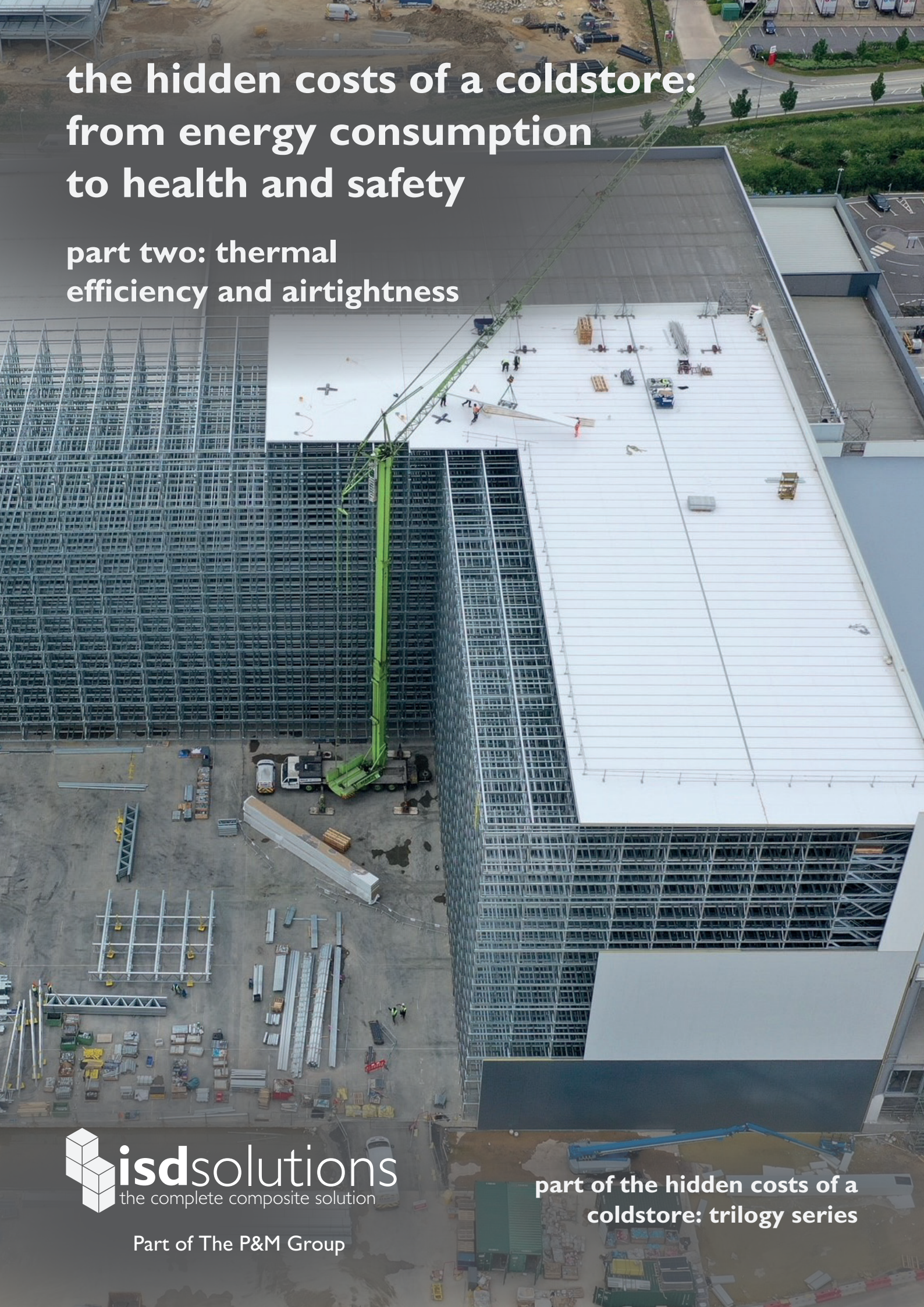
the hidden costs of a coldstore: from energy consumption to health and safety

part two: thermal efficiency and airtightness



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Part of The P&M Group

part of the hidden costs of a coldstore: trilogy series

the hidden costs of a coldstore: part two of our whitepaper trilogy

Welcome to the second in our series of reports published jointly by The P & M Group and its constituent companies, in collaboration with the Cold Chain Federation. In part two of this trilogy, we look at the twin issues of thermal efficiency and air tightness – key elements in reducing immediate and long-term facility costs, as well as improving environmental performance.

This follows the first report in the trilogy, which was an overview of the issues surrounding pipework insulation. This had a specific focus on system protection and efficiency in the cold storage industry. The third report, to be published later this year, will explore the importance of good operational procedures for doors and openings.

We hope that this report, along with the other two in the series, will provide some valuable insight into the environmental and cost benefits of using more energy efficient coldstore fabric. High energy bills, coupled with increased pressures from regulators and stakeholders to reduce environmental impact, mean that this issue is moving up the agenda. There has never been a better time to explore more energy efficient solutions to support the triple bottom line of People, Profit and Planet.

We hope that you find the paper useful and informative. If you would like to discuss its contents further, we would be delighted to have that conversation with you.

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about the author

ISD Solutions is the UK's leading contractor specialising in the development, construction and maintenance of cold stores, firewalls, data centres, clean rooms, single-envelope, external industrial cladding and doors. Founded in 1947, it today has over 180 employees, many of whom are long-serving and together provide unrivalled expertise in the design and installation of composite panel facilities.

ISD Solutions is a member of The P&M Group Ltd, which includes our insulation specialists PLG Insulations, coldstore installation specialists S Tysoe Installations and QuayTherm Manufacturing, a metal fabricator and insulated door manufacturer.

Where carbon emissions have been estimated, this is based on the 2022 UK average of 0.193kg CO_2e per kWh of electricity.

Where energy costs have been calculated, we have used a price of 25p per kWh, based on average 2022 UK electricity costs and balancing potential future fluctuations. Note that some companies have paid much higher rates than this depending on when contracts renewed.

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with thanks... As a business, collaboration is in our culture, so we would like to thank all those who have contributed to pulling this report together. Thanks to the Cold Chain Federation for their guidance and influence on the climate change elements, to Dr Dermot Cotter of Star Technical Solutions for his energy consumption calculations, to Eyemouth Freezers Ltd for the case study and to all those at The P & M Group who have committed their expertise.

the importance of correct design in thermal efficiency

Built environments account for around 40% of global emissions and decarbonising buildings must be a top priority in the drive to Net Zero. We have to think more creatively and sustainably about design if we are to reap the environmental and financial benefits of energy efficiency.

Nowhere is this more pertinent than in the coldstore sector. Refrigeration requires a large amount of energy and as the global population rises, so too will demand for industrial refrigeration. We must find smarter ways of meeting that demand in a way that balances the needs of People, Planet and Profit.

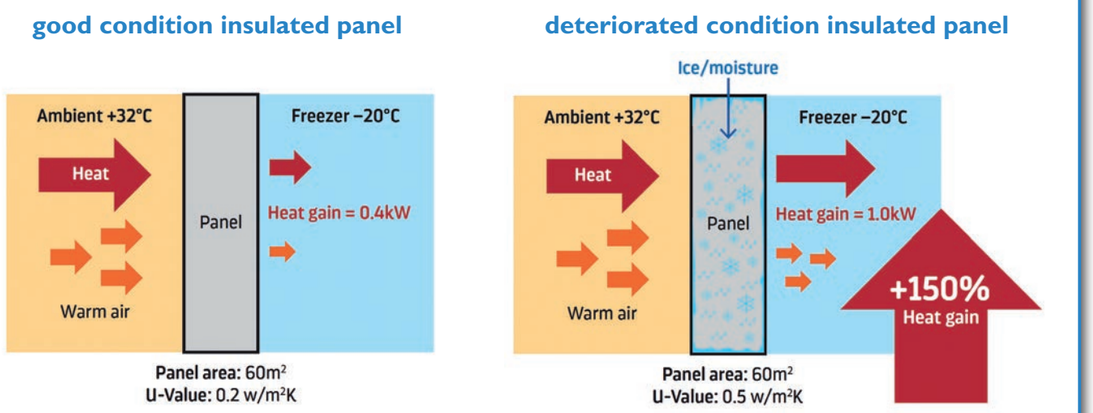
After so many years in the industry, we are still shocked by the poor design of many coldstore buildings. Not only are they inefficient, but they are needlessly costly to operate and potentially hazardous for their contents and personnel.

Fortunately, more businesses now recognise the benefits of extra investment up front in designing efficiency into coldstore facilities, both in terms of reducing environmental impact and keeping energy and maintenance costs to a minimum.

Paying more attention to design fundamentals must be integral to improving coldstore environmental performance, longevity and safety. It can help ensure that these facilities last for several decades, operating at high efficiency and with little requirement for replacement parts.

Establishing a good maintenance regime is also reducing costs and minimising risk. Even well designed facilities need to be properly maintained to avoid deterioration and maximise operational efficiency.

diagram showing comparisons between good and poor performance



long term condensation leads to water ingress and subsequent damage

the basics of efficient coldstore construction

Having previously worked with polyurethane (PU) for more than 50 years, we now recommend its close and superior relative, polyisocyanurate (PIR). **The leading products on the market offer a hybrid solution, providing top thermal performance, together with fire-resistant properties.**

The right choice of sandwich panel thickness is crucial to improving energy efficiency. It may be tempting to reduce the thickness of insulation at design stage to save money, however these initial savings may quickly be outweighed by the costs of running the coldstore. **Over a potential lifetime of 30 to 40 years, running cost savings will be significant.**

As part of our maintenance work, **we regularly carry out surveys on existing facilities**, some of which are several decades old. **The worst-case scenario is when water gets into the panel and freezes, greatly increasing the weight of the panel and causing undue stress on the whole structure.** This is often due to high humidity or lack of air movement within a roof void. A lack of thorough maintenance could also play a part, meaning that things like damaged panels or vapour seals and leaking roof structures or roof void services are not rectified. **All of this causes long term condensation and the aforementioned water ingress.**

The panels we install work due to the core insulation being a very poor conductor. When laden with ice and water (although ice is itself a good insulator), the insulation becomes compromised, and the panels become seriously degraded. This increases their U value as they become a better conductor of heat. This difference in energy performance can be significant and **when the insulation is compromised, it is the equivalent of using much thinner panels.**

thermal efficiency in practice

Our photographs below demonstrate the effect of inefficient panels, either because the solution is too thin or because air ingress and moisture have caused the insulant to break down. In these photos, the coldstore is operating at -24C with a roof void temperature of 8C. You can very clearly see the heat emitted from the inefficient panels.

The following examples demonstrate the impact on thermal efficiency of using different types of panel thickness, and the detrimental effects of poor vapour sealing.

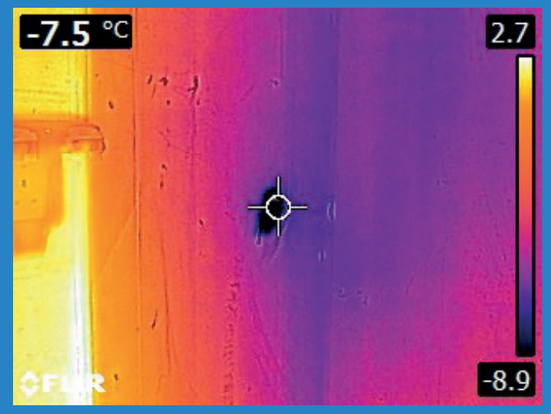
Based on a typical medium-sized freezer facility measuring 20m by 40m with a height of 7m, and using two different panel thicknesses – 100mm PIR or 175mm PIR – the thinner panels result in an increased heat gain of 47%. It is important to note that the relative heat gain between the two panel thicknesses will be the same regardless of the external temperature.

For a larger store – we have modelled these calculations on a high bay facility measuring 129m x 67.3m x 35m – we wanted to consider the effects of ice build-up in the panels caused by water ingress. As explained above, ice leads to panels increasing thermal value. In this scenario, the store uses an estimated extra 60kWh of energy, which at current energy prices would cost the business around £132,000 per year.

That's a huge cost, without counting the 101 tonnes of additional CO2e emissions.

This demonstrates how vital it is to the total cost of ownership to combat ice build-up. It also highlights the crucial importance of selecting the right panel at design stage. Whilst we have modelled this on a large facility, this applies to any temperature-controlled envelope.

In addition to the above, from a safety perspective, an ice laden ceiling can become 2 or 3 times heavier and has potential to collapse, putting both product and personnel at risk. It is vitally important therefore to protect the envelope from any potential moisture ingress.



based on a typical medium-sized freezer facility measuring

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or

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adding to the atmosphere

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benefits and methods for air tightness

Total cost of ownership is a key priority when constructing a coldstore and air tightness will play a large part in reducing running and maintenance costs for refrigeration. It is also vital to the longevity of the structure, given the damaging effects on the fabric from airborne moisture ingress.

The standard of installation and build quality are fundamental factors in ensuring the best performance for your coldstore. This should be applied to every element of your construction, and we believe the return on investment can be significant over the life of the facility. Good maintenance of your coldstore structure and systems will also greatly enhance its lifespan and overall thermal efficiency.

Doors are another important factor in managing air tightness and energy costs. Poor design, operational procedures and/or management can result in significantly reduced air tightness and additional unnecessary energy costs. We will discuss this further in the third instalment of this series.

Generally, the air moving into coldstores or chill stores will be relatively warm and will contain moisture. This moisture will condense in the cold environment and, depending on the chamber temperature, may either form pools of water or will freeze causing a slip hazard.

Air tightness levels are also a significant factor when designing hypoxic fire suppression systems. These active fire suppression systems rely on the chamber air tightness to maintain a hypoxic (oxygen reduced) environment which prevents fire from burning. The level of envelope air tightness achieved directly relates to the level (and cost) of equipment required to achieve a fire safe environment.

regulations and testing

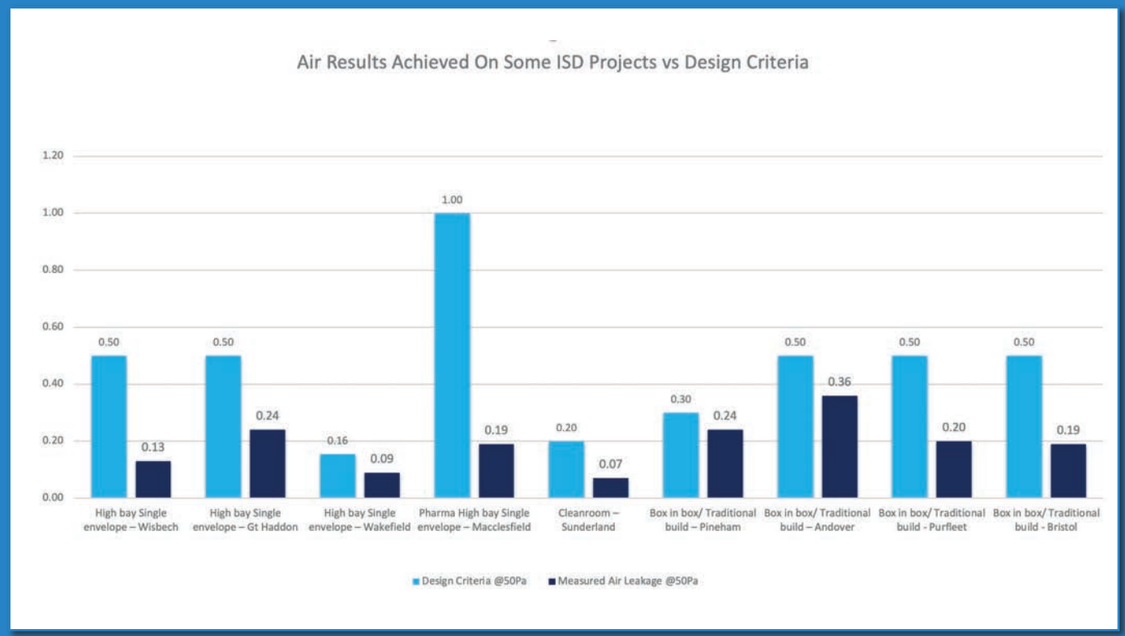
In April 2002, the UK Government introduced legislation to enforce standards of building air tightness. The intention was to lower running costs, verify the standards of materials used and ensure good workmanship.

As a result, air permeability testing is a necessary means of demonstrating that the air tightness targets that are used in energy calculations to be compliant with Part L of building regulations, have been achieved.

The testing scheme is run by The Air Tightness Testing & Measurement Association (ATTMA), created in 2008 and overseen and operated by The Building Compliance Testers Association (BCTA).

The measurement used for testing is air leakage rate per hour per square metre at a test pressure of 50 Pascals abbreviated as m3/(h.m2)@50Pa.

For coldstores, ATTMA states that 'best practice' air tightness should be 0.20m3, with a 'normal' level being 0.35m3. We regularly exceed this best practice level, with our best ever result to date being 0.07m3.



doors are an important factor in managing air tightness and energy costs. Keep an eye out for the third in our 'the hidden costs of a coldstore: whitepaper trilogy'

tips for air tight buildings

The following are important considerations when developing refrigerated envelope designs to ensure optimum air tightness is achieved and to minimise the cost of ownership.

Joint bonding

Panel joints should achieve an air tightness of 0.02 m3/(h.m2)@50Pa when sealed. Refrigerated envelopes should be well vapour sealed externally by design. A continuous bead of specialist sealant should be applied between the panel joints during installation (sometimes known as 'wet bonding'), as well as applying a pointing vapour seal to the external joint to ensure a good positive seal.

Door type

Doors play an integral role in designing an air-tight structure. Refrigeration solid leaf hinged and sliding doors are generally able to achieve an excellent level of air tightness. Fabric leaf (rapid roll) doors offer a less effective air seal. Yet due to their operating speed, which reduces the time the door is open, these doors can provide a more efficient overall solution. We will discuss this in greater depth in our third report.

Penetrations

Penetrations in the insulated envelope for mechanical and electrical services, refrigeration system, lighting, sprinklers and so on, are all potential weak areas. The refrigeration chamber installer should take full control and responsibility for thermal insulation and vapour sealing of all penetrations through the insulated envelope.

joint bonding

door type


penetrations

how is an air test carried out?

To complete the test, the Air Tester will install a fan to an existing door opening then pressurise the chamber, both positively and negatively, to 50 pascals.

When under pressure, air will flow through any air leakage pathways such as unsealed joints, penetrations and openings within the envelope of the building. Internal and external temperatures are recorded, along with barometric pressure and wind speed. The fan, which can be controlled by a computer or manually, is run at various speeds to adjust the pressure inside the building, with the readings recorded at various pressures.

A computer programme then calculates the air leakage of the building. The test will show how much air is leaking through the structure and whether the overall result meets the criteria. Level 2 air testers can use multi-fan blower door systems instead of single-fan systems to test the air tightness of large commercial buildings.

Returning to the study of the large high bay facility (measuring 129m x 67.3m x 35m), we found that air leakage at industry standard rates through the walls was causing an extra 50% of heat load on top of that from the coldstore envelope (walls and ceilings, excluding floor). At peak loads of 32C outside, this was 76.8kW on top of 157.9kW for the walls and ceilings. Even at the average 12C external temperature, we found an extra heat load from air leakage of 40.8kW, on top of 83.9kW from the walls and ceiling, a similar ratio as at peak loads.

By employing a quality contractor and having proper air tightness measures installed, you could potentially halve the industry standard air leakage on your facility. This would achieve a reduction in energy use of 10kWh and save 87,600kWh per year, or £21,900 in energy costs. Over a 30-year lifetime, that equates to 2,600,000 kWh, or more than £650,000 in costs and 500 tonnes of CO2e emissions..

The key to achieving this is good vapour sealing. It is important to mention that this will not cost any extra in build price, as it is generally specified and allowed for within the overall project cost plan. The difference is whether it is installed and how well it is installed by the specialist contractor.

Done incorrectly, vapour sealing will cost the end user significantly in terms of greater energy consumption, every minute of every day, as detailed above. Good vapour sealing is one of the main design fundamentals for any refrigerated envelope. It should be a given that it is incorporated.

by halving industry standard air leakage over a 30-year lifetime could save you 2,600,000kWh / £650,000

new builds

While maintenance, materials and installation all have a major impact, the easiest time to establish the thermal efficiency of a coldstore fabric is during the construction phase. While retrofits are often possible in a range of scenarios, **it makes sense to choose the most appropriate design for the purposes of your business and to maximise the efficiency of the facility's envelope**. We would suggest finding a specialist contractor with the necessary expertise and understanding of your requirements to design the most suitable building for you.

different types of coldstores

There are three main methods of constructing a coldstore.

First is the traditional '**Box in box**' arrangement, where the refrigerated chambers are constructed within a fully weathered cladding envelope. For multi chamber facilities, food processing for example, this is usually the most efficient arrangement.

Second is a '**Dutch barn**' configuration where the refrigerated chamber is constructed below and within a cladded 'hood' comprising of a complete roof and apron walls extending below the level of the chamber ceiling. The chamber walls remain exposed externally as there is no external wall cladding to the building.

Third is the **Single Envelope** design, which we first pioneered over 20 years ago. This design removes the need for an external cladding layer as the refrigerated chamber is enhanced and suitably weathered to act as both the refrigerated envelope and the cladding envelope to the building. For warehouse facilities this is by far the most efficient, with reduced cladding material requirements, a steel frame supporting structure and roof void fire suppression systems. Single envelopes are also up to 30% quicker to construct than the two other more traditional design options. Embodied carbon in construction is also reduced in this method.

Regardless of which type of coldstore you are constructing, the most important factors for thermal efficiency and air tightness are your sandwich panels, the envelope construction details and the integrity of thermal continuity and vapour sealing.

construction details to consider

It is important that coldstore operators take a holistic approach to reducing energy usage and driving decarbonisation. As well as investing in thermal efficiency and air tightness, businesses should consider further actions. These include the following:

The importance of floor insulation

While product load is the factor which has by far the largest impact on energy costs for a freezer with high throughput, floor insulation is also important. For example, on our large high-bay facility mentioned previously, the heat load was 41.67 kWh through the use of 150mm thick floor insulation, equating to 21% of the total envelope heat load at peak loads (32 degrees outside). This figure will be constant, regardless of the outside temperature, because the temperature of the ground below the facility remains the same. At average temperatures (12 degrees), this makes up 24% of the total envelope heat load.

As with any part of the envelope, good vapour sealing is essential. **A failing vapour seal to the floor area can lead to moisture ingress, which, as it is hidden within the floor construction, will go unnoticed until potentially irreparable damage occurs.** Replacing the floor is extremely challenging and expensive once a facility is up and running.

Reducing roof heat gain

On an unshaded roof summer heat could see temperatures on that roof rise to 60C. This is due to the materials absorbing heat and emitting it, like a pavement in the sunshine. There are two effective ways to tackle this issue, as well as the resulting potential heat gain of around 78kWh on our large high-bay example.

Firstly, consider thicker roof panels. The added cost will be offset by energy savings. Secondly, consider shading the roof with solar panels. This could drop your fabric temperatures way down to around 32C and reduce heat gain to 51.5kWh.

Airlocks

The purpose of an airlock is to reduce the volume of air ingress to the coldstore, limiting this volume to the size of the airlock. To keep the airlock moisture free, a dehumidification system may be required. This will depend on the exact requirements of your coldstore. We will go into this in more depth in our third report.

maintenance

We have been inspecting facilities over many years and it is still rare to find coldstores that have been properly maintained.

This shortcoming is largely down to financial drivers. For many companies, the construction and operation of a temperature-controlled facility is a huge expense to their business. Therefore, many question why they should invest extra funds in making sure it is properly maintained and fit for purpose.

Yet increasingly we believe that a number of global and domestic factors are combining to challenge attitudes in the industry. There is growing awareness that sustainability makes business sense for the triple bottom line of People, Planet and Profit. It not only helps protect the environment and combat climate change, but allows businesses to build resilience and operate more efficiently.

Effective sustainable design and a robust and active maintenance system embedding a culture that puts safety first are key to managing risk both in terms of environmental impact and health and safety. It is not over dramatic to say that compromising for any reason can have tragic consequences for both people and businesses.

vapour seal

Tackling moisture

Poor vapour sealing is a major cause of damage to coldstore envelopes. When the external vapour seal fails, moisture is naturally drawn into the fabric of the insulation, resulting in saturation of the insulation core and potential pooling of water within the chamber. In freezer envelopes this vapour will not only freeze but will continually expand, adding significant weight to the envelope and imposed weight to the supporting structure. The results are potentially catastrophic.

Fortunately, some of the remedies are easy to implement. A regular visual inspection to identify breaches of the vapour barrier, which are easily rectified, is a simple first step solution.

Asset protection

Composite panel and refrigeration doors are vulnerable to operational traffic damage. We recommend a good level of carefully designed asset protection to help avoid costly damage and possible loss of production time due to failing components and essential repairs. Timely repair works are essential in preventing issues from escalating and in maintaining the efficiency of the envelope.

Peak performance

It is also important to make sure that equipment is operating at its peak performance. For example, ice build-up around evaporators would be a sign of excessive moisture ingress and would require investigating.

You would also be well advised to ensure doors and other elements of your facility are properly maintained and looked after. In addition, we recommend working with a refrigeration engineer to ensure you have a proper schedule for checking that all equipment is clean, dry and working well.


bitumen paint


airlock

case study – Eyemouth Freezers

Eyemouth Freezers Ltd is an independent food processing company based in the South-East of Scotland. Its core business is freezing and storing peas grown by local farmers and supplying them to UK supermarkets. Its coldstore facilities comprise two buildings that take up around 80% of factory space.

The business recognised the need for more effective coldstore maintenance to reduce energy consumption as part of its commitment to Net Zero. It is focusing most of its capital investment over the next decade on energy efficiency and is aiming to reduce its greenhouse gas emissions by 50% over the next 20 years.

Eyemouth Freezers needs an effective way of measuring progress in terms of decarbonisation and is being guided by Specific Energy Consumption (SEC), a variable used to express how much energy is used per m3 volume of the coldstore. A new build facility would be expected to have an SEC of around 20 kwh per m3 per year. Its facility, dating back to the late 70s, is currently operating at an SEC of 40. The business estimates that if it can halve this figure through energy efficiency investment, it would not only reduce its environmental impact but could cut its electricity bill by as much as £180,000 a year.

There was a strong relationship built over several years with ISD's Fred Weaver (National Sales Manager) on specialist panel installation works, and they were the first in mind when Managing Director, Hubert Brady, was considering facility upgrades to help meet their goals. ISD's experienced team began by undertaking a thermal imaging survey of the coldstore buildings which led to key recommendations, resulting in the installation of new vapour seals and painting the panels with bitumen to minimise heat loss in Coldstore 2. An airlock and interlocking doors were also installed to further improve energy efficiency. Immediately there was a noticeable improvement with far less air leakage.

Coldstore 1 is an older building and ISD has recommended replacing the entire ceiling. Eyemouth Freezers has applied for a grant from the Scottish Industrial Energy Transfer fund to carry out the work and fund more efficient refrigeration equipment. If successful, savings in terms of carbon and energy costs will be significant.

The company is committed to a long-term programme of energy efficiency improvements, having capitalised on quick wins and put an ambitious upgrade plan in place. They recognise it is the only way they can meet their emissions reduction targets. It is keen to generate energy on site too and is investigating installing solar panels.

In addition, the business is exploring how to use space more efficiently and is looking to replace cardboard pallets with a modern system that will increase capacity by 16%. At peak times the business currently sends overspill product to be stored in other facilities at a significant financial and environmental cost.

Hubert Brady, Managing Director, says:

"The ISD team is key to helping us deliver our investment programme, providing advice, recommendations and technical expertise to put efficiency improvements at the heart of our growth strategy."

operational procedures

As mentioned above, we believe it is vital that anyone working in a temperature-controlled facility is aware of the importance and vulnerability of its structure, and the impact of any damage. Usually these are finely tuned, high performing facilities which are too often neglected by those operating within them.

So, from operational procedures such as correct use of doors to ensure minimal ingress of warm air and moisture, to practical techniques for avoiding risk of panel damage by forklifts or other machinery, what might seem like individually insignificant steps can make a major impact on the total cost of ownership. In addition, the overall environmental impacts of the facility can be improved too.

a few suggestions from us are as follows:

Consider your type of door before construction

How regularly will it open and will it be for personnel access or for vehicular traffic? For traffic access, rapid roll doors are often more efficient due to their speed of operation and reduced 'open' time. On the other hand, solid leaf doors provide better thermal values and airtight seals and may be preferred for infrequent use. We will discuss this in further detail in the final instalment of this series.

Speed of entry into a cold space

Generally, there will be similar air pressure between the cold box and the rest of the warehouse, so there will be a delay before the transfer of air begins. It therefore makes sense for the door to open and close as quickly as possible.

Training of personnel

As mentioned previously, staff should be aware of the value of the facility in which they are operating. Unfortunately, it is very common for accidents to happen where vehicles collide with and damage walls. Every instance of this compromises the efficiency of your coldstore.

Managing air differences

In some instances warm air ingress is unavoidable, for instance within freezer dock pods where it is impossible to create a 100% seal between delivery vehicles and the freezer envelope.

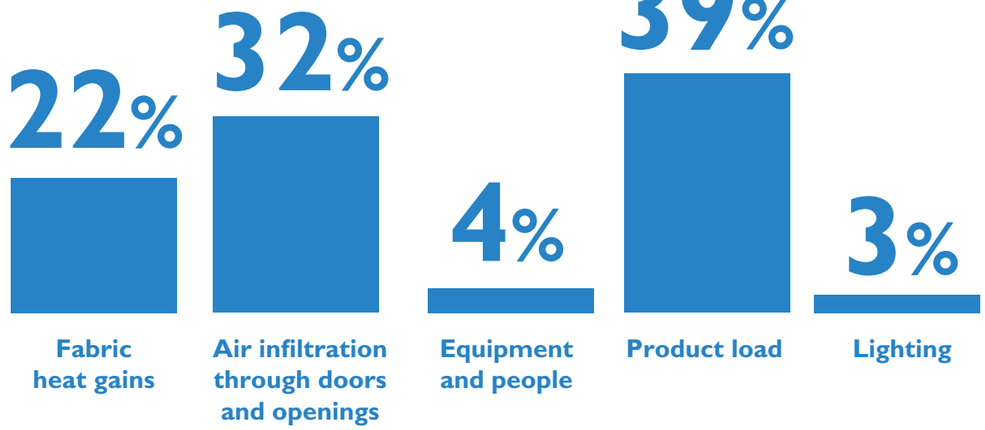
To avoid the operational hazards and facility damage resulting from condensation and freezing, dehumidification may be the right solution. This is particularly the case when you are looking at extreme temperature differences between chambers.

Dehumidification is however an energy hungry system. Other options may be additional internal airlocks or even strip curtains to stop the rapid crossover of warm and cold air.

Other contributing factors are the speed of the door in opening and closing, and its insulating U value. Which of these has more impact depends on the door's use. We will talk about this in more depth in our next report.

typical cold storage heat loads

The main heat loads in cold storage vary, depending on how the building is used. The graph below shows typical coldstore heat loads, where the product throughput is high, and the product arrives warm. It highlights that 22% of the heat gains in a coldstore are through the fabric. **A further 32% is a consequence of air infiltration through doors and openings, a topic we will cover in our next report.**



energy efficiency is the key sustainability challenge for cold storage operators

The Climate Change Act enshrined in law the requirement for the UK to hit Net Zero by 2050. We are not currently on course to hit that goal or the target set by the Paris Agreement to limit the global average temperature rise to well below 2°C and preferably below 1.5°C above pre-industrial levels. This means there is a growing pressure for businesses across all sectors to accelerate decarbonisation and understand what Net Zero means for them. Whilst governments undoubtedly need to do more to support in the transition, it is also up to business to innovate and adopt behavioural changes too.

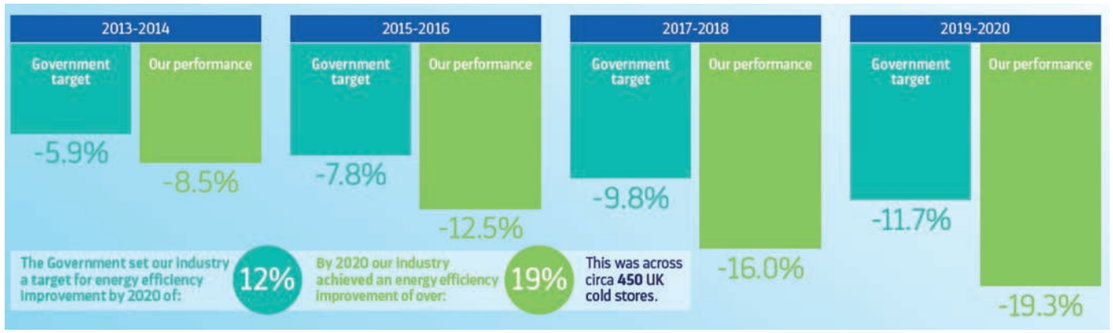
For cold storage operators, carbon emissions come from two main sources – directly from escaping refrigerant gases and indirectly from energy consumed by the operation of the site equipment.

Regulation is in place to gradually phase out high GWP refrigerants and many coldstores are already utilising low GWP alternatives, so the primary focus for many will be to use less energy. Investing in energy efficiency measures will both have a major impact on a company's carbon footprint and bring significant cost savings at a time of energy price inflation. The topics covered in parts 2 and 3 of this series – fabric heat gains and air infiltration through doors and openings – account for more than half of coldstore heat gains (see graph on previous page) and are therefore a major source of wasted energy in cold storage.

The Climate Change Agreement (CCA) scheme is currently the only government policy to directly target energy efficiency in coldstores. In 2020, the approximately 425 coldstores registered under the Cold Chain Federation's CCA used 3.5bn kWh of primary energy, which is the equivalent of 710kt CO2e.

The coldstore sector has collectively performed well under the CCA, having consistently outperformed the target set for improving energy efficiency. It most recently recorded a 19.3% improvement against a 2008 baseline. However, further analysis of the data shows there is variability in performance across the UK's cold storage estate, with approximately 50% of sites missing the target individually. The CCA's targets are only set to get more challenging in the coming years, so there are still significant improvements to be made.

relative energy efficiency progress in cold storage under the climate change agreement



Ensuring the highest standards of thermal insulation, whether it be on pipework, a buildings fabric or cold store doors and openings, is one of the most important measures a business can take to bring their energy use under control and reduce their emissions. Addressing insulation and heat ingress will not only enable businesses to save money but will also help them to stay ahead of future anticipated regulation on energy performance in industrial buildings.

with thanks...
to Tom Southall, Executive Director of Cold Chain Federation for contributing the contents of this page.

"Whilst our members have been performing well in making energy efficiency improvements under the Climate Change Agreement scheme, they must now go beyond the low hanging fruit to achieve the even greater reductions in energy use which are going to be demanded by government policy. The information in this report will equip them to do exactly that, saving their businesses money and reducing their impact on the planet."

Shane Brennan, Chief Executive, Cold Chain Federation

"ISD Solutions, together with S Tysoe Installations, have been driving standards in coldstore construction and maintenance for decades. This report is the culmination of that experience, our contribution to raise standards even further and make a wider impact beyond our own business in the drive to net zero. If you'd like to discuss your facility, we'd be delighted to help."

Tony Wall, Group MD, The P&M Group and Chairman, CEBA UK and Simon Tysoe, Managing Director, S.Tysoe Installations Ltd

"With 22% of the heat gains in a coldstore coming from the fabric, and the drive in the industry towards net zero, this report is very timely."

"At the same time, it's important to consult the experts during design or when planning upgrades to ensure the best solution for your facility. This report, coupled with expert guidance from the right contractor will serve you, your business and the planet."

Dr Dermot Cotter, Managing Director, Star Technical Solutions

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