RAPID ASSESSMENT CHAMBER (RAC)

Explanation of Development and Opportunity for the Industry

Introduction

Created by the Insulating Glass Certification Council (IGCC), a 501 (c)(3) not for profit organization, the Rapid Assessment Chamber (RAC) was developed, funded, and patented by IGCC, with financial and technical support from the Insulating Glass Industry, including the Insulating Glass Manufacturers Alliance (IGMA). Early research was undertaken by IGMA and focused on three potential technologies with the final selection as a rough prototype of the current RAC equipment.

The impetus for the development of the RAC was to create a **faster** technically justifiable alternative to existing ASTM test methods for the evaluation of Insulating glass units (IGU's). While ASTM standards had served the IG industry, consumers and marketplace well, the duration of the ASTM process was just not sustainable to support product design and innovation as IGU certification and regulatory compliance became more mandatory and less voluntary. The ASTM process historically averaged more than 6 months.

ASTM E2190 Process

The current ASTM and certification process has served the industry well and is still the final determination of IGU performance. The IGMA 25-Year Field Correlation Study (1980-2005) to the predecessor ASTM standard and the new ASTM Field Correlation Study to the ASTM E2190 standard currently underway demonstrate that the ASTM standard is a reasonably good predictor of real-world performance.

Rationale for RAC

The current ASTM testing with corresponding test laboratory delays has been one of the main impetus for developing the RAC. Current testing can take up to 10 months to get results even though the test methodology itself is 4 months.

Great work has been done by IGCC codifying guidelines and the equivalency of product options and attributes, product development is ever evolving. There are

just too many "what if's" so a technically justified physical test was needed that had some connection to proven ASTM E2190 results.

Due to the rapidly changing energy and durability requirements, IGU products are getting more and more complex with new products entering the market in an expedited fashion. The National Renewable Energy Laboratory (NREL), FDR Design and Intertek have all worked toward a faster, more flexible solution for testing Insulating Glass Units.

Early Development

Early on, IGCC undertook a new initiative called the Provisional Certification Program. This program rated units with physical measurements and visual observations. The compiled data eventually showed little better than the flip of a coin. Good looking units sometimes fail, and bad looking units sometimes pass. Therefore the need for a physical test. Current testing equipment is expensive to build and maintain, so one of the key criteria was to develop test equipment that was relatively inexpensive and easy to operate.

The decision to focus on exposure in heating only (not cooling) was due to consensus that most failures occur in heating conditions and to support ease of operation of the RAC.

Although chamber design was a challenge, it was not the primary obstacle in development. It is well established that some IGU designs perform better or worse depending on the application. Developing exposure test conditions that would not disadvantage certain IGU designs was critical and was the greatest challenge.

RAC R&D

The iTiG sensor developed by FDR Design is a key to understanding IGU performance. For the first time, the industry can understand the real dynamics of what is happening inside the IGU. Real time results show IGU performance to relative humidity, atmospheric pressure, temperature and gas content. Every 6 seconds each specimen's iTiG reports via Bluetooth to a dedicated server, these 7 readings include:

- atmospheric pressure (absolute pressure)
- RH (Relative Humidity)
- Frost Point

- Temperature of Cavity Gas
- Thermal conductivity of Cavity Gas
- UVA and UVB radiation
- Moisture by volume - the percent of cavity gas that is water vapor

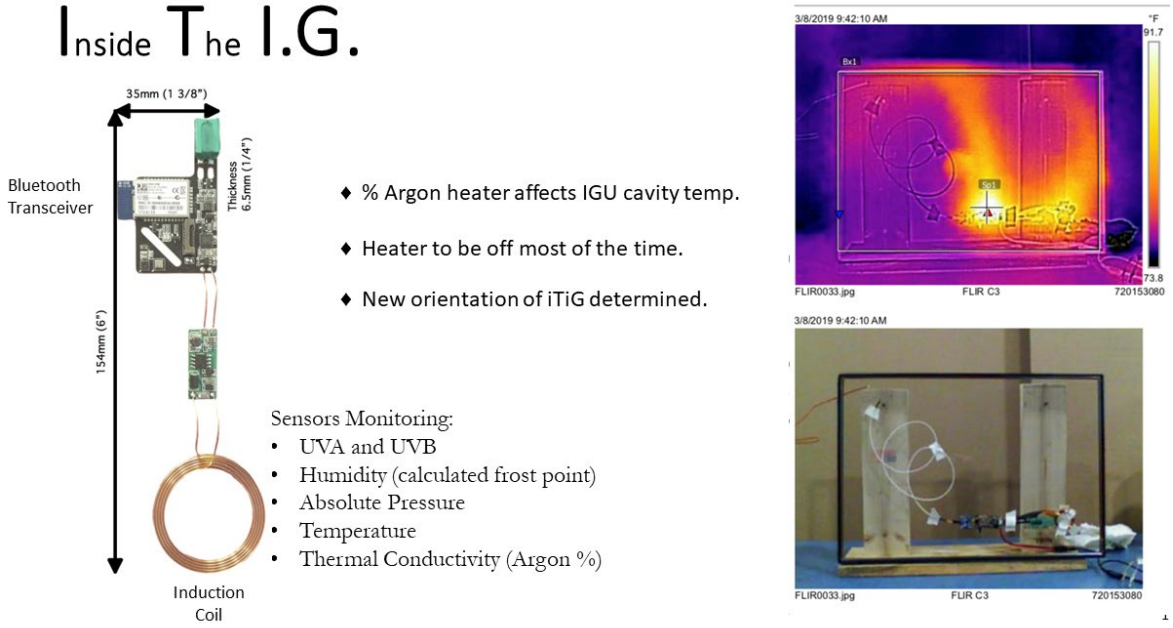

Figure 1 ITIG

Phase 1: If the IG samples failed too quickly, test parameters were made easier thus lengthening the test. If failure was too slow, the test parameters were made harder. Multiple trials resulted in a set of conditions and optimized chamber operations, the target being a 14 day test exposure.

Phase 2: Based on earlier testing and research, RAC phase 2 testing focused on 1 IG design that best represented a baseline for product performance. Through a scientifically established design of experiment (DOE) this phase incorporated varied operating conditions which correlated to conditions seen through ASTM E2190 testing, and determined what final operating conditions were ideal for provisional certification testing with the RAC.

Phase 3: With the results of Phase 2 the operating conditions were verified through a validation testing process to determine if the test could mirror historical pass and failure rates of ASTM E 2190.

In phase 1 there were102 samples tested. For phase 2's DOE a total of 132 samples were tested. Finally, 152 samples have been tested in phase 3's validation testing at the conditions determined from Phase 2's DOE. In total 386 samples (64 sets) have been tested within the RAC.

It is worth noting that Type's 2, 3 and 5 represent 79% of IGCC certified products, and the 6 types tested represent 92% of certified products (see Figure 2).

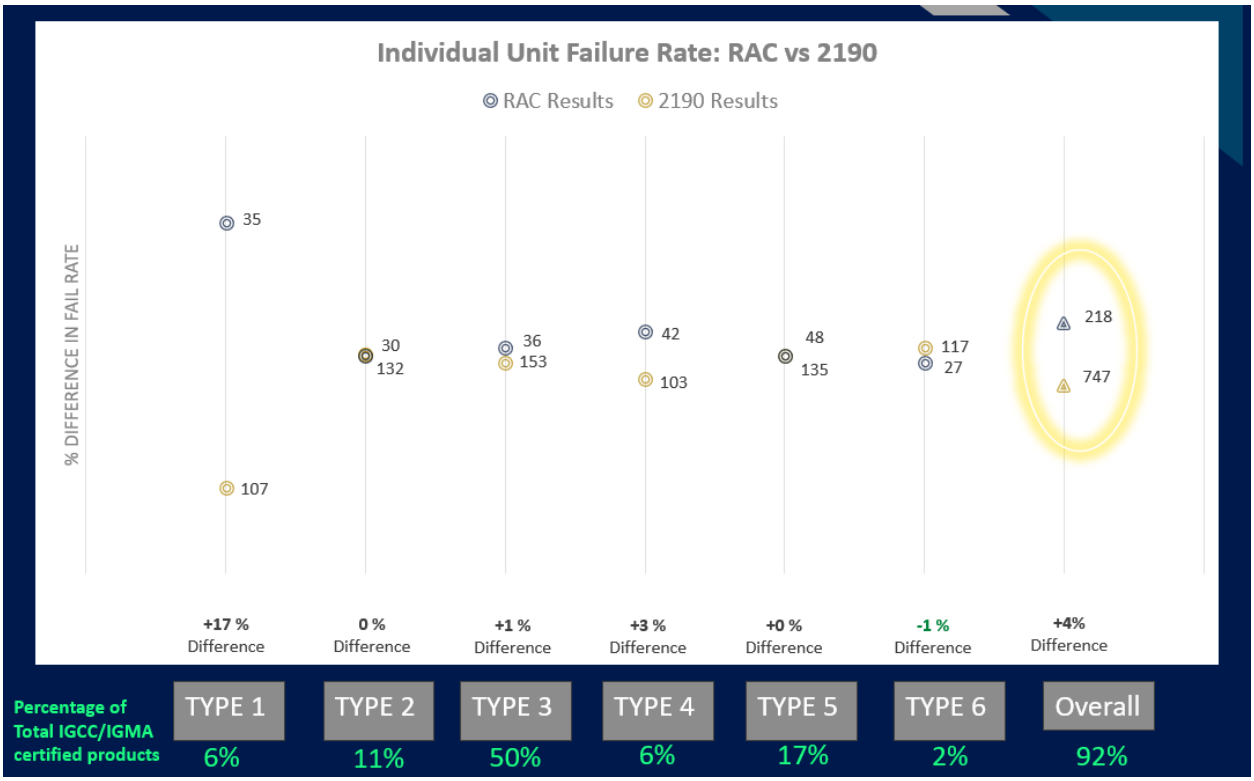

Figure 2 – Validation Testing (Phase 3) Results

Figure 3 – Chamber Appearance

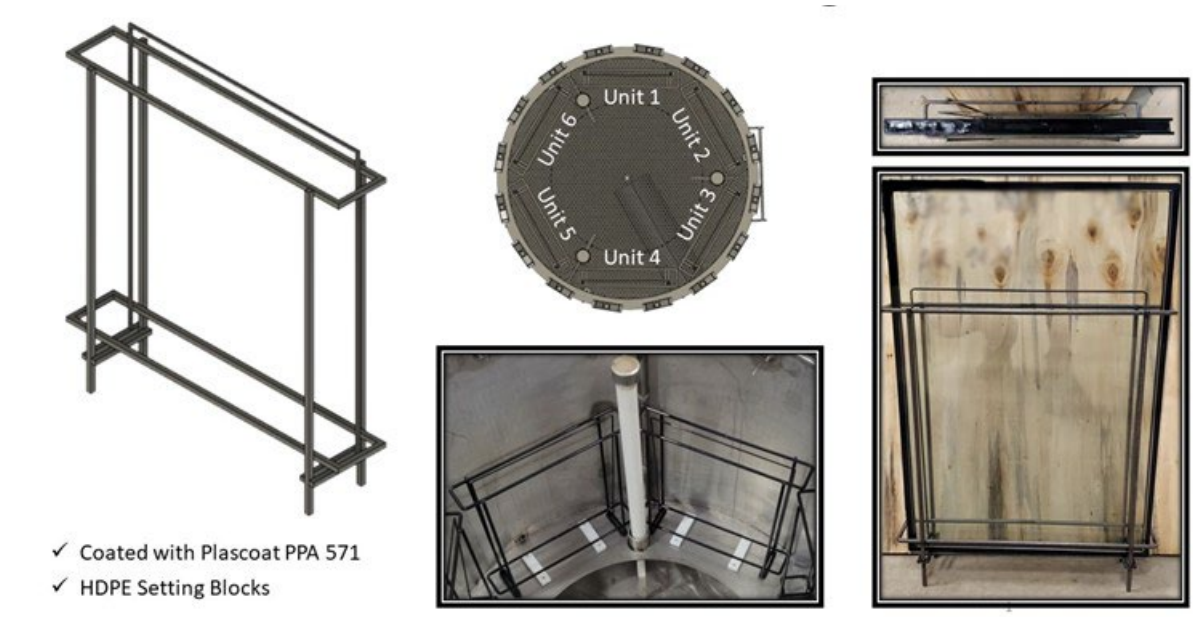

Figure 4 Unit Mounting Frame and Setting Blocks

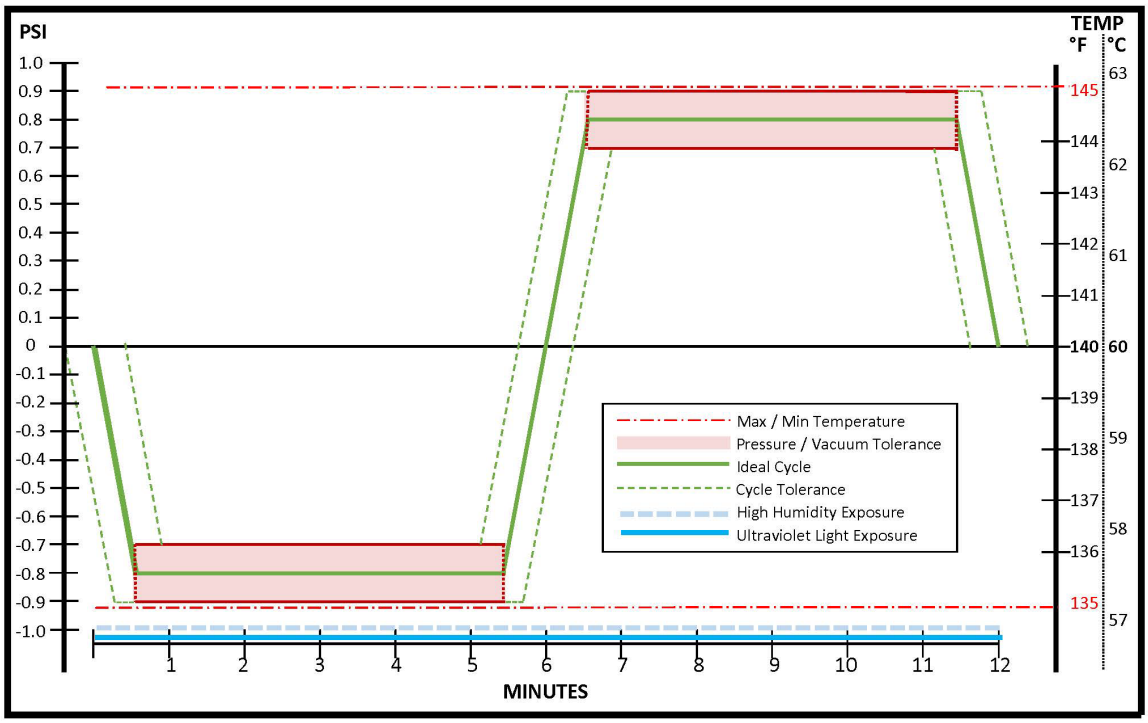

Figure 5 Provisional Certification Single Operating Cycle

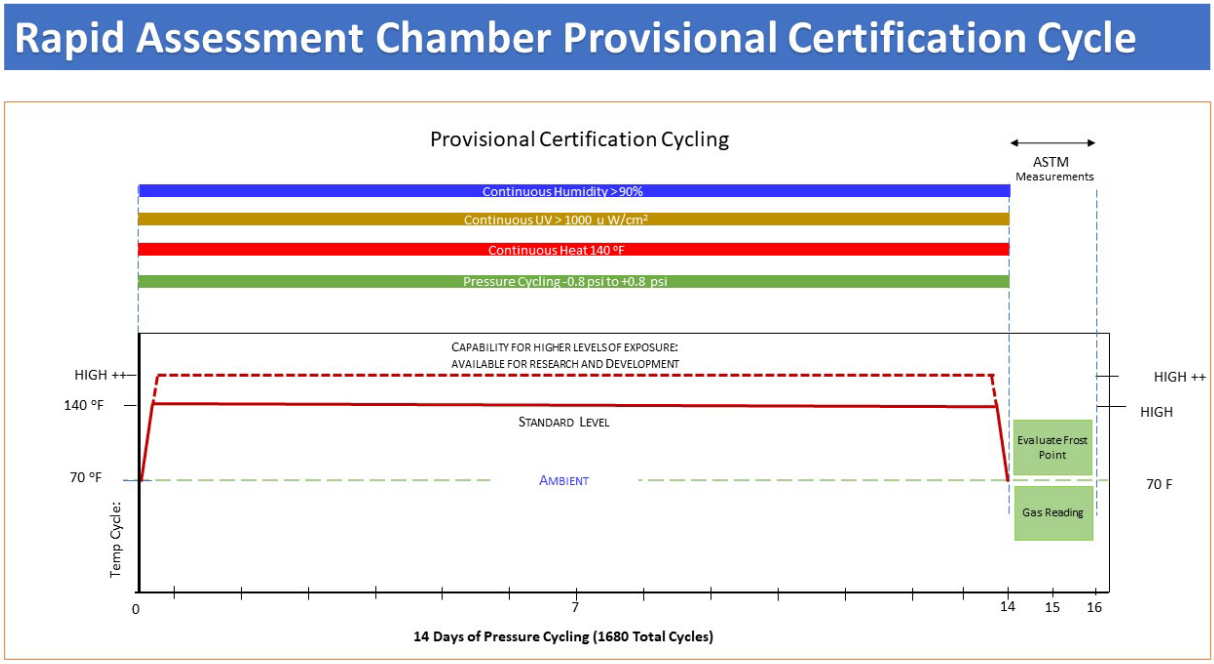

Figure 6 RAC Provisional Certification 14 Day Operation

ASTM E2188/E2189/E2190 vs RAC

Parameter	ASTM E2188, E2189, E2190	RAC
High Humidity Test		
Max. temp.	60 ± 3C | 140 ± 5F	60 ± 3C | 140 ± 5F
Min. temp.	(constant temperature)	(constant temperature)
%RH	95% ± 5%	95% ± 5%
Total time	42 days (14 days + 28 days)	14 days
Accel. Weather Cycle Test		
high temp.	60 ± 3C | 140 ± 5F	60 ± 3C | 140 ± 5F
low temp.	-29 ± 3C | 73 ± 5 F	
UV source	F72T12BL/HO	F24T12BL/HO
UV output	2000-6000 $\mu W/cm^2$	Greater than 2000 $\mu W/cm^2$
moisture	30 min. spray	Steam
%RH		95 ± 5%
Pressure		Cycle of positive to negative 0.8 psi ± 0.1 psi
time per cycle	6 hr.	12 minutes
# of cycles	252	1,680
total time	63 days	14 days
Volatile Fog Test		
Type	Full Immersion box	
Glass temp at corner	50 ± 3C | 122 ± 5F	
Glass temp at other locations	50 ± 3C | 122 ± 5F	
Cooling plate temp	21 ± 2C | 70 ± 4F	
Cooling plate area	0.018m^2 (150mm dia.)	
UV lamp	Osram Ultra Vitalux 300w	
Lamp output	400 µW/cm^2 @ 355 nm	
Specimen's		
Width	355 ± 6mm | 14 ± ¼ in	355 ± 6mm | 14 ± ¼ in
Height	505 ± 6mm | 20 ± ¼ in	505 ± 6mm | 20 ± ¼ in
Number for weathering	6	6
Number for high humidity	Uses same 6	0
Number for volatile fog	2	2
Evaluation Criteria		
Frost point test	E546 with dry ice or CGSB 12.8 method	E546 with dry ice or CGSB 12.8 method
Max. frost point	-40C | -40F	-40C | -40F
Visible fog	No fog at arm's length	No fog at arm's length
Argon initial	≥90%	≥90%
Argon final	≥80%	≥80%
Test equipment	SES	SES

Application of RAC

Primary development of the RAC was done to address testing delays, however there are many applications for this equipment due to its cost efficiency and ease of operation that will be of benefit to the industry.

In addition to complementing the ASTM approach, the RAC will be a valuable testing tool for provisional certification of products, correlation testing, R&D design validation, minimizing supply chain disruptions, determining component equivalency, new product testing, in plant quality assurance and advanced testing.

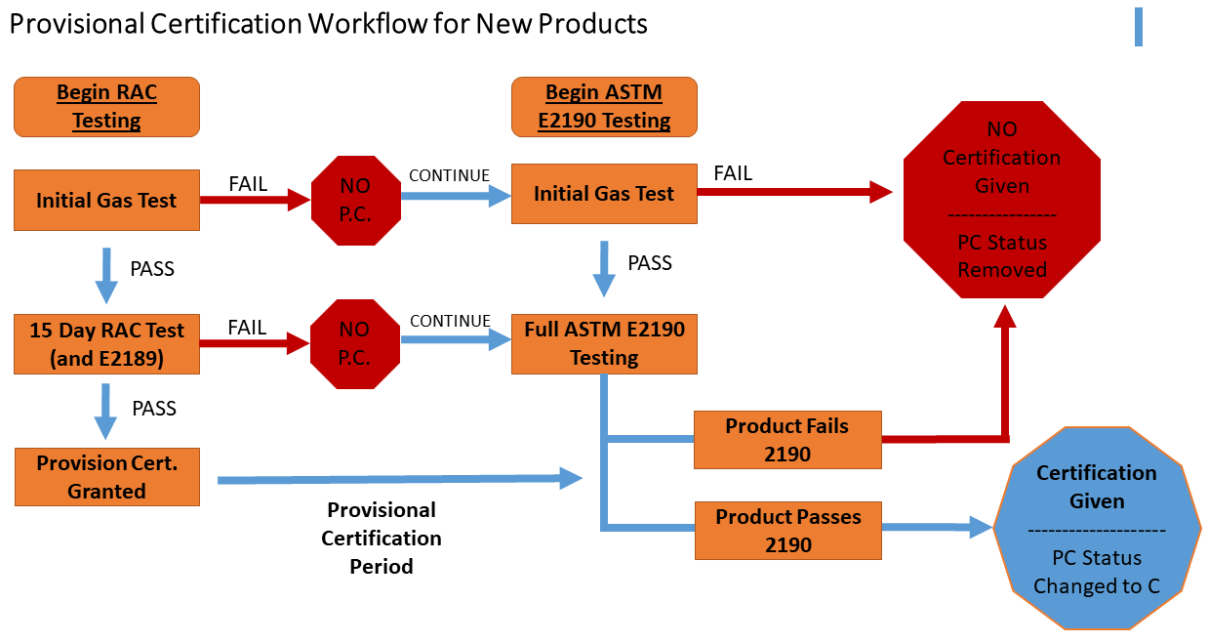

Figure 7 Provisional Certification Flowchart

Conclusion

For decades, the existing testing technologies have served the industry well. Today, IGU fabricators require easy to operate expedited testing to generate results at an affordable cost. The RAC addresses the current needs of the industry. The ASTM E2190 test specification will continue to be the definitive performance assessment however it cannot meet the needs of a rapidly changing industry. The RAC does that.

IGCC has developed this new, innovative test equipment over many years. Its operation has been technically validated and the resulting data has been peer reviewed to meet industry standards. An ASTM standard is under development and will be presented to the ASTM E06-22 group for further development. The RAC is available for purchase from IGCC. Please contact AMS for further information.