LandVac®

Tempered Vacuum Insulated Glass

VIG Technologies

LandVac & VIG Technologies presents:

VACUUM INSULATING GLASS

WHERE THE WINDOW BECOMES THE WALL!

HISTORY OF VIG

In 1893, James Dewar, a British physicist and chemist, invented the vacuum flask.

From then on, people began thinking how to use this technology on architectural glass.

In 1913, a German, Mr. Zoller, put forward the concept of vacuum glass in his patent for the first time.

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OVERVIEW

- Who are the players.
- What is a VIG and what makes it work?
- Why is VIG ready today?
- A look at the performance numbers.
- A VIG factory overview.
- VIG in a high performance curtain wall (case study).
- Q&A.

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WHO IS LANDVAC?

- LandVac is a division of LandGlass Technology Co. Ltd.
- LandGlass manufactures and sells glass tempering furnaces worldwide
- LandGlass developed & patented LandVac Vacuum Insulating Glass
- 100 Scientists
- 8 Years of research and development
- LandVac is exclusively represented by VIG Technologies in North America

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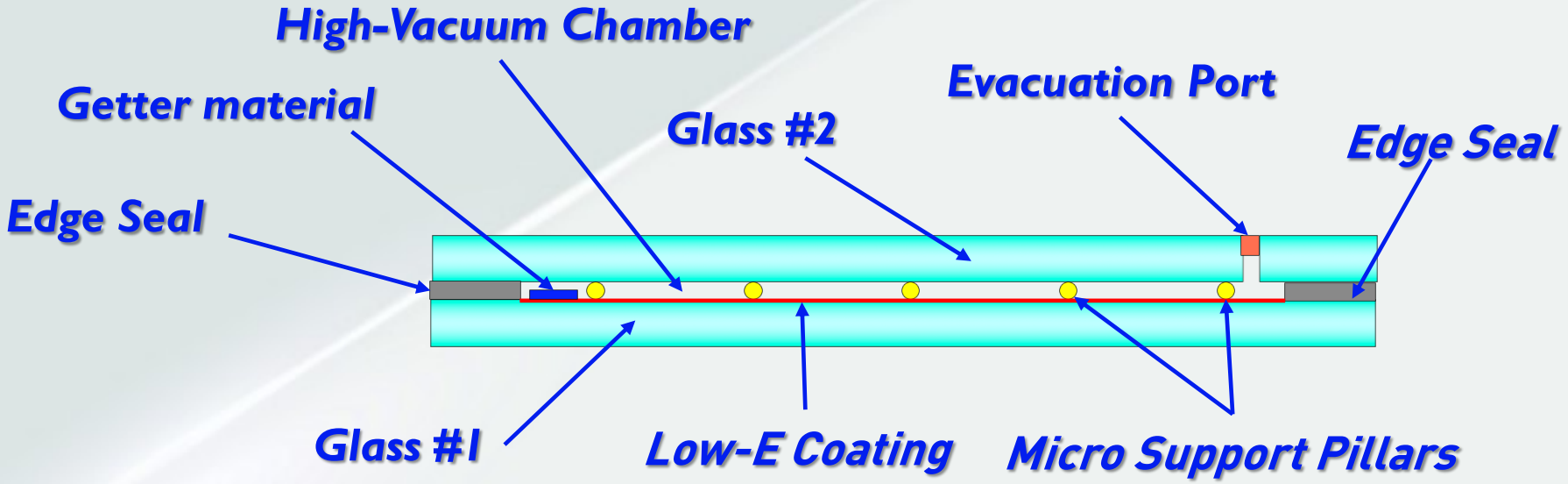
WHO IS VIG TECHNOLOGIES, LLC?

- Headquartered in Jupiter, Florida – USA
- VIG Technologies, LLC proudly serves as the exclusive North American distributor for LandVac®.
- Shares it location with IGE Glass Technologies

ABOUT OUR VACUUM INSULATING GLASS OR VIG

VIG is an insulating glass unit with a 0.3mm vacuum gap between the glass panes instead of air or inert gas.

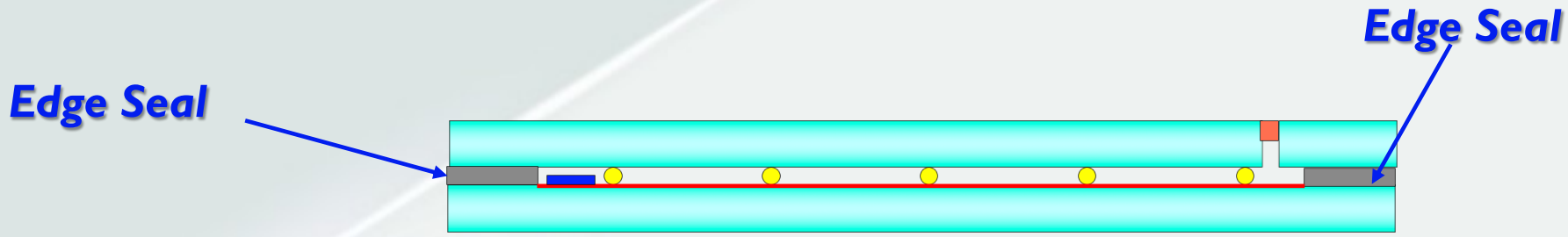
Structure of ***LandVac*** *Vacuum Insulating Glass*



ABOUT OUR VIG

*Components of **LandVac** Vacuum Insulating Glass*

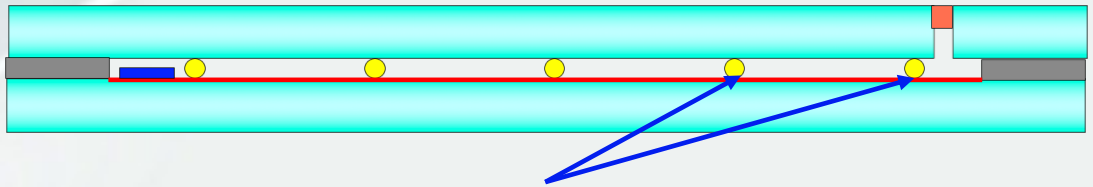
- Super long life – 25+ years
- Proprietary – Low Temperature Sealing Technology
- High compression flexible edge seal – 4x



ABOUT OUR VIG

*Components of **LandVac** Vacuum Insulating Glass*

- Aesthetically pleasing
- 0.3mm - 0.01” diameter pillars
- 60mm – 2.4” spacing

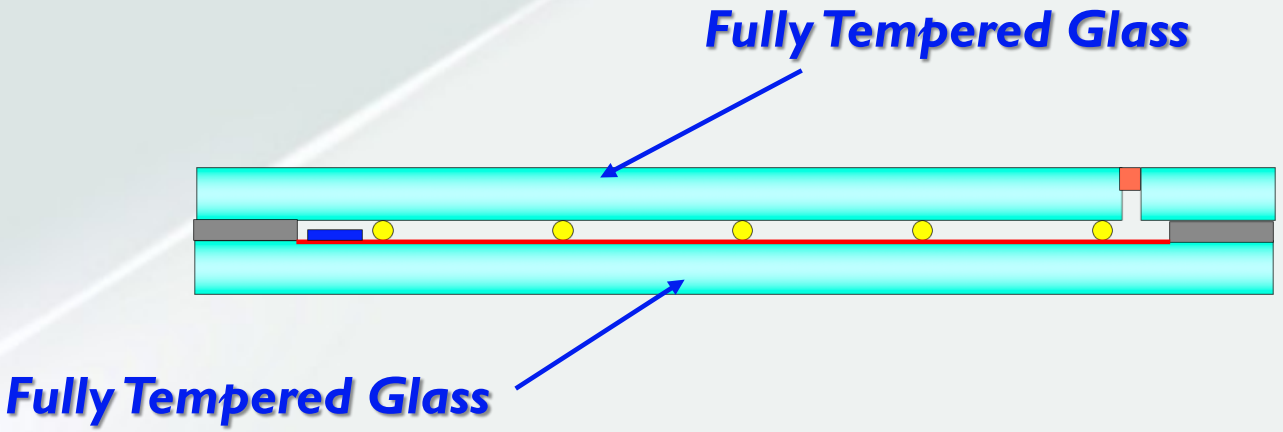


Micro Support Pillars

ABOUT OUR VIG

*Components of **LandVac** Vacuum Insulating Glass*

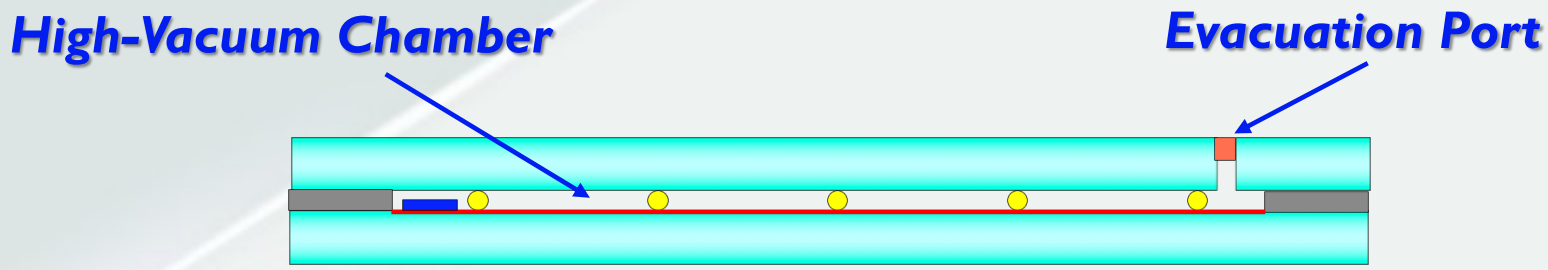
- Windload
- Flatness
- Safety (SGCC – certified)



ABOUT OUR VIG

*Components of **LandVac** Vacuum Insulating Glass*

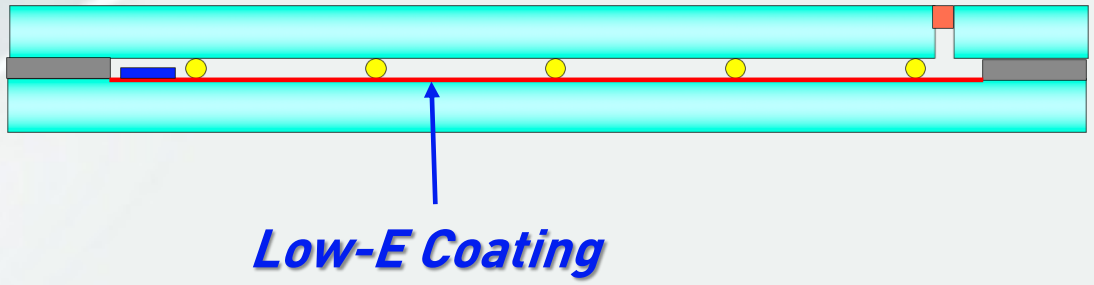
- Not all VIG's are equal
- Highest vacuum VIG (10 -4 mTorr)
- Evacuation Port – 25+ years



ABOUT OUR VIG

*Components of **LandVac** Vacuum Insulating Glass*

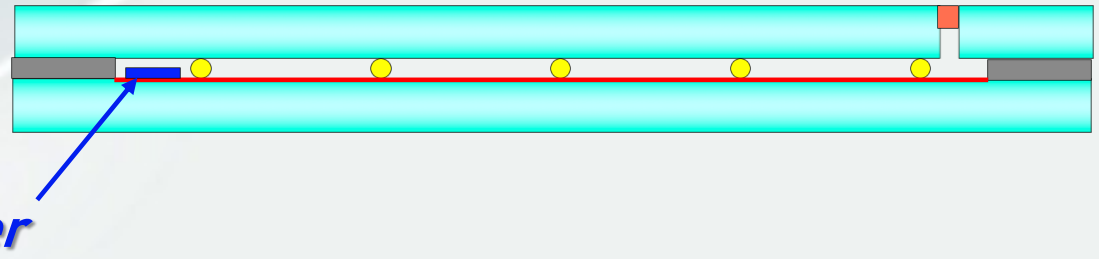
- Improve U-value (R-value)
- Improved SHGC
- Different Low-E's available



ABOUT OUR VIG

*Components of **LandVac** Vacuum Insulating Glass*

- A **getter** is a deposit of reactive material that is placed inside a vacuum system, for the purpose of completing and maintaining the vacuum



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WHY IS **LANDVAC** VIG READY FOR COMMERCIALIZATION **TODAY**?

- Fully functioning VIG factory operating since 2015
- Maximum size available today: 60x96” - 1.5x2.5m
- Minimum size : 12x12” – 0.3x0.3m
- Maximum size 78x125” - 2.0x3.2m Available 2020
- Millions of sq.ft. of capacity available today
- 182 patents on product and process (+240 patents)
- Patented convection tempering technology for super flat glass
- LandVac metallic “cool-seal, no-lead” edge seal technology

IGU / VIG PERFORMANCE DEFINITIONS

- *U-value/factor*: A measure of heat gain or heat loss through glass due to the thermal conductance. The lower the better and the reciprocal of R-value.
- *R-value:* Thermal resistance of a glazing system. The higher the better and the reciprocal of the U-value.
- *VLT:* The percentage of visible light that is transmitted through the glass.
- *SHGC:* Solar energy that enters into the building's interior. The higher the SHGC the higher the heat gain.
- *STC:* Sound Transmission Class Rating is used to categorize acoustic performance. The higher the better.

SO NOW THE NUMBERS

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CURRENT IGU PERFORMANCE VALUES

Double Silver Low-E

Makeup	Thickness	U-Value (R)	SHGC	VLT
Air	1” / 25.4mm	0.34 (3.0)*	0.38	70%
Argon	1” / 25.4mm	0.25 (4.0)*	0.37	70%
Triple, Air	1 3/4” / 44.5mm	0.22 (4.7)	0.34	63%
Triple, Argon	1 3/4” / 44.5mm	0.19 (5.2)*	0.34	63%

*measured at an independent lab

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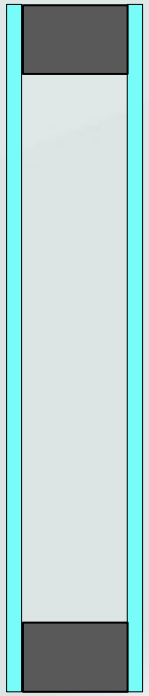
Triple, Argon	1 3/4” / 44.5mm	0.19 (5.2)*	0.34	63%
VIG*	**5/16” /8.3mm**	**0.07 (15.4)***	**0.37**	**70%**

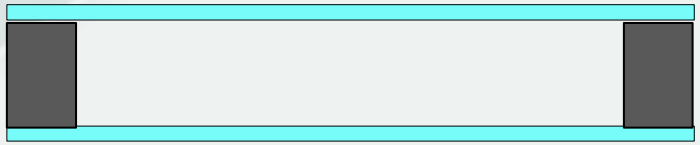
*VIG pillar spacing is 60mm
*measured at an independent lab

CURRENT IGU PERFORMANCE VALUES

Double silver Low-E IGU with Argon



In vertical position
R-Value = 4.0



In horizontal position
R-Value = 2.7

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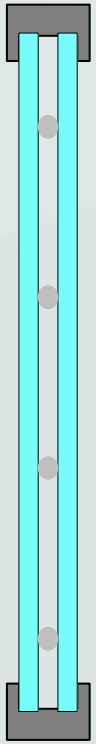
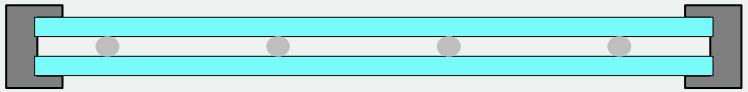
LANDVAC VIG PERFORMANCE VALUES

VIG unit



In vertical position
R-Value = 15.4



In horizontal position
R-Value = 15.4

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CURRENT IGU PERFORMANCE VALUES

Makeup	Thickness	U-Value (R)	SHGC	VLT
Standalone VIG	5/16” / 8.3mm	0.07 (15.4)*	**0.37**	**70%**
Hybrid, DS	1 1/8” / 28.5mm	0.06 (18.0)*	**0.27**	**56%**
Hybrid, TS	1 1/8” / 28.5mm	0.05 (18.3)	**0.22**	**50%**

*DS = Double silver Low-E coating
*TS = Triple silver Low-E coating

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DOUBLE VIG'S & HYBRIDS

"Double VIG" = two VIG units with an airspace between.
"Double VIG Hybrid" = Low-E-coated outboard with two VIG units inboard.

Makeup		Thickness	U-Value	SHGC	VLT
Double VIG	Argon	1 3/16" / 30mm	0.03 (28.8)	0.27	50%
Double VIG	Argon, #4 Low-E	1 3/16" / 30mm	0.03 (30.0)	0.27	50%
Double VIG	Krypton, #4 Low-E	1" / 25.4mm	0.03 (30.2)	0.27	50%
Double VIG Hybrid	Argon	2" / 50.8mm	0.03 (32.8)	0.20	40%
Double VIG Hybrid	Argon, #4 Low-E	2" / 50.8mm	0.03 (34.2)	0.20	40%
Double VIG Hybrid	Krypton, #4 Low-E	1 5/8" / 41.3mm	0.03 (35.1)	0.21	40%

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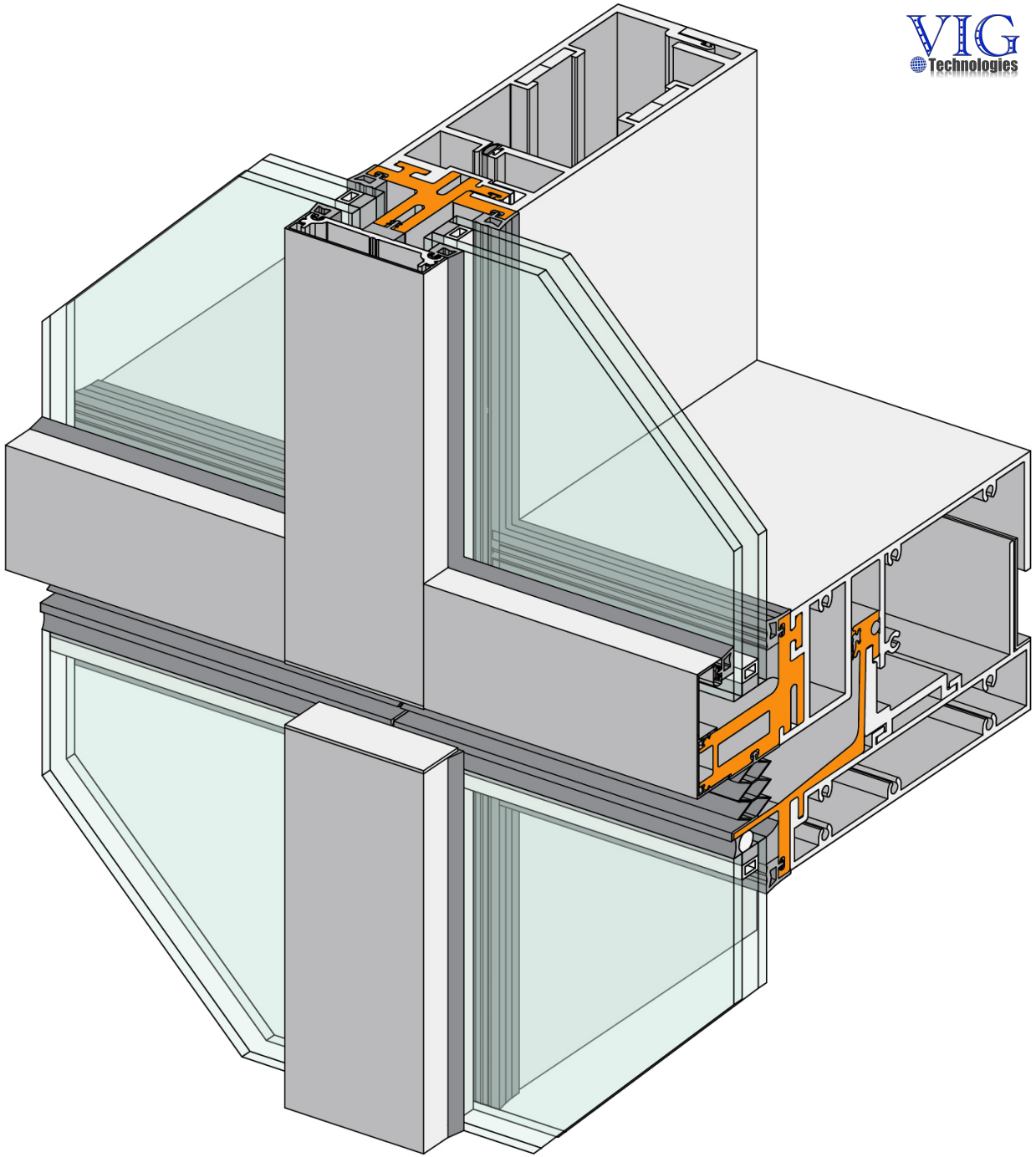
THE R-10 CURTAIN WALL

Better

- UCW3500 Unitized Curtain Wall
- Assembly U factor = .28 BTU/hr-sqft°F /1.59 W/m²K
- System R-value = 3.57



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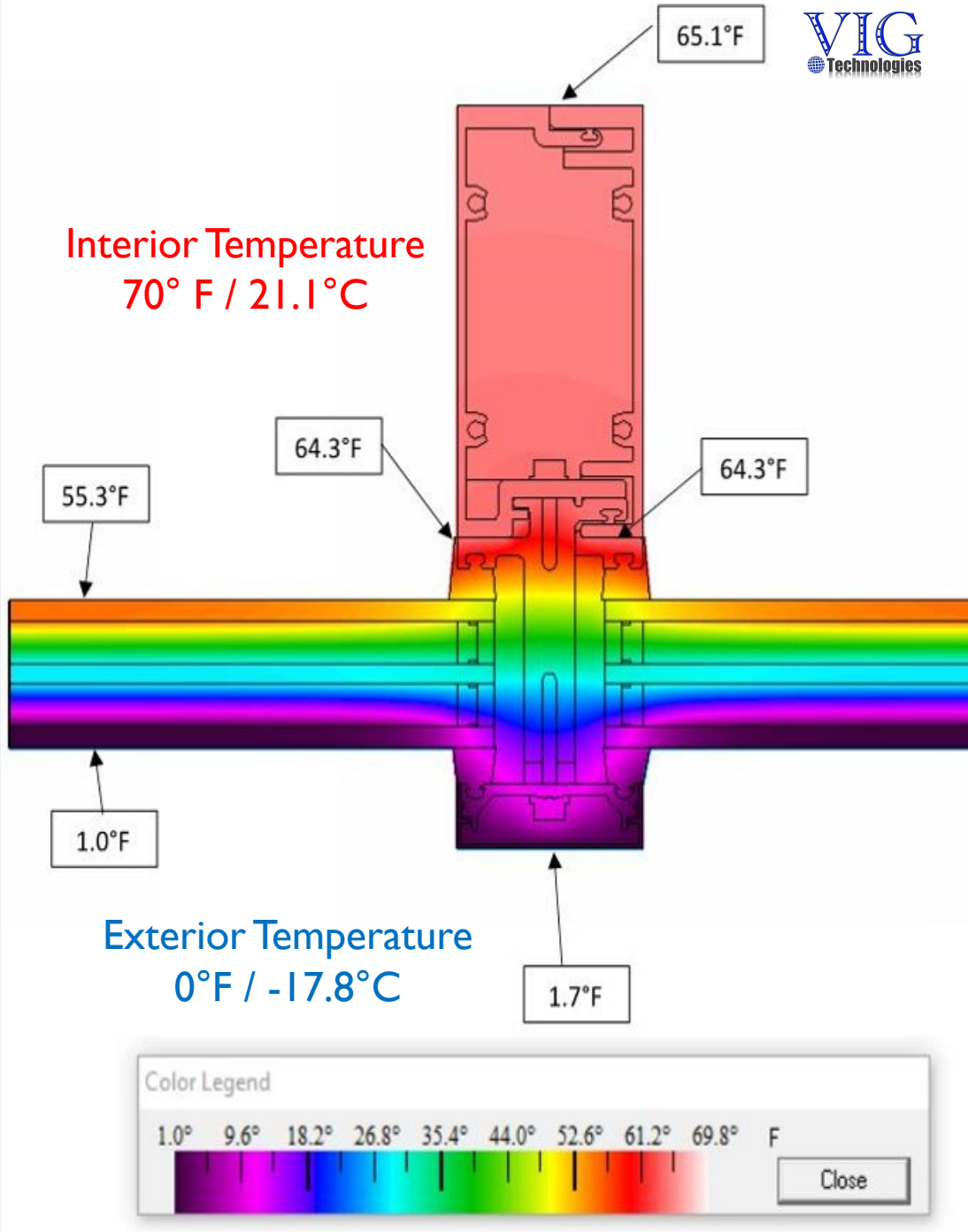
THE R-10 CURTAIN WALL

Todays best

- COG U factor = .12 BTU/hr-sqft°F / .681 W/m²K
- Assembly U factor = .17 BTU/hr-sqft°F / .965 W/m²K
- System R-value = 5.88



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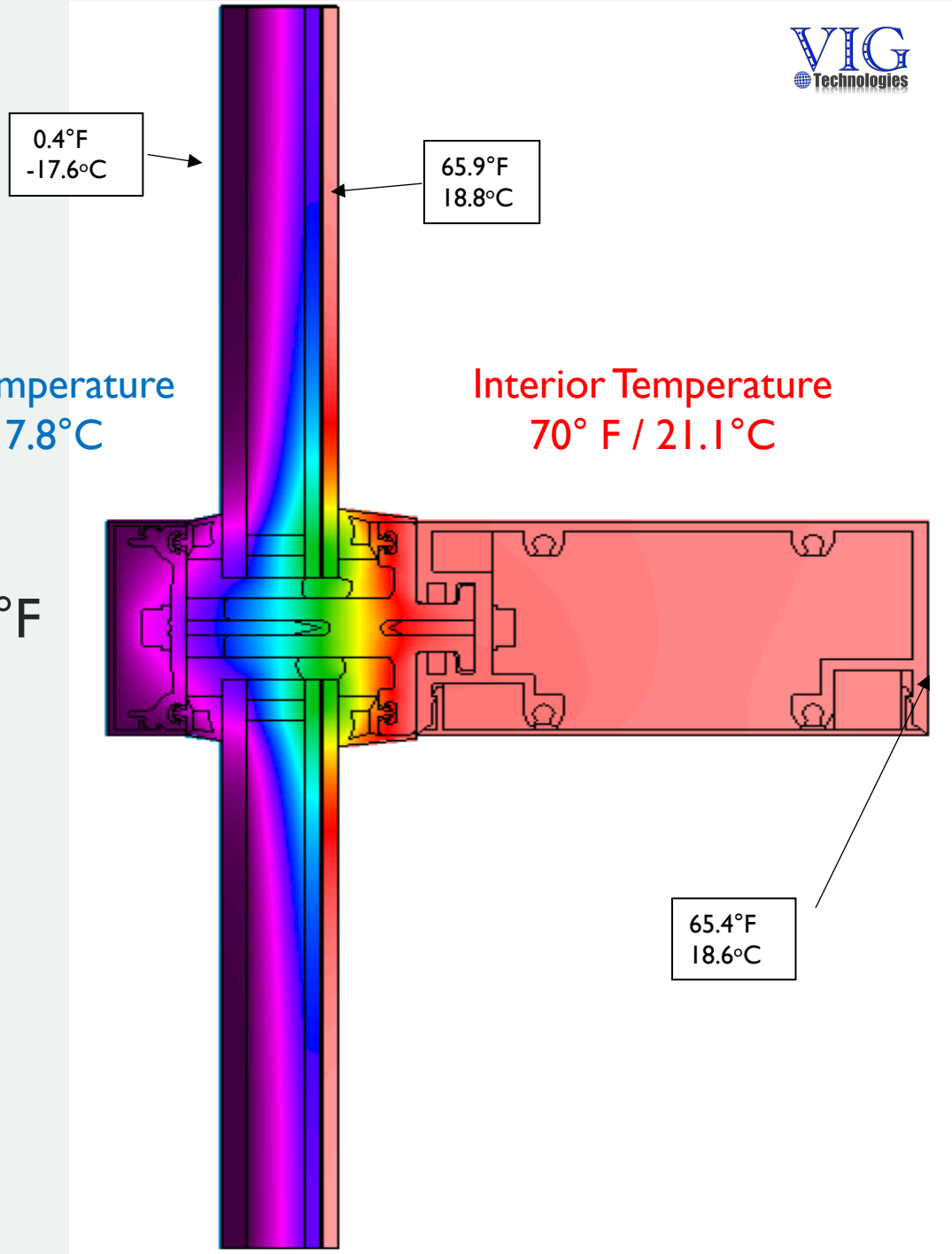

- H-VIG -COG U factor (imperial) = .052 BTU/hr-sqft°F
  (metric) = .295 W/m²K
- Assembly U factor (imperial) = .108 BTU/hr-sqft°F
  (metric) = .612 W/m²K
- System R-value = 9.26 → **10.0**
- 100°C - 180 °F Delta T

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TESTING PERFORMED

- ASTM E1233, ASTM E330
  - Pressure cycling and sustained loads performed with no breakage
- Modified ASTM E2188
  - Acoustics:
  - STC Rating: 33
    - ASTM E90 /ASTM E413
  - OITC Rating: 32
    - ASTM E1332
  - Weighted Sound Reduction Rw= 36-39 dB
- ANSI Z97.1: Fully tempered

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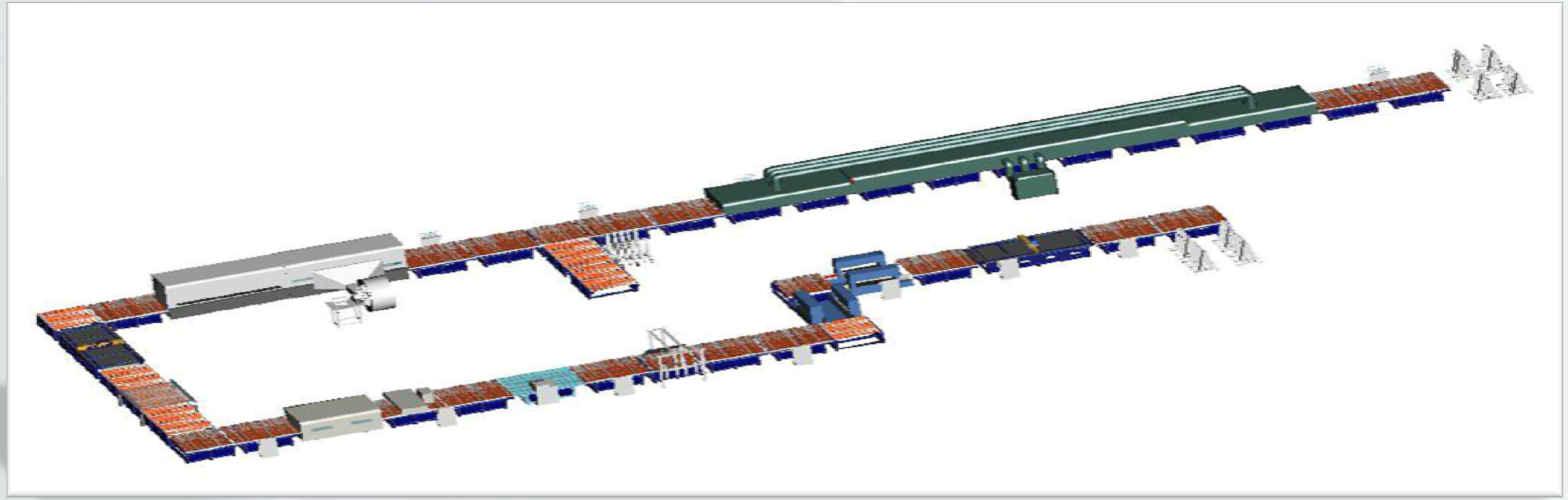
VIG MANUFACTURING FACILITY IN NORTH AMERICA USING LANDVAC INTELLIGENT AUTOMATION TECHNOLOGY



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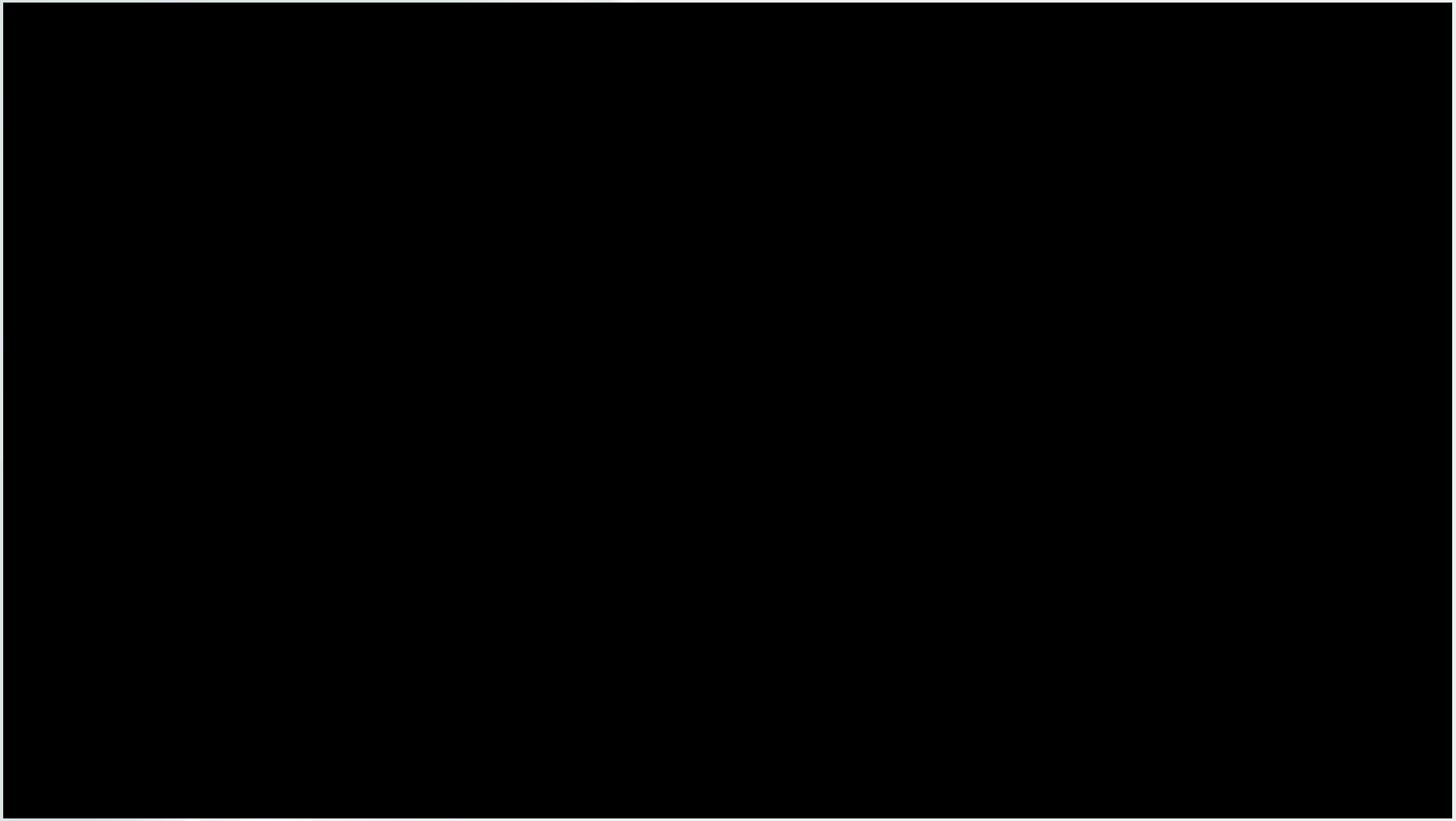
VIG FACTORY FACTS

- **Space required:** 150,000 sq.ft. / 15,000 m2 per line
- **Annual output per line:** 2.5-4.0 million sq.ft. (250k-400k m2)
- **Power:** 5.0 Mega Watts per line
- **Max. Glass Size:** 78” x 125” (2.0m x 3.2m)
- **Fully automated factory**
- **Investment required**
- **ROI** less then 3 years
- VIG fabrication only – **sell to everyone**



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MARKETS

- Residential
- Commercial
- Institutional
- Refrigeration
- Others
- Stand alone VIG, Hybrid VIG & more
- Net-zero energy buildings
- Passive house projects


Architecture and Construction

Building Integrated Photovoltaics


Agriculture

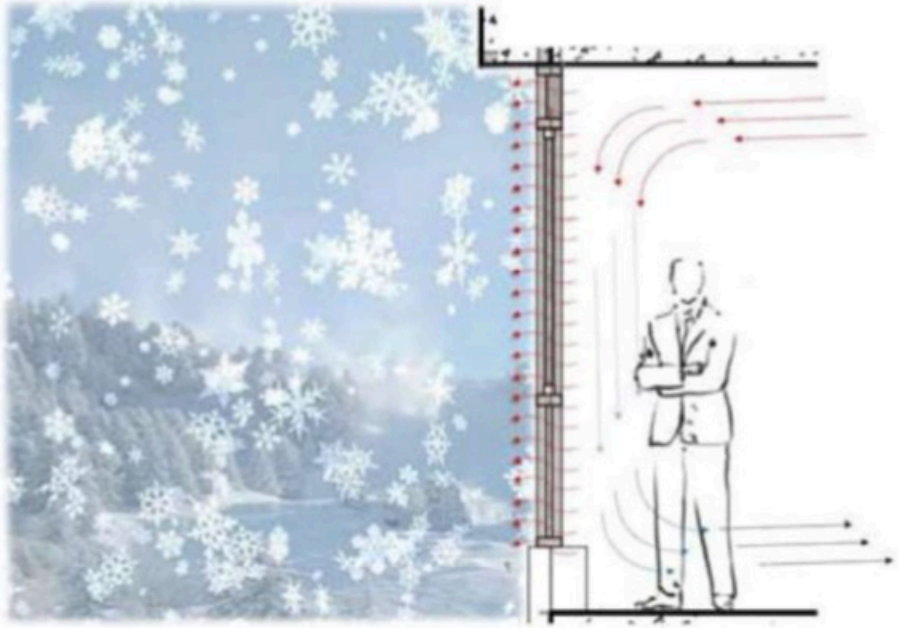

Automotive & Transportation

LandVac

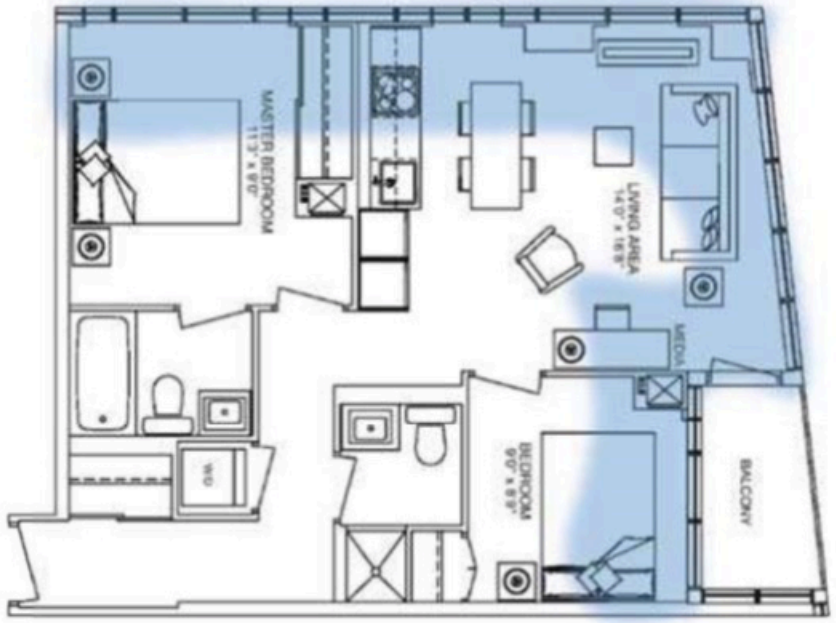
Thermal Comfort

- **Trends:** Occupants most often misinterpret down-drafting as air infiltration
- **Sources:** Downdraft currents resulting from high temperature variations at center of glass

Downdrafting

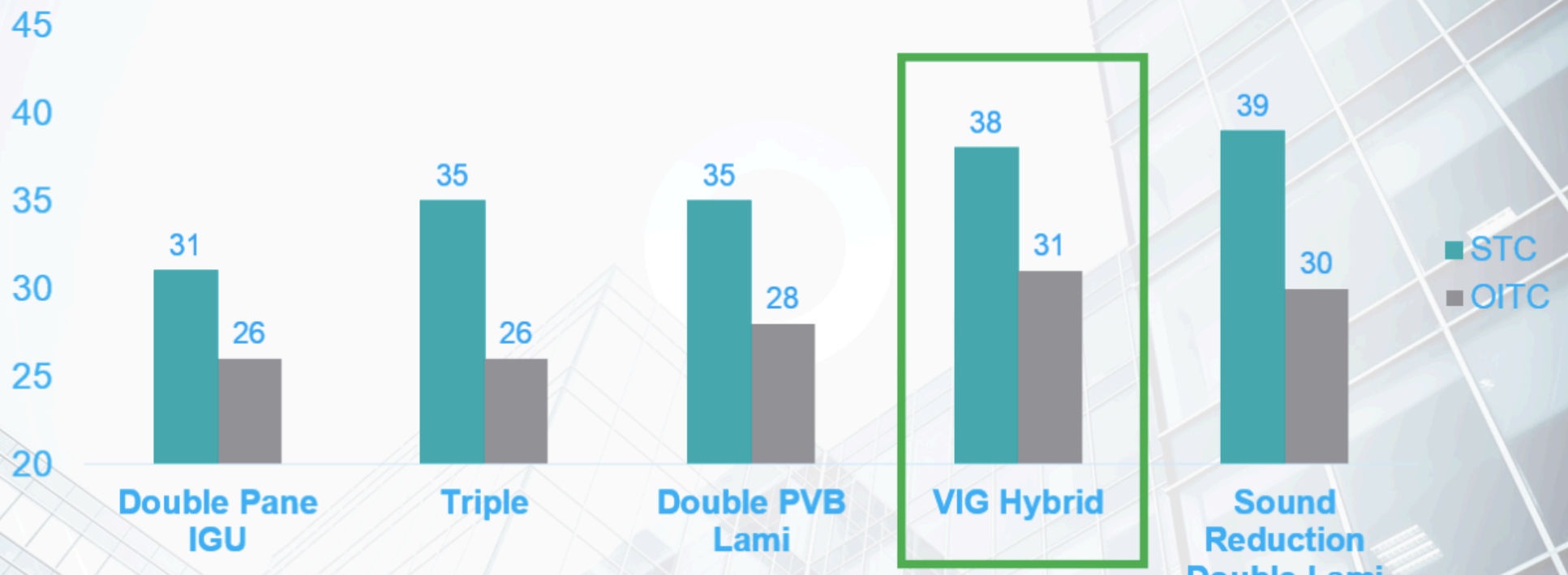


Perimeter Zone of Discomfort



SLIDES

VIG Performance: Acoustic Comfort



Results assume basic aluminum, thermally broken window System

THE FUTURE IS NOW

Thank you!

Questions?