

EVALUATING AUTOMATION OPPORTUNITIES IN HAZARDOUS CHEMICAL STORAGE ENVIRONMENTS

Opportunities, constraints and assessment criteria for hazardous warehouse operations

Executive perspective

The purpose of this briefing is not to advocate automation as the default answer. Its purpose is to support a structured assessment of whether automation, conventional storage, semi-automated storage, or a hybrid approach is most appropriate for the operation.

1. Executive summary

Chemical and hazardous-material storage operations often face a difficult balance between capacity, safety, traceability, access, and compliance. Many sites continue to rely on block stacking, conventional pallet racking, and forklift-intensive handling because those methods are familiar, proportionate, and in some cases entirely suitable.

However, warehouse automation should not be ruled out solely because an operation involves hazardous area requirements. Historically, DSEAR considerations, hazardous-area classification and the need for suitably rated equipment have created significant barriers to automation adoption, particularly where sites store palletised chemicals, IBCs, drums, tank containers, or other hazardous load formats. Recent developments in storage systems designed for use with appropriately rated equipment in hazardous areas mean that some of these assumptions now warrant re-evaluation.

The assessment should begin with the operating problem, not the equipment. If the primary challenge is usable capacity, routine forklift activity, handling exposure, traceability or controlled retrieval, automation using equipment suitable for the relevant hazardous area classification may be worth examining. If volumes are low, load formats vary significantly or the business case is weak; a simpler storage route may remain the better answer.

2. Industry context

For decades, warehouse automation has created measurable benefits in conventional logistics environments. Adoption within chemical, pharmaceutical and hazardous-material storage operations has been more limited

because the operating environment introduces legitimate constraints that standard warehouse systems were not designed to address.

Typical constraints include ATEX zoning requirements, hazardous load formats, containment considerations, ignition-risk controls, operational restrictions, and the need to maintain safe access, inspection, and emergency response arrangements. These constraints can make automation unsuitable in some facilities, or commercially difficult to justify.

The strategic question is therefore not whether automation is possible in principle. The more useful question is whether automation is appropriate for the specific products, load formats, hazardous-area classification, access pattern, throughput requirement, and business case.

DSEAR, ATEX and hazardous-area classification Automation must be evaluated against the DSEAR assessment, hazardous area classification, substance profile, ignition-risk controls, and operating procedures.	Load format and handling risk Pallets, IBCs, drums and tank containers introduce different stability, transfer-point and containment considerations.
Capacity and access pressure The strongest cases usually involve constrained sites where more usable capacity or better access is difficult to achieve conventionally.	Traceability and control Regulated operations may value visibility, retrieval control, and movement of records as much as storage density.
	Strategic implication ATEX rated equipment suitability should not be treated as a standalone business case. Overall suitability depends on the relationship between safety, hazardous area requirements, capacity, control, movement reduction, and commercial value.

3. Where hazardous area automation may create value

ATEX-compatible automation can be relevant where hazardous materials are stored in formats suitable for controlled automated handling and where the operation has a defined problem that conventional storage methods struggle to solve. AutoCube®-X is intended for suitable ATEX-regulated applications involving palletised goods, IBCs and barrels, with hazardous storage formats including palletised chemicals, IBCs, drums, tank containers and palletised tanks.

When the fit is right, the potential value is not limited to density. The broader opportunity is to create safer, more controlled, and more visible material flow within the existing warehouse environment.

- Increasing usable storage capacity within an existing footprint.
- Reducing routine forklift entry into hazardous storage areas.
- Reducing unnecessary handling and operator interaction with hazardous inventory.
- Supporting controlled automated storage and retrieval for suitable load formats.
- Improving inventory visibility and traceability through warehouse orchestration software such as MAXIQ®.

4. Where automation may not be the right answer

A credible automation assessment should also identify where automation may not be justified by the operational or commercial value it creates. This is particularly important in chemical operations, where safety and compliance requirements can increase engineering complexity. A technically feasible system may still be commercially or operationally inappropriate.

Low inventory volumes

If the warehouse is not constrained and storage volumes are modest, automation may not create sufficient operational value.

Highly unpredictable access patterns

If almost any load may need to be accessed at any time, direct access requirements may favour a different storage route.

Highly variable load formats

Large variation in load size, packaging, condition or handling requirement can reduce standardisation opportunities.

Limited throughput requirement

If existing processes meet operational demand safely and reliably, automated throughput may not be a priority.

Existing storage already performs effectively

If the site already has safe access, clear control, adequate capacity and reliable movement processes, automation may not solve a meaningful problem.

5. Evaluation framework

Before discussing a specific system design, the operation should be screened against the areas below. The purpose is to determine whether ATEX-compatible automation warrants a more detailed engineering assessment, or whether a conventional, semi-automated or hybrid solution is more appropriate.

Assessment area	Question to examine	Why it matters
Capacity profile	Is the site constrained by usable capacity, floor space, height utilisation or external storage?	Density alone is not a sufficient justification. The value must be tied to usable capacity, layout constraints, or avoided expansion.
Hazardous-area context	Which zones, substances, ignition-risk controls and operating procedures apply?	ATEX capability must be evaluated against the specific site environment and operating model.
Load format	Are pallets, IBCs, drums or tank containers consistent enough for engineered automated handling?	High variation in load condition, size, or handling requirement can reduce suitability.
Handling exposure	Where does routine forklift movement or operator interaction create risk, delay, or inefficiency?	The strongest cases often connect capacity improvement with reduced routine movement in hazardous areas.
Control requirements	Would the operation benefit from stock-location visibility, movement records and controlled retrieval?	Traceability and visibility can be as valuable as additional storage density in regulated environments.
Commercial case	Can the project be justified through space avoided, external storage reduction, throughput, labour productivity or risk reduction?	A technically possible project may still be commercially inappropriate if the operational value is limited.

6. Technical and operational review areas

Where the initial screening suggests automation may be relevant, the next step should be a structured review of the site, products, load formats, and operating requirements. This review should be undertaken before any recommendations are made.

Workstream	Typical review considerations
Materials and load formats	Chemical products, packaged format, pallet type, IBC configuration, drum and tank-container handling, load condition and stability.
Hazardous environment	DSEAR assessment, hazardous area classification, ATEX equipment requirements where applicable, COMAH context, ignition-risk controls, emergency arrangements and operational restrictions.
Operating profile	Throughput, stock turns, SKU count, access patterns, replenishment frequency, and production or dispatch interface.
Safety and containment	Transfer points, containment strategy, spill-risk considerations, maintenance access, recovery approach, and operator interaction.
Commercial justification	Capacity pressure, avoided external storage, building constraints, forklift activity, labour input, risk reduction and value of improved control.
	Assessment principle The first question should not be: can this warehouse be automated? The first question should be: what operating problem are we trying to solve, and which storage route solves it most effectively?

7. Role of Thistle Systems

Thistle Systems works with organisations that need to evaluate storage approaches for complex operational environments, including chemical, process, pharmaceutical and hazardous-material storage.

In this context, AutoCube®-X should be viewed as one possible route within a broader assessment of storage design, handling activity, safety, capacity, traceability and commercial return.

The appropriate recommendation may be AutoCube®-X, a semi-automated shuttle approach, high-density IBC storage, conventional racking, or a hybrid solution. The objective is to identify the most suitable storage route for the operation rather than starting from a predetermined equipment answer.

Concluding Perspective

For many years, automation was considered impractical in many hazardous chemical storage environments, particularly where potentially explosive atmospheres, DSEAR requirements, and equipment rating considerations created additional engineering constraints. In many facilities, that conclusion was entirely justified.

Today, advances in hazardous storage technology means some organisations may have more options available than they realise. However, that decision should never begin with a technology choice.

The most successful projects begin with a clear understanding of the operational challenge, followed by a structured assessment of the available storage approaches and a robust evaluation of safety, compliance, performance, and commercial viability.

The question is not whether a warehouse can be automated. The question is whether automation is the most effective way to solve the problem the warehouse is facing.