Hygienic Design Best Practices

A Technical Brief and Practical Guide

Prepared by Kodiak Process & Installation

Executive Summary

Hygienic design plays a critical role in safe, efficient, and reliable process operations. Whether producing food, beverages, pharmaceuticals, personal care products, or other sensitive materials, facilities depend on equipment and systems that are easy to clean, resistant to contamination, and built for long-term performance.

Poorly designed equipment can create hidden risks. Product buildup, difficult-to-clean surfaces, improper drainage, hard-to-access components, and dead zones can all contribute to contamination, downtime, and unnecessary maintenance. By applying hygienic design best practices early in the design, installation, and operation of a system, manufacturers can improve product safety, simplify cleaning, reduce waste, and support consistent production.

At Kodiak Process, we believe hygienic design is not just about meeting requirements. It is about creating smarter systems that help teams work safely, efficiently, and confidently.

Why Hygienic Design Matters

In a process environment, every surface, seal, fitting, valve, pump, and connection can affect cleanability. If equipment is difficult to clean or inspect, residues may remain in place after production or cleaning cycles. Over time, these residues can increase the risk of microbial growth, allergen cross-contact, product quality issues, and unplanned shutdowns.

A strong hygienic design approach helps manufacturers:

- Reduce contamination risks
- Improve cleaning effectiveness
- Support regulatory and quality expectations
- Minimize downtime between production runs
- Extend equipment life
- Improve worker access and maintenance efficiency
- Protect product integrity and brand reputation

Rev 01 06/25/2026

The most successful hygienic systems are designed with the full process in mind. That means considering product characteristics, cleaning methods, flow paths, materials, utilities, maintenance needs, and operator access before equipment is installed.

Core Principles of Hygienic Design

Cleanability

Equipment should be designed so that product-contact surfaces can be cleaned effectively and consistently. This includes eliminating hard-to-reach areas, unnecessary crevices, sharp corners, and surfaces that can trap product.

Cleanability should be considered for both manual cleaning and automated clean-in-place systems. If equipment cannot be cleaned thoroughly, it can create ongoing operational and safety challenges.

Proper Material Selection

Materials must be compatible with the product, cleaning chemicals, temperature, pressure, and operating environment. Stainless steel is commonly used in hygienic applications because of its durability, corrosion resistance, and cleanability.

Gaskets, seals, elastomers, and plastics should also be carefully selected. These components must withstand repeated exposure to cleaning agents, process conditions, and mechanical stress without degrading or creating contamination risks.

Smooth Product-Contact Surfaces

Surface finish has a direct impact on cleanability. Rough surfaces, scratches, pits, and poor welds can hold product residue and make cleaning less effective. Smooth, properly finished surfaces help reduce buildup and support repeatable cleaning results.

Weld quality is especially important. Welds should be smooth, continuous, and free from cracks, pits, or crevices that may trap product.

Drainability

Hygienic systems should be designed to drain completely whenever possible. Standing liquid can create contamination risk, reduce cleaning effectiveness, and contribute to corrosion or microbial growth.

Proper slope, equipment orientation, and connection layout all help improve drainage. Pumps, tanks, valves, piping, and instruments should be reviewed as part of the full system, not only as individual components.

Rev 01 06/25/2026

Elimination of Dead Zones

Dead zones occur where product, cleaning solution, or rinse water does not move effectively through the system. These areas may be found around poorly placed fittings, oversized branches, unused ports, or improper valve configurations.

Reducing dead zones improves flow, cleaning coverage, and process consistency.

Accessibility for Inspection and Maintenance

Even well-designed equipment needs regular inspection and maintenance. Hygienic systems should allow operators and maintenance teams to access key components safely and efficiently.

This includes access to pumps, valves, seals, spray devices, strainers, instruments, and removable parts. When equipment is difficult to access, inspections may be delayed, cleaning may be less effective, and maintenance may take longer than necessary.

Compatibility with Cleaning Methods

The system should be designed around the intended cleaning method. Clean-in-place, clean-out-of-place, manual cleaning, sanitization, and sterilization all have different design requirements.

For clean-in-place systems, flow rate, turbulence, temperature, chemical concentration, contact time, spray coverage, and drainability must all be considered. A hygienic system is only effective when the equipment design and cleaning process work together.

Common Hygienic Design Challenges

Many hygienic design problems are not caused by one major failure. They often come from small details that add up over time.

Common issues include:

- Poorly drained piping or equipment
- Dead legs or unused branches
- Incompatible gasket or seal materials
- Rough or damaged product-contact surfaces
- Threaded connections in product-contact areas
- Hard-to-clean valve assemblies
- Instruments installed in areas with poor flow
- Improperly designed spray coverage in tanks
- Equipment placed too close to walls or other machinery

Rev 01 06/25/2026

- Inadequate access for inspection or maintenance

These challenges can often be prevented by reviewing hygienic design requirements during the planning and engineering stages rather than after installation.

Best Practices for Implementation

Start with a Risk-Based Review

Every product and process has different risks. A low-viscosity beverage, a high-fat food product, a pharmaceutical ingredient, and a personal care formulation may all require different design considerations.

A risk-based review should consider:

- Product sensitivity
- Microbial risk
- Allergen risk
- Cleaning requirements
- Temperature and pressure conditions
- Product viscosity and flow behavior
- Changeover frequency
- Maintenance needs
- Regulatory or customer expectations

This review helps define the right level of hygienic design for the application.

Design the System as a Whole

Hygienic performance depends on the full process system. A sanitary pump or valve cannot overcome poor piping layout, inadequate drainage, or insufficient cleaning coverage.

The best results come from reviewing the entire process path, including:

- Raw material receiving
- Storage tanks
- Transfer lines
- Pumps
- Valves
- Heat exchangers
- Mixers
- Fillers

Rev 01 06/25/2026

- Instrumentation
- Utility connections
- Cleaning systems

Each component should support the overall hygienic goal.

Choose Components Carefully

Selecting hygienic components is not only about choosing sanitary-rated equipment. Components should match the product, process, cleaning method, and maintenance strategy.

Key considerations include:

- Material compatibility
- Seal and gasket design
- Surface finish
- Drainability
- Ease of disassembly
- CIP compatibility
- Documentation and traceability
- Availability of replacement parts
- Reliable component selection can reduce downtime and make cleaning and maintenance more predictable.
- Plan for Cleaning Verification

Cleaning should be repeatable and measurable. Depending on the process, verification may include visual inspection, ATP testing, microbiological testing, conductivity monitoring, temperature records, chemical concentration checks, or other quality controls.

Designing for verification helps teams confirm that cleaning procedures are working as intended.

Involve Operations and Maintenance Early

Operators and maintenance teams understand how equipment performs in real conditions. Their input can help identify access issues, cleaning challenges, changeover concerns, and maintenance risks before installation.

Early collaboration can prevent costly modifications and improve long-term system performance.

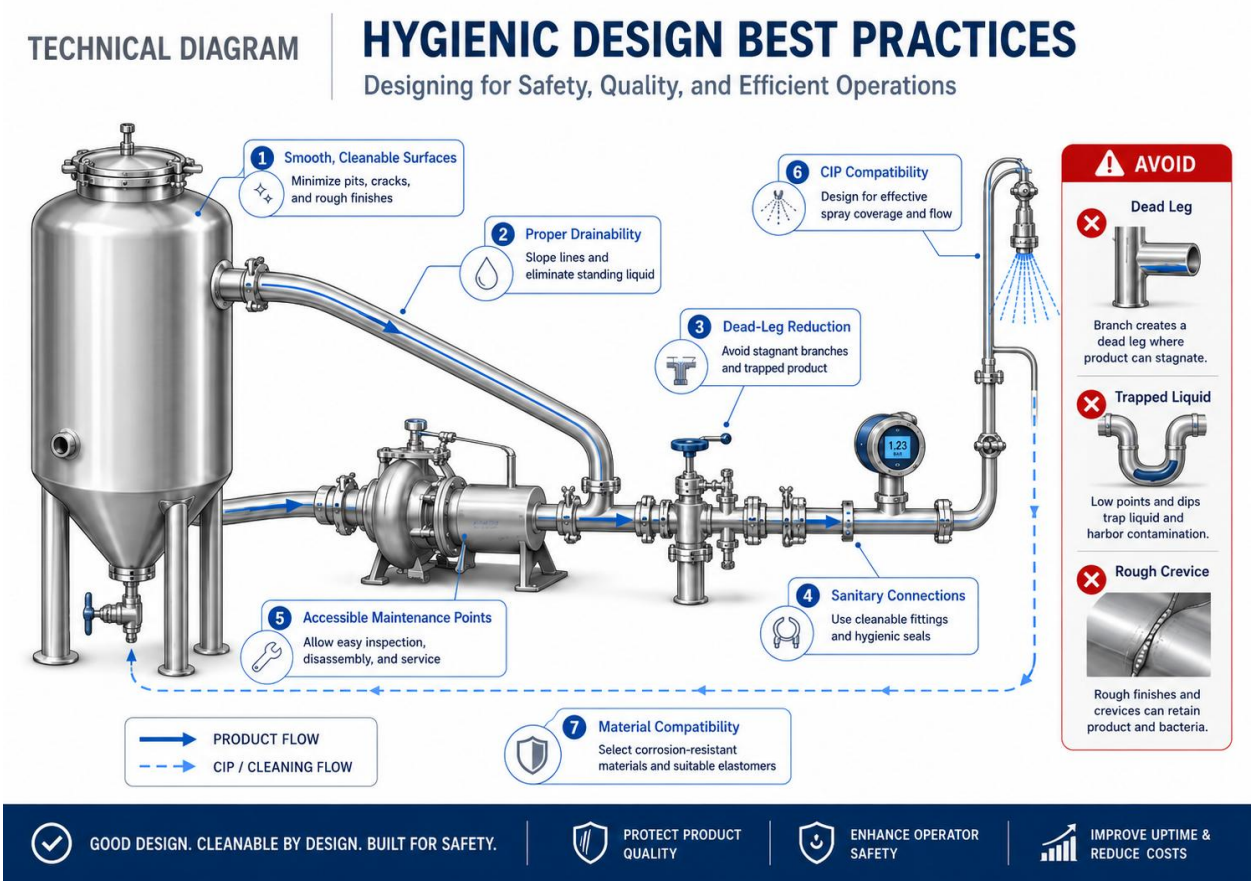
Rev 01 06/25/2026

Practical Hygienic Design Checklist

Before finalizing a process system, teams should ask:

- Can all product-contact surfaces be effectively cleaned?
- Does the system drain properly?
- Are there any dead zones or unused branches?
- Are materials compatible with the product and cleaning chemicals?
- Are welds and surface finishes appropriate for the application?
- Can operators safely inspect and maintain the equipment?
- Are valves, pumps, and instruments installed in cleanable locations?
- Does the system support the intended cleaning method?
- Are gaskets, seals, and elastomers suitable for repeated use?
- Is documentation available for critical components?
- Has the complete process path been reviewed, not just individual pieces of equipment?

This checklist can help teams identify potential issues before they become production problems.



Rev 01 06/25/2026

The Business Value of Hygienic Design

Hygienic design supports more than product safety. It can also improve operational efficiency.

When systems are easier to clean and maintain, facilities can reduce cleaning time, improve changeover speed, lower water and chemical use, and reduce the risk of unplanned downtime. Better design can also help extend equipment life and improve consistency from batch to batch.

In many cases, the cost of addressing hygienic design during the planning stage is far lower than correcting problems after installation. A well-designed system helps protect people, products, and profitability.

Conclusion

Hygienic design is a foundation for safer and more efficient processing. By focusing on cleanability, material selection, surface finish, drainage, accessibility, and cleaning compatibility, manufacturers can reduce risk and improve long-term performance.

Kodiak Process helps customers evaluate, select, and implement process solutions that support hygienic operation from the start. With the right design approach, teams can build systems that are easier to clean, easier to maintain, and better prepared for the demands of modern production.

About Kodiak Process

Kodiak Process specializes in sanitary process design, fabrication, and installation for food and beverage facilities—building systems that prioritize cleanability, uptime, and long-term reliability. Contact us at info@kodiakprocess.com or visit us at www.kodiakprocess.com.

Rev 01 06/25/2026