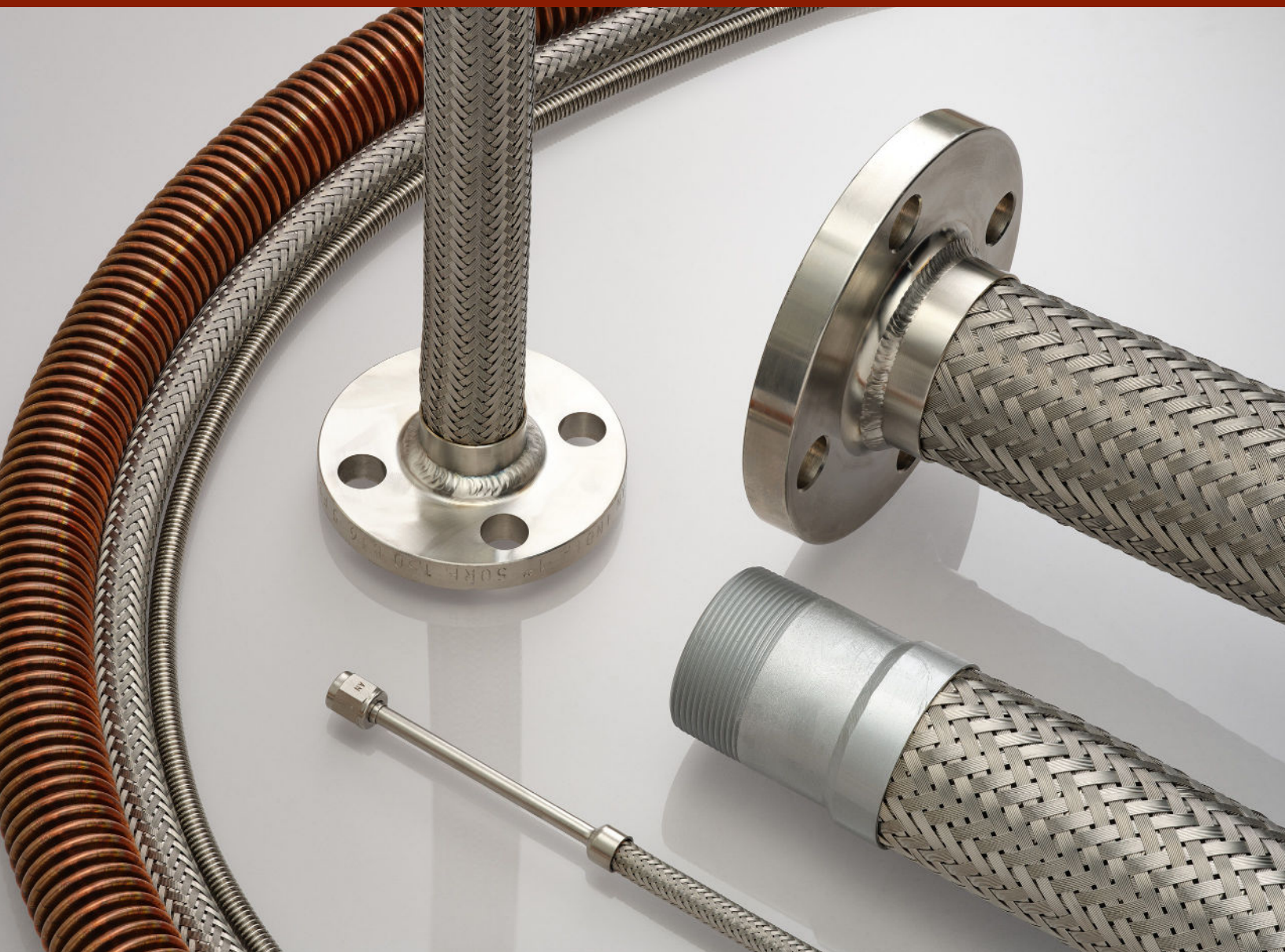


METAL HOSE SOLUTIONS FOR SEMICONDUCTOR SYSTEMS

Flexible metal hose assemblies combine the corrosion resistance and strength of stainless steel with leak-tight construction to create clean, easy-to-route solutions for high-purity gas, process chemical, and cooling systems.



METAL HOSE SOLUTIONS

Where pipe is rigid, hoses bend.
While polymers are permeable, metal is non-porous.

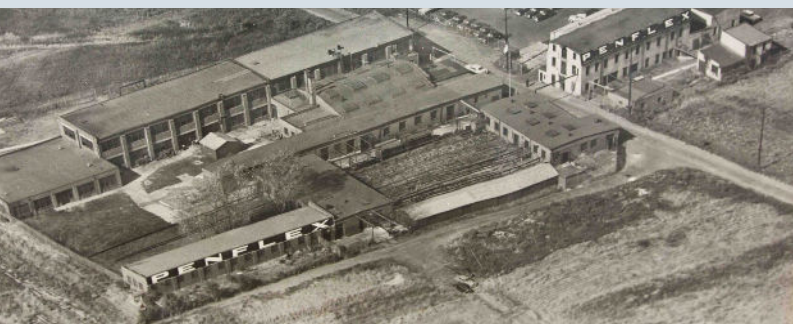
What problems does metal hose solve?	3
Corrosion resistance for longer service life	4
Cleanliness for high-purity applications	5
Leak-tight construction for critical systems	6
Partnering with Penflex	7

About Penflex

Precision, cleanliness, and reliability define semiconductor manufacturing environments. Every piece of equipment and each component must support strict contamination control and perform consistently under demanding operating conditions.

Flexible metal hose may not originate in semiconductor manufacturing, but the engineering principles that govern its performance—material compatibility, leak integrity, and operation within design limits—are universal. With more than a century of experience designing and manufacturing metal hose assemblies, Penflex understands how these components behave in challenging environments across industries ranging from chemical processing to cryogenics.

Founded in 1902, Penflex is an ISO 9001-certified manufacturer with headquarters and production based in Gilbertsville, PA. We also maintain a warehouse in Houston, TX and a second manufacturing facility in Ho Chi Minh City, Vietnam. Our ASME Section IX-certified weld shop and non-destructive testing capabilities ensure every assembly meets rigorous quality and performance standards.



Our role is simple: to help engineers and system designers understand how flexible metal hose can improve reliability, safety, and service life in semiconductor systems, and to deliver the expertise and products needed to make those solutions work.

PART 1:

What problems does metal hose solve?

When considering the application requirements, operating environment, and performance expectations in semiconductor manufacturing, there are a lot of things that can go wrong. High-purity gases can degrade. Aggressive chemicals can corrode. Cleaning agents can leave a residue. Some processes require high temperatures, others high pressures, while still others operate in a vacuum. Even small leaks or trace contaminants can impact wafer yield and equipment uptime.

Thus, an equal number of things must go right to avoid problems that lead to unplanned downtime and associated financial, logistical, and reputational costs. Managing these risks starts with the components that connect critical systems and transport process media. Metal hose assemblies are a flexible, durable solution for safely transporting the gases and fluids in semiconductor manufacturing systems.

Metal hose solves problems caused by:

- Corrosive media
- Contamination
- Gas permeation
- Elevated temperatures
- Cryogenic temperatures
- High working pressures
- Thermal expansion
- Dynamic system movement
- Vibration
- Misalignment



PART 2:

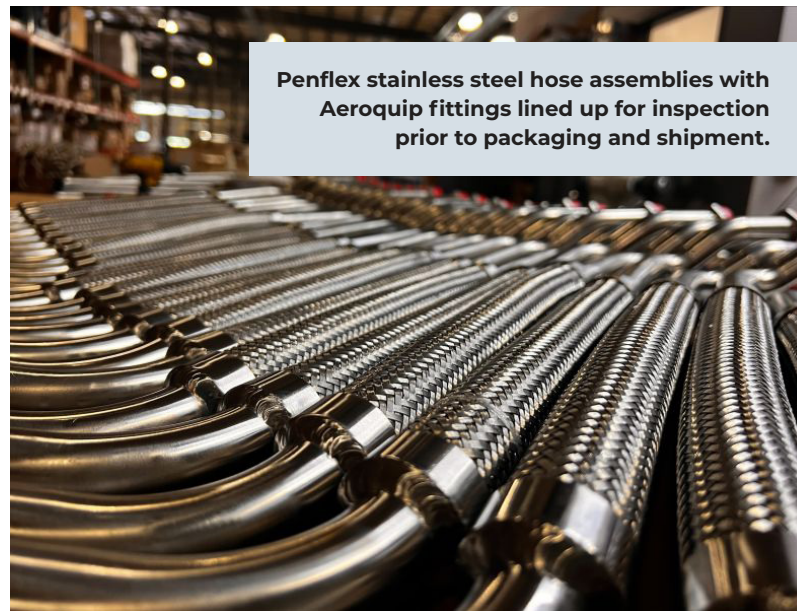
Corrosion resistance for aggressive applications

Materials engineered for semiconductor chemicals and gases

Semiconductor manufacturing systems routinely transport reactive gases and chemicals for etching, deposition, and chamber cleaning. Materials used in these systems must withstand prolonged exposure to aggressive media while maintaining structural integrity.

Flexible metal hoses made from 316L and 321 austenitic stainless steel provide strong corrosion resistance in these environments. They are compatible with many fluorine-containing gases commonly used in semiconductor processes, including hydrogen fluoride (HF), nitrogen trifluoride (NF₃), sulfur hexafluoride (SF₆), and tungsten hexafluoride (WF₆). As corrosion progresses more slowly in corrosion-resistant stainless steel alloys, system operators can expect longer life in service with metal hose than with hoses made from alternative materials.

Chemical compatibility is only one part of the equation. Engineers must also account for wall thickness and operating conditions when designing reliable fluid conveyance systems. Higher temperatures, elevated pressures, and repeated mechanical stresses can accelerate corrosion mechanisms and material fatigue. Selecting appropriate materials and construction helps ensure metal hose assemblies maintain performance under these demanding conditions.



Penflex stainless steel hose assemblies with Aeroquip fittings lined up for inspection prior to packaging and shipment.

Stainless steel advantage: Non-porous material

Semiconductor process gases can lose effectiveness when evaporation occurs or when exposed to even trace contamination that alters their chemical composition. Unlike polymer-based materials, stainless steel is non-porous. Metal hose assemblies create a secure barrier that prevents gases from permeating the hose wall while also protecting the system from external contaminants.

PART 3:

Cleanliness for high-purity applications

Products and processes designed to minimize contamination

Traditional hose manufacturing methods can introduce moisture, oils, or lubricants that must later be removed through time-consuming post-production cleaning procedures. Penflex Clean ID hose is produced using an innovative mechanical forming process that eliminates internal tooling and lubrication, producing a hose with a truly clean inside.

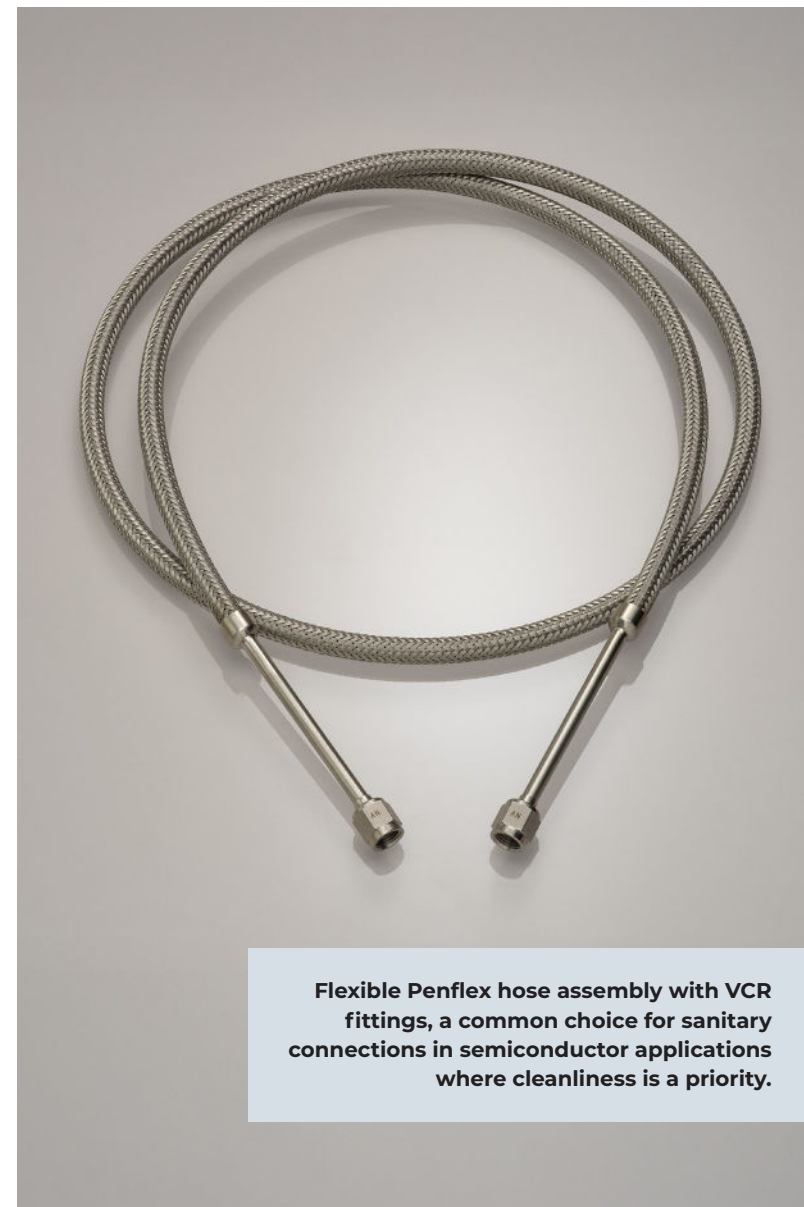
Key benefits

- No moisture, oils, grease, or particulate introduced during forming
- Eliminates many post-production cleaning steps
- Reduces risk of contamination
- Enables faster and more reliable leak testing
- Supports shorter lead times and streamlined supply chains

Case study: Clean ID drives more efficient operations

One leading US manufacturer of cryogenic coolers found that switching to Clean ID allowed them to eliminate a time-consuming cleaning process, meaning hoses could be installed sooner and the team of five responsible for cleaning the inside of the hoses was reassigned to other production tasks.

For semiconductor equipment manufacturers, the benefit is straightforward: components that arrive ready for installation, reducing preparation steps, minimizing contamination risk, and helping accelerate system assembly.



Flexible Penflex hose assembly with VCR fittings, a common choice for sanitary connections in semiconductor applications where cleanliness is a priority.

PART 4:

Leak-tight construction for critical systems

Reliable containment for process gases and cooling fluids

Leak prevention is critical in semiconductor manufacturing systems where gases, chemicals, and cooling fluids must be transported safely and reliably. Penflex hose assemblies are designed to deliver leak-tight performance under demanding operating conditions.

Quality welds

High-quality welds are essential to hose integrity and long-term performance, especially in semiconductor fabs. At Penflex, this is achieved through a proven process that includes TIG welding and argon purging, producing clean, strong welds without compromising corrosion resistance. Our team includes ASME Section IX-certified welders, on-site certified welding instructors, and non-destructive examination (NDE) specialists, ensuring every assembly meets strict quality standards before leaving our facility.

Leak testing

Each hose assembly destined for semiconductor manufacturing applications undergoes our standard air-under-water leak test. When required, more sensitive methods are used. Helium mass spectrometry, our most sensitive testing method, can detect leaks as small as 10^{-12} cubic centimeters per second.

Leak-tight assemblies help protect equipment, maintain system safety, and support consistent production.



All Penflex assembly welds are performed by ASME Section IX welders to rigorous quality standards.



All sanitary hoses are individually sealed and bagged to prevent contamination post leak testing and cleaning.

PART 5:

Partnering with Penflex

Supporting OEMs and EPC/MEP teams in developing and installing semiconductor systems

In addition to supplying reliable system components, Penflex partners with equipment manufacturers, engineering firms, and construction teams throughout semiconductor system design and fab build-out. EPC and MEP providers must integrate process equipment, facility utilities, and cleanroom requirements into a cohesive, high-purity environment. It's a complex task, and fluid conveyance is not always a core discipline within these firms.

Many organizations rely on suppliers like Penflex to provide products, services, and expertise in specialized areas. Successful semiconductor system design and fab construction projects depend on suppliers who can augment internal capabilities while providing consistent documentation, traceability, and installation guidance.

Our customers count on us not only for quality products, but also for expertise, responsive service, and resources to help them get the most out of their investment.

- **Dedicated Engineering Support:** Account managers work closely with customers from project prototype through delivery, helping define requirements for new products and replacements.
- **Practical Technical Resources:** From online calculators and engineering bulletins to training, we give users the confidence to install, operate, and maintain hoses for maximum longevity.
- **Full Quality Documentation:** Complete record packs—with MTRs, leak and pressure test results, and cleaning procedure documentation—support full traceability.



Metal hose assemblies are commonly used in:

High-purity gas delivery systems

Chemical supply and return lines

Hot air extraction processes

Cooling circuits

Thermal management systems

Vacuum and cryogenic systems

