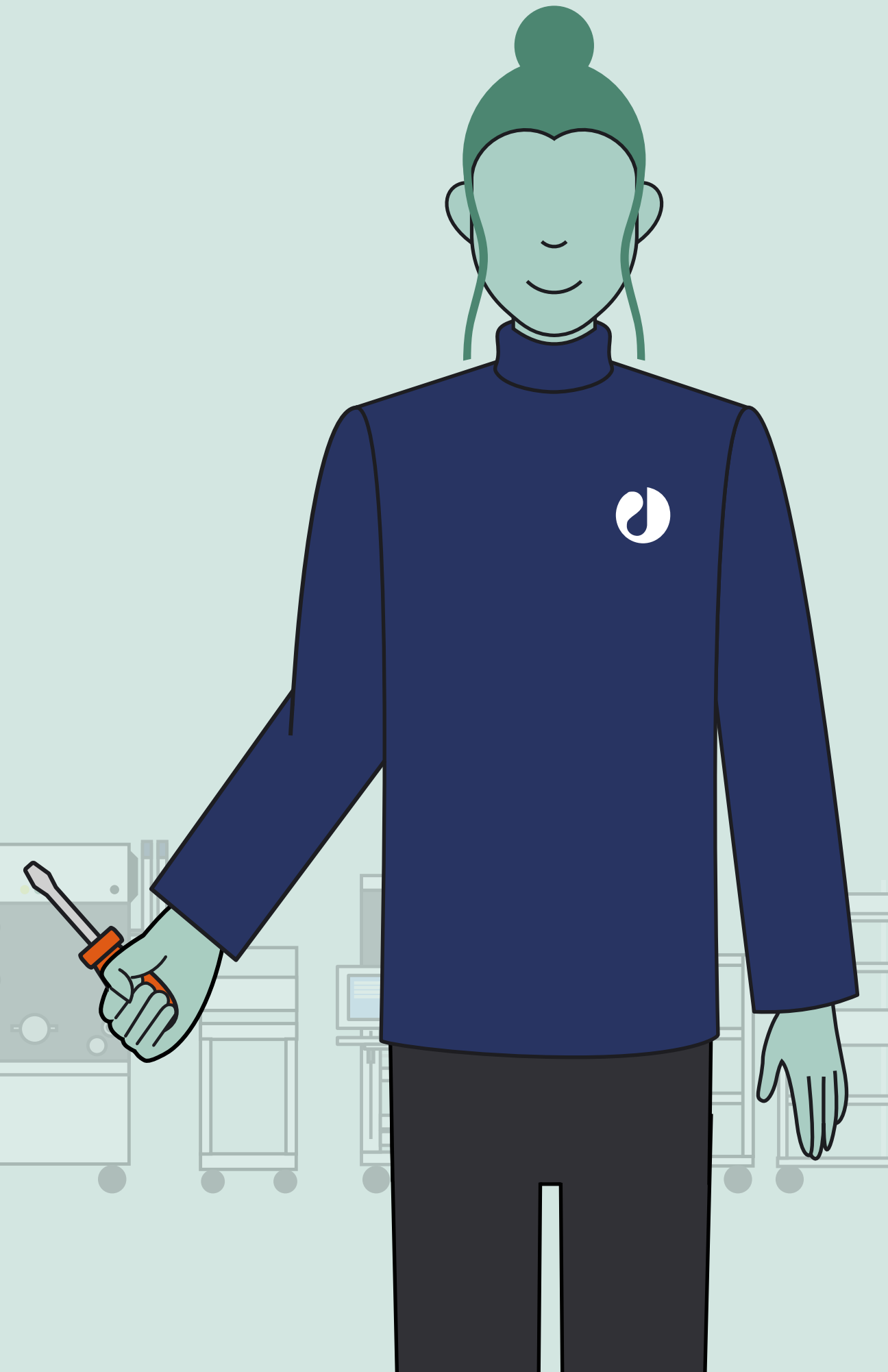


ebook



# Future-proof workflows with preventive maintenance

Maximize equipment uptime, improve cost efficiency, and ensure regulatory compliance

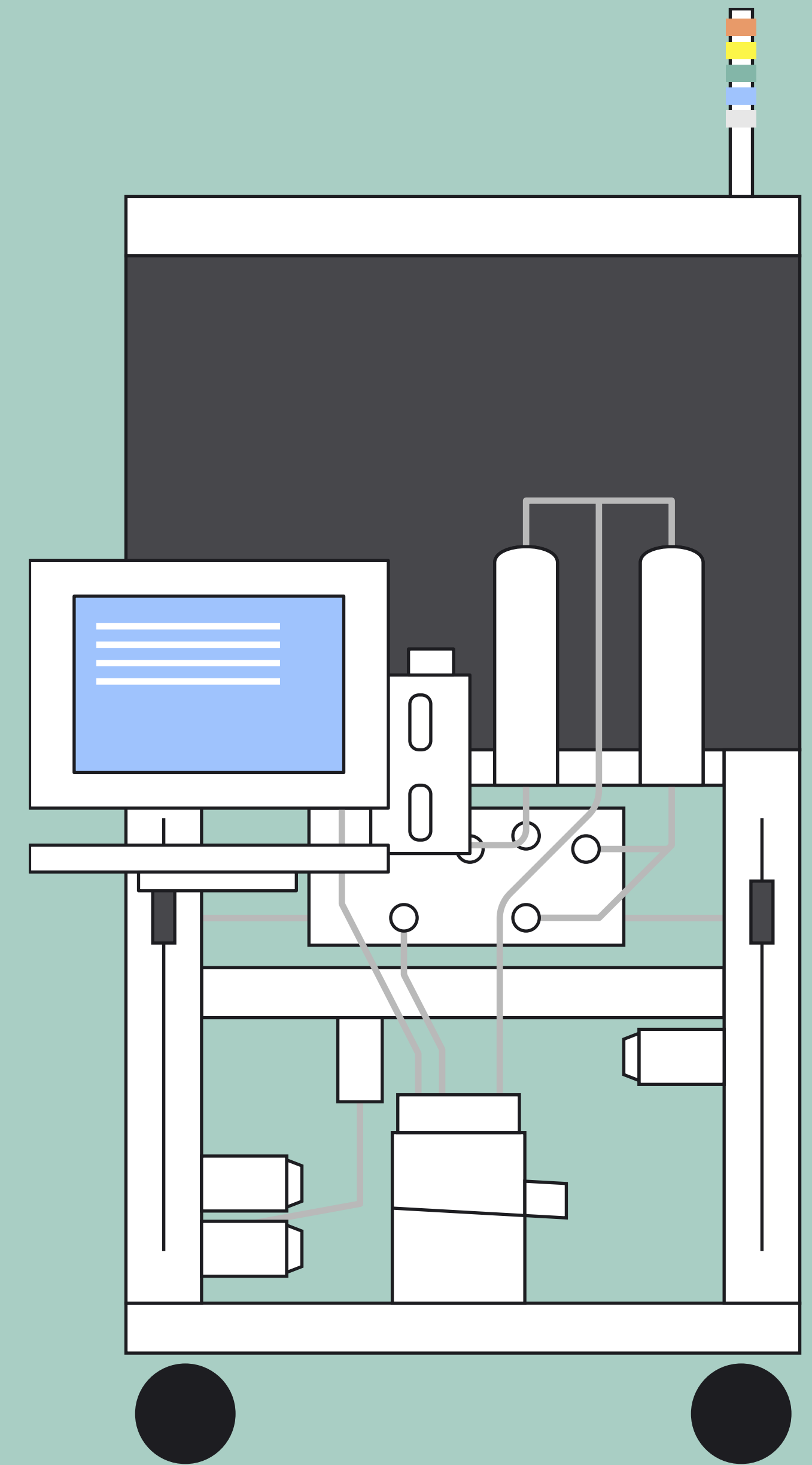
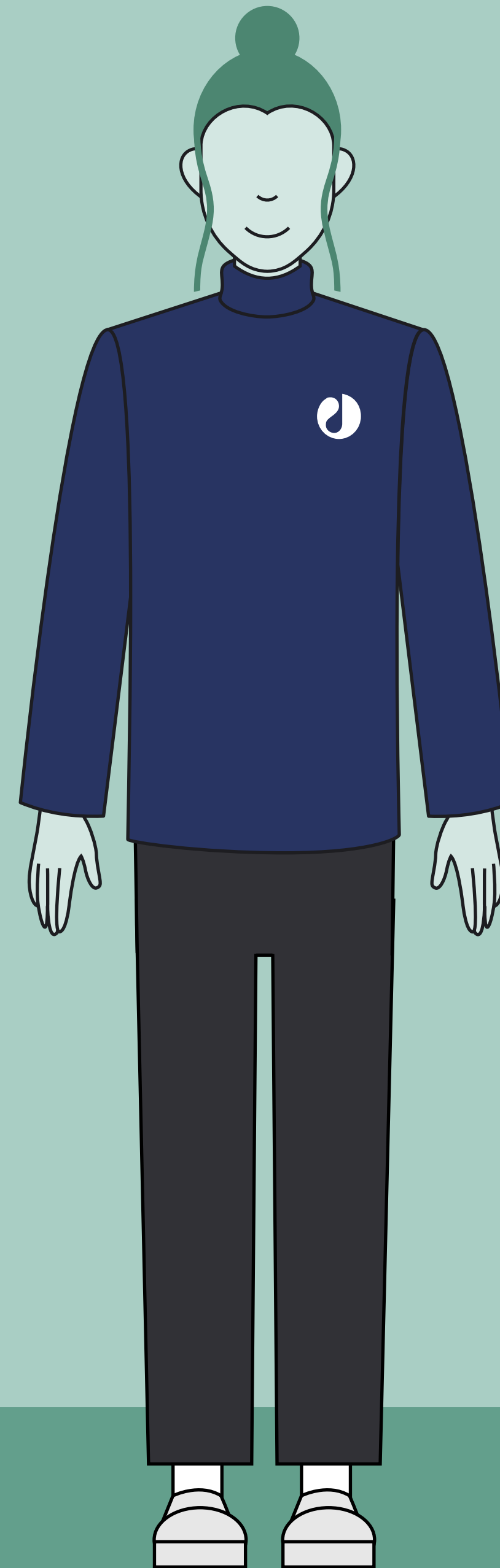


# Introduction

Imagine key bioprocessing equipment fails out of the blue. Your team has to scramble to diagnose the issue, identify and order the required spare parts, and pray they arrive quickly. Because in today's challenging biomanufacturing environment, companies are under increasing pressure to scale manufacturing, all while facing tightening budgets, evolving regulatory expectations, supply chain fragility, and the need to integrate advanced technologies. As resolution times lengthen, you risk compromising batch quality and the costs associated with equipment downtime continue to rise. When reactive equipment maintenance is standard procedure, unexpected failure throws a serious wrench in the works for biomanufacturing operations. The knock-on effects can include jeopardizing product quality and exceeding budgets to risking compliance and delaying production.

That's why preventive maintenance approaches focus on anticipating and resolving problems before they happen. Regular checks, inspections, and technology upgrades help reduce downtime and keep your equipment performing at its best.

In this eBook, we explore why preventive maintenance is essential for your bioprocessing. We delve into ongoing and upcoming challenges for the industry, and how preventive maintenance can help overcome these. You can also find practical tips to help you weave preventive maintenance into your daily operations, ultimately helping you future-proof your workflows.



# Why preventing equipment downtime is more important than ever

Here's a closer look at how current macroeconomic factors are encouraging a move from current reactive or preventive maintenance strategies.

## Economic uncertainty

In recent years, financial pressure has been a large challenge for biomanufacturers. With global political and economic uncertainty, investors are cautious, funding is tighter, and the costs of energy, raw materials, and consumables continue to rise. This means there is little room for error. Equipment downtime or quality issues due to unplanned failures can quickly lead to major financial losses, through lost batches, missed deadlines, and disruptions to business continuity.

A single lost batch wastes substantial investment in materials, labor, and production and testing time. The fallout doesn't stop there, with urgent repairs and emergency engineering callouts further adding to costs and disruption. In many cases, repairing equipment can be prolonged because spare parts or engineers might not be immediately available. Meanwhile, production remains on hold, placing even greater strain on budgets.

Economic pressures can also lead to short-term cost-cutting decisions that only create bigger risks further down the line. Companies may opt for reconditioned or second-hand equipment, but these systems are often less reliable and may lack complete maintenance histories. This increases the likelihood of failure and long-term cost compared to new equipment.

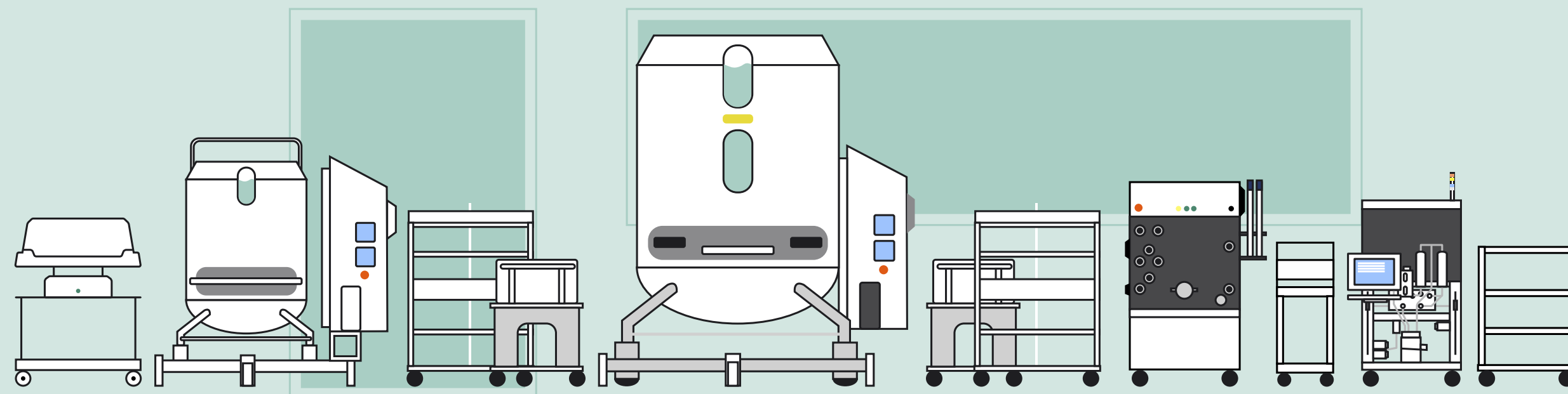
## Evolving regulatory standards

For biomanufacturers working under current good manufacturing practice (cGMP) or other current GxP environments, evolving standards are placing greater emphasis on risk-based approaches and robust data management systems. Regulators now expect manufacturers to anticipate issues before they happen, prioritizing equipment reliability and proactive care. With greater scrutiny on data integrity, traceability, and continuous monitoring, reactive strategies can leave organizations exposed to compliance risks.

## Technological and operational challenges

Advances in bioprocessing technology are bringing new challenges for manufacturers. As systems become more complex, specialist knowledge and training are required to operate and maintain equipment. Problems can take longer to troubleshoot, especially when teams are managing multiple systems and priorities. This means that reactive equipment maintenance approaches are riskier than ever, with added system complexity potentially leading to increased equipment downtime.

Operational challenges can also be a large problem for bioprocessing teams, with fragile supply chains and limited spare parts availability risking prolonged equipment downtime if failure occurs. Custom components may take weeks or even months to manufacture, and global shipping delays can extend this further. Without advance planning and critical parts kept on hand, organizations face extended disruption if essential equipment fails unexpectedly.



# The benefits of shifting from reactive to proactive maintenance

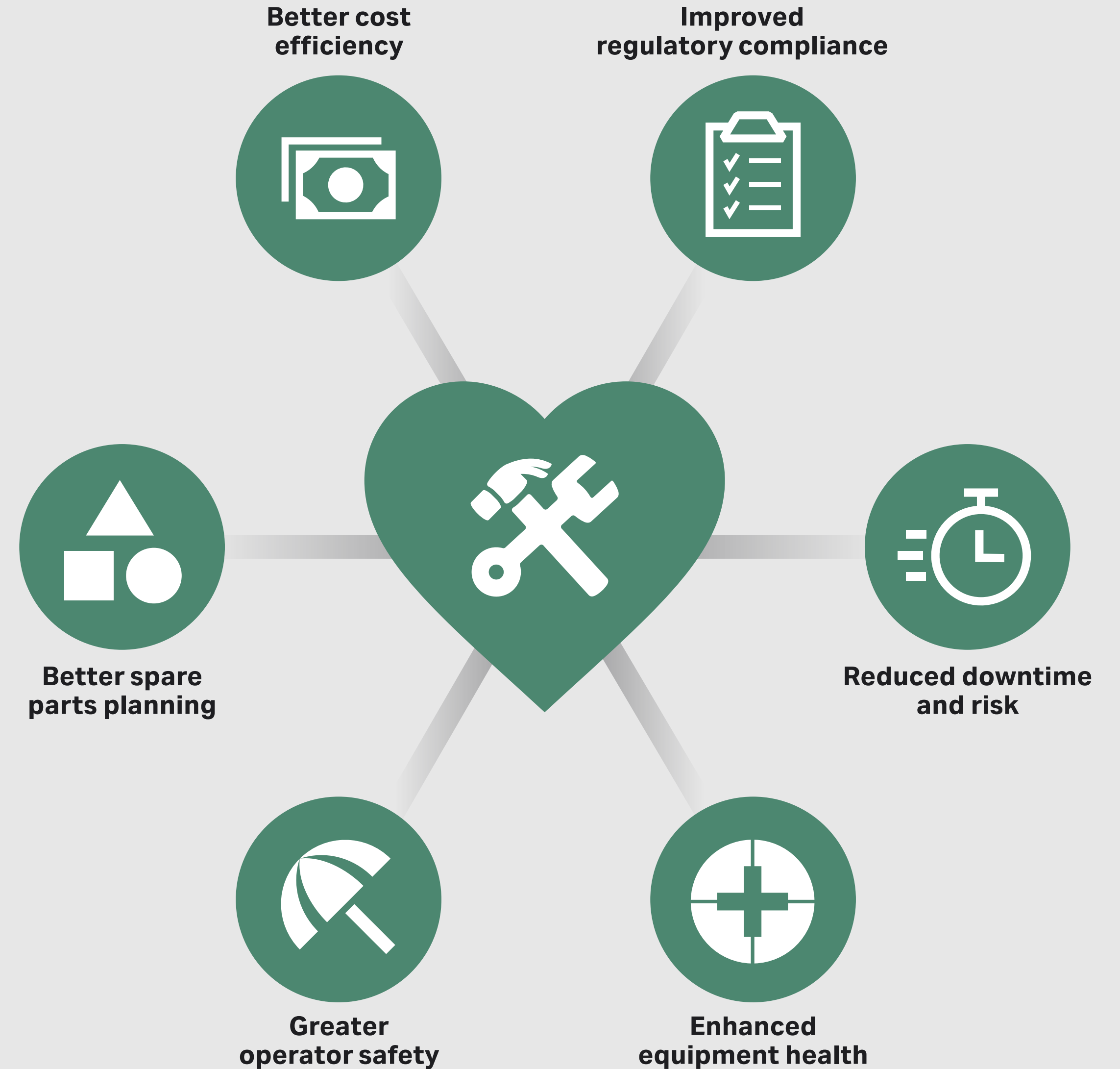
Moving away from traditional corrective maintenance models and switching approaches to proactive, preventive maintenance means servicing and maintenance of the equipment takes place at planned intervals to optimize performance and minimize the risk of breakdowns. Every system has recommended maintenance schedules, and by following these, you can avoid costly repairs and prevent unplanned downtime. Here's an overview of the benefits that proactive maintenance offers:

## Better cost efficiency

Investing in planned maintenance is essential to help prevent the financial losses associated with equipment downtime. Instead of facing unpredictable repair bills, you can plan service costs in advance to reduce financial uncertainty. While it may seem like an additional expense at first, preventive maintenance delivers long-term cost-effectiveness by ensuring equipment continues to perform. Some service providers include preventive maintenance as standard within care packages so if you're signed up with a care package, you avoid the administrative and logistical burden of obtaining separate quotes, raising purchase and work orders and paying invoices as well as additional costs.

## Improved regulatory compliance

Current GMP and other GxP guidelines emphasize proactive quality assurance, where manufacturers are expected not only to react to issues, but to anticipate and prevent them. Preventive maintenance aligns with modern GMP expectations by helping ensure consistent performance, reducing risk, and supporting long-term operational resilience.



## Reduced downtime and risk

Planned servicing to ensure equipment performs at its best lowers the risk of sudden equipment failure, helping to prevent costly delays in testing and manufacturing. By making downtime predictable and manageable, maintenance can be scheduled during planned breaks rather than disrupting production. This results in shorter interruptions, more effective fixes, and faster recovery.

## Enhanced equipment health

Regular servicing ensures that systems continue to operate within manufacturer specifications. This not only supports process efficiency but also improves overall equipment reliability, as equipment that is consistently maintained runs more smoothly, lasts longer, and contributes to ongoing savings across its lifecycle.

## Greater operator safety

Preventive maintenance supports crucial workplace safety. Constant throughput and heavy use can lead to wear, unvalidated modifications, and an increased risk of operator injury. Scheduled maintenance with a certified service engineer verifies the functionality of safety systems, such as interlocks and alarms, giving you confidence that your equipment is operating safely and reducing injuries.

## Better spare parts planning

Preventive maintenance makes it easier to anticipate which components are nearing the end of their lifecycle and plan replacements in advance. This way, you can ensure critical spare parts are available on site at the right time, avoiding the scramble for costly emergency shipments, or the temptation to use alternatives that may jeopardize quality and compliance.



# Integrating predictive and prescriptive maintenance

Over the last decade, the bioprocessing industry has steadily been adopting Industry 4.0 technologies. This includes the integration of artificial intelligence (AI), automation, the Internet of Things (IoT), big data, and machine learning (ML) – all of which are creating smarter, more connected operations. For bioprocessing, this means it is now possible to remotely monitor equipment, automate routine tasks, and analyze performance data in real time, helping to make more informed decisions that optimize production.

These technological advances have paved the way for predictive maintenance (PdM) and prescriptive maintenance (RxM) models, which allow you to not only prevent equipment failures but also anticipate and respond to them quickly and efficiently. This type of digital maintenance solution offers a more cost-effective service, swiftly resolving equipment issues and ensuring a rapid return to uptime.

## Predictive maintenance (PdM)

This strategy uses the IoT, which is a vast network of connected sensors and devices that collect and share data in real time. In a bioprocessing environment, sensors are built into equipment to monitor parameters such as vibration, temperature, pressure, and flow. Instead of relying on periodic manual checks, IoT provides a continuous stream of performance data.

These data can then be analyzed using AI and ML to spot patterns that indicate early signs of wear or performance decline. Using advanced techniques such as regression, decision trees, and neural networks, ML models can predict when a failure is likely to occur. This allows issues to be addressed long before they escalate, and sometimes even remotely, and downtime can be scheduled around production needs.

## Prescriptive maintenance (RxM)

Prescriptive maintenance goes beyond predicting when a failure might happen. It analyzes equipment condition and operating data to recommend the best actions to reduce risk and extend asset life. For example, while predictive maintenance might forecast when a bearing will fail, prescriptive maintenance can suggest lowering equipment speed or adjusting operating conditions to delay that failure until a planned shutdown.

Prescriptive analytics is central to RxM. As the ability to collect equipment data increases, the complexity of analysis also grows. Prescriptive analytics uses algorithms and AI to explore multiple “what-if” scenarios and simulate their outcomes without disrupting live operations. This gives maintenance teams a range of options, from adjusting parameters to scheduling interventions, along with the likely consequences of each. By presenting clear trade-offs, prescriptive maintenance enables you to make more informed, proactive, and cost-effective decisions. Remote monitoring in this way can also empower your in-house teams, by giving them the data and guidance to resolve many issues themselves without relying on external engineers.

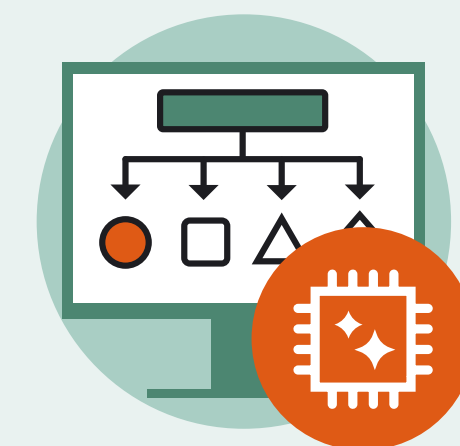
You can learn more about predictive and prescriptive maintenance strategies in our [blog](#).



**Preventive maintenance**



**Predictive maintenance**



**Prescriptive maintenance**

# Tips for successful preventive maintenance

Transitioning from reactive to proactive maintenance is not achieved through technology alone. It requires embedding a structured approach into your daily operations, combining digital tools, skilled personnel, and disciplined processes. Here are our top tips to help you optimize your preventive maintenance and future-proof your bioprocessing workflows.

## 1 Develop a proactive maintenance model supported by digital technologies

Build your maintenance strategy around remote monitoring approaches such as predictive and prescriptive maintenance. Use tools such as IoT, AI, ML, and automation to reduce downtime and improve the efficiency and long-term resilience of your processes.

## 2 Provide continuous training for staff

Ensure maintenance staff receive training that equips them to carry out preventive tasks confidently and consistently. Training should always be updated when equipment changes, upgrades, or process modifications occur. Regular refreshers can help maintain knowledge and reduce reliance on external engineers, whilst building long-term capability within your teams.

## CHECKLIST

- 1  **Develop a proactive maintenance model supported by digital technologies**  
Build your strategy around remote monitoring approaches
- 2  **Provide continuous training for staff**  
Training that equips team members to carry out preventive tasks confidently and consistently
- 3  **Establish a maintenance calendar**  
Create a calendar of daily, weekly, monthly, and annual activities with defined preventive maintenance included
  - Daily**  
Visual inspections, fluid level checks, sensor status confirmation.
  - Weekly**  
Functional tests, alarm log review, cleaning of key components.
  - Monthly**  
Sensor calibration, diagnostic testing, system performance review.
  - Annually**  
Comprehensive servicing, software updates, requalification as required.
- 4  **Follow manufacturer guidelines**  
Align preventive maintenance with OEM guidelines.
- 5  **Leverage OEM expertise**  
Leverage certified service engineers, and genuine OEM parts.

### 3 Establish a maintenance calendar

Preventive maintenance must be systematic. You should create a calendar of daily, weekly, monthly, and annual activities. These should of course be tailored to each system, and regular maintenance tasks may include:

**Daily:** visual inspections, fluid level checks, and confirmation of sensor status.

**Weekly:** functional tests, review of alarm logs, and cleaning of key components.

**Monthly:** calibration of sensors, diagnostic testing, and review of system performance data.

**Annually:** comprehensive servicing, software updates, and requalification as required.

Assigning clear responsibilities for each activity and tracking completion in a centralized system ensures preventive tasks are completed consistently and documented for audit purposes.

### 4 Follow manufacturer guidelines

Preventive maintenance schedules should always be aligned with Original Equipment Manufacturer (OEM) guidelines. These are based on a strong knowledge of system design and are essential for maintaining validated equipment statuses in GMP environments. Deviating from these recommendations risks compromising performance, voiding warranties, and raising compliance concerns. Embedding OEM guidelines into maintenance SOPs ensures teams follow best practices and remain inspection-ready.

### 5 Leverage OEM expertise

Work with the OEM to take advantage of their deep product expertise and certified service engineers. They can provide advance notice of when components are likely to need replacement, allowing you to order spare parts proactively and avoid delays. OEMs also offer training to equip your in-house teams with the knowledge and skills to maintain equipment and ensure systems run smoothly. Always use genuine OEM parts, as third-party alternatives may compromise quality, compliance, and performance.

**Maintenance calendar for my ÄKTA™ system**


	Weekly	Monthly	6 mo	PM <sup>1</sup>	Notes	Date	Signature
Changed pump-rinsing solution	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Calibrated pressure sensors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Fraction collector washed and sensors wiped off	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Replaced online filter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Inspected valves for leakage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Replaced buffer inlet filters	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Cleaned UV cell	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
Replaced pH electrode	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
PM performed by Cytiva representative	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			
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<sup>1</sup> PM = preventive maintenance

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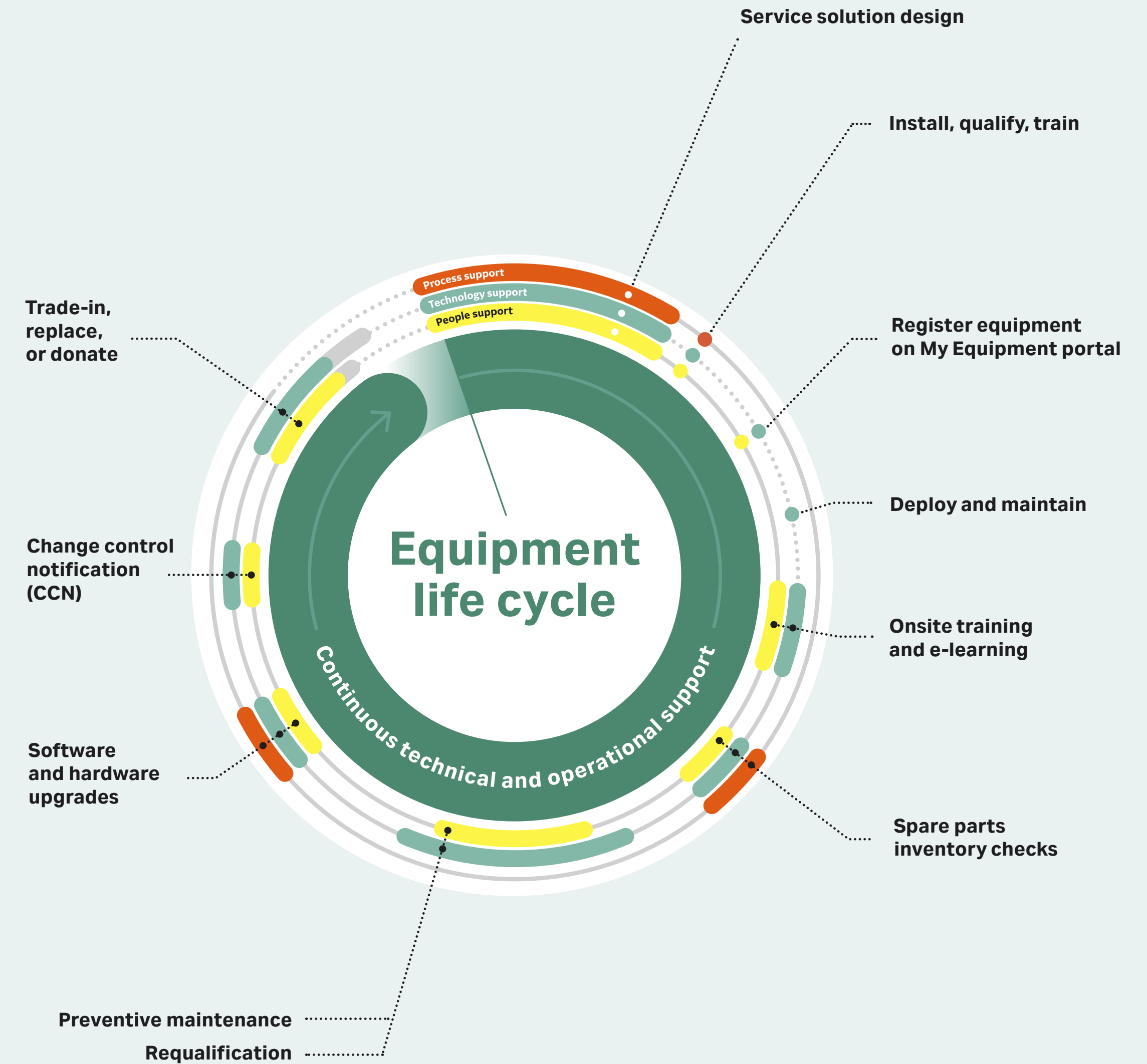
# Summary

Preventive maintenance is essential in today's demanding bioprocessing workflows, as pressures rise and facility managers look for more cost-effective and future-proof solutions. Reliable equipment performance keeps products on schedule, protects quality, and prevents unnecessary disruption. It also helps equipment last longer, keeps costs under control, supports compliance, and makes day-to-day operations run more smoothly. Given these wide-ranging benefits, shifting from reactive to proactive preventive maintenance is a real no-brainer!

The key to shifting from preventing failures to proactively managing them is digital technologies. Predictive and prescriptive maintenance, enabled by advanced digital technologies, turn maintenance into a data-driven process that anticipates issues and guides precise interventions. This approach can significantly optimize the efficiency and stability of your bioprocessing workflows.

Our service solutions are built to support your preventive maintenance needs and help keep your biomanufacturing equipment performing at its best throughout its lifecycle. We offer flexible service contracts that include preventive maintenance visits, tailored training to keep your teams operating the equipment effectively, and the support of our global network of more than 800 specialists to help overcome more complex failures should they occur.

Learn more about our equipment service solutions [here](#).





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