A True Game-Changer For Walk-In Unit Frame Performance

New **FUSION**FRAME® system from KPS Global combines polyurethane foam and a structural core to optimize R-values and condensation resistance for walk-in cooler and freezer units

By James Costanza

***FUSION**FRAME® from KPS Global, Inc., is a revolutionary new frame/rail system that combines a structural core comparable to wood and polyurethane foam in a method of construction that can be five times more efficient than traditional wood frames in keeping unwanted heat and humidity from entering walk-in storage units.*

From the moment they are plugged in, turned on and begin the task of reaching and maintaining a predetermined interior temperature, walk-in coolers and freezers are locked in a never-ending battle against physics. Namely, it is a war to keep the warmer exterior air and humidity that are constantly assaulting them from entering the interior, where they can compromise the walk-in unit's cooling and freezing capabilities, cause excess refrigeration runtime leading to the creation of condensation and ice that damage the products contained within, and create slip-and-fall hazards.

This thermodynamic confrontation is one that operators in the grocery, foodservice, convenience store, big box retail, restaurant, warehousing and scientific industries have been battling since they first deployed walk-in coolers and freezers. For many years, wood has been the material of choice when constructing the framing and rails that connect what is known as the walk-in unit's "thermal envelope" – the walls, ceiling and floor that act as a physical barrier between the conditioned and unconditioned air of a building.

Admittedly, wood has performed its task admirably. It is structurally sound, easy to mold and cut, readily available, low cost and able to withstand the repeated opening and closing (and slamming) of doors, along with most other forms of general abuse that a walk-in cold-storage unit is subject to throughout its lifetime. Where wood does not quite stand up is in its R-value, or its ability to resist energy flow through it. As mentioned, this is critical since the walk-in unit must constantly fight to keep warm exterior air and humidity from intruding and compromising the unit's operational capabilities.

While the manufacturers of walk-in cold-storage units – and, by extension, their customers – have worked diligently to optimize the design and performance of wood frames and rails, there has been only so much they could do. Until now. This white paper will illustrate how **FUSION**FRAME®, a new type of frame/rail system from KPS Global®, Inc., can replace traditional wood structural framing and deliver optimal thermal-envelope performance, lower energy usage and utility costs, a reduced carbon footprint and offer scalability for use with any size or configuration of walk-in cold-storage-unit solution.

The Challenge

The assault on the walk-in unit comes from all flanks and attacks all components of the thermal envelope – walls, ceilings, floors, doors and windows. The heat can enter the walk-in unit in a variety of ways. These include the panel system and floor, through open doors, from room-temperature product stored in the unit, and from lights, motors and humans. To remove this unwanted heat, a refrigeration system is used to keep the air in the walk-in at a preset temperature.

One thing to keep in mind when considering heat flow into a walk-in unit is that the wider the variance in the exterior and interior temperatures, the harder the heat will work to find its way into the interior. For example, if it is 70ºF outside the walk-in and 50ºF inside, the heat energy will move relatively slowly from outside to in; however, if the exterior temperature is 80ºF and the interior is set at 10ºF, the heat energy will move more rapidly into the unit. This means that the refrigeration system in a freezer will have to work much harder to maintain the interior temperature.

A second environmental variable to pay attention to is the dew point – or the point at which condensation forms – of the air surrounding the walk-in unit. The factors that determine the dew point are the air temperature, surface temperature and the amount of humidity, or water vapor, in the air. Humidity infiltrates the walk-in unit through doors that are continuously being opened and shut, or that remain open for a long period of time. A walk-in unit that is also located in a humid environment or near an area where a lot of water is being used will also be more susceptible to humidity intrusion. No matter the source, when humidity-based water vapor enters the walk-in unit, it will reside there until it is collected by the refrigeration system and removed in the form of condensate that is collected on the coils of the evaporator and eventually drained away.

When the refrigeration system is unable to remove all of the humidity from the interior of the walk-in unit, especially if it's a freezer, the water vapor will freeze and collect on the freezer's interior, as well as the evaporator unit. When the surface temperature falls below the dew point temperature, condensation will form, and if enough condensation forms, it will create rivulets of water that will run and drip to the floor, creating puddles of water or freeze as ice.

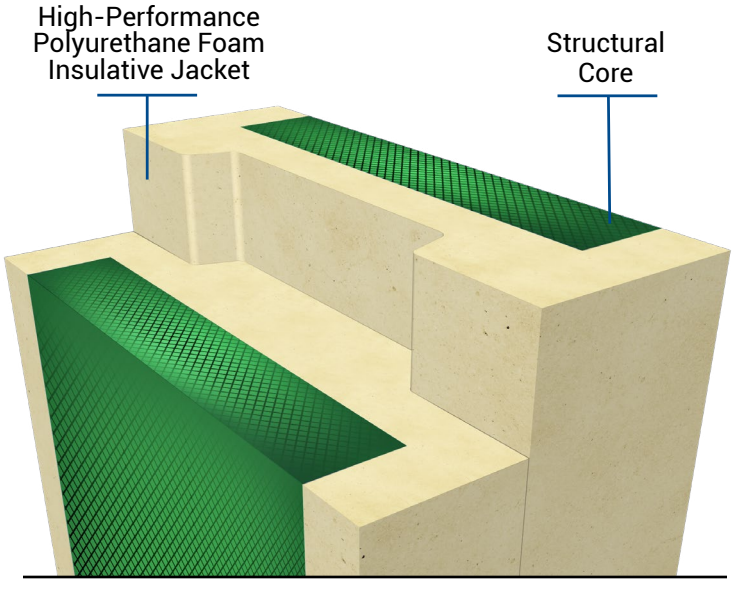
More pertinent to our discussion, condensation can form at wood frame joints and work its way into the walk-in unit's framing system and collect on its wood surfaces. If the wood framing becomes saturated with moisture, its R-value will degrade over time. When the R-value is reduced, the temperature of the framing is also lowered, which can lead to the formation of ice. When this happens, the operator will need to spend money to treat the iced panel-joint condition, which is an added hit to the operation's bottom line.

The problems that can be caused by heat flow and condensation have been recognized for years, and the manufacturers of walk-in cold-storage units have taken great pains to create thermal envelopes that can combat these unavoidable environmental conditions. However, the effects of physics are a constant challenge that is just too difficult to overcome when working with traditional wood framing.

The Solution

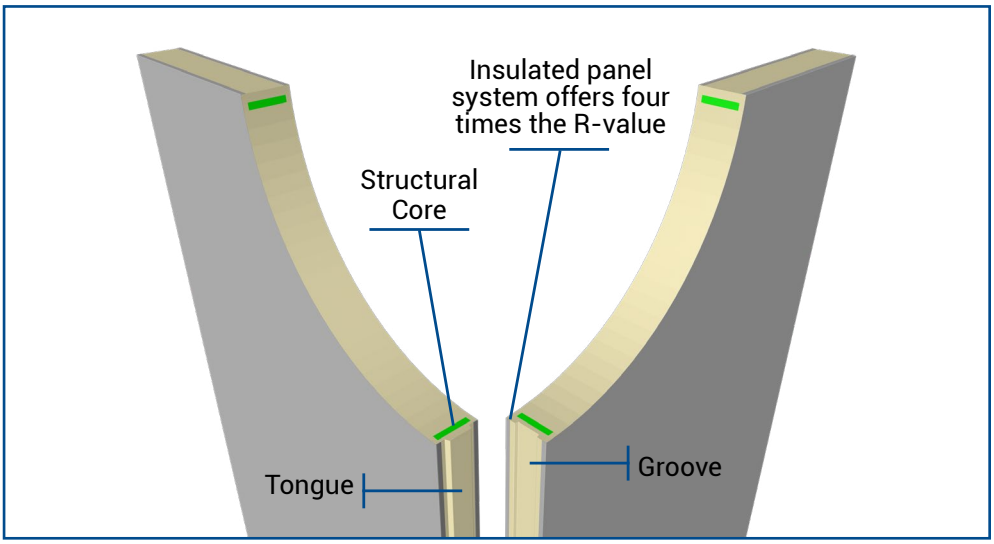
After five years of intense research and determining the pros and cons of various concepts for improved frame/rail systems, KPS Global has unveiled the innovative **FUSION**FRAME® system for use in conjunction with walk-in cooler and freezer thermal-envelope wall, ceiling and floor panels.

FUSIONFRAME® is a step ahead for the industry because its design combines the proven structural performance of wood framing with the thermal performance of polyurethane insulation. The system features a foam-frame component with a structural element embedded in it, resulting in a framing system that increases walk-in unit R-values to a level that slow the rate of heat flow and condensation formation, while limiting issues concerning life-cycle performance that can plague traditional plain wood-framed systems.



The key to the improved performance of the **FUSION**FRAME® system is a method of construction that injects a polyurethane foam insulation jacket around the structural member. The polyurethane is injected with a blowing agent that can form a rigid plastic, but only 3% of the material in the foam insulation is a solid. The other 97% consists of millions of miniscule air bubbles that have the blowing-agent gas inside them. These air bubbles are better able to resist the flow of heat through them when compared to wood.

Additionally, the density of the polyurethane foam is only 5 pounds per cubic foot (lbs/ft^3). By comparison, wood framing weighs between 27 and 30 lbs/ft^3, making it up to 15 times denser than the polyurethane foam, and the principle of thermodynamics tells us that heat can flow more readily through denser materials. The result is that using polyurethane foam gives the **FUSION**FRAME® an R-value of R5.9 per inch of thickness, while the typical R-value of wood is R1.2 per inch of thickness, making the **FUSION**FRAME® system around 5 times more resistant to heat flow than wood.



Keeping in mind the ability of the **FUSION**FRAME® to better resist heat flow and condensation formation, there are three main benefits for the operator who chooses to install walk-in coolers and freezers that feature the **FUSION**FRAME® technology:

- **Energy Savings.** A high volume of heat that flows into the walk-in unit will force the refrigeration system to work harder to remove it, along with any humidity that is present. If less heat is flowing into the unit, there is less that needs to be removed, which means the refrigeration system doesn't work as hard. This requires less electricity to power the system, which lowers utility costs. See sidebar on page 4.
- **A More Airtight Construction.** When two pieces of wood are joined together in a framing system there will be a temperature difference at the joint. It is in this area, where the temperature is lower, that the heat will conduct at a greater rate. **FUSION**FRAME® rails use a tongue-and-groove connection that fits together more snugly at the joints than wood. This allows the frame components to essentially seal themselves through a locking action that restricts moisture vapor entering into the center of the panel joint. This reduces the chance that any vapor will get deep enough into the panel joint to create condensation and build ice on the framing, which can shorten the walk-in's life cycle and result in costly repairs or the need for premature replacement.
- **Energy-Efficiency Standards.** The U.S. Department of Energy (DOE) has created an energy-efficiency standard for the insulation used in constructing the walk-in unit's walls and ceiling. The minimum R-value for the freezer wall and ceiling insulation must be R32. However, walk-ins built with wood-only frames will allow a level of heat conductance and humidity intrusion that can reduce the overall R-value to as low as R21. Operators can get an assist in maintaining – or improving – the R32 R-value threshold by using **FUSION**FRAME® framing and rails in the construction of their walk-in units.

To sum up, there are eight significant reasons why the **FUSION**FRAME® system is a true step forward in the performance of walk-in unit frame and rail operation:

- The structural core embedded in polyurethane-foam insulation allows less heat intrusion than traditional wood-framed rails, resulting in lower cost to operate the refrigeration unit
- The significantly lower rate of energy flow eliminates the problems that can be caused by humidity and its resultant condensation

Seeing Is Believing

In these days of tightened operational budgets that place a premium on optimized energy usage and cost, everyone is looking for the most energy-efficient solution regarding electricity use. The good news for users of the new FUSIONFRAME® frame/rail system is that, based on third-party verified tests, a 5-inch thick FUSIONFRAME® frame/rail will allow the walk-in cooler or freezer unit to deliver an average savings of 9.05 kilowatt (kWh) per day of operation for every 1,000 square feet of panel surface when compared to the performance of a 5-inch thick wood frame/rail. That daily savings equates to 3,303 kWh of energy savings per year for every 1,000 square feet of cooler and freezer panel surface.

According to the website electricchoice.com, the average cost of a kWh of electricity in the United States, as of March 2019, was 13.19 cents. At that cost and the rate of kWh savings of 9.05 per day, the daily savings is $1.19. At that rate, the annual kWh savings will be $434.35 per every 1,000 square feet of panel surface.

- The **FUSION**FRAME® R-value does not degrade over time like wood
- Reduces the potential for ice to form in the freezer frame like wood
- The softer foam rail allows for a tighter, more heat-resistant fit at the joints
- Comparable to traditional wood-framed panels in span tests
- It contributes to a longer operational life cycle for the walk-in cold-storage unit
- Carbon footprint is reduced through a reduction in the amount of fossil fuels that are needed to create the electricity that is consumed during the operation of the refrigeration system

KPS Global is also continuing to develop additional technical advancements that will further increase the R-value of the **FUSION**FRAME® system.

Conclusion

The assault on walk-in cooler and freezer units by exterior heat and humidity will never end, but for the first time in decades, operators have a new ally in the battle against these ruthless invaders. The **FUSION**FRAME® system from KPS Global is a true game-changer in walk-in cold-storage design and operation, because it truly offers the best of both worlds: the structural benefits of wood combined with the insulative properties of foam. The benefits inherent in the design, construction and operation of the **FUSION**FRAME® system mean that operators that rely on walk-in coolers and freezers as a fulcrum of their businesses will not have to sacrifice performance over cost ever again.

About the Author:

James Costanza is a Technical Fellow for KPS Global®, Inc., Fort Worth, TX, USA, and can be reached at james.costanza@kpsglobal.com. Formed in 2015 after a series of strategic acquisitions by the D Cubed (D3) Group private-equity firm, KPS Global designs, manufactures and installs insulated panel solutions across multiple industries, including grocery store, convenience store, big box retail, warehouse and scientific, and has manufacturing operations in Fort Worth, TX; Goodyear, AZ; Piney Flats, NC; San Dimas, CA; and Conyers, GA. For more information on KPS Global and its many walk-in cooler and freezer solutions, panel systems, manufactured doors and other cold-storage-unit components, please visit fusionframe.com.