Safely scaling high potency API manufacturing: containment, strategy and commercial readiness in modern pharma

Manufacturing High Potency Active Pharmaceutical Ingredients (HPAPIs) requires precise handling, robust containment and disciplined process control. As more therapies rely on highly active compounds, particularly in oncology and immunology, the ability to manage these materials safely and efficiently has become a defining capability for pharmaceutical manufacturers and CDMOs.

This whitepaper outlines the key considerations in HPAPI manufacturing from how potency is defined and classified to the practical challenges of process design, containment and scale up. It explains how an integrated containment strategy combining equipment design, facility layout and procedural controls supports both operator safety and regulatory compliance.

The paper also explores how advances in automation, digitalisation and sustainability are shaping the future of high potency manufacturing and helping organisations reduce risk and improve efficiency while maintaining the highest standards of quality and safety.

READERS WILL LEARN:

- How HPAPIs are defined and managed within Occupational Exposure Limit (OEL) and Occupational Exposure Band (OEB) frameworks.
- Common sources of risk in high potency manufacturing and how integrated containment controls address them.
- Practical design and operational strategies for safe and compliant HPAPI production.
- How technical transfer and scale up are managed for high potency products.
- The role of digitalisation, automation and sustainability in next generation HPAPI operations.

INTRODUCTION

The evolving role of HPAPIs in modern drug development

High potency active pharmaceutical ingredients (HPAPIs) now play a central role in modern drug pipelines, particularly in oncology, immunology, hormone therapies, and targeted therapies where very small doses deliver meaningful pharmacological effects. Their increasing prevalence reflects a broader shift towards precision medicines where low-dose, high-activity compounds require increasingly sophisticated, risk-driven containment strategies aligned with the latest regulatory expectations.

These requirements represent a technical and strategic challenge for modern pharmaceutical development and manufacturing. Effective handling of potent materials depends on specialised infrastructure and equipment such as isolators or split valves, controlled transfer technologies, robust HVAC systems, and validated cleaning processes designed to prevent cross-contamination and protect operators. CDMOs with established high-containment systems and quality frameworks are therefore an essential part of the supply chain for companies that lack internal capability or capacity.

HPAPI programmes carry elevated timelines and risk profiles. As products progress through scale-up, maintaining control becomes more challenging due to large batch sizes, demanding cleaning validation, and strict regulatory expectations. These pressures highlight the importance of clear potency classification, risk assessments and well-designed containment strategies. Without a clear classification framework, it becomes difficult to design processes that reliably protect operators and ensure product quality.

DEFINING AND CLASSIFYING HIGH POTENCY APIs

What makes an API high potency?

High potency APIs are characterised by their ability to exert therapeutic or biological effects at very low doses, which can cause unintended pharmacological effects. If exposure is not tightly controlled, these effects can pose a risk to operators. Careful classification is therefore essential so that handling requirements, containment approach and overall control strategy are correctly specified from the outset.

This classification is based on a combination of potency and toxicological profile. These factors must be considered together, as potency alone does not determine risk. The way a material behaves during handling, transfer and processing, and the frequency and duration of operator interaction, play a critical role in defining the level of containment required to protect both operators and product integrity.

In practice, this classification forms the foundation for all subsequent decisions, including equipment selection, facility design, cleaning strategy and personnel protection.

How OEL and OEB guide handling requirements

Two frameworks are commonly used to define the controls required for high potency materials:

- **OEL:** Sets the maximum acceptable concentration of an API in workplace air, typically expressed in $\mu g/m^3$. It is established to protect workers from all relevant exposure pathways, including inhalation, dermal contact and, where applicable, ingestion. OEL directly informs containment design, engineering controls, personal protective equipment (PPE) selection and cleaning validation limits by providing a quantitative, compound-specific exposure threshold.
- **OEB:** Groups substances into qualitative or semi-quantitative hazard categories based on potency and toxicology. These bands indicate the degree of containment required and commonly range from OEB 1 (low hazard) to OEB 6 (high hazard). However, band definitions are not standardised and can vary between organisations, suppliers and regions, which can create challenges during technical transfer or supplier qualification.

Both frameworks aim to support safe operations, but they differ in precision and application.

OEL as the more reliable standard

The OEL provides a quantitative, compound-specific value that can be consistently applied across development, manufacturing and quality operations. It is the basis to define the level of engineering containment required, and sets expectations for PPE and environmental monitoring.

Because OEB systems lack standardisation, OEL is generally regarded as the more reliable basis for risk assessment and containment strategies. While regulatory authorities primarily focus on permitted daily exposure (PDE) values and cleaning validation, a scientifically justified OEL remains essential for occupational risk management and containment design in high potency environments

In environments where specific HPAPI guidance is not fully harmonised, the OEL becomes a critical reference point for demonstrating that containment strategies are appropriate, proportionate and grounded in toxicological science.This enables accurate risk assessment by ensuring that process and facility design decisions are grounded in a clear, measurable exposure threshold.

With potency classification and exposure limits established, the next step is to consider how these requirements shape real-world production controls.

PRODUCTION CHALLENGES AND CONTROL STRATEGIES

A) Integrated containment approach

Effective HPAPI manufacturing relies on an integrated containment strategy built across three layers: equipment-level controls, facility design and procedural measures. These all operate together to prevent operator exposure and cross-contamination, ensuring that manufacturing remains safe and compliant under varying process conditions. Importantly, these layers are not applied uniformly. Their design and interaction are defined by structured, science-based risk assessment, recognising that zero risk does not exist and that controls must be proportionate to the potential for exposure.

1. Primary containment: equipment and process design
Primary containment focuses on keeping potent materials fully enclosed during processing. This is achieved through closed processes such as isolator-based designs or contained equipment that maintain separation between operators and product across dispensing, granulation, compression and cleaning steps. Containment at each stage minimises opportunities for cross-contamination during processing, maintenance or equipment cleaning. Enclosed transfer methods, such as powder transfer systems, vacuum transfer and split butterfly valves, enable material movement between equipment without breaching the system. The choice between active and passive split valves is critical, as this directly affects containment performance at transfer points and must be matched to the compound OEL and process frequency.

Cleaning systems also contribute to primary containment. Wash-in-place (WIP) and clean-in-place (CIP) technologies reduce manual intervention and therefore reduce exposure risk. In high-potency environments, WIP is generally considered a baseline requirement to minimise operator exposure, while CIP is applied selectively depending on equipment design, process complexity and cleaning validation needs. Single-use parts may be applied when cleaning validation is difficult or when avoiding product-to-product carryover is critical. Campaign production further supports containment by limiting changeovers and maintaining consistent system performance throughout batch sequences.

2. Secondary containment: facility and HVAC design
Secondary containment provides an additional layer of control to ensure airborne potent material cannot migrate beyond designated manufacturing areas, particularly in the event of a primary containment breach. Facility engineering plays a central role in this, using structural and airflow controls to maintain separation between high-potency zones and the surrounding environment.

Negative-pressure rooms, airlocks and pressure cascades establish predictable airflow patterns that draw air into, rather than out of, high-potency spaces. This directional control is supported by single-pass air systems and multi-stage filtration, typically using G4, F9 and H13 filters, to remove particulate matter and prevent recirculation of potent materials within the HVAC system. Air recirculation is generally avoided for HPAPI operations and, where considered, must be justified through risk assessment.

Further protection is achieved through facility zoning. Segregated air-handling units (AHUs) maintain independent control over different manufacturing areas, while defined flows of personnel, equipment and materials reduce opportunities for accidental crossover between clean and contaminated zones. Measures such as misting showers provide an additional barrier when moving between areas where airborne particulate may be present. Clean and dirty equipment follow designated routes through the facility to prevent back-contamination during washing, storage or transport.

3. Tertiary containment: procedural and behavioural controls
Tertiary containment focuses on the procedural and behavioural measures that ensure containment systems perform as intended. Entry to high-potency areas is controlled through defined gowning requirements and operator qualification steps, ensuring that only trained and appropriately protected personnel handle potent materials. PPE may include chemical suits, powered air-purifying respirators and double-glove systems, depending on the OEL of the compound and the activity being performed. PPE is the final line of defence, applied after engineering and facility controls have reduced exposure as far as reasonably practicable.

Routine monitoring supports ongoing operational control. Environmental monitoring tracks airborne particulate and verifies that airflow and pressure conditions remain stable, while hygiene monitoring checks for accidental contamination on surfaces or garments. Together, these activities ensure that containment measures continue to perform effectively during day-to-day manufacturing.

Primary, secondary and tertiary controls operate as overlapping layers of protection, creating a comprehensive containment system for HPAPI operations. All three are defined, challenged and refined through structured risk assessment across the product lifecycle, balancing operator protection with operational practicality.

B) Protecting personnel

Protecting personnel is a core requirement in HPAPI manufacturing and relies on a combination of engineering controls, appropriate PPE and restricted access to high-potency areas. The grade of protection has to reflect both the potency and toxicity of the compound and the level of exposure in each task. For example, dispensing pure API at high frequency requires a different protection strategy than occasional handling of coated tablets. It is therefore essential to establish a robust OEL value before working with a new API.This value defines the primary and secondary containment strategies, with personnel protection forming the final layer of protection. PPE and containment decisions should be grounded in a clear exposure limit rather than applied conservatively by default.

PPE requirements escalate with potency and may include chemical suits, powered air-purifying respirators (PAPRs) and protective hoods. These measures ensure that operators remain protected even during tasks where equipment needs to be opened. Access to high-potency zones is restricted to personnel who have received specific training and, in some cases, are subject to ongoing health surveillance to confirm fitness for work in contained environments.

Monitoring activities support the early detection of any loss of containment. Hygiene monitoring checks for the presence of potent material on surfaces or garments, helping identify accidental exposure or operational deviations. Environmental monitoring complements this by verifying that airborne particulate and pressure conditions remain within defined limits.

Personnel protection also relies on preparedness. Emergency procedures and drills provide operators with clear actions to follow in the event of containment failure, equipment malfunction or accidental exposure. Regular rehearsal of these scenarios supports rapid, coordinated responses and reduces the likelihood of harm. Together, these measures create a structured, multi-layered approach that ensures operator safety during all stages of HPAPI manufacturing.

C) Process design

Effective process design is essential to maintaining containment across every unit operation. From dispensing to final packaging, each operation must be configured so that potent material remains enclosed and operator exposure risks are minimised. Each step introduces its own handling and exposure considerations, and the process must be configured so that potent materials remain fully enclosed throughout.

Dispensing typically begins within isolators using high-integrity transfer systems to prevent airborne particulate release. As material moves into granulation, dry granulation or roller compaction is often selected because these methods avoid heat, moisture and solvents, supporting both product stability and reliable containment. Blending continues this enclosed approach, with IBC systems and split valves enabling material charging and discharge without opening vessels.

Controlled mixing is achieved through IBC-based blending systems fitted with split butterfly valves, which enable secure charging and discharging without opening the vessel. Downstream operations maintain the same principles. Tableting equipment uses enclosed feeders, dedicated dust extraction and WIP-enabled designs to manage particulates at the point of generation.

Coating pans fitted with WIP functionality reduce manual contact and simplify cleaning between batches. Maintenance and monitoring activities are similarly designed to avoid containment breaches. Bag-in/bag-out (BIBO) systems allow safe filter changes and component replacement under containment, while in-process control sampling (IPC) sampling is performed through isolated or under-pressure ports to prevent dust release.

D) Facility design

Facility design is central to maintaining containment during HPAPI manufacturing, ensuring that potent materials remain controlled as they move through different stages of production. Zoning is used to separate key operations, such as dispensing, manufacturing, coating, packaging, and quality control, so that each area operates within a designated zone, minimising cross-contamination risks.

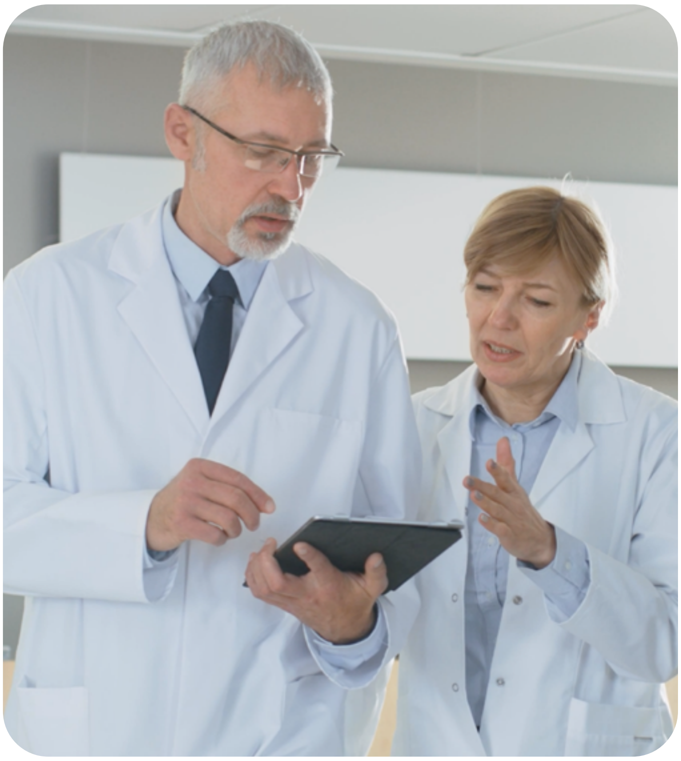
Airflow control and personnel/material flow is another critical part of this architecture. To ensure air consistently moves from cleaner to more potent zones, facilities use:

- **Pressurised zones** ensure predictable directional airflow, with people and material airlocks designed as self-contained "bubbles" that prevent reverse flow into cleaner areas.
- **Misting showers** provide an additional decontamination step when moving between zones, minimising the transfer of airborne particulate.
- **Single-pass air systems** eliminate recirculation, ensuring that air containing potent material is never returned into the facility.
- **High air-change rates** (typically >10 per hour) rapidly remove airborne particulate and stabilise room conditions during high-dust operations.
- **Safe-change filters**
- **Independent HVAC systems** that prevent air from crossing between areas and help maintain containment boundaries

Movement through the facility is also tightly managed. Defined routes for personnel, equipment, raw materials and waste help maintain separation between clean and potentially contaminated pathways. Within QC areas, sampling and analytical activities are supported by safety airlock system (SAS) equipped rooms or laminar-flow cabins that allow potent materials to be handled safely without compromising sample integrity or operator protection.

Waste management forms the final crucial design consideration. Hazardous waste generated during manufacturing or testing must be collected, transferred and removed under containment, using defined routes to prevent accidental release.

Together, these design principles ensure that the facility itself functions as a containment barrier, supporting the safe and compliant handling of potent materials throughout the production lifecycle.



E) Regulatory and cost considerations

Containment strategies must align with EU GMP requirements, ICH risk-management principles and recommendations for ISPE guidance, all of which emphasise the need for scientifically justified controls and demonstrable protection of operators and product. In the absence of fully harmonised HPAPI-specific regulatory guidance, sites are expected to justify their containment strategies through robust risk assessment and toxicological rationale. Designing systems that meet these standards from the outset supports smoother inspections and reduces the likelihood of remediation later in the product lifecycle.

These requirements contribute to the higher capital investment typically associated with high-potency manufacturing. Facilities must incorporate isolators, enhanced HVAC capacity, multi-stage filtration systems, safe-change components, and the transfer technologies needed to maintain closed processes. These systems represent a significant upfront cost but are essential for managing potent materials safely and compliantly.

Operational expenditure is also influenced by the demands of high-potency handling. Single-pass air systems create higher energy use by design, while the need for trained personnel, controlled PPE use and validated cleaning routines requires ongoing investment. Together with routine monitoring and equipment maintenance these form a high operational cost.

Fortunately, automation can help offset some of these pressures by reducing manual handling, improving turnaround times and lowering the likelihood of deviations linked to human intervention. Over time, streamlined operational practices support both compliance and cost stability.

With these containment, facility and operational controls in place, the next challenge is applying them reliably as products move from development into scale-up.

SCALE-UP: FROM DEVELOPMENT TO COMMERCIAL PRODUCTION

Scale-up introduces a new set of challenges for HPAPI manufacturing, requiring the development-scale strategies to perform reliably under higher throughput and greater equipment complexity. The fundamental principles remain the same, but the operational demands increase significantly as batch sizes grow and processes transition into commercial environments. At this stage, risks that were manageable at development scale can become critical if containment and process behaviour are not reassessed systematically.

Adapting to larger volumes

As batch sizes increase, dust generation rises and airflow demand grows accordingly. Larger-scale operations place greater loading on filtration systems, with both airflow capacity and filter performance needing reassessment to ensure that exposure stays within defined OEL limits. Facilities must verify that containment systems (isolators, transfer technologies and ventilation controls) perform consistently under higher throughput, as even small changes in airflow or material handling frequency can influence the total particulate burden in production areas. Containment performance should therefore be challenged under worst-case operating conditions rather than assumed to scale automatically. These verifications are typically carried out through airflow tests and containment checks conducted before routine commercial manufacture.

Changes in process behaviour during scale increase

Process behaviour does not scale linearly. Increases in batch size affect flow properties, blend uniformity and granule characteristics, which in turn influence downstream operations such as compression. At a larger scale, differences in mass and flow can alter tableting forces and feed dynamics, requiring refinement of process parameters or the addition of in-process monitoring to maintain consistent performance. These behaviours must be understood early, as variations in blend uniformity or granule density can lead to content uniformity issues if not appropriately controlled. Predictive tools such as ReciPredict™ can support this stage by highlighting scale-sensitive parameters early, helping teams refine settings before large-scale equipment is introduced.

Increasing complexity in cleaning and validation

Cleaning becomes more demanding as equipment size and complexity increase. Additional surface area, more contact points and a greater number of interfaces create multiple locations where residue may accumulate. Although toxicology-based acceptance limits remain unchanged, demonstrating compliance at commercial scale often requires more sampling locations, revised cleaning cycles or updates to WIP/CIP programmes to ensure complete removal of potent material. The increased number of valves, seals and interfaces raises the importance of worst-case selection when defining cleaning validation strategies.

Larger systems also increase the number of components, such as gaskets and valves, that must be included in validation studies.

Maintaining reproducibility across development and commercial sites

When a process moves from development to commercial facilities, even small differences in equipment configuration, airflow behaviour or sampling practices can influence process performance. Reproducibility cannot be assumed and must be demonstrated. It depends on ensuring that the receiving site can replicate the conditions under which the process was originally developed.

As part of technical transfer, teams assess equipment capability, containment arrangements, ventilation control and cleaning methodology to determine whether the site can achieve the required exposure limits. Containment performance is verified before trial batches begin, allowing gaps to be identified and resolved before routine manufacture rather than during commercial production. Any deviations are addressed prior to routine manufacture to ensure both process stability and operator protection.

Key design considerations during scale-up

- Increased dust generation requires reassessment of airflow and filtration capacity.
- Process behaviour does not scale linearly and must be re-evaluated at commercial volumes
- Material flow and blend properties shift with mass, impacting compression performance.
- Cleaning validation must account for additional surfaces and interfaces at commercial scale.
- Differences in equipment and containment between sites must be harmonised to maintain reproducibility.

TECHNICAL TRANSFER

Technical transfer for HPAPI processes requires structured preparation, detailed risk assessment and rigorous verification to ensure that containment, product performance and quality expectations are reproduced reliably at the receiving site. The process is data-driven and centres on confirming that the new environment can meet the same operational and exposure-control requirements established during development. For high-potency products, technical transfer is not a simple replication exercise but a critical risk-management activity.

Preparation and data alignment

Transfer begins with compiling the information needed to characterise the process and its containment requirements. This typically includes OEL and PDE values, formulation data, critical process parameters, sampling approaches and equipment specifications. Clear definition of exposure limits at this stage is essential, as these values underpin containment design, cleaning validation and PPE selection at the receiving site.

These inputs allow both sites to establish a shared understanding of the exposure risks and process sensitivities that must be protected during transfer. Data-driven insights from tools such as ReciPredict™ help identify scale-up or transfer risks early, supporting smoother introduction of the process at the new site and reducing the likelihood of late-stage design changes or remediation.

Assessment of exposure risk and containment requirements

A structured SHE risk assessment is carried out to identify where exposure could occur during the process, taking into account each operation and the points at which material is handled or transferred. This assessment examines both routine operations and non-routine activities such as maintenance, cleaning and sampling, which often represent the highest exposure risk.

The receiving site evaluates these risks against its existing isolators, transfer systems, HVAC design and PPE provision to confirm whether the required level of containment can be achieved. This step establishes whether the site can meet the defined OEL or PDE limits with its current infrastructure or whether adaptations are needed before the process can be introduced. Where gaps are identified, mitigation measures are defined and implemented before any material is introduced into the facility.

Process set up at the receiving site

With containment requirements confirmed, the receiving site configures the process environment. Equipment may be installed or adapted to match the original operating conditions, and containment performance is checked before product is introduced. These checks provide evidence that airflow, pressure regimes and transfer technologies perform as intended under operating conditions.

Cleaning validation is completed to demonstrate that the site's cleaning approach can reliably meet the toxicology-based limits associated with the API. At the same time, IPC and QC methods are aligned to ensure that monitoring and analytical practices will provide results consistent with those obtained at the development site, providing a sound basis for the trial batches that follow. This alignment helps ensure that any deviations observed during transfer can be interpreted correctly and addressed efficiently.

Verification and stabilisation

The first batches manufactured at the receiving site serve to confirm that the process performs as expected under new conditions. These runs provide practical evidence that both containment and process behaviour remain stable. They also confirm that cleaning, monitoring and procedural controls perform reliably under routine operating conditions.

Issues are addressed and the process is adjusted where needed before routine manufacture begins, ensuring that the commercial operation reflects the performance achieved during development and that the site enters routine production in a state of control rather than stabilising post-launch.

MODERNISING HPAPI MANUFACTURING

As more highly potent compounds enter development, manufacturers are placing greater emphasis on technologies that support consistent and compliant operation at scale. Traditional engineering controls remain essential, but they are now complemented by automated systems, digital monitoring tools and more sustainable process designs. Together, these approaches play a critical role in reducing exposure risk, strengthening operational control and supporting long-term commercial readiness for high-potency products. These capabilities create a more resilient manufacturing environment capable of meeting evolving technical and regulatory expectations for HPAPI production.

A) Automation and robotics

Automation is increasingly embedded into high-potency manufacturing as a means of reducing manual handling and strengthening containment performance. By limiting the need for operators to interact directly with potent materials, automated systems help maintain and reduce variability introduced through manual interventions. This shift supports both operator protection and process consistency, particularly at points in the workflow where exposure potential is highest.

Automation also extends to cleaning activities. WIP and CIP functions eliminate the need for manual cleaning inside enclosed equipment, removing a significant exposure risk and reducing the dependency on operators. Automated cleaning is particularly important for non-routine activities, which often present higher exposure risk than steady-state production. These automated sequences provide predictable cleaning performance and shorten turnaround between batches, improving the reliability and efficiency of high-potency operations over time.

Robotics provide an additional level of control for tasks that would otherwise require operators to work in close proximity to potent materials. Activities such as feeding or sampling can be carried out inside isolators using robotic systems, reducing the need for direct operator involvement. By executing movements consistently, robotics support repeatability in routine tasks and help minimise the exposure risks associated with manual intervention.

As HPAPI products continue to increase in complexity, automation provides a way to manage higher containment demands without placing additional burden on operators. When integrated early and maintained through scale-up and commercial manufacture, these technologies support both containment integrity and predictable long-term operation.

B) Digitalisation

Digitalisation is playing a growing role in strengthening the control and oversight of high-potency manufacturing. Real-time environmental monitoring provides continuous visibility of key parameters such as pressure, humidity, and airborne particulate levels, allowing sites to confirm that containment conditions remain stable during processing. This continuous verification supports proactive control, enabling deviations to be identified and addressed before they affect product quality or operator safety.

Digital batch records further support operational control by improving traceability and reducing the risk of manual documentation errors. Integrated data capture provides a consolidated view of process performance, making it easier to track trends and demonstrate compliance during audits. These systems also enable early detection of process variation, forming a basis for ongoing optimisation and continuous improvement across high-potency operations.

C) Sustainability

Sustainability considerations are increasingly influencing how high-potency facilities are designed and operated. Many of the technologies used to support containment and exposure control also deliver environmental benefits when implemented effectively. Several process and equipment choices used in HPAPI manufacturing inherently support reduced resource consumption while maintaining the necessary level of containment:

1. Dry granulation offers a more efficient option for many high-potency formulations, as it removes the need for solvents and the associated energy demands of drying. This not only simplifies the process but also reduces the environmental impact of solvent use and handling.

2. Containment at the equipment level can also contribute to more sustainable facility operation. By preventing the spread of particulates at the source, enclosed systems reduce the load placed on room-scale HVAC, which in turn can lower the overall airflow and filtration capacity required to maintain safe operating conditions.

3. Efficient WIP and CIP systems minimise the volume of water and cleaning agents needed for equipment turnaround, while also reducing the operator time and manual handling typically associated with manual cleaning. These systems support both environmental objectives and operational efficiency.

4. Waste handling systems are designed to prevent environmental release of APIs during collection, transfer, and disposal, ensuring that robust containment is maintained beyond the production process itself.

Realising the full benefit of automation, digitalisation and sustainability initiatives depends on integrating them into a cohesive containment and risk-management strategy, rather than implementing them as isolated upgrades. Working with experienced partners helps ensure these technologies are applied in a way that supports safe, compliant and commercially viable HPAPI manufacturing.

HOW RECIPHARM SUPPORTS HIGH POTENCY API DEVELOPMENT & MANUFACTURING

Specialised high potency infrastructure

High-potency programmes often stall because the infrastructure simply cannot deliver the level of containment, consistency or flexibility they require. Purpose-built high-containment facilities are therefore critical to maintaining momentum as products move from development into commercial manufacture. Our Leganés site provides a fully contained platform for high-potency API development and manufacturing, allowing customers to progress without the compromises or delays that come with adapting non-specialised facilities for potent compounds.

Each stage of the process, from dispensing through to coating, is executed within systems engineered for low-OEL work. Closed transfer methods prevent the product losses, exposure risks and deviation events that often occur when teams are forced to adapt non-potent equipment for potent compounds.

Our WIP-enabled units reduce cleaning time and avoid schedule disruptions for manual cleaning checks. This approach supports both operator protection and predictable turnaround between batches. Dedicated HVAC systems, with stable pressure control and multi-stage filtration, give customers confidence that containment conditions remain stable from batch-to-batch. The site operates within a mature global quality system and established regulatory framework, supporting consistent compliance as products move towards and through commercial launch.

Our centres of excellence provide scalable, compliant high-potent manufacturing for partners of all sizes. With global expertise and local presence, we offer the flexibility to meet today's needs and support future growth.

Integrated analytical and quality control capability

QC is a common pressure point in high-potency programmes, particularly when laboratory spaces are not aligned with the containment standards used in manufacturing. At Recipharm, our QC laboratories are structured to manage potent materials safely while supporting routine testing at pace.

Analysts work within SAS-equipped rooms and controlled-airflow environments that protect personnel while maintaining sample integrity. This alignment between manufacturing and analytical containment reduces the risk of contamination, rework or testing delays. As a result, routine testing can progress without interruption, even for highly potent products.

To avoid uncertainty around contamination risk, we define clear pathways for receiving, preparing and disposing of samples to ensure potent materials remain contained throughout the analytical workflow.

Cleaning validation is aligned with the toxicological profile of each API, and environmental monitoring provides an ongoing check that conditions remain stable across batches. Together, these controls give customers confidence that QC processes will support timely batch release and uphold the same safety and containment standards established in manufacturing.

Expert support for transfer scale up and long term supply

High-potency programmes progress most effectively when development, scale-up and commercial manufacture are connected through a single, aligned framework. Fragmented approaches increase the risk of late-stage adjustments, containment gaps and schedule disruption. Our end-to-end support model aligns these requirements early, reducing uncertainty during transfer and creating a stable foundation for scale-up and long-term supply.

Transfer activities begin with a focused assessment of exposure risks to ensure containment requirements are fully understood and appropriately replicated at the receiving site. This early alignment helps avoid reactive changes during later stages of the programme.

To ensure that the operating environment is consistent with development so scale-up can proceed, our equipment mapping confirms that isolators, transfer technologies, HVAC performance and WIP functions align with the needs of the compound and the process. Our digital tools and scientific approach is used to anticipate how a process may respond as equipment scales or site conditions change. These insights help identify potential sensitivities early, supporting more informed decision-making and reducing the likelihood of unexpected behaviour during transfer or scale-up.

Potent compounds form a routine part of production at Leganés, and our teams bring deep operational experience in managing the subtle factors that influence both process behaviour and containment performance. This expertise enables early identification and resolution of issues that might otherwise slow progression or compromise control.

By combining development, scale-up and commercial manufacturing within a unified high-potency platform, we provide our customers with a predictable and connected pathway through the product lifecycle. This continuity strengthens regulatory readiness and supports long-term, inspection-ready supply for products that require consistent, well-controlled handling.

> Through integrated services, we support a coordinated, compliant transition from development to scale-up. With certified quality, a strong performance record and global capacity, Recipharm provides long-term continuity and consistent compliance across markets.

CONCLUSION: STRENGTHENING COMMERCIAL READINESS IN HPAPI MANUFACTURING

Achieving commercial readiness in high-potency manufacturing depends on containment systems that perform reliably under the demands of larger-scale operation. As batch volumes increase, the stability of HVAC, filtration, isolator performance and closed transfer technologies becomes essential, providing the consistent control required for safe and compliant processing. At commercial scale, containment performance must be repeatable and resilient, not just technically sufficient. When these systems are stable, scale-up can progress without introducing avoidable variability or compromising operator protection.

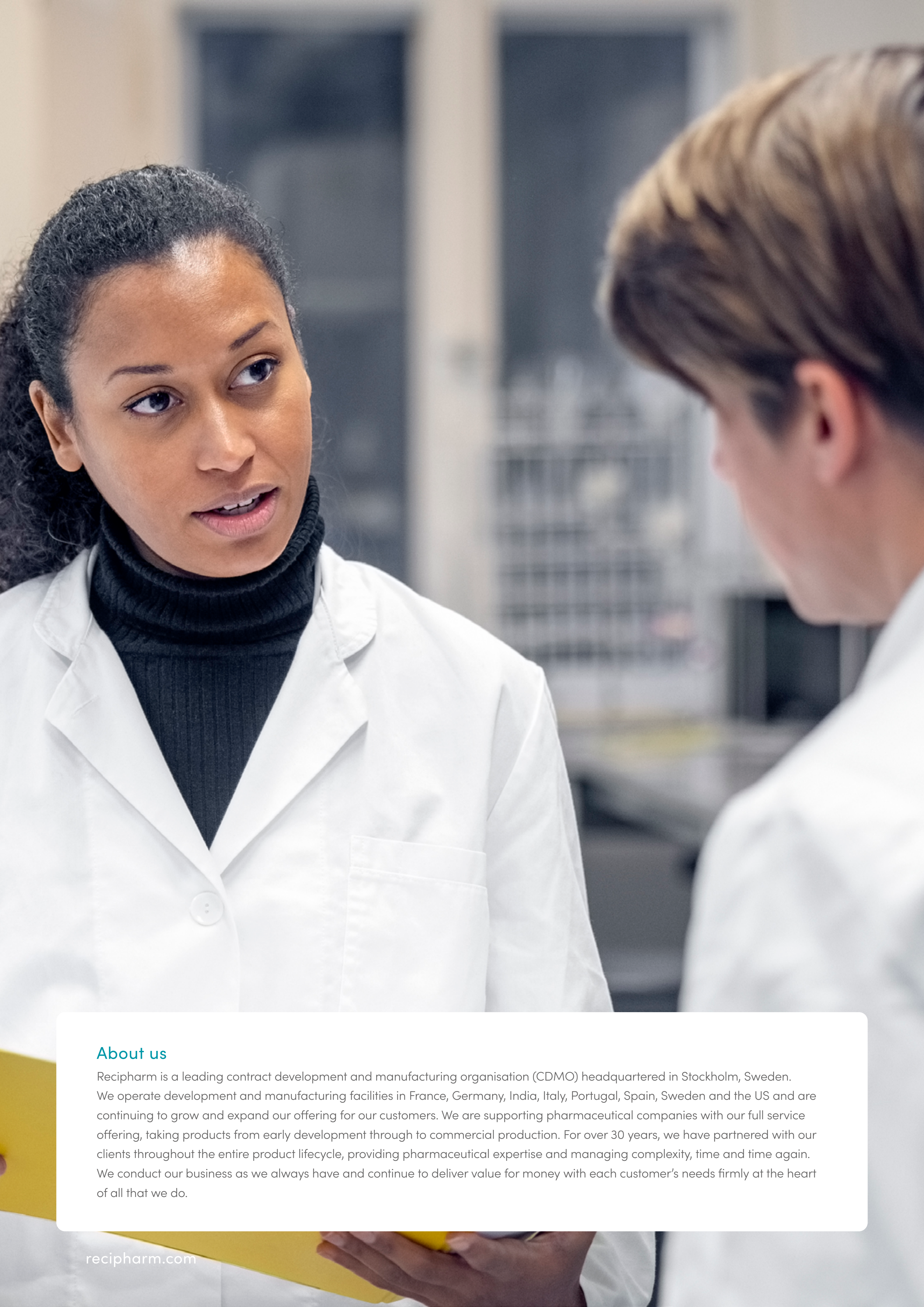
Equally important is a strong understanding of how processes behave as equipment or batch sizes change. High-potency products leave little room for drift, and commercial success relies on ensuring that process adjustments do not affect quality or containment performance. Continuous improvement frameworks support this by refining cleaning strategies, strengthening operational control and improving efficiency over time, enabling safer operation, better yields and more predictable turnaround. This ongoing refinement is central to maintaining control throughout the commercial lifecycle, not just during initial launch.

Digitalisation and automation now play a central role in delivering the predictability customers expect from modern HPAPI facilities. Real-time monitoring, automated cleaning and closed handling systems increase control and reduce uncertainty, creating scalable operations that align with regulatory expectations and the need for consistent performance across successive batches. Together, these capabilities transform containment from a static design feature into an actively managed system.

For many organisations, the final step in achieving commercial readiness is finding a partner with proven capability at low OELs and the technical depth to guide products through development, transfer and long-term manufacture. Working with an experienced CDMO provides access to established containment systems, purpose-built high-potency infrastructure and teams trained to operate confidently within these environments.

Expert partners such as Recipharm help shorten development timelines, reduce transfer risk and provide the clarity and predictability needed to progress high-potency products to market with confidence.

Contact Recipharm's experts for more information >>



About us

Recipharm is a leading contract development and manufacturing organisation (CDMO) headquartered in Stockholm, Sweden. We operate development and manufacturing facilities in France, Germany, India, Italy, Portugal, Spain, Sweden and the US and are continuing to grow and expand our offering for our customers. We are supporting pharmaceutical companies with our full service offering, taking products from early development through to commercial production. For over 30 years, we have partnered with our clients throughout the entire product lifecycle, providing pharmaceutical expertise and managing complexity, time and time again. We conduct our business as we always have and continue to deliver value for money with each customer's needs firmly at the heart of all that we do.