Guidelines for Designers of Cold Storage Roofing Systems

July 2025

NOTE: The contents of this guide are considered accurate at the time of posting. All information contained within should be validated for accuracy as it relates to specific project conditions or requirements. Specific codes, uplifts or other factors may result in changes to the information contained within this document. Validate all specific conditions with a Elevate Regional Technical Coordinator prior to its use.

The information provided in this document is intended for informational purposes only. Amrize Building Envelope LLC ("Amrize") does not engage in the practice of engineering. The information provided herein does not constitute any form of endorsement, representation, or assumption of liability by Elevate related to product selection, applicable design loads or building tolerances, the use and placement of air or vapor retarders, or any other design elements of a complete roofing system for cold storage building applications. Elevate explicitly disclaims liability under any theory of law related to the adequacy of the information provided herein to suit any particular structure. All roofing systems designed for cold storage applications should be reviewed by a qualified architect, engineer, or other design professional.

Cold Storage Buildings

General

1. Cold storage type buildings constitute a special condition. A designer familiar with best practices in cold storage construction should be consulted in the design and integration of the roof system with the rest of the building envelope. Refer to the ASHRAE Refrigeration Handbook for additional information.
2. Cold Storage facilities are classified into two groups; coolers with commodities stored at temperatures usually above 32°F (0 °C); and freezers operating below 32°F (0°C). For insulation purposes, the specific purpose of the cooled space further divides the categories into four typical conditions: coolers between 40°F (4.44°C) – 50°F (10°); chill coolers between 25°F (3.89°C) – 35°F (1.67°C); holding freezer between -10°F (-23.33°C) – -20°F (-28.89°C); and blast freezer between -40°F (-40°C) – -50°F (-45.56°C).
3. Elevate ISOGARD™ GL and ISOGARD CG insulations patented formulation has been engineered to increase R-Value in cold storage roof assemblies.
4. Contact your regional Elevate Technical Coordinator for information on warranty requirements.

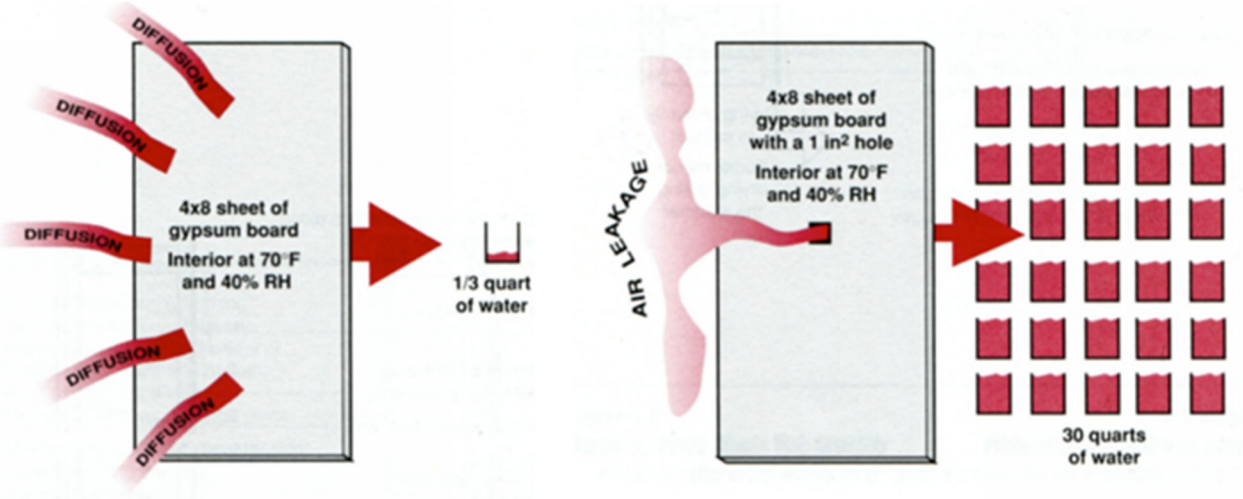
Building Science Considerations for Cold Storage Buildings

Liquid Water Intrusion – As for all buildings, preventing liquid water intrusion is the top priority for the building envelope. For the roof, this is accomplished by the roofing membrane. The walls of cold storage are commonly constructed with insulated metal panels and the outer metal skin functions as the Water Resistive Barrier (WRB). For other wall assembly types there should be a dedicated WRB control layer that is properly transitioned around the structure into the other WRB control layers like the roofing membrane.

Uncontrolled Air Leakage – Second to the WRB, but critical for cold storage buildings, is preventing air leakage into or out of the conditioned space. The 2nd Law of Thermodynamics - for the purposes of building science this law refers to the physics properties that hot moves to cold, moist moves to dry and high pressure moves to low pressure.

Air Leakage into the assembly of the roof or walls can lead to condensation, which leads to ice. Both cause damage to the components in the assembly and lessen the effectiveness of the insulation in that area. On average throughout the year, with geographical exceptions, the exterior environment will be warmer than the conditioned cooled space. This means the warmer air is trying to flow to the colder space. With warm air comes a higher relative humidity and following the 2nd law, moist moves to dry. Warm wet air usually has a higher vapor pressure than the cold dry air and high pressure moves to low pressure.

Even a tiny exterior hole providing an air leakage path can allow large quantities of moisture into an assembly.



Credit: Building Science Corp. – Moisture vapor diffusion due to pressure differences vs. moisture vapor transport due to air leakage.

Due to the extra cold surfaces on the inside of the assemblies of cold storage buildings, the intruding warm moist air is far more likely to cause condensation than typical occupied building assemblies that are kept at around 72°F (22.2° C). In the opposite direction, air leakage out of cold storage doesn't need to escape the assembly entirely to cause issues. Air spaces within the assembly or pathways from the cold interior into the wall or roof can draw in cold air, leading to potential problems.

Wind pressure affects structures both in the positive direction by pushing on surfaces and the negative direction by pulling on them. Various conditions around the roof can create negative pressures on surfaces like roofing membranes, resulting in a lifting or pulling force away from the deck. When this force is significant, it causes the roofing membrane to flex and lift, drawing interior air into any voids within the assembly. Cold air, although relatively dry, can infiltrate the assembly, bypassing the insulation and cooling components below the dew point. When cold air accesses pathways around the insulation, it renders the insulation ineffective. Any warm air in the assembly or moisture left over from the construction process is now more likely to condense or freeze. This can lead to failures such as icing, rust, or damp and ineffective insulation.

Vapor Diffusion – A slow process of water vapor molecules passing through a material like wood, membrane control layers, concrete, gypsum, etc., due to the vapor pressure difference from one side to the other side of said material. The 2nd law of thermodynamics – high pressure moves to low pressure. Typically, warm air has a higher relative humidity than cold air for a given location. Generally, this means the warm air has a higher vapor pressure than the cold air inside the cold storage structure. Therefore, the majority of the year the vapor drive is from the outside moving inward on cold storage structures. Depending on the type and use of the cold storage building, there are times of the year when the exterior temperature is colder than the interior. Regionally, this occurs more often in Climate Zones 6-8. When this occurs, it is possible for the vapor drive to switch and now push from the interior to the exterior. While this is critical to understand for some cold storage types, diffusion is a slow process and when moving from the interior to the exterior there is much less available moisture to be moved than from the opposite condition with a warm weather climate.

The likelihood of vapor drive through cold storage building envelopes may prompt a designer to conduct a hydrothermal analysis to determine the potential for condensation development. Among the various technical results produced by this analysis, the dew point of the assembly is of particular interest, as it indicates where condensation is expected to occur, if at all. If the analysis shows that condensation is likely, the designer may choose to rerun the analysis, modifying the assembly by incorporating a vapor control layer until the risk of condensation is mitigated.

Control layers in the building envelope specifically intended to reduce the movement of vapor through the assembly are called vapor retarders. There are three classes of vapor retarders:

VAPOR RETARDER CLASSES			
Class	**Permeance (US Perms)**	**Metric Perms**	**Description**
I	0.1 perm or less	Less than 6	Impermeable
II	Greater than 0.1 perm to less than 1.0 perm	6-60	Semi-Impermeable
III	Greater than 1.0 perm to less than 10 perm	60-600	Semi-Permeable
NA	Over 10	Over 600	Permeable

The lower the perm rating, the greater the ability of the material to slow the movement of vapor through it. Air permeability is different than vapor permeability. It is possible for a material to be an air barrier but still be vapor permeable. If the intent of the control layer is to greatly reduce the movement of vapor, a Class I, less than 0.1 perm material should reduce vapor transmission more so than a Class II or III. It is a generally understood material property that TPO, PVC and EPDM roofing membranes classify as having perm ratings less than 0.1 perm. Designers should confirm with the individual manufacturer of the membrane before intending it as a vapor control layer. Cold storage building envelopes are complicated to design given the extreme temperatures being maintained. The location of air barriers or vapor retarders inside the roofing assembly for cold storage buildings should be determined by the design professional. They will analyze the intended use temperature, building location, structural design, and many other factors before determining the location of the air and vapor control layers.

Insulation for Condensation Control – Without insulation, mechanical equipment would not be able to maintain the desired temperature of most cold storage buildings. Insulation is critical to energy efficiency as well as condensation control. By separating cold surfaces from warm, humid air, insulation prevents condensation from occurring on and in the structure.

Condensation occurs on a cold glass of ice water on a hot day because the exterior surface of the glass has gotten cold enough to reach dew point, the temperature at which the moisture in the surrounding air condenses from a gas to a liquid. Just like how using an insulated thermos can make it a lot harder for condensation to occur on the outside surface of a drink, so too does insulation on the roof and walls of a cold storage building make it harder for condensation to occur on the exterior surfaces. Determining the correct amount of insulation for condensation control is technically a design choice for any building. The American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE, has developed a best practice, minimum, insulation value table for cold storage buildings.

TYPE OF FACILITY	TEMPERATURE RANGE °F (°C)	THERMAL RESISTANCE R-VALUE (°F•FT²•H/BTU)		
		Floors	**Wall/Suspended Ceiling**	**Roofs**
Coolers	40 to 50 (4.44 to 10)	Perimeter Only	25	30
Chill Coolers	25 to 35 (-3.89 to 1.67)	20	25	35
Holding Freezer	-10 to -20 (-23.33 to -28.89)	27	35	45
Blast Freezer	-40 to -50 (-40 to -45.56)	30	45	50
NOTE: Values pulled from 2022 edition of ASHRAE Handbook-Refrigeration				

The total insulation value is not the only factor influencing the performance of roof insulation. The installation method of the insulation boards also plays a critical role. For cold storage buildings, adhering to best practices—such as using multiple layers of insulation and offsetting board joints—is crucial. This approach helps limit vertical pathways around the insulation boards. However, insulation, like all materials, undergoes thermal expansion and contraction due to seasonal and climatic variations between interior and exterior temperatures. Therefore, it is essential to install the boards meticulously to prevent air gaps between them before the building experiences seasonal changes.

Control Layer Continuity – The purpose of the building envelope is to separate the exterior and interior environments. To achieve this, the enclosure must control liquid water, air and vapor movement, and thermal transmission. Modern construction utilizes control layers for each of these elements, whether as individual

materials or combined into as few as a single layer. These control layers must seamlessly transition from the foundation to the walls and roof to provide the necessary performance.

Cold storage buildings often present challenges with these transitions because the entire building might not be dedicated to cold storage. They may have subdivided interior spaces with standard occupied areas adjacent to the cold storage sections. Special consideration must be given to the control layer transitions of interior cold storage walls. Unlike typical occupied buildings, which do not require control layers in interior walls, cold storage buildings do. The air, vapor, and thermal control layers located in interior cold storage walls need to be properly transitioned into the foundation and roof. These transitions will likely require project-specific details provided by designers.

Thermal Bridging – Thermal bridging occurs when insulation is bypassed by structural members or other physical materials such as fasteners. Just as it is crucial to maintain the desired temperature within a conditioned space, it is equally important to prevent structural elements like columns and beams from penetrating the insulation. These structural components are often made of metal, which is highly conductive. As a result, the cold from the interior can transfer through the member to the exterior, creating a cold condensing surface. Although not all structural thermal bridges lead to condensation, they invariably reduce energy efficiency by allowing heat transfer through the insulation, causing mechanical equipment to work harder than necessary.

Care should be taken when choosing how to attach roofing materials to a cold storage building. Mechanically fastened roofing membranes require screws that span the entire thickness of the assembly. These fasteners result in a thermal bridge by providing a conductive material from the outside of the assembly that then passes though the insulation down to the deck or interior of the assembly. Where insulation is supposed to separate the interior temperatures from the exterior temperatures, there are now many screws allowing energy transfer between the assembly. A cold screw head on a hot day may cause condensation that over time can degrade the screw and insulation around it. It could also react with any air gaps at insulation joints or remaining construction moisture in the assembly. To avoid these thermal bridges, designers typically follow best practices of adhered roofing systems and limit fasteners to the first layer of insulation and having all subsequent insulation layers and membranes fully adhered to reduce the thermal bridging risks.

Additional Considerations for Cold Storage Buildings

Insulation at Roof Perimeter – The perimeter of the roofing assembly is a critical zone for the buildings control layers. The intersection of roof layers and wall materials can result in different structural and thermal movements. Additionally, the necessary installation technique of overlapping and offsetting rigid insulation board joints can create gaps of varying dimensions between the insulation perimeter and the adjacent vertical wall. To address these variable gaps, ensuring the required insulation value and reducing air infiltration pathways, it is common practice to apply closed-cell spray foam between the vertical walls and the rigid roof insulation. Designers will need to confirm compatibility with any control layers and substrates the spray foam will adhere to.

ASHRAE Refrigeration Handbook – The 2022 ASHRAE Refrigeration Handbook, specifically Chapter 23, Facility Design, is an excellent resource for designers and those interested in guidance for cold storage building design. The following subject areas are described in more detail in the ASHRAE Refrigeration Handbook, Ch. 23:

- Temperature Pulldown – some cold storage buildings are designed to operate at extremely low temperatures. As the interior cools, the surrounding materials also experience a temperature drop. This section provides procedures and guidance to avoid rapid thermal contraction of components due to the temperature pulldown. Designers should consider the materials chosen for the structure in relation to this section during their planning.
- Fire Protection – fires in cold storage buildings are possible due to the use of electrical components that can short circuit, susceptibility to lightning strikes, offsite fire spread, and potential human errors. Roof assemblies should be installed according to their fire-tested and listed assemblies, but fire suppression systems may still be utilized. Designers should confirm the compatibility of the fire suppression system with the cold storage operation and local regulations.
- Inspection and Maintenance – The extreme operating conditions and the potential for rapid damage in cold storage buildings when leaks occur necessitate a rigorous inspection and maintenance program. Key wear locations on roofs, such as access points and penetrations, should be considered when developing the maintenance program.

- **Repairing, Recovering, or Re-Roofing Cold Storage Facilities –** Cold storage buildings constitute a special condition and require designers familiar and practiced with their operation to design them. The same expertise should be utilized when a cold storage facility's building envelope needs modifications. Considerations vary significantly between roof repairs, recovering, and re-roofing of cold storage buildings. The facilities manager and architect/designer should coordinate in advance with the roofing contractor to fully understand the project's scope and time requirements. Weather conditions are particularly crucial for cold storage roof modifications due to the essential role each roofing component plays in maintaining the assembly's expected performance. Depending on the project's scope and timeframe, the designer of record may determine that the cold storage facility needs to be shut down to bring temperatures back to ambient conditions. This document provides building science reasoning for why and how the various roof components work together to achieve a dry and well-insulated roof. Removing roofing components while the cold storage is operational may put the performance of the assembly at risk.

COLD STORAGE DETAILS	
Category	**Detail Name**
Roof Edge	CS-RE-01 - COLD STORAGE - UNIVERSAL ROOF EDGE DETAIL WITH METAL FASCIA OR GRAVEL STOP WITH NAILER
	CS-RE-02 - COLD STORAGE - UNIVERSAL ROOF EDGE DETAIL WITH METAL FASCIA OR GRAVEL STOP WITH TERM BAR
	CS-RE-03 - COLD STORAGE - UNIVERSAL ROOF EDGE DETAIL WITH METAL FASCIA OR GRAVEL STOP
	CS-RE-04 - COLD STORAGE - UNIVERSAL ROOF EDGE DETAIL WITH FACTORY FORMED METAL FASCIA
	CS-RE-05 - COLD STORAGE - UNIVERSAL ROOF EDGE DETAIL WITH GUTTER
Termination	CS-T-01 - COLD STORAGE - UNIVERSAL DECK TERMINATION AT PARAPET WITH METAL COPING
	CS-T-02 - COLD STORAGE - UNIVERSAL WALL TERMINATION AT PARAPET WITH METAL COPING
	CS-T-03 - COLD STORAGE - UNIVERSAL DECK TERMINATION AT WALL WITH COUNTER-FLASHING
	CS-T-04 - COLD STORAGE - UNIVERSAL WALL TERMINATION AT WALL WITH COUNTER-FLASHING
	CS-T-05 - COLD STORAGE - UNIVERSAL ROOF EDGE DETAIL WITH FACTORY FORMED METAL FASCIA
	CS-T-06 - COLD STORAGE - UNIVERSAL TIE-IN TRANSITION USING MEMBRANE COVER STRIP - WALL ABOVE DECK
	CS-T-07 - COLD STORAGE - UNIVERSAL TIE-IN TRANSITION - WALL BELOW INSULATION
	CS-T-08 - COLD STORAGE - UNIVERSAL TIE-IN TRANSITION - WALL BELOW DECK
	CS-T-09 - COLD STORAGE - UNIVERSAL TIE-IN TRANSITION USING MEMBRANE COVER STRIP - OFFSET AT WALL
	CS-T-10 - COLD STORAGE - PREPARATION AT INSULATED METAL PANEL WALL
	CS-T-11 - COLD STORAGE - PREPARATION AT PRECAST CONCRETE WALL
	CS-T-12 - COLD STORAGE - INTERFACE AT STEEL DECK - AIR SEAL
Expansion Joint	CS-E-01 - COLD STORAGE - UNIVERSAL BUILDING TIE-IN USING MEMBRANE COVER STRIP WALL ABOVE DECK – NEW TO EXISTING
	CS-E-02 - COLD STORAGE - EXPANSION JOINT (FIELD FABRICATED) WITH WELDED SEAM ROOF TO WALL
Penetration	CS-P-01 - COLD STORAGE - INSULATED PIPE PENETRATION - PENETRATION POCKET AND MEMBRANE FLASHING
	CS-P-02 - COLD STORAGE - INSULATED PIPE PENETRATION - PIPE JACKET
Scupper	CS-S-01 - COLD STORAGE - THRU-WALL SCUPPER
Barrier Placement	CS-BP-01 - COLD STORAGE - SELF-ADHERED AIR AND VAPOR CONTROL MEMBRANE PLACEMENT - ENCAPSULATE INSULATION
	CS-BP-02 - COLD STORAGE - SELF-ADHERED AIR AND VAPOR CONTROL MEMBRANE PLACEMENT – EXTENDED PAST INSULATION
	CS-BP-03 - COLD STORAGE - AIR/VAPOR CONTROL BARRIER PLACEMENT - ROOF EDGE AND BASE TIE-IN
	CS-BP-04 - COLD STORAGE - AIR/VAPOR CONTROL BARRIER PLACEMENT - TRANSITION AT WALL
	CS-BP-05 - COLD STORAGE - SELF-ADHERED AIR AND VAPOR CONTROL MEMBRANE PLACEMENT - ENCAPSULATE INSULATION

This guide is meant to highlight Elevate products and specifications provided by Amrize Building Envelope LLC and is subject to change without notice. Amrize takes responsibility for furnishing quality materials which meet published Elevate product specifications or other technical documents, subject to normal roof manufacturing tolerances. Neither Amrize nor its representatives practice architecture. Amrize Building Envelope LLC offers no opinion on and expressly disclaims any responsibility for the soundness of any structure. Amrize accepts no liability for structural failure or resultant damages. Consult a competent structural engineer prior to installation if the structural soundness or structural ability to properly support a planned installation is in question. No Amrize representative is authorized to vary this disclaimer.