Project Title: "High Reliability R-10 Windows Using Vacuum Insulating Glass Units"

Approved Project Period: August 17, 2010 through September 16, 2012

First Final Report Submission Date: November 24, 2012

Final Report Re-Submission Date: April 10, 2013

Recipient: EverSealed Windows, Inc.
Attn: David Stark
1999 Interlocken Drive
Evergreen, CO 80439-8952

Website (if available): www.EverSealed.com

Award Number: DE-EE0004024

Working Partners: Cardinal Glass Industries; Pella Corporation; LBNL; NREL

Cost-Sharing Partners: None

PI: David Stark
President and CTO of EverSealed Windows, Inc.
Phone: 303-674-1197
Fax: 303-670-1249
Email: David@EverSealed.com

Submitted by: Project PI David Stark

DOE Project Team: DOE Contracting Officer: Debra A. Duncan – NETL Pittsburgh
DOE Project Officer: Yana K. Rasulova – DOE Golden Field Office

David Stark April 10, 2013

Signature Date

Executive Summary

The objective of this effort was for EverSealed Windows ("EverSealed" or "ESW") to design, assemble, thermally and environmentally test and demonstrate a Vacuum Insulating Glass Unit ("VIGU" or "VIG") that would enable a whole window to meet or exceed the an R-10 insulating value (U-factor ≤ 0.1).

To produce a VIGU that could withstand any North American environment, ESW believed it needed to design, produce and use a flexible edge seal system. This is because a rigid edge seal, used by all other know VIG producers and developers, limits the size and/or thermal environment of the VIG to where the unit is not practical for typical IG sizes and cannot withstand severe outdoor environments. The rigid-sealed VIG's use would be limited to mild climates where it would not have a reasonable economic payback when compared to traditional double-pane or triple-pane IGs.

ESW's goals, in addition to achieving a sufficiently high R-value to enable a whole window to achieve R-10, included creating a VIG design that could be produced for a cost equal to or lower than a traditional triple-pane IG (low-e, argon filled). ESW achieved these goals. EverSealed produced, tested and demonstrated a flexible edge-seal VIG that had an R-13 insulating value and the edge-seal system durability to operate reliably for at least 40 years in the harshest climates of North America.

High-Level Project Accomplishments

EverSealed produced, tested and demonstrated a flexible edge-seal VIG that had an R-13 insulating value and had the edge-seal durability to operate reliably for at least 40 years in the harshest climates of North America.

A. Background

Pella Corporation provided ESW a "Letter of Support" for ESW's Grant Proposal submission in which Pella pledged enough support to design and produce a working window especially for ESW's VIG. No U.S.-produced operating window has enough insulation in its sash and frame to achieve an R-10 insulation value due to the low insulation properties of wood, fiberglass, vinyl or aluminum unless the window system is designed to take advantage of ESW's very highly insulating VIGU. Since the time of Pella's pledge to create a window specifically for ESW's VIGU, the housing market and window market have plunged. As a result, Pella has had to close some of their facilities and for the first time in their history, lay off employees. In addition, Pella no longer has the internal funds to design and produce an operating window that could achieve an R-10 value using ESW's VIG, but can still reach R-10 using a non-venting or fixed window which many would call a picture window.

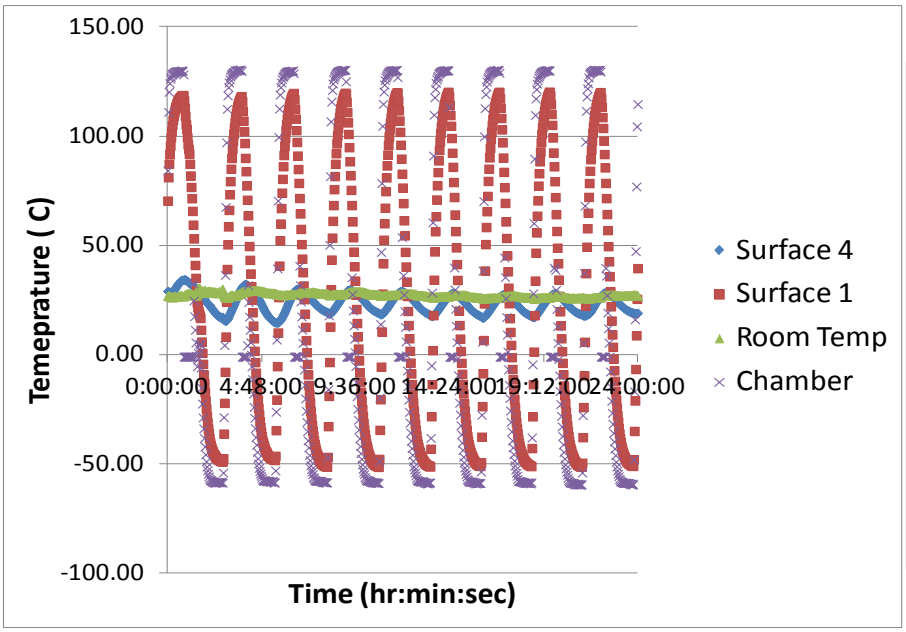
As stated above, Pella could achieve a whole-window R-10 value with one of its "Fixed" or "non-venting" windows, but ESW wanted to demonstrate its VIGU in a fully operating window such as a double-hung window. Recent modeling by LBNL's thermal

team under the direction of Steve Selkowitz showed that ESW's VIGU will allow a vinyl double-hung whole window of today's traditional design for a double-pane IG would achieve an R-8.4 to R-8.6 value. Steve Selkowitz stated that this would be a great achievement and should satisfy the Grant requirements.

B. Demonstrated Reliability of ESW's VIG

In April 2012, ESW completed thermal cycling the first assembled VIGU in our thermal-cycle chamber. Our thermal cycle inside the chamber (on lite 1, surface # 1) was from -60 C (-76 F) to +130 C (+266 F) with a 30-minute dwell at each temperature extreme. 266 thermal cycles would statistically prove the hermetic flexible edge-seal system surviving more than one (1) forty year (14,600 days) lifetime in one of the most severe U.S. climates, Ely, Nevada. We stopped cycling after passing 306 cycles with no failures. Steve Selkowitz's thermal group at LBNL calculated this first VIGU would have a center-of-glass ("COG") R-value of 4.5. Our measurements with numerous thermal couples validated LBNL's performance predictions.

We initiated thermal cycling our second assembled VIG after the first unit had experienced 230 cycles. The second VIG, with a COG R-value of 13, saw 66 thermal cycles with no failures. We stopped cycling the second VIG at the same time we stopped testing the first VIG.



40 years = 14,600 days

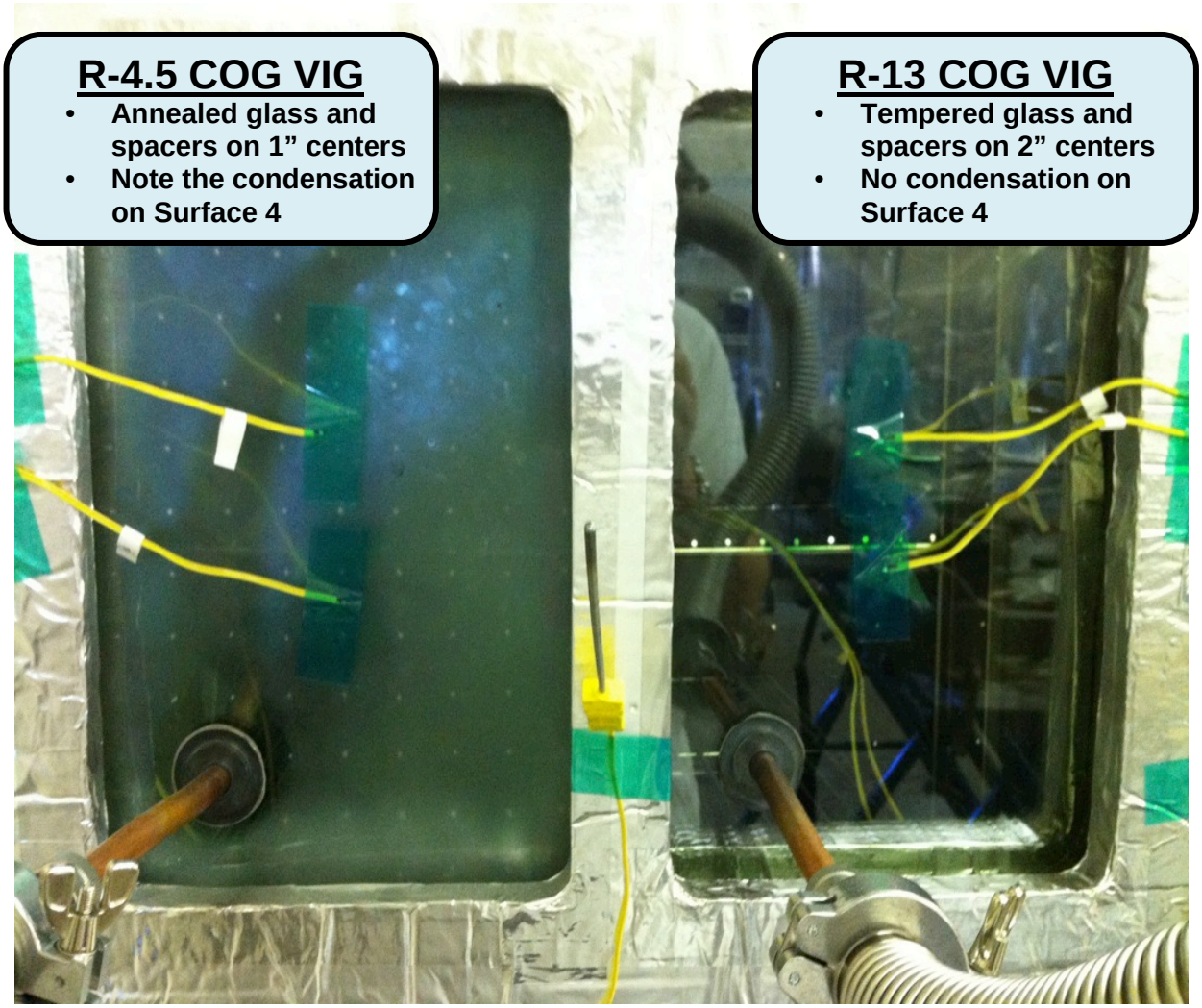
For Eli, Nevada:

- **35^0 C diurnal temperature change in late June/July**
- **1.93 factor for solar heat gain on surface 1**
- **67.6^0 C worst-case diurnal temperature change for 14,600 days**

229 Thermal Cycles from -60^{0}C to +130^{0}C

- **Yields 90% confidence in 95% reliability for 40 years in Eli, Nevada (according to Baye's Success Run Statistics)**

Eight thermal cycles of the R-13 VIG. Due to the extreme insulation properties of EverSealed's VIG, the room-facing Surface 4 of the VIG stayed very close to actual room temperature when the opposite surface (Surface 4) was exposed to 15 minutes of -60 C (-76 F) and 15 minutes of +130 C (+266 F).



Two VIGs with low-E coating shown mounted in the door of EverSealed’s thermal chamber cycle chamber with the interior of the chamber held at -60^0 C.

The R-4.5 COG VIG is on the left and the R-13 COG VIG is on the right.

- Surface 1 is exposed to the chamber’s -60^0 C convection current
- Surface 4 exposed to ambient (room temperature ~ 23.5^0 C)

The results of our tests demonstrated that we had developed and tested a VIG with the following properties when compared to any other double-pane insulating glass unit (IGU), triple-pane IGU or VIG:

- We demonstrated the world’s first known VIGU with a flexible, hermetic metal seal system.
- Our R-13 COG VIG has a higher R-value (insulating performance) than any other known conventional IGU or VIGU world-wide.
- Our VIGU has a far-greater reliability than any other type of IG, including suspended film IGs.

- Our VIGU can be used reliably in any residential or non-residential installation in any climate worldwide. No other VIG can survive anywhere near the temperature range we demonstrated.
- Our VIG used low-E tempered and clear glass without loss of any of the original tempered strength of the glass. No other VIG can claim this accomplishment.
- Our stand-offs produced zero scratches on either inside surfaces of the VIG (the clear or low-E coated surfaces).

Patents Applied For or Resulting From This Award

Provisional (P) or Non-Prov. (NP)	Name of Filed Application	USPTO or Int'l PCT Filing Date	USPTO App. # (Serial #)	Int'l PCT or USPTO Publication No.
P	SEAL FOR MULTI-PANE GLASS UNIT HAVING ADHESIVE AND HERMETIC COATING LAYER	13-Dec-10	61/422,268	
Int'l PCT	ASYMMETRICAL FLEXIBLE EDGE SEAL FOR VACUUM INSULATING GLASS	18-Feb-10		WO 2010/019484 A2
P	INSULATING GLAZING UNIT AND COMPLIANT SEAL FOR AN INSULATING GLAZING UNIT	5-May-11	61/482,701	
NP	TWO-PIECE HERMETIC SEAL BELLOWS FOR SINGLE-SIDED PLACEMENT ON AN INSULATING GLASS UNIT OF HIGHLY INSULATING VACUUM GLASS UNIT (Provisional filed prior to this award, so this NP is not the result of this award.)	2-Jun-11	13/152,249	
NP	MULTI-PANE GLASS UNIT HAVING SEAL WITH ADHESIVE AND HERMETIC COATING LAYER	2-Jun-11	13/152,201	

Int'l PCT	MULTI-PANE GLASS UNIT HAVING SEAL WITH ADHESIVE AND HERMETIC COATING LAYER	2-Jun-11		PCT/US2011/038973
NP	METHOD AND APPARATUS FOR AN INSULATING GLAZING UNIT AND COMPLIANT SEAL FOR AN INSULATING GLAZING UNIT	4-May-12	13/464,951	
Int'l PCT	METHOD AND APPARATUS FOR AN INSULATING GLAZING UNIT AND COMPLIANT SEAL FOR AN INSULATING GLAZING UNIT	5-May-12	PCT/US2012/036693	
P	STAND-OFF CONSTRUCTION FOR VACUUM INSULATED GLASS	22-May 202	61/650,343	

TASKS TO BE PERFORMED

PHASE 1 (BP-1)

Task 1.0 – Project Management and Planning

REQUIREMENT: The Recipient shall submit a Project Management Plan within 20 calendar days of project award. This Project Management Plan (PMP) will be updated by the Recipient as the project progresses, and the Recipient must use this plan to report schedule and budget variances. The DOE Project Manager/Project Officer (PM/PO) shall have 15 calendar days from receipt of the PMP to review and provide comments to the recipient. Within 15 calendar days after receipt of DOE's comments, the Recipient shall submit a final PMP to the DOE PM/PO for review and approval. The PMP will serve as the basis of the project kickoff meeting that shall be held within sixty (60) calendar days after issuance of award. The Recipient shall review and update the PMP at the end of each Budget Period (Phase) and resubmit as a part of the budget period continuation application. The PMP shall also be modified on an ad hoc basis to reflect significant changes or deviations of planning.

RESULTS:
ESW completed Task 1.0 per all requirements.

Task 2.0 – Coordination of VIGU and Whole Window Requirements

REQUIREMENT: Appropriate Recipient personnel and industry collaborators will determine the requirements for the design of VIGU and the residential window that will use the VIGU as its glass component(s).

RESULTS:
ESW established with its industry collaborators the following set of goals for its proof-of-concept or demonstration VIG:

- Enable Whole Window ≥ R-10
- Use Tempered and Low-E Glass From Any Quality Supplier

- No loss of fully-tempered strength from assembly processes and materials
- All assembly processes compatible with both tin-side and non-tin side of clear glass
- Assembled Using Off-The-Shelf Materials And Processes
- Commercially-available lead-free materials and catalogue equipment

- Suitable For Any Traditional Residential Or Commercial Application
  - Same Form/Fit/Function As Today's Double-Pane IGs
    - Fits in current sash designs with limited sash modifications
      - The ESW VIG Is thinner than a conventional IG
    - No new material handling or packaging requirements for window producers
- Practical For Use In Any U.S. Climate
- 40 Years' Performance And Reliability

EverSealed met and demonstrated every one of the above goals.

Task 3.0 – Develop and Test Lead-Free Solder Glass

> **REQUIREMENT:** The Recipient's current glass-to-metal bonds have been formed using an intermediate material called a "solder glass", "sealing glass" or "interlayer". The material used up to now contains a large percentage of lead. The goal of this task is to develop a solder glass that does not contain lead or other toxic materials and that provides a strong, highly hermetic glass-to-metal seal.

RESULTS:
EverSealed, working with LGP in St. Petersburg, Russia successfully completed this task. However, when ESW and LGP attempted to produce VIGs with the LGP-produced solder glass, the parties were unable to reflow the solder glass at a low enough temperature and short enough time to enable use of tempered glass and not de-temper the glass. Both parties spent almost two months at ESW's thermal process subcontractor, Vacuum Process Engineering ("VPE") in Sacramento, California performing process trials using 9" by 13" tempered glass supplied by Cardinal Glass Industries. A significant contributor to the difficulties encountered was that we were using an extremely large and high thermal-mass furnace which meant long heat-up time and an overnight cool-down to a temperature within 100 degrees F of room temperature. We might have had better results with a smaller and faster furnace but ESW believes that the LGP formulation would probably still be inappropriate for use with tempered glass.

Task 4.0 – Develop Stress model for Large Bonds

REQUIREMENT: A software tool will be developed that uses inputs variables including glass parameters, metal parameters and the solder glass composition and outputs reflow (soldering) process parameters. The model will be used to substantially shorten the cycle-time required to create the bonding process recipe for the assembly of a test coupon with a long glass-to-metal bond and then the prototype VIGUs.

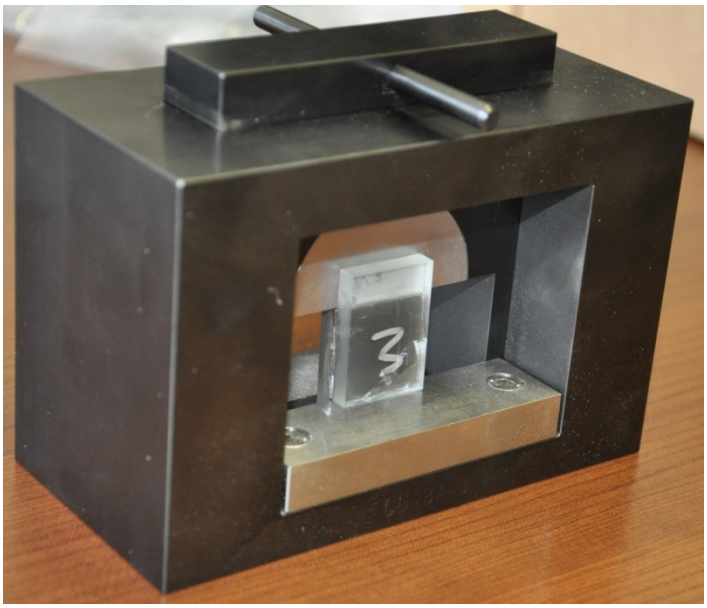
RESULTS: EverSealed collaborated on this task to LGP, which has performed similar software tools in the past. The resulting tool was named "Glassburger" by LPG and met the requirements defined by EverSealed.

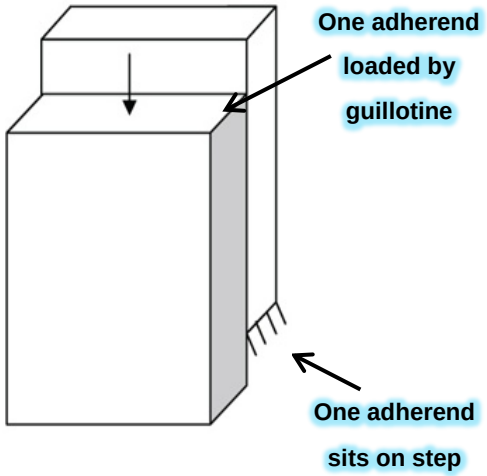
Task 5.0 – Test Mechanical Properties of the Lead-Free Solder Glass

REQUIREMENTS: Assembled test coupons, with bond areas of increasing size, for example, from 1 square inch up to 9 square inches, using the pre-selected metal alloy, generic annealed or tempered soda-lime glass and the lead-free interlayer solder glass that holds the assembly together will be mechanically tested. A shear test will be performed on a load cell to determine the shear strength of the glass-to-metal bond.

At least 8 coupons of each assembled size will be tested prior to or without thermal cycling, and at least 8 coupons of each size will be tested after a pre-determined number of thermal cycles over a temperature range corresponding to industry/NFRC requirements for testing IGUs.

RESULTS:
EverSealed completed this task. The metal alloy used for this and all subsequent work was Alloy 49, an iron-nickel alloy with a very close CTE match to generic North American soda-lime float glass. The bond strength for these Test Vehicles #1 (TV-1s) exceeded the minimum calculated shear strength requirements of 200 psi by a factor of about 7X, averaging 1,489.6 psi.





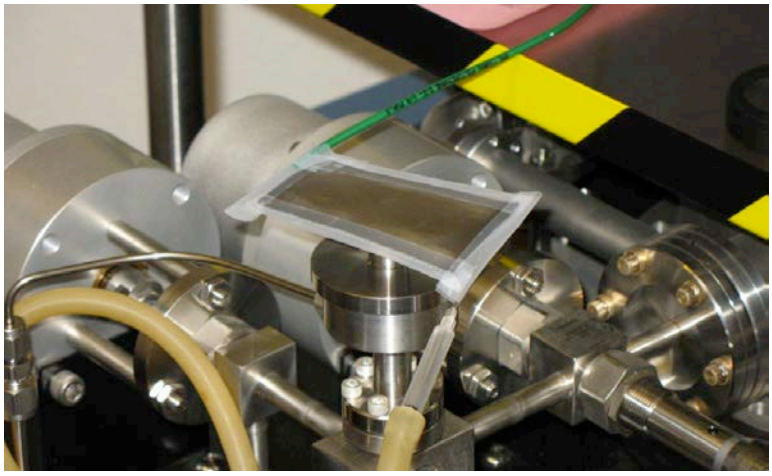
ASTM D905 Test Fixture

Task 6.0 – Test Lead-Free Solder Glass Bond Hermeticity

REQUIREMENTS: The glass-to-metal bonds' hermeticity will be tested to ensure that pressure in the VIGU's cavity never decays (increases) above 10^{-3} torr during the intended lifetime of the VIGU. The 10^{-3} torr is the inflection point on the thermal conductivity curve for the level of "vacuum" or very low pressure. A very sensitive helium leak detector will be used for fine leak testing.

RESULTS:

The hermeticity requirement for our 4" by 4" glass-to-metal bonded test coupons was a leak rate of no more than 10^{-13} cc/second. We assembled and tested 10 parts. All parts had passing leak rates.



Solder-Glass Bonded Helium Leak Test Coupon on the Helium Lead Tester

Cumulative Helium Leak Detector ("CHLD")

Task 7.0 – Design and Model Functional Bellows for a large TV-3 Test Unit and for Incorporation into Residential Window Units

REQUIREMENTS: A bellows system will be designed for and used with a TV-3 test unit of approximately 12 inches square to demonstrate the producibility/manuafacturability of such a system and to test this small VIGU before producing a larger, prototype-sized VIGU.

A second and larger bellows system will be designed that will enable an industry partner to assemble residential windows with prototype VIGUs. One or more prototype VIGUs will be tested to show that they will pass window industry/NFRC thermal cycle test requirements. The bellows system will be designed, modeled and simulated to meet as many of the industry partner's wish-list of desired attributes as feasible.

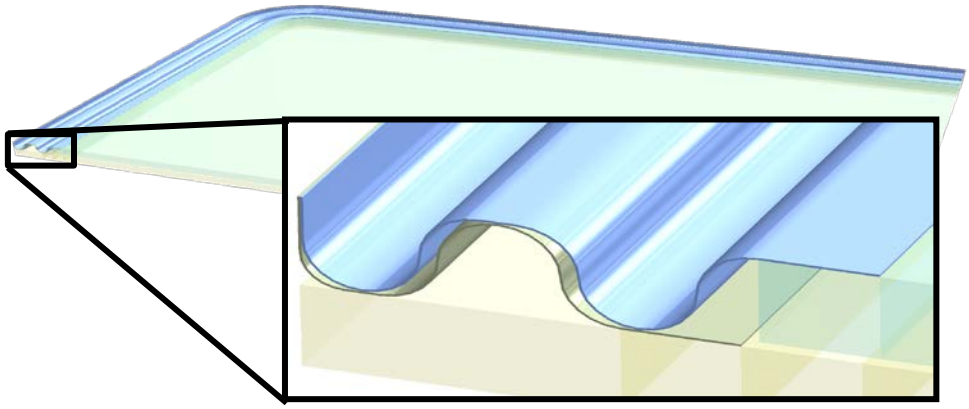
The method of fabricating the two or more pieces that will constitute the final bellows will be determined in conjunction or concurrently with the design process to ensure the bellows is producible. One or more metal fabricators will be consulted at the beginning of the design process to ensure appropriate collaboration of the bellows designer and the eventual fabricator.

RESULTS:

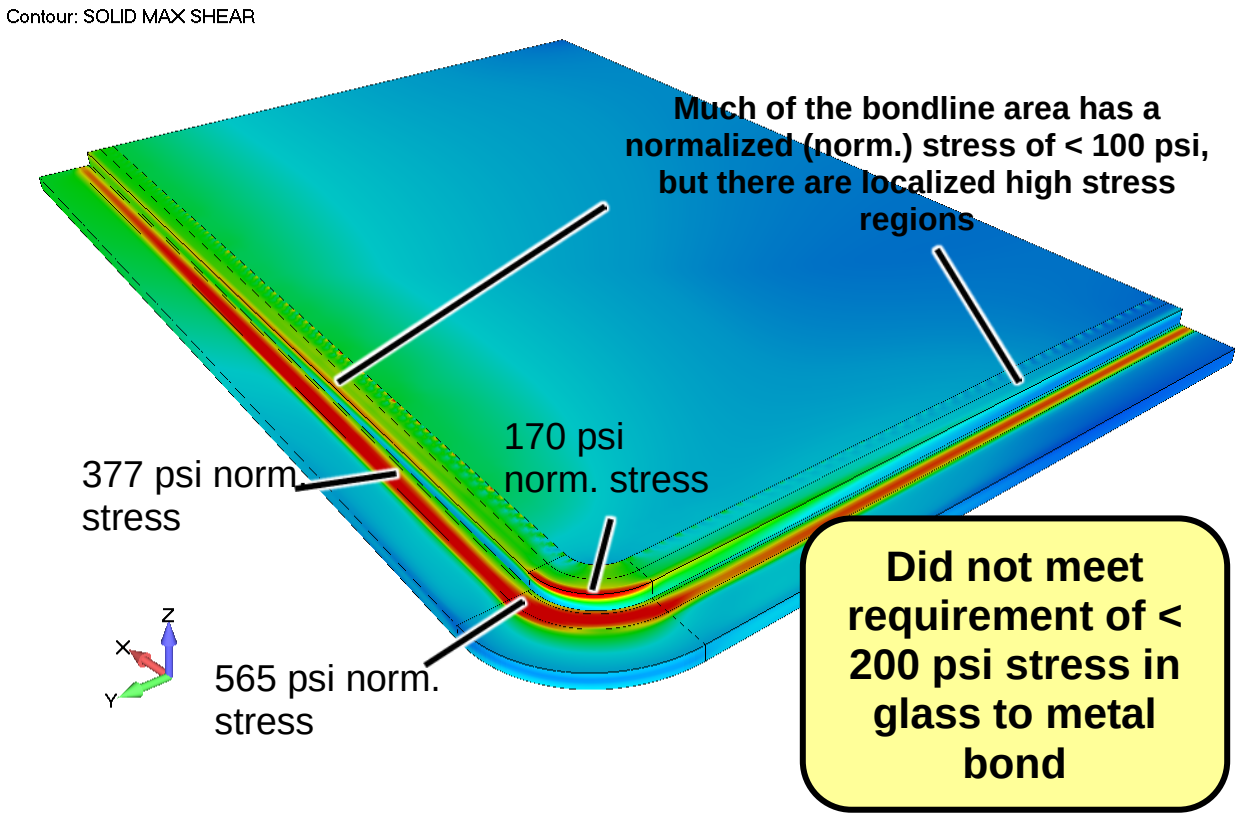
EverSealed developed a list of technical performance requirements for the flexible edge seal system. We then designed a system to meet the thermal-induced, cyclic deformation requirement, tested for performance and identified the next steps toward full component qualification for commercial use.

Requirements		Value	Compliance Method
Level 0 Requirements			
1	VIGU System Level R Value	10	See below
2	Lifetime in North American Residential Installation	40 yrs	See below
Level 1 Requirements (Derived from Level 0)			
2.1	Maximum Survival Temperature Extremes (Surface 1	-60 and 105 C	Static Test
2.2	Extreme Average Diurnal Surface 1 Temp. Delta	10 C to 48 C	Analysis, Accelerated Test
2.3	Thermal Cycles at 2.2 temperatures	14600	Analysis, Accelerated Test
Level 2 Requirement (Derived from Level 1)			
1.1.3	Formed Edge seal hermeticity after cycles in 2.2.2	<1E-13 cc/s total gas intrusion	He leak check
1.1.4	Weld hermeticity	<1E-13 cc/s total gas intrusion	He leak check
2.1.1	Flexible Edge Seal Shear Deflection Static Limit	0.016 in	Analysis, Test
2.2.2	Edge Seal Fatigue (Strength & Hermiticity)	14,600 @ 0.0036", fully reversed	Test
3.1.2	Low Cost Alloys in Edge Seal	< TBD $/lb	Design, Inspection
3.2.2	Manufacturable Edge Seal Design	Comply	Design, Manufacturing Trials
3.2.3	Single Edge Seal Configuration for all VIGU Sizes	Comply	Design, Manufacturing Trials
3.3.2	Allowable Edge Seal Bite	<0.5 in	Design, Inspection

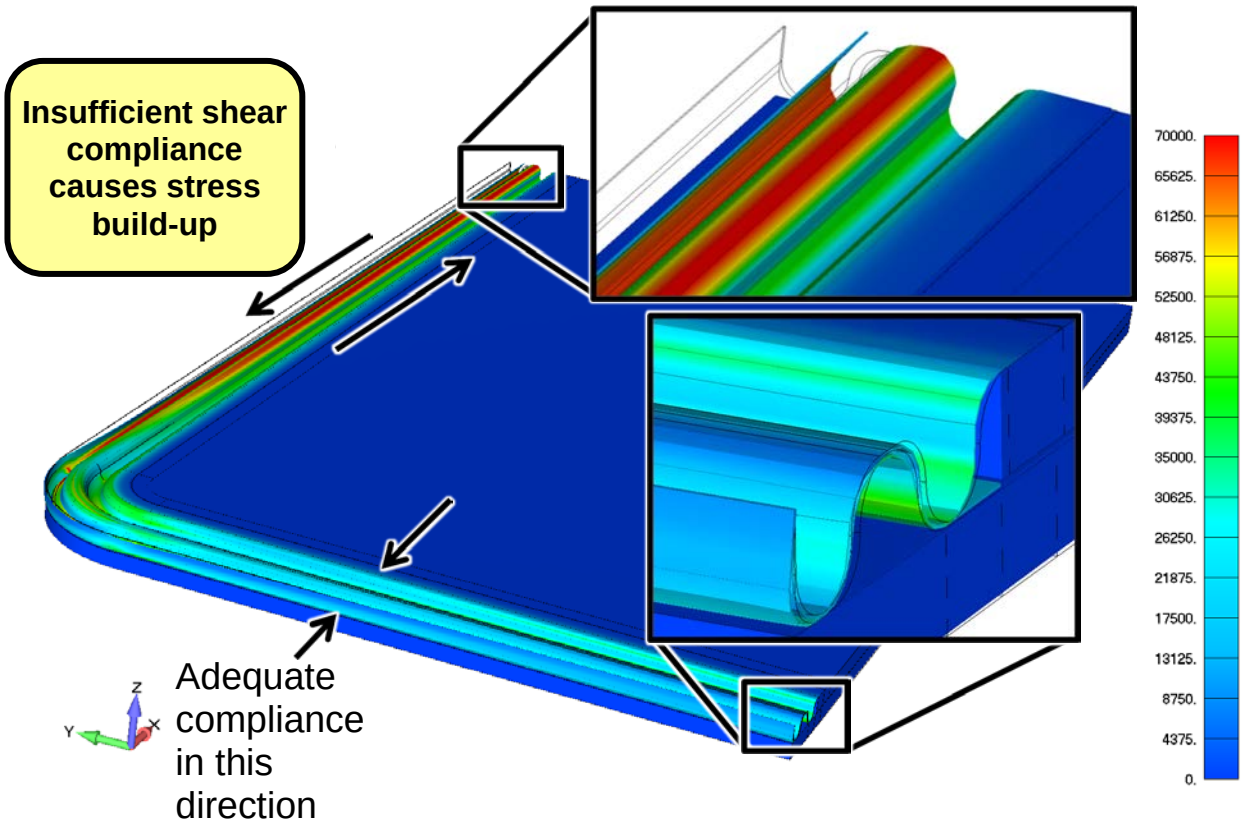
Table of Edge Seal Requirements for ESW's Proof-of Concept VIG for the DOE Program



One of the Many Asymmetrical Nesting Bellow Designs Which EverSealed Windows Developed, Modeled and Simulated for Determination of Maximum Shear Stresses in the Glass-to-Metal Bonds of the Bellows to the Surfaces of the Glass Lites of the VIG



Preliminary Analysis of One of the EverSealed Edge-Attached Bellows Systems

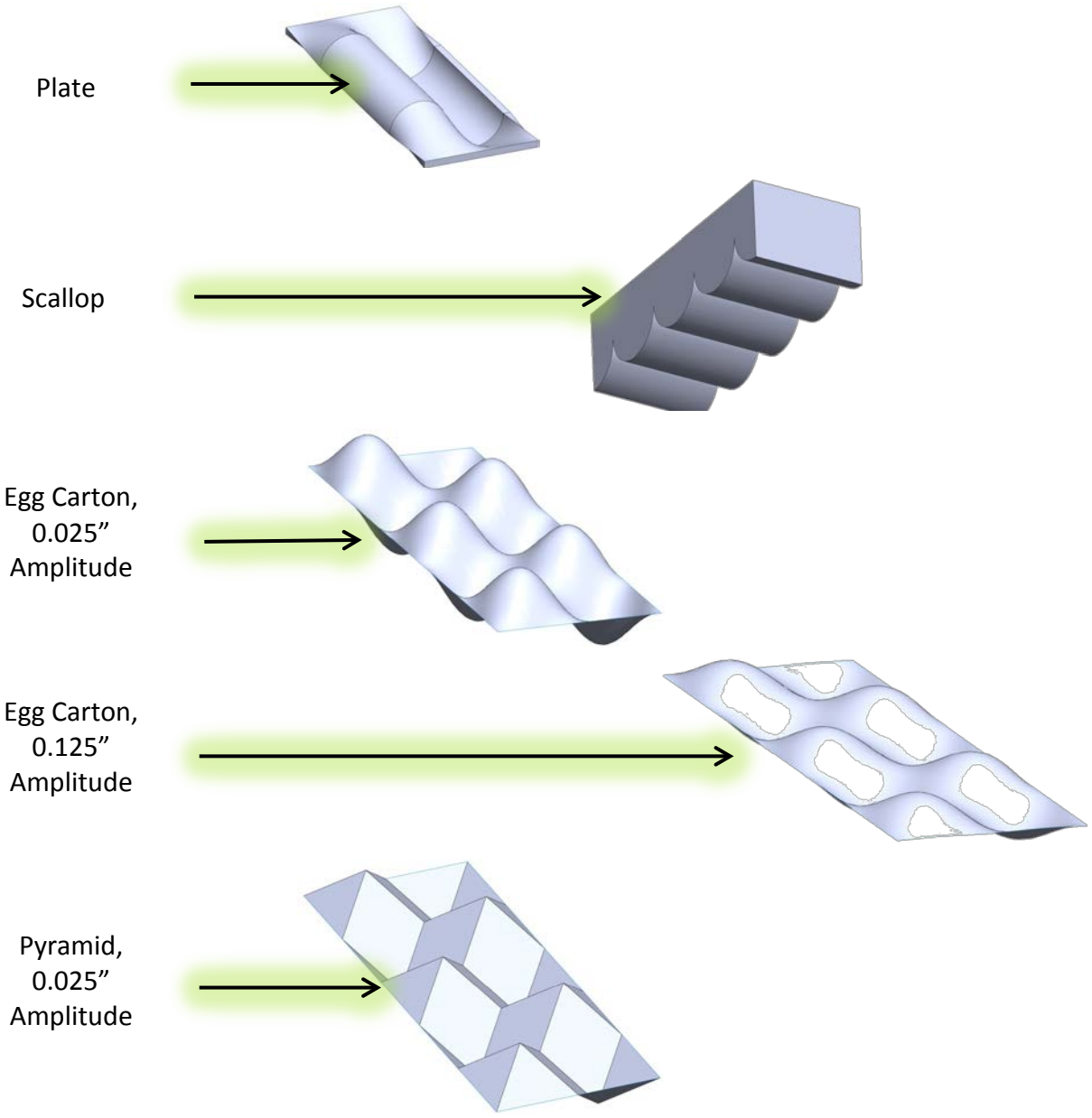


Additional Preliminary Analysis of the EverSealed Edge-Attached Bellows Systems Shown Above on the Previous Page

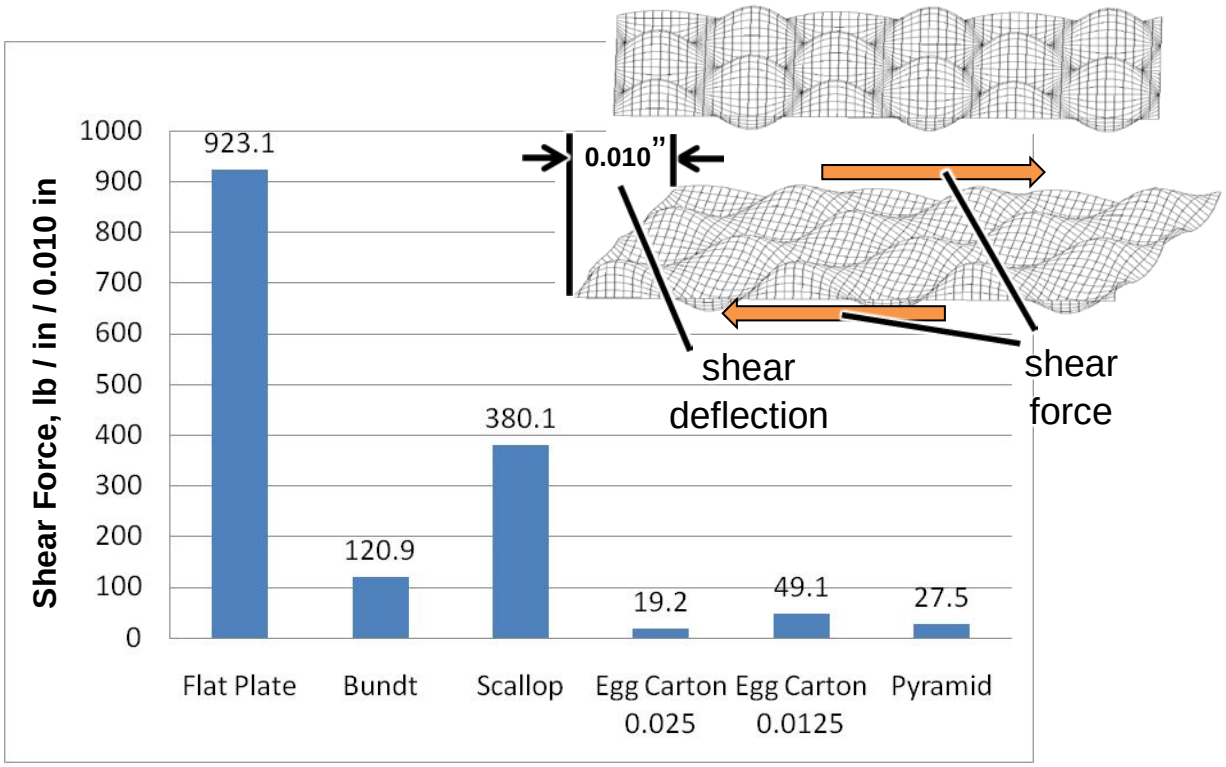
The EverSealed Concepts for two-piece flexible bellows provided adequate compliance perpendicular to the edges of the two lites of the VIG during simulated thermal cycling. However, all bellows designs demonstrated insufficient compliance perpendicular to the edges of the lites. The maximum shear stress in the bond lines is at the junction of the straight portion of the bellows and the tangent of the corner radii.

EverSealed abandoned the bellows concept and in January 2011, held a brainstorming session to conceptualize alternatives which would overcome the build-up of stresses at the VIG corner's tangent points.

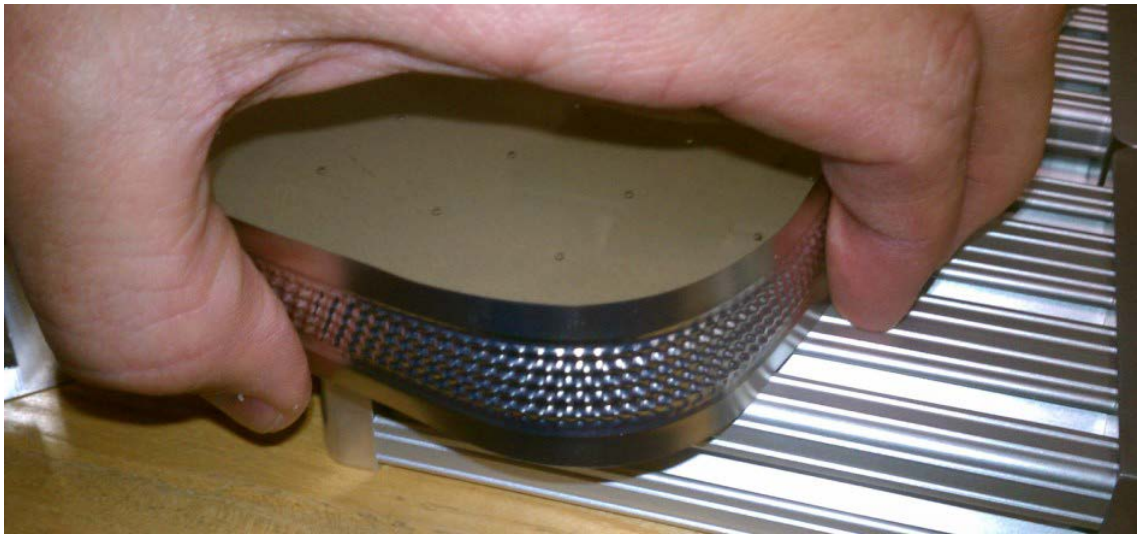
The following illustrations show the evolution of EverSealed's patent-pending flexible seal system.



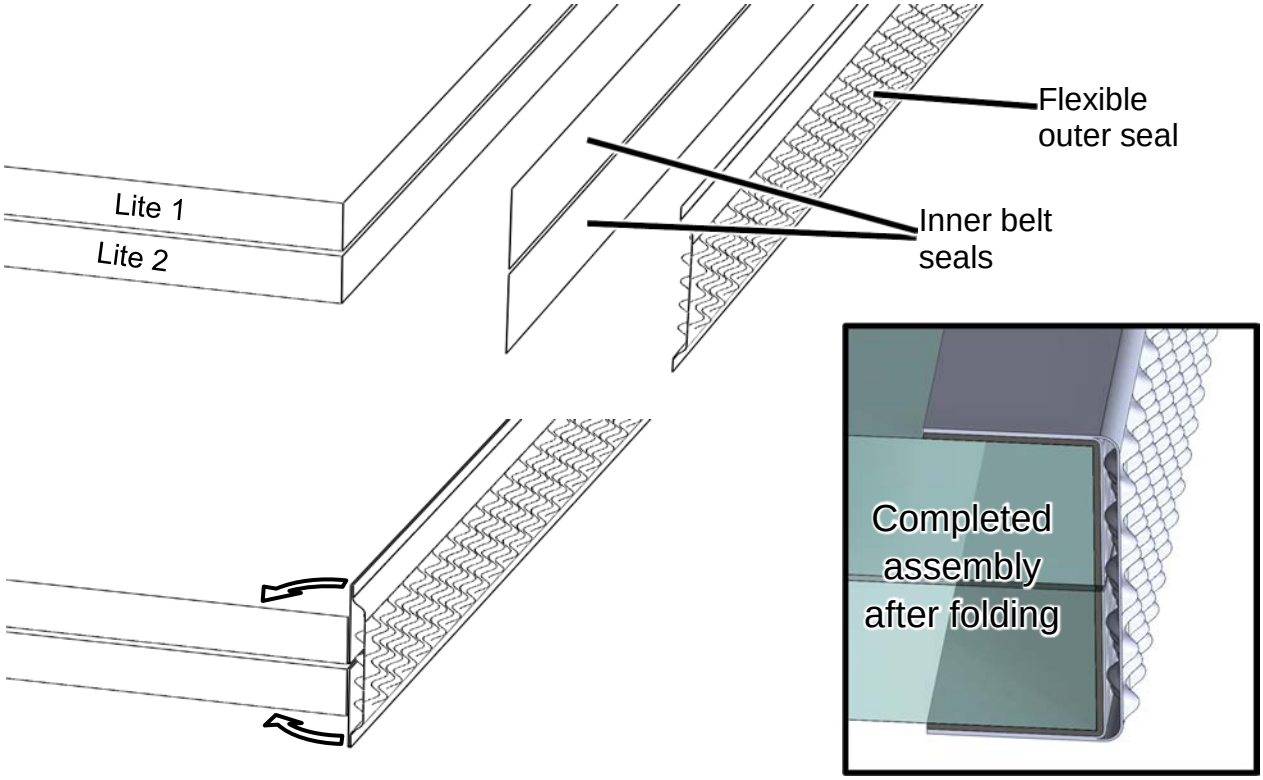
Some of the Some of the Shapes Conceived for the EverSealed Windows' Flexible Hermetic Metal Seal System at the January 2011 Design Brainstorming Meeting



EverSealed Windows Chose the Egg Carton Form for its New Flexible Metal Seal System

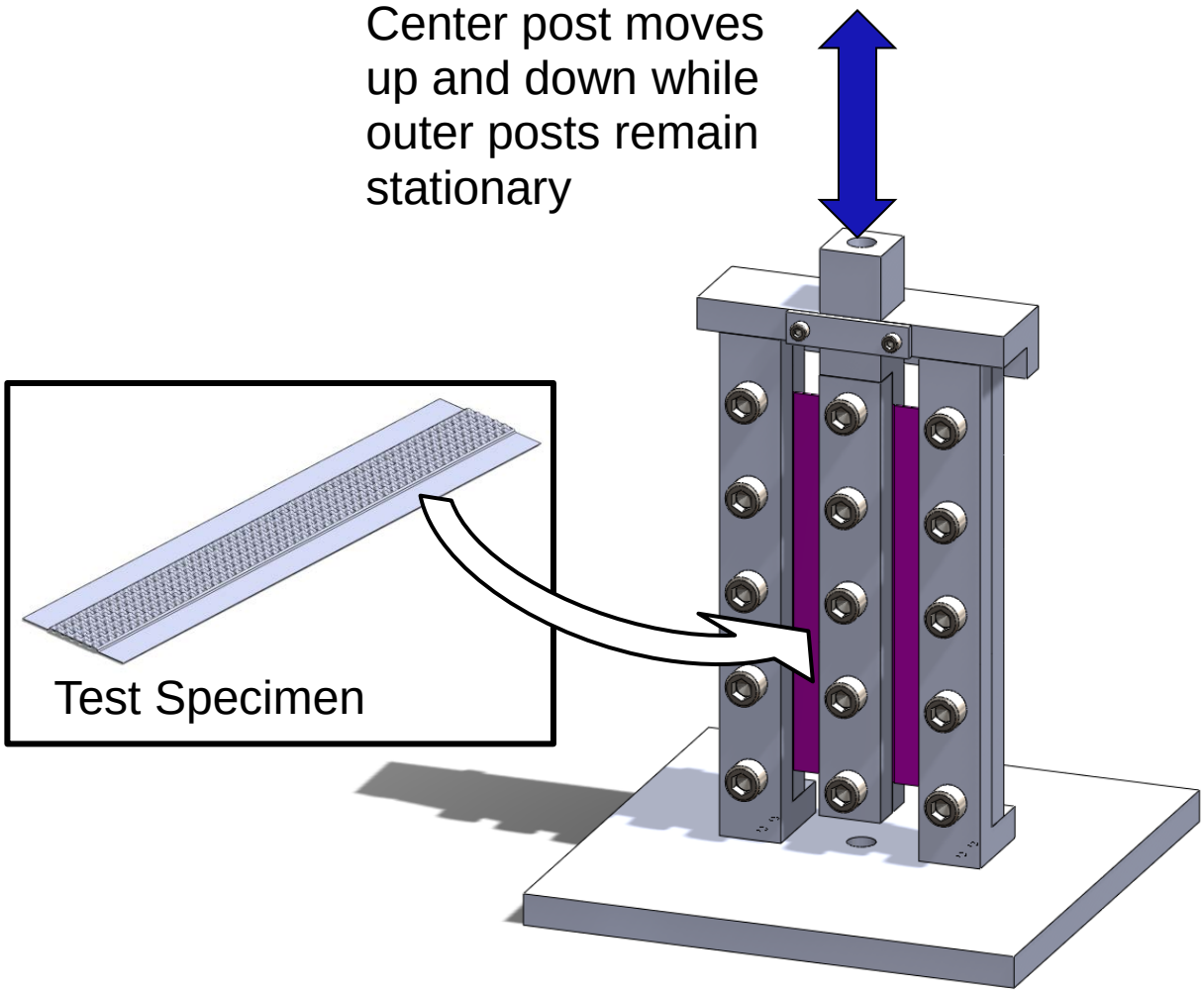


A ¾ depth flexible foil from Allmetal, wrapped around the 1" radius of two 9" by 13" lites with pre-screen printed glass stand-offs on this lite.
This outer (flexible) metal band is made of 201 stainless steel.



The EverSealed Seal System Developed and Used for its Proof-of-Feasibility VIGs Consists of Three Metal Bands:

- **Two Inner Bands of Alloy 49, Hermetically Soldered to the Perimeter of Lites 1 and 2, and**
- **An Outer Flexible Metal Band, Hermetically Welded to the Inner Metal Band's Exposed Flanges**



The EverSealed Designed and Fabricated Test Fixture for Mechanically Cycling the Two Strip of the Flexible Metal Seal

- **Conforms to the ASTM Three Rail Shear Test**
  - **Two Specimens to Balance the Load**
  - **Performs Static and Fatigue Testing**

PHASE 2 (BP-2)

Task 8.0 – Assemble and Test Prototype VIGUs with Simulated Stand-Offs

REQUIREMENTS: Materials selection, design and assembly of an early-stage stand-off system to maintain the close separation of lites 1 and 2 of the dual-pane VIGU against atmospheric pressure will be completed. Development of the stand-off system is a long-lead item requiring evaluation of potential materials and system assembly procedures and will be initiated during BP-1.

At least three prototype VIGUs, using a simplified stand-off system and functional bellows, will be assembled. At a minimum, the tests conducted on one or more of the first prototype VIGUs will include the protocol of the window industry/NFRC test methods for demonstrating the durability/reliability of insulating glass units (IGUs).

RESULTS:
EverSealed Assembled and tested two VIGs with fully-functional stand-offs. One VIG used annealed clear and low-e coated lites with the ESW-developed stand-offs on 1" centers. The second VIG consisted of tempered clear and low-e coated lites with stand-offs on 2" centers.

The Windows Group at LBNL performed simulations to predict the thermal performance of the two VIGs. Their new software for simulating VIG performance calculated the annealed glass VIGs would have a Center-of-Glass ("COG") insulating value of R-4.5 and the tempered glass VIG would achieve R-13.

EverSealed instruments surfaces 1 and 4 of both VIGs with thermal couples and put the two VIGs in a modified opening of its Tenny thermal cycle chamber. The VIGs' were fitted into opening in Dow rigid insulating foam board. Then the VIGs were held in place in their opening in the foam by placing another sheet of foam board with ¼" smaller openings on each side of the VIGs to hold them in place in the opening of the thermal cycle chamber. See the figure on the next page.

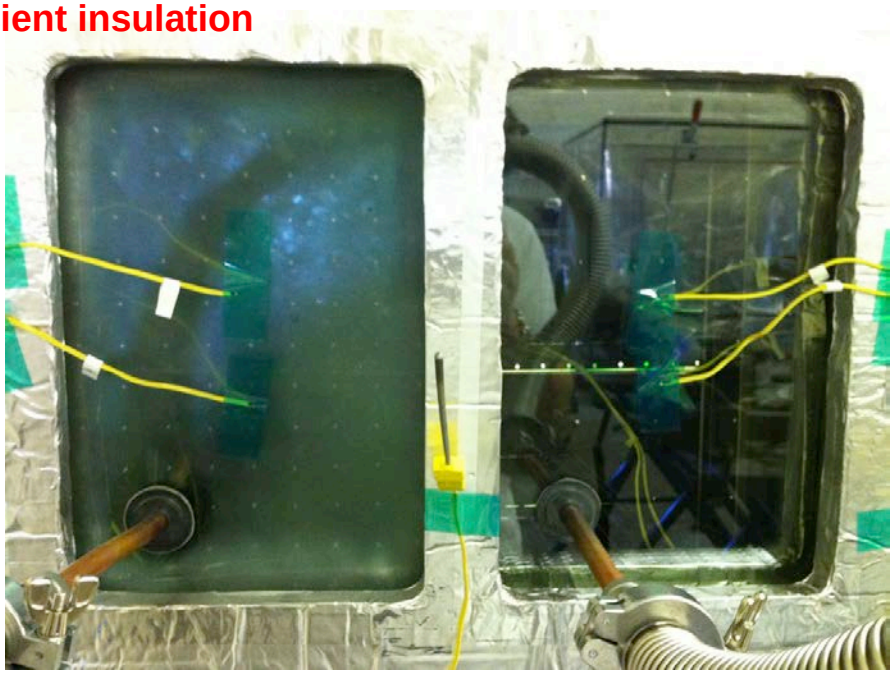
Thermal couples were positioned 1" from the two VIGs' surface 1 on the inside of the chamber and 1" from their surface 4 on the outside of the chamber. This way, the temperature of the air on each side of the VIGs could be constantly measured and recorded during thermal cycling.

ESW tested the VIGs, the effects of the stand-offs on the surfaces of the clear glass and low-e coating (surfaces 2 and 3) and the durability of the seal system to allow the glass to remain flat and maintain hermeticity. These tests were performed using highly accelerated thermal cycling with cooling ramp rates averaging 4 degrees C per minute and heating ramp rates averaging 10 degrees C per minute. Initially, we used liquid nitrogen to boost the cooling rate to 7 degrees C per minute but found the consumption of liquid nitrogen and the number of dewars to be kept on hand to be excessive.

Our thermal cycle inside the chamber (on lite 1, surface # 1) was from -60 C (-76 F) to +130 C (+266 F) with a 15-minute dwell at each temperature extreme. 266 thermal cycles would statistically prove the hermetic flexible edge-seal system surviving more than one forty year (14,600 days) lifetime in one of the most severe U.S. climates, Ely, Nevada. We stopped cycling after passing 306 cycles with no failures. Steve Selkowitz's thermal group at LBNL calculated this first VIGU which was assembled with annealed glass would have a center-of-glass R-value of 4.5. Our measurements with numerous thermal couples validated LBNL's performance predictions. We initiated thermal cycling our second assembled VIG which used tempered glass after the first unit had experienced 230 cycles. The second VIG, with an R-value of 13, saw 66 thermal cycles with no failures. We stopped cycling the second VIG at the same time we stopped testing the first VIG.

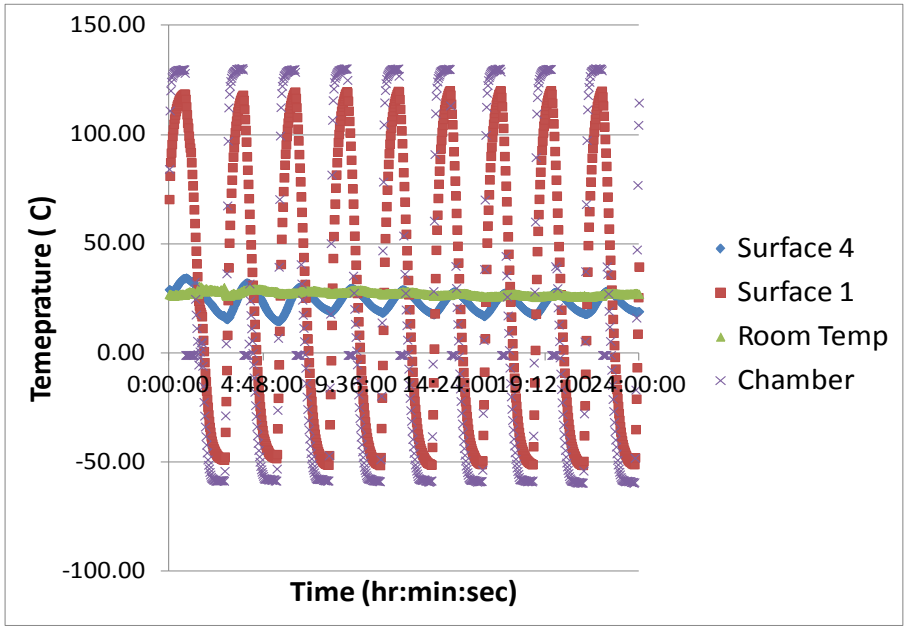
Since completion of the formal thermal cycle tests, both VIGs have been exposed at least an additional 50 thermal cycles during demonstrations. During servicing of the chamber, the cold cycle was extended down to -70 degrees C for a few cycles.

~R4.5 VIG: Note condensation on surface 4 due to insufficient insulation



~R13 COG VIG: Note the lack of condensation on surface 4 due to this VIG's high insulation (i.e., the temperature of surface 4 is at or near room temperature.)

Two VIGs Shown Side-by-Side During Thermal Cycle Testing While the Test Chamber' Interior Temperature is Held Constant at -60^0 C



40 years = 14,600 days

For Eli, Nevada:

- **35^0 C diurnal temperature change in late June/July**
- **1.93 factor for solar heat gain on surface 1**
- **67.6^0 C worst-case diurnal temperature change for 14,600 days**

229 Thermal Cycles from -60^{0}C to +130^{0}C

- **Yields 90% confidence in 95% reliability for 40 years in Eli, Nevada (according to Baye's Success Run Statistics)**

Eight thermal cycles of the R-13 COG VIG. Due to the extreme insulation properties of EverSealed's VIG, the room-facing Surface 4 of the VIG stayed very close to actual room temperature when the opposite surface (Surface 4) was exposed to 15 minutes of -60^0 C (-76^0 F) and 15 minutes of +130^0 C (+266^0 F).

The results of our tests demonstrated that we had developed and tested a VIG with the following properties when compared to any other double-pane insulating glass unit (IGU), triple-pane IGU or VIG:

- We demonstrated the world's first known VIGU with a flexible, hermetic metal seal system.
- Our VIG has a higher R-value (insulating performance) than any other known conventional IGU or VIGU world-wide.
- Our VIGU has a far-greater reliability than any other type of IG, including suspended film IGs.
- Our VIGU can be used reliably in any residential or non-residential installation in any climate worldwide. No other VIG can survive anywhere near the temperature range we demonstrated.
- Our VIG used low-E tempered and clear glass without loss of any of the original tempered strength of the glass. No other VIG can claim this accomplishment.
- Our stand-offs produced zero scratches on either inside surfaces of the VIG (the clear or low-E coated surfaces).

Task 9.0 – Design, Assemble and Test Prototype VIGUs for Incorporation into Residential Window Units

ORIGINAL CONTRACT REQUIREMENTS:

The size (length and width) of the rectangular VIGUs which the Recipient's window industry collaborator desires for incorporation into its residential window unit may differ from the size of the initial or first-generation prototype units produced and tested in Task 8.0. If required, the prototype VIGU will be redesigned to the collaborator's desired outside dimensions. The desired VIGU size will be fabricated and assembled to the window industry collaborator's specifications for incorporation into a finished window unit for demonstration.

REVISED CONTRACT REQUIREMENTS:

Hold a technical "peer" review for EverSealed's industry and government laboratories' collaborators and obtain their feedback as to the progress and viability of the EverSealed VIG technology.

RESULTS:

1) ESW held a 2-day technical peer review on April 10, 2012 in Bloomington, CO and at its development lab in Louisville, CO. Attendees included technical representatives from Allmetal, Cardinal Glass, Pella Corporation, Lawrence Berkeley National Laboratory, National Renewable Energy Laboratory and the Golden Field Office of the DOE. After the review, ESW sent a survey of open-ended questions to all participants. Every respondent stated that ESW seemed to have the only viable approach for reliable VIGs and that the DOE should continue to fund ESW's development efforts.
2) The Windows Program at the DOE EERE asked ESW to give a 5-minute presentation at the EERE's Windows Roadmapping Session on morning of Thursday June 28, 2012. This Roadmapping Session was held in conjunction with, and on the last day of the Window and Door Manufacturers Alliance's (("WDMA's") 14th Annual Conference, held last year in Minneapolis, MN. After the presentation, WDMA members and the presenters for the Roadmapping session were arranged into focus groups with each group responsible one of the broad areas of focus presented at the session. They rated the quality of the work presented and also rated the importance of the DOE's funding each of the areas of technical development. EverSealed's presentation received the highest score among all technical presentations and R-10 windows' development received the highest score for importance of DOE funding. The DOE posted this presentation, including supplemental information not shown in the 5-minute allotment on-line at http://www.eereblogs.energy.gov/buildingenvelope/file.axd?file=2012%2F7%2Fwindow_roadmap_workshop_eversealed_062812.pdf.

Task 10.0 – Design, Assemble and Test Prototype R-10 Residential Window Prototype

ORIGINAL CONTRACT REQUIREMENTS:

The window industry collaborator will design and assemble one or more residential windows which use the prototype VIGU produced in Task 9 as the glass component for the window system. The whole-window system will be tested to determine its thermal performance and the durability of the VIGU following, as a minimum, the accepted industry test methods (ASTM standards) for whole residential windows.

REVISED CONTRACT REQUIREMENTS:

Disseminate information on program results to the public through published articles, group presentations or through other appropriate means and forums.

Additional Post-Contact Requirement – Have an Independent Audit Conducted of EverSealed's Financial Transactions for the Calendar Year 2011 Per the DOE's Guidelines.

This assignment was made mandatory for every "American Recovery and Reinvestment Act of 2009" ("ARRA") grant recipient that spent ≥ $500,000 of DOE funds in any of the grant's calendar years. EverSealed expended more than this threshold amount in calendar year 2011.

RESULTS:

The CPA firm Eide Bailly LLP in Golden, CO completed its independent audit of EverSealed's financial transactions for the Calendar Year 2011 per the DOE audit requirements. Their report which stated that EverSealed was in compliance and passed the audit was forwarded to NETL Pittsburgh and the Golden Field Office.