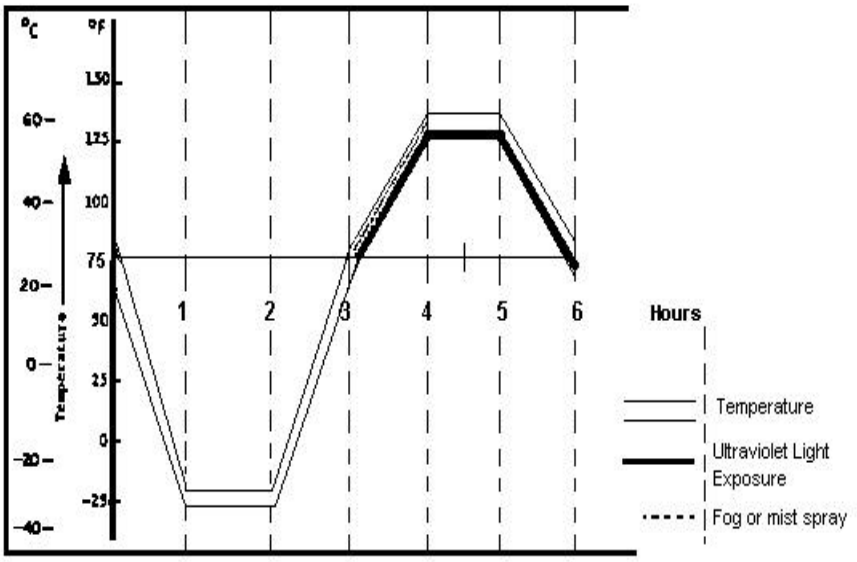



Fig. 3 Location of Fluorescent Black Light Lamp Relative to the Test Specimen

Fig 3 Location of the UV light bulbs.




Note-This figure represents the ideal cycle described in this test method. Any temperature variation within the tolerance zone shown is acceptable.

**FIG. 4 Schematic drawing of Each Cycle for Accelerated Weather Cycle Test**

Fig 4 Illustration of the weather cycle

## Test procedure for seal durability

**Initial Frost/Dew Point Test**: This measurement is to determine the initial frost/dew point on all airspaces on all units submitted using test method E 546 [7] or equivalent.

**High Humidity Phase**: Six randomly selected units are placed in the high humidity chamber at 60 ± 3°C and 95 ± 5 % relative humidity for 14 days. When the specified time period has been attained the test specimens are removed. The test specimens are allowed to equilibrate at 23 ± 3°C for not less than 24 h. Then, the frost/dew point is determined in accordance with Test Method E 546 or equivalent. For triple pane units, the frost/dew point is determined for all airspaces. If liquid appears, temperature at which it occurs is recorded.

**Weather Cycle Phase**: The same six units used in the high humidity phase are placed in the weather cycle chamber. The units are mounted such that one exterior surface of the specimen is exposed to the weather cycles and the other to room temperature (23 ± 3°C). All specimens are installed as shown in Figures 1&2, ensuring that no stress is induced in the test specimens by the method of fastening. The test specimens are oriented in the weather cycle chamber with the number one surface facing the weather changes as it does in normal field exposure.

**Cycling**: Each cycle is 6 h ± 5 min and composed of the following test conditions (see Fig. 4): During the first 60 ± 5 min, the temperature is decrease from room temperature to -29 ± 3°C. The temperature is maintained at -29 ± 3°C for 1 h ± 5 min. Then, the heat is turned on and allow temperature to rise from -29 ± 3°C to room temperature over a period of 60 ±5 min. The ultraviolet lamps are turned on and over a time period of 60± 5 min the temperature rise is controlled from room temperature to 60 ± 3°C. At the beginning of this same 60 min period, water is turned on or mist is supplied. The interior of the chamber, at the test specimens, shall reach a minimum of 90 % relative humidity within this time period. The water or mist supply is turned off after 60 min.

The temperature is maintained at 60 ± 3°C and the ultraviolet exposure is continued for a period of 60 ± 5 min. Over a period of 60 ± 5 min, the temperature is decreased from 60 ± 3°C to room temperature, and the ultraviolet exposure is continued. At the end of this period, the ultraviolet lamp is turned off. When the specified time period (cycles) has been attained, the test specimens are removed.

**Test Duration**

Six randomly selected specimens are tested for 14 days in the high humidity chamber. The same units are then tested for 63 days in the weather cycling rack followed by 28 days in the high humidity chamber.

**Performance requirement for the edge seal durability**

The six units that complete the weather cycling and high humidity tests shall not show any signs of breakage. Initial, intermediate (after the weather cycle phase) and final dew point temperature (after high humidity phase) shall be recorded. The final dew point temperature shall be -40°C or cooler when measured in accordance with ASTM E546 standard. The final dew point temperatures are determined after 24 h but no longer than 7 days from the completion of the test.

**Fogging test**

The fogging test is intended to determine the resistance to fogging of preassembled permanently sealed insulating glass units or insulating glass units with capillary tubes intentionally left open. The test is conducted in a special box equipped with a UV light source, an air circulating fan and a cooling plate as illustrated in Figure 5.

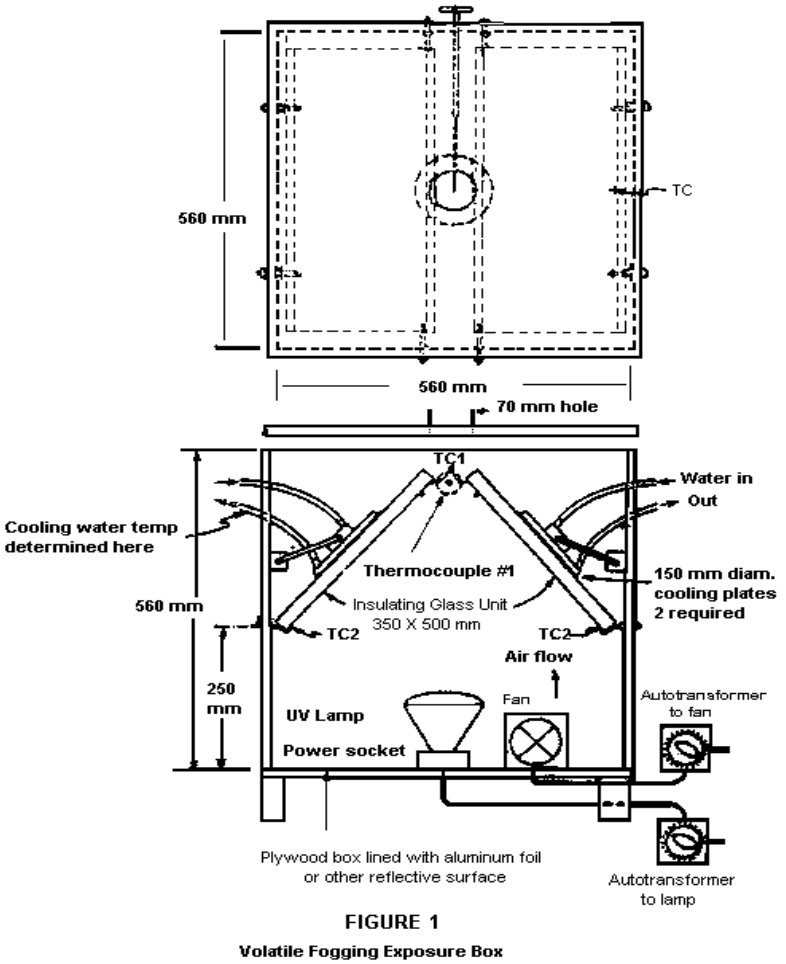



**FIGURE 1**
**Volatile Fogging Exposure Box**

Fig 5 Illustration of the UV fogging test apparatus

The UV box is designed such that it is capable of maintaining air temperature of 50±3ºC. Cooling plates are constructed from a conductive material such as copper or brass. Thee cooling plates are nominally 150 ±5 mm in diameter and are placed in contact with the glass surface during the test.

The ultra violet light source is supplied by a bulb to provide UV light at 400 $\mu W/cm^2$.

**Fogging test procedure**

The specimens used for this test are similar in construction and dimensions to those used in the edge seal durability tests. For coated glass, the cooling plate is place in contact with the coated lite. Two IG units are placed in the UV box as illustrated in Figure 5, and the UV lamp is turned on. The air temperature is maintained at 50±3ºC as measured by thermocouples #3 & 4 in Figure 5. The temperature difference between thermocouple 1 & 2 is not to exceed 3ºC. The same limitation is applied for the temperature measurement of thermocouple 3 and 4, in Figure 5.

The cooling water temperature is maintained at 21±2ºC. The specimens are exposed to these conditions for 7 days. For triple glazed units, both cavities are tested.

After the completion of the test, the units are removed from the UV box and carefully examined for the presence of visible fog by holding the unit at an arm's length in front of a light source, by the examiner. The examiner moves the unit at any possible angle in front of the light source in order to detect the presence of any fogging or deposits on the surface of the glass. When no fogging or deposits are observed, the test is complete. However, when fogging or deposits are observed, the unit is kept at the room temperature for 24 hours and re-examined to determine if the fogging or deposits are still present. More details about the performance requirement are given in the following section.

**Performance requirements for the fogging test**

The fogging test is intended to determine the resistance to fogging of IG units. The performance requirement is that the units tested show no signs of fogging or deposits after the test is completed. There is however some provisions for the unit to stabilize before the final results are recorded. For example, after the seven days exposure to UV light in the box:

- If there is visible fogging on the glass surface, the units are left to stabilize for 24 hours and re-examined again.
- If after 24 hours there is no fogging, the units pass the test
- If after 24 hours, there still signs of fogging, the unit are conditioned at the lab temperature for six more days
- If after six days there is no signs of fogging, then the unit passes the test, and the test is complete
- If after six days there still signs of fogging, then the unit fails the test.

For the units to pass this test, they shall show no evidence of fogging.

**Argon gas concentration in IG units**

The CAN/CGSB 12.8 standard includes requirements to determine the argon gas concentration in IG units before and after the weather cycling test. The procedure is based on taking gas samples from the IG units by means of a syringe through a septum plug inserted through the metal

spacer bars. In case of other types of spacer bars, it is possible to take samples through the spacer bar and (as a precaution) the sealant is resealed.

The gas samples are analysed by means of gas chromatograph (GC) to determine the initial argon concentration. More details about this test method and the column used in the GC are given in Reference 1.

**Performance requirement of argon gas**

Ten units are used to determine the average initial argon concentration. According to the CAN/CGSB 12.8 standard, two units used for the fogging test, four units from the eight units used for the weather cycling test and four units from the eight units used for the high humidity test. For the set of units to pass this test, the average initial argon concentration shall be 90% or higher. Otherwise, the units are considered air filled.

Similar test method is currently under review through the appropriate ASTM task group to develop an ASTM test procedure to determine the argon concentration in IG units. Once this is achieved, such a test procedure will be balloted through the CAN/CGSB 12.8 committee for the possibility of adopting it for the Canadian certification program.

**Comments on the harmonized test methods**

The harmonized standard test procedure for the durability of edge seal of IG units (ASTM standards) presents a compromise between the Canadian and the previous ASTM test methods. The idea of moving the units between the weather cycling rack and the high humidity chamber seems to exert the necessary stresses on the edge seal, similar to that in the old test methods. In addition, the introduction of UV light exposure during the weather cycling test does have an impact on the degree of severity of the test.

During the development of the harmonized durability of edge seal test standards, a series of tests were conducted in Canada to compare the results when testing units according to the three procedures: ASTM, CAN/CGSB 12.8 and the proposed harmonized standards. Twenty sets of IG units of different design and configurations supplied from several manufacturers were tested. The test results indicated that the proposed test procedures are consistent with the other two standards. Although this was not a “statistically significant” exercise, it indicated that units that failed one test also failed the other tests. In addition, the units that passed the harmonized test methods also passed the other test procedures, which is an encouraging sign of the suitability of the proposed test methods.

In Canada at the present time, IG manufacturers are still using the test procedures outlined in the Canadian CAN/CGSB 12.8 standard for the durability of edge seal testing and certification purposes. As of this year, in USA, the new ASTM standard test procedures and specifications were adopted by the certifying agencies. It is expected that the CAN/CGSB 12.8 standard committee will ratify the new ASTM harmonized standards through the balloting process sometime this year or early next year.

It should be noted that for the next few years, there would be a program to monitor the IG units tested in the participating testing laboratories to determine the precision and bias associated with the new test procedures. If deemed required, some changes will be made to any of the test procedures to improve the quality of assessing the durability of edge seal of IG units.

**Comments on the certification programs**

The certification program of IG units is conducted by designated organizations in Canada and USA. In Canada, the certification program is carried out by the Insulating Glass Manufacturers Alliance (IGMA), which is an organisation representing IG manufacturers and suppliers of IG units in Canada and USA. In USA, the certification program is conducted by a number of organisations including: Associated Laboratories Inc. (ALI), Insulating Glass Certification Council (IGCC) and National Accreditation and Management Institute Inc. (NAMI). There may be other organizations that offer similar certification programs, but those mentioned are those recognized by IGMA.

At present time, the Canadian certification program differs from those in the USA in many details. However, following the amalgamation of the Canadian (IGMAC) and the American (SIGMA) organisation into IGMA, efforts are now directed towards establishing one certification program that can be used in both countries.

**Closing remarks**

After a number of years of debate and development, there exist a harmonized North American durability test procedure for the durability of the edge seal of IG units. The next step is to adopt a single certification program that can be used in Canada and USA.

The benefits of adopting a harmonized standard in Canada and USA are great, particularly when the trade volume (in this sector of industry) is a multi-million dollars business.

IG manufacturers as well as consumers, as a result of this harmonization program, also realize economical and financial benefits.

**References**


1- CAN/CGSB 12.8-1997 Insulating Glass Units, Canadian General Standards Board, Ottawa, Ontario, Canada.

2- ASTM E 773 Standard Test Method for the Accelerated Weathering of Sealed Insulating Glass Units, ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 USA.

3- ASTM E774 Specifications for the Classification of the Durability of Sealed Insulating Glass Units, ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 USA.

4- ASTM E 2188-02, Standard Test Method for Insulating Glass Units, ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 USA.

5- ASTM E2189-02, Standard Test Method for testing Resistance to Fogging in Insulating Glass Units, ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 USA.

6- ASTM E2190-02, Standard Specification for Insulating Glass Unit Performance Evaluation, ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 USA.

7- ASTM E 546, Test Method for Frost Point of Sealed Insulating Glass Units, ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 USA.