Why Thermal Assurance Is the Key to a Resilient Cold Chain

The secure delivery of temperature-controlled shipments has evolved drastically in recent years, especially in regard to visibility that products are not compromised during transit. But, within that same period of time we've seen greater challenges to the cold chain emerge.

From a geopolitical perspective, trade wars and tariffs have caused delays and difficulties, whilst regulatory challenges, for example the still-lingering consequences of Brexit, have weakened some regional cold chain infrastructures. With major pharma producing regions such as the EU and US striving for greater resilience, the upheaval of reshoring and nearshoring is another recent complication to long term cold chain planning.

Alongside the impact of manufacturing relocation, economic sanctions and regulatory restrictions, are the ongoing complexities of navigating conflict-affected regions which may have limited cold storage facilities, damaged transport networks and complex access processes, further complicating the construction of a resilient distribution network.

Intensifying environmental pressures are also adding strain, both in terms of the pursuit of sustainability goals and the real-world impact of climate change. Whilst the industry is making great strides in reducing carbon emissions across Scope 1 and 2, Scope 3 emissions (those most relevant to supply chain) still account for 80–90% of the pharmaceutical sector's total climate impact. The responsible specification of cold chain packaging is also under scrutiny, with The World Health Organisation's (WHO) Guidelines for the International Packaging and Shipping of Vaccines (2025), for example, placing a clear emphasis on the role of reusable, sustainable packaging.

Meanwhile, the impact of environmental neglect in decades past is manifesting today as growing incidents of extreme weather. The number of weather-related disasters has increased by a factor of five over the past 50 years, with extreme rainfall events increasing globally, and a growing frequency of tropical cyclones in historically uncommon locations.[1,2,3]

Add in the yet to be defined role of AI, its impact on the workforce and potential vulnerability to cyber-attack and the result is a highly charged landscape in which cold chain resilience is of paramount importance.

Where once the response to these challenges was reactive, focused on how to protect the cold chain and how to minimise the impact of incidents, the current landscape demands proactivity, and a fully realised ecosystem with thermal assurance at its heart. This means combining best-in-class product solutions, emerging and established technology, and human expertise to create an end-to-end strategy that goes beyond shipment integrity and into broader network resilience.

Specification and Route Qualification

Comprehensive thermal assurance, meaning a strategic approach to robust and resilient cold chain logistics, begins with expert packaging consultancy and a data-driven approach to route planning.

The greatest challenge for cold chain logistics historically has been visibility. The basics of where a shipment is and whether it's on track as the first layer of information, then evolving to reporting disruptions or incursions in transit, to today, where real-time data can indicate the risk of temperature fluctuation and inform risk scores, along with product testing and knowledge.

Basic digital insight, such as track and trace, is now effectively standard within the industry. But what can more advanced and emerging technology offer in terms of actionable insights, and how does this contribute to end-to-end thermal assurance?

One of the most critical tools is thermal modelling. In terms of its use in packaging specification, thermal modelling has become a central factor in determining the selection of packaging type and pack out per shipment, using qualified data points to ensure the most efficient and reliable solution is selected each time.

High level providers now offer customised insulated shipping systems which are not only specified in-line with laboratory and real-world data, but which can be tailored to specific operational and regulatory needs. This, alongside the ability to customise pack outs in-line with product needs, means that every element of packaging can be optimised for the greatest level of assurance. Furthermore, this forensic approach to packaging selection allows for ongoing optimisation and right-sized solutions for each shipment, providing financial and environmental benefits.

Modelling technology, powered by ambient data as gathered by shipment sensors, also offers an enhanced level of risk management, predicting thermal behaviour and temperature mapping complex supply chains to provide quantified recommendations. This can include utilising data on which regions may have infrastructure challenges which pose a risk to temperature control, which ports or airports have a pattern of delays in customs procedures, or risks of extreme weather, allowing for contingencies to be built into a route ahead of time.

Similarly, ambient data modelling can provide initial lane qualification, using historic and real-time data to flag the potential environmental, logistical and regulatory risks of a given route. This detailed insight and predictive analysis, alongside technical advice from a trusted provider, allows for the creation of a data-informed cold chain shipment that has been risk assessed at every level and developed with contingencies in place for pre-identified challenges within the supply chain.

This approach, which takes the process of packaging and route selection to a granular level, represents a strategic shift in how cold chain shipments are managed, moving from basic temperature monitoring to comprehensive thermal assurance.

From a sustainability point of view, high performance reusable packaging provides the opportunity to balance the importance of

robust packaging and real-time monitoring with a contribution towards sustainability targets. Options which can be leased offer a lower-cost-per-use reusable solution which can dramatically reduce storage requirements, whilst also delivering a fossil fuel use reduction. These environmentally shippers are available with support through return and redeployment via tracking, and certain providers also include tools to track landfill avoidance for enhanced ESG reporting.

Actionable Insight, Human Oversight

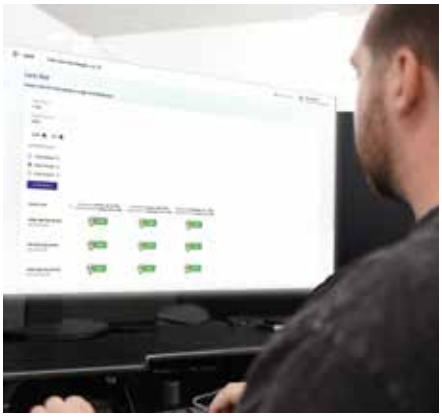
While data is critical to packaging selection and route qualification, it extends far beyond these elements.

Today real-time monitoring is now integrated into the majority of cold chain networks to a greater or lesser extent. But the scope of that data, and the ways in which it is used, make a big difference to how a cold chain can be protected, maintained and optimised.

In terms of providing a true picture of a shipment's thermal assurance, end to end visibility is essential.

Aside from how this level of monitoring can be used retroactively, the real-time visibility offered by end-to-end tracking provides the opportunity for proactive risk management mid-shipment. This proactivity is where the human element to thermal assurance becomes critical. Where technology is able to identify patterns to predict possible risk, and where data can be used to qualify future routes, the navigation of a critical situation as it unfolds requires the intervention of an experienced cold chain logistics expert.

Access to a global network of expertise, in conjunction to data-driven insights, allows for the quick and effective resolution, or total avoidance, of mid-shipment incidents. Instant data sharing means that wherever a shipment has encountered difficulty, your partner supplier should be able to provide regional assistance, combining their knowledge of local regulatory considerations with insights from both previous shipments and the one in progress.



Advanced thermal assurance ecosystems incorporate a mix of technologies, from monitoring tools to modelling systems, along with a strong network of specialised technical advisors to consult before, during and after a shipment. For those supplying product globally via cold chain networks, the ability to access neutral, context-driven guidance around packaging selection, risk management, regulatory compliance and thermal strategy, as well as digital insights, is critical to thermal assurance.

Optimisation

Outside of risk management, data modelling and the insights generated as a result can also contribute to cost efficiencies and route optimisation. Intelligent systems can digest huge volumes of information, looking for patterns or gaps and assessing where refinements to existing processes can be made. Operational analysis which would once have taken weeks and months can be done in minutes or hours, allowing for ongoing refinements to the cold chain, driving further robustness and resilience.

By applying these actionable insights to every element of the cold chain, companies can identify opportunities to reduce waste, lower costs and improve reliability, contributing to an increasingly more impregnable thermal assurance strategy.

Ultimately, safe, effective and efficient cold chain management is only part of the broader picture of thermal assurance. Companies using temperature-controlled shipping should now be seeking strategic partners which are able to combine proven thermal solutions, next generation digital intelligence and a global network of human expertise to deliver not only reliability but optimisation, reducing risk, lowering costs and increase sustainability.

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Luiza Cervetto

Luiza Cervetto, Senior Global Strategy and Product Manager, Cold Chain Technologies. With over twelve years' experience in strategy and product management, Luiza co-ordinates multi-functional teams across Cold Chain Technologies with a view to solving customer challenges and delivering end-to-end thermal assurance for pharmaceutical businesses globally.