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WHITEPAPER

Breaking the GLP-1 Manufacturing Bottleneck

How Single-Use Powder Handling Supports Safer, More Efficient Scale-Up

Executive Summary

The rapid rise in GLP-1 demand is pushing pharmaceutical manufacturers to scale faster than ever, placing new pressure on production capacity, facility readiness, material handling, and operational consistency. As manufacturers expand output, they also face greater process risk across complex workflows. Without the right powder-handling and containment strategy, efforts to increase capacity can create new bottlenecks, increase cleaning and material-transfer demands, expose operators to potent compounds, and introduce variability that slows progress.

A strategic single-use powder-handling approach can help manufacturers expand capacity without proportionally expanding reusable container fleets, cleaning infrastructure, storage areas, cleaning validation, and container-tracking requirements. It can also support safer material transfer, a stronger Contamination Control Strategy (CCS), and more consistent execution across complex production workflows. While reusable stainless-steel systems impose significant demands on washing, drying, storage, and infrastructure, single-use solutions can enable faster changeovers, streamlined manufacturing processes, and lower overall costs.

ILC Dover, an Ingersoll Rand Business, supports pharmaceutical manufacturers with single-use powder-handling and containment solutions, helping teams evaluate process requirements, equipment interfaces, and scale-up needs across the workflow.

Market Pressure Outpaces Manufacturing Readiness

GLP-1 demand has grown faster than manufacturers were prepared to support. Shortages have made it clear that production capacity is now a major challenge, with EMA statements linking GLP-1 shortages to increased demand and manufacturing constraints,[1] and the FDA indicating that available supply is a determining factor in resolving shortages.[2]

Market forecasts show this pressure is expected to continue; J.P. Morgan projects the global incretin market, which includes GLP-1s, will reach $200 billion by 2030.[3]

The World Health Organization (WHO) has recognized GLP-1 therapies as globally relevant for obesity treatment while noting that access remains severely constrained; even with rapid production expansion, GLP-1 therapies are projected to reach fewer than 10% of people who could benefit by 2030.[4]

Manufacturers are investing in capacity, but scaling GLP-1 production is technically complex. Peptide-based GLP-1 manufacturing typically relies on solid-phase peptide synthesis (SPPS), whereas small-molecule oral solid dosage (OSD) programs use chemical synthesis followed by downstream drug-product processing. Each pathway creates different material-handling, transfer, and containment requirements.

As production expands, manufacturers face increasing pressure across the full operating model. Cleaning cycles can reduce equipment availability, while reusable container fleets require additional wash space, storage, utilities, and status management. At the same time, powder loss can affect yield, open transfers can increase exposure and contamination risk, and repeated or uncontrolled handling can add time and variability to the process.

These pressures become especially significant in peptide manufacturing, where multiple materials must be staged, transferred, and charged in a precise sequence. Expanding production without addressing the supporting powder-handling infrastructure can perpetuate the same operational constraints that limit capacity today.

For manufacturers rapidly expanding peptide capacity, the challenge isn't only how much equipment to install, but how to prevent powder handling, cleaning, and container management from becoming the next bottleneck.

Sources:
1. https://www.ema.europa.eu/en/documents/report/report-multistakeholder-workshop-shortages-glucagon-peptide-1-glp-1-receptor-agonists_en.pdf
2. https://www.fda.gov/drugs/drug-alerts-and-statements/fda-clarifies-policies-compounders-national-glp-1-supply-begins-stabilize
3. https://www.jpmorgan.com/insights/global-research/current-events/obesity-drugs
4. https://www.who.int/news/item/01-12-2025-who-issues-global-guideline-on-the-use-of-glp-1-medicines-in-treating-obesity

Streamlining Operational Efficiencies to Increase Capacity

The GLP-1 manufacturing landscape requires manufacturers to scale production quickly, whether through new greenfield sites or expanded capacity at existing facilities. Traditional powder-handling technologies have relied heavily on stainless-steel bins, also known as Intermediate Bulk Containers (IBCs). However, the CapEx required for a fleet of IBCs, along with the infrastructure needed to support their use, can extend scale-up timelines and increase operating costs.

Flexible Intermediate Bulk Containers (FIBCs) offer a single-use alternative designed to meet production-speed requirements while reducing CapEx and OpEx. DoverPac® systems from ILC Dover provide a complete, highly effective solution for achieving high containment. As outlined below, DoverPac systems can help streamline operations and support greater manufacturing efficiency.

Reusable Stainless-Steel Bins (IBCs)	Single-Use DoverPac® Systems (FIBCs)
Require CapEx for a fleet of IBCs, including inventory for in-production use and processing hold times for cleaning.	Require minimal CapEx to implement DoverPac technology.
Require dedicated floor space, reducing available production space or cluttering work areas and creating material-handling and safety concerns.	Can be stored conveniently in the warehouse without occupying production space, then deployed when a campaign is ready to begin.
Require additional cleaning infrastructure and floor space. Bin washers or clean-in-place (CIP) systems may be required, along with expanded water-for-injection (WFI) and cleaning-chemical systems.	Are completely disposable and require no cleaning. After powder is discharged, DoverPac systems are removed from the facility for incineration or disposal.
When powder transfers exceed 25 pounds, additional infrastructure is required to lift and position the IBCs. These lift systems can be highly expensive, depending on how the IBCs dock at the process connection.	Require a lift system, but their simpler positioning and docking requirements can allow less expensive hoist systems to be used. DoverPac lifting also does not require rotation for discharge, while IBCs typically require additional space and mechanics to rotate 180 degrees.
Risk of significant powder retention along the walls, and can retain larger amounts of powder due to poor flow. This batch shrinkage can affect quality and must be monitored for process adjustments.	Support powder flow and minimize retention through flexible-wall construction and anti-static capabilities. Operators can confirm that all powder has been discharged and perform final manipulation to help assure complete discharge.

Promoting Sustainability by Evaluating the Complete Product Life Cycle

A common misconception is that single-use technology is less sustainable than equivalent reusable technology. Much of this perception stems from public awareness of consumer single-use plastics, which are made from nonrenewable fossil fuels and can harm the environment, particularly waterways.

A closer evaluation of single-use technology in drug processing shows a different result. When used and disposed of responsibly, single-use technology actually has *less* impact on the global ecology. Studies have shown that, at the point of use, single-use technology can offer a stronger sustainability profile than reusable technology because reusable systems rely heavily on water and chemicals for cleaning.[1] The energy, treatment, and disposal associated with these cleaning systems often outweigh the environmental impact of single-use technology.

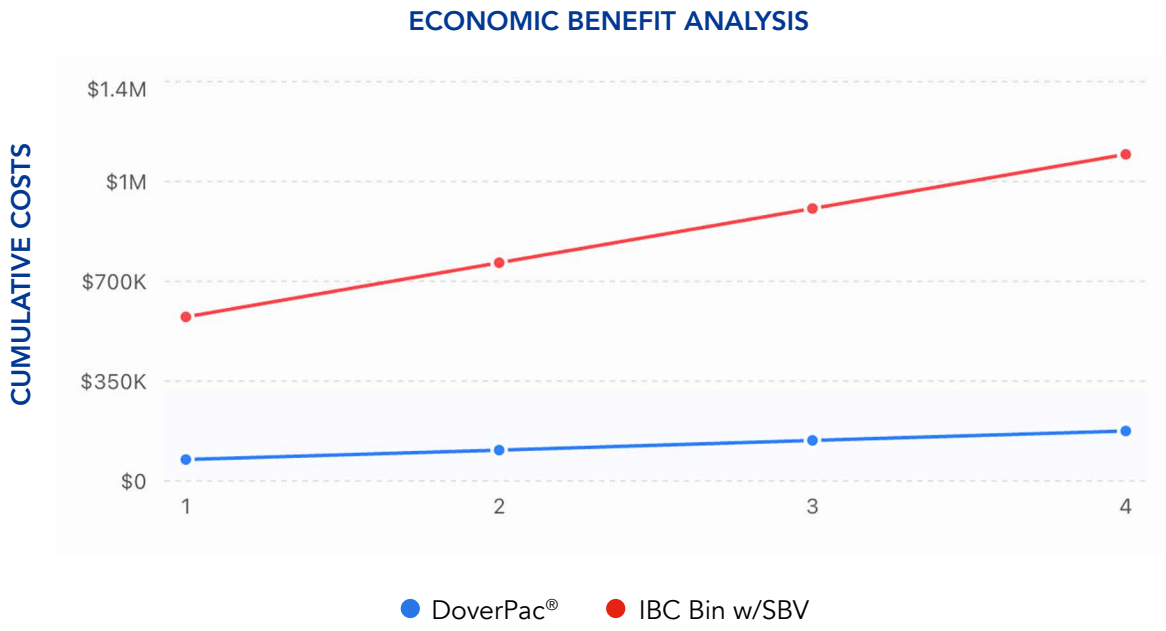
The table below compares the sustainability considerations of reusable IBCs and single-use DoverPac® systems across the complete product life cycle.

Reusable Stainless-Steel Bins (IBCs)	Single-Use DoverPac® Systems (FIBCs)
Require cleaning processes that consume significant amounts of water and chemicals. Cleaning water must be WFI grade, requiring substantial energy to produce, and is often temperature-controlled during cleaning.	Fully disposable and require no cleaning process.
Require chemicals ranging from detergents to solvents, which must be produced and can create hazardous waste streams.	Fully disposable and require no cleaning process.
Produce contaminated cleaning liquids that must be processed or disposed of after use. Disposal has high environmental impact, and incineration is often selected despite its high energy consumption. The transportation and energy consumption associated with handling these liquids must also be considered.	Can be disposed of through landfill or incineration, with incineration most often selected as the end-of-life option. Most DoverPac systems contain less than 20 pounds of thermoplastic material, which incinerates efficiently and generates a relatively small carbon footprint.
Studies have evaluated the environmental impact of stainless steel mining and smelting, as well as fabrication processes. These add to the carbon footprint imbalance compared to single-use systems.[1]	Studies have evaluated the fossil fuel base and its impact on the manufacturing of plastic materials used in single-use technology. There's a smaller carbon footprint, and recycling programs can further reduce it.[1]

Source:
1. https://www.sciencedirect.com/science/article/abs/pii/S0959652612005197

Comparing the Long-Term Economic Impact

The economic benefits of single-use technology extend beyond the initial capital investment. This illustrative analysis compares the cumulative cost of a 700-liter DoverPac® system with a reusable IBC system fitted with a split butterfly valve. Under the operating assumptions used, DoverPac requires substantially less upfront investment and maintains a significantly lower cumulative cost through the first three years of operation.



Results will vary based on facility requirements, production frequency, labor rates, cleaning processes, utility costs, and other operating assumptions.

Powder Handling & Containment as a GLP-1 Scale-Up Strategy

Whether scaling SPPS for injectable GLP-1 production or chemical synthesis and downstream processing for OSD programs, manufacturers need to understand where material handling affects safety, contamination control, equipment availability, yield, and production speed.

A strong powder-handling and containment strategy begins with a clear evaluation of where material moves, where risk enters the process, and where cleaning, infrastructure, transfer, or equipment-interface requirements can restrict production. In SPPS, this includes the charging of solid materials into the reactor.

1. PROCESS STEP	2. MATERIAL RISK	3. INTERFACE RISK	4. SCALE REQUIREMENT
Identify where material moves through the workflow and where risk or delay may be introduced. Review charging, sampling, transfer, discharge, and pack-off activities to determine where open handling, unnecessary intervention, cleaning, or equipment downtime can interrupt production. **Operational Decision** Determine which process steps require a different handling approach to improve flow, reduce delays, or maintain containment.	Assess how each material behaves during handling and transfer. Consider potency, airborne potential, static sensitivity, solvent exposure, flow characteristics, batch value, and the importance of low-retention discharge. Also evaluate whether reusable containers introduce added cleaning, segregation, or status-control requirements. **Operational Decision** Define the level of containment, recovery, static control, and material segregation required for each application.	Evaluate how materials connect with reactors, drums, bins, valves, isolators, mills, dryers, and downstream equipment. Review whether each transfer is open, semi-contained, or closed, and whether operators can complete connection and disconnection through a safe, controlled, repeatable process that minimizes product loss and exposure risk. **Operational Decision** Select connection and transfer solutions compatible with the equipment that support controlled material movement.	Match the powder-handling approach to the current production stage, facility limitations, and future capacity needs. Consider whether the process is at R&D, clinical, or commercial scale; whether the workflow is manual, semi-automated, or automated; and what storage, wash space, utilities, or reusable-container fleets may be required as production expands. **Operational Decision** Choose systems that meet current workflow needs without creating new infrastructure or scale-up constraints.

Key outcomes supported by this strategy:

1. Streamlined workflows
2. Lower infrastructure burden
3. Personnel protection
4. Contamination control
5. End-to-end execution

Workflow Deep Dive: Supporting SPPS Powder-to-Liquid Mixing

Injectable GLP-1 manufacturing commonly relies on SPPS, which uses multiple amino acids and other materials in a controlled sequence. As production scales, powder-handling efficiency can affect batch execution, product recovery, equipment utilization, and operator exposure.

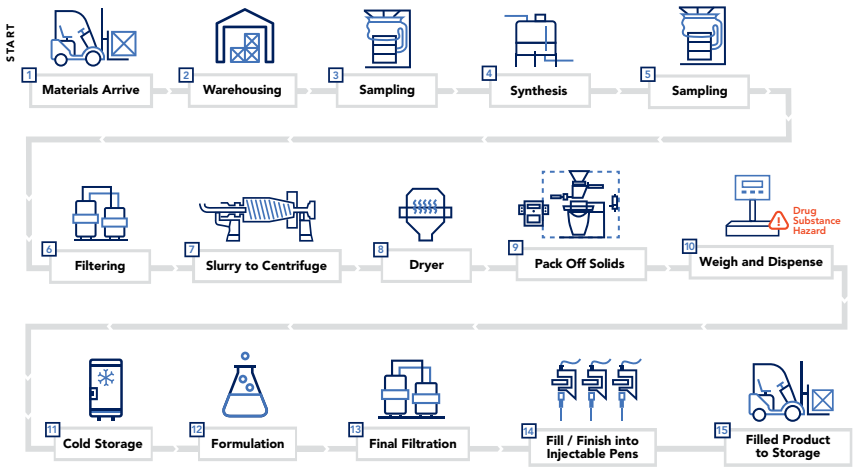
Because powder addition is part of a larger process, the handling system should be evaluated alongside the receiving vessel, connection method, mixing requirements, batch size, and material characteristics.

JetMixer™ Systems for Powder-to-Liquid Mixing

JetMixer™ can be integrated into SPPS workflows for powder-to-liquid incorporation where consistent dispersion, operator safety, and process efficiency are critical.

When paired with contained powder-transfer technologies such as DoverPac®, JetMixer™ supports a connected approach to charging and mixing. Custom configurations are available.

Solid-Phase Peptide Synthesis (SPPS)



Workflow Deep Dive: Chromatography Resin Handling

Following SPPS, injectable GLP-1 manufacturing moves into purification. Chromatography is a liquid-phase operation that separates the target peptide from process-related impurities and helps achieve the purity required for formulation and fill-finish.

As chromatography columns increase in scale, larger volumes of dry resin or media may be required for column packing. Managing higher solid volumes efficiently is an important consideration for production throughput, and single-use FIBCs can accommodate larger quantities of resin or media and enable faster, more efficient transfer into column-packing operations.

ILC Dover can support contained resin staging, transfer, and charging into chromatography-column packing operations using single-use powder-handling and containment solutions configured around the material and equipment interface. This can help reduce open handling, support cleaner material transfer, and create a more controlled and repeatable column-packing process.

Workflow Deep Dive: Small-Molecule OSD GLP-1 Manufacturing

Small-molecule OSD GLP-1 manufacturing follows a separate pathway from injectable production. Rather than relying on SPPS, it begins with API chemical synthesis and continues through downstream OSD drug-product processing. Each phase introduces distinct requirements for powder handling, transfer, containment, low-retention discharge, and batch consistency.

Unlike injectable SPPS workflows, OSD manufacturing requires powder controls across both chemical synthesis and downstream drug-product operations. The containment approach should therefore be selected according to the process step, material characteristics, equipment interface, and production scale.

API Chemical Synthesis

The API chemical-synthesis phase may include repeated reactor charging, sampling, filtration, centrifuge transfer, drying, milling or sieving, and pack-off. Potent or airborne-prone powders may require controls that limit operator exposure and environmental release. High-value intermediates may also require handling methods that minimize retention, product loss, contamination, and interruptions as material moves between process steps.

DoverPac® systems can support contained storage, transport, charging, discharge, and offloading across applicable synthesis and solids-handling steps. Pack-off stations can support contained discharge from dryers, mills, or other process equipment, while flexible enclosures, continuous liners, and transfer hardware can support controlled operator handling at equipment-interface points.

OSD Drug-Product Processing

Following API production, downstream OSD processing may include weigh and dispense, blending, wet granulation or solubilization, spray drying, secondary drying, milling, tableting, sampling, and final packaging. These unit operations create distinct requirements for operator protection, static control, material recovery, controlled transfer, and batch consistency.

ILC Dover can configure solutions around the needs of each operation and connect them across the broader workflow.

- DoverPac® supports contained material movement, charging, transport, and offloading.
- EZ BioPac® supports smaller-volume solids transfer.
- EZ PowderZip™ supports contained transfer at selected interfaces.
- Pack-off stations support equipment discharge.
- Flexible enclosures can support weigh-and-dispense.
- Continuous liners support contained material removal and transfer.

Applying a Risk-Based Approach to Powder Handling & Containment

Scaling GLP-1 production requires manufacturers to evaluate powder-handling and containment risks across each process step, material transfer, and equipment interface. Following the principles of ICH Q9(R1), this assessment should be grounded in scientific knowledge, aligned with the level of risk, and focused on protecting product quality, personnel, and ultimately the patient.[5]

A well-defined risk assessment considers three fundamental questions:

- What might go wrong?
- How likely is it to occur?
- What are the potential consequences?

For powder-handling applications, these questions can be applied across charging, sampling, transfer, discharge, drying, milling, blending, tableting, and pack-off. Manufacturers should evaluate where open handling, airborne material, product retention, incompatible connections, cleaning requirements, or equipment downtime may introduce risk.

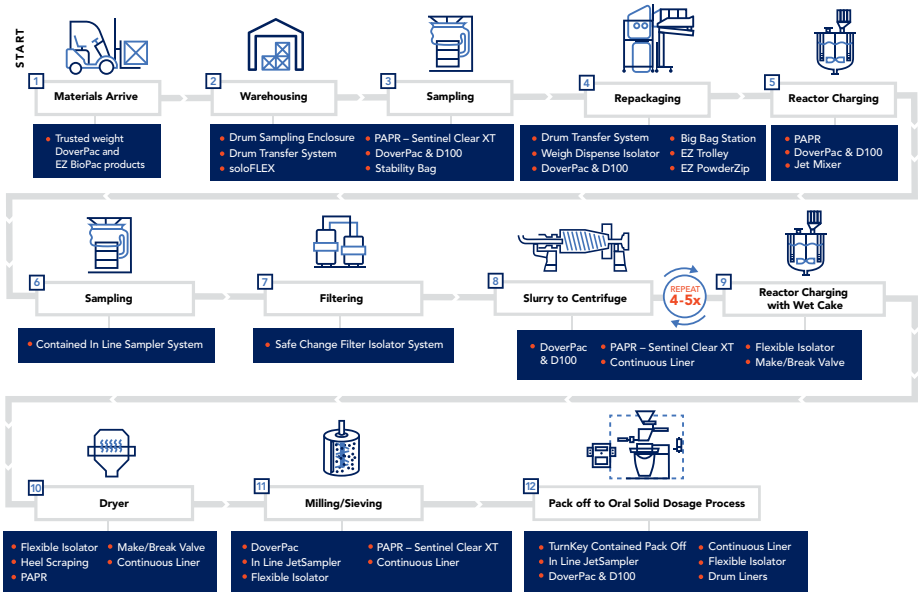
1. IDENTIFY THE HAZARD	2. ASSESS THE RISK	3. APPLY THE CONTROL	4. VERIFY PERFORMANCE
Where can exposure, contamination, product loss, or delay occur?	Consider likelihood, severity, material characteristics, and process conditions.	Select the appropriate containment, transfer, connection, or discharge solution.	Confirm that the control meets containment, recovery, operational, and scale-up requirements.

Source:
5. https://database.ich.org/sites/default/files/ICH_Q9%28R1%29_Guideline_Step4_2023_0126_0.pdf

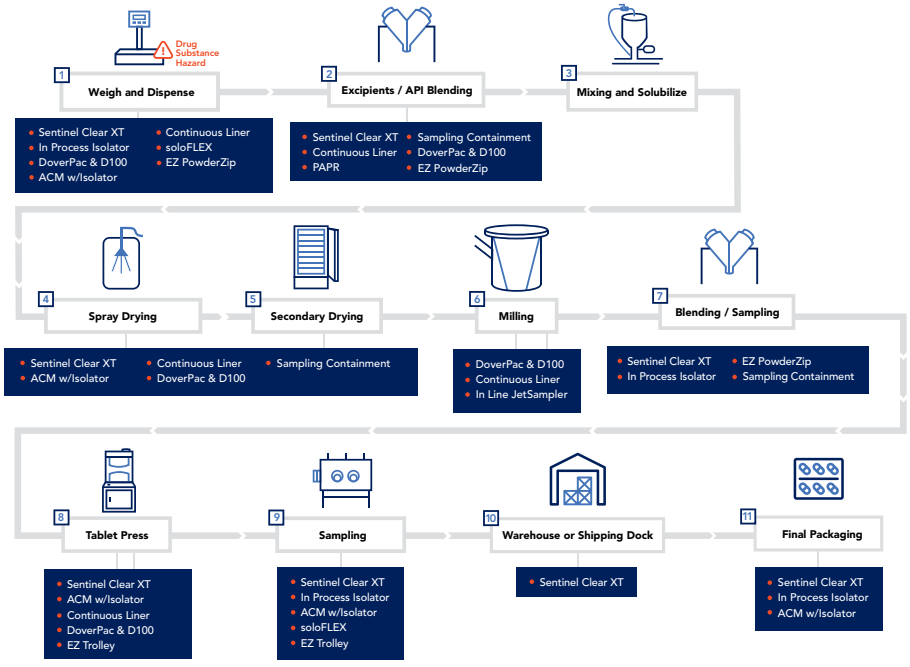
GLP-1 Drug Substance Production

This workflow map highlights key transfer points across GLP-1 manufacturing and where powder-handling and containment solutions can support the process.

Chemical Synthesis



Transition to OSD Drug Product Processing



Powder Handling Is Part of Manufacturing Capacity

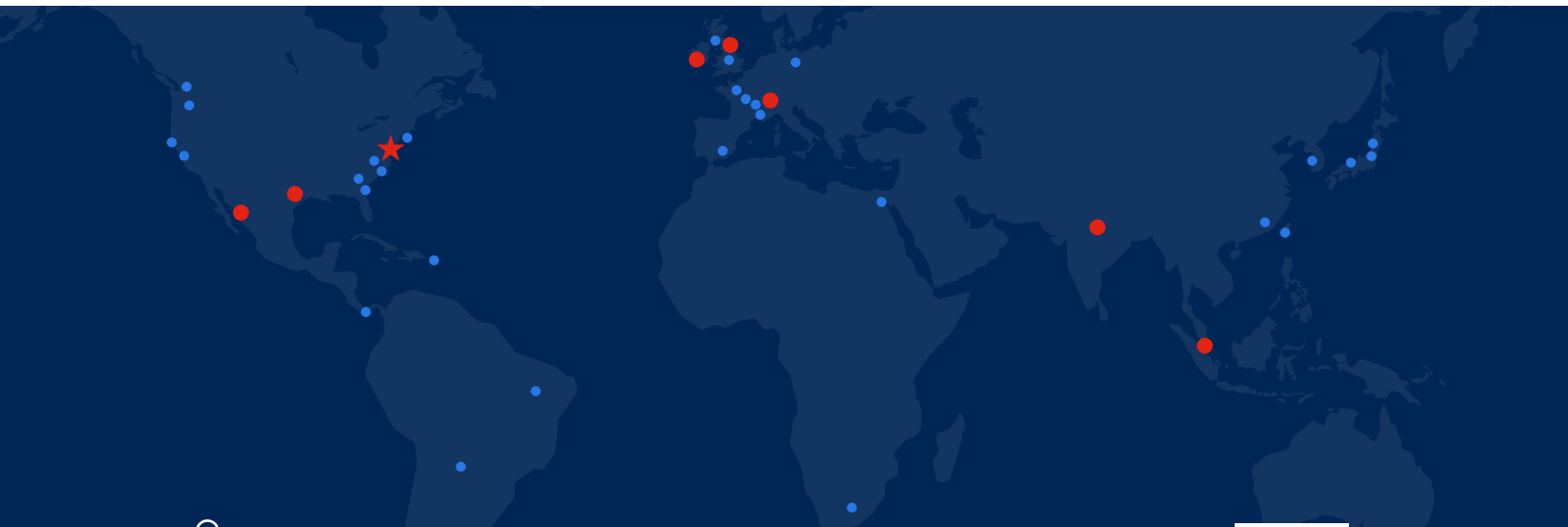
GLP-1 demand has created pressure to expand manufacturing capacity, but added equipment alone doesn't determine how effectively that capacity performs. Across injectable and OSD production, material handling affects process flow, operator protection, contamination control, cleaning requirements, storage needs, and equipment availability.

A workflow-based powder-handling and containment strategy helps manufacturers evaluate these requirements at each transfer point and identify where reusable containers, open handling, or cleaning activity create additional operational burden.

Together, these outcomes reflect ILC Dover's focus on operational efficiency, lower infrastructure burden, personnel protection, contamination control, and end-to-end execution. ILC Dover provides powder-handling and containment solutions for injectable and OSD production. From workflow evaluation and equipment interface review to solution selection and scale-up planning, we help manufacturers configure systems to meet their process requirements.

Ready to strengthen your GLP-1 manufacturing workflow?

Map your process with an ILC Dover specialist to identify material-handling gaps, evaluate equipment interfaces, and align powder-handling solutions with current and future production requirements.



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