CARDINAL UHP

AMETEK®
THERMAL PROCESS MANAGEMENT

From concept to reality

Cardinal UHP has been supplying a variety of industries with specialty piping components and services for over 20 years. We introduced multiple best practice methods that are now recognized as industry standards.

Cardinal continues to supply the finest in ultra high purity fittings and piping components to manufacturers and industries requiring critically pure production systems. We also supply a wide range of tubing and specialty services for other markets including medical, food processing, biotechnology, pharmaceutical, semiconductor, and telecommunication.

Our ISO 9001 quality system begins with the specifications for raw materials and continues through to packaging, delivery and support of the finished product.

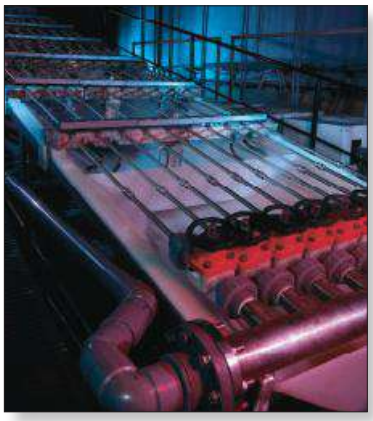
Quality starts with a finished product specification. To meet customer needs Cardinal UHP offers products to a variety of material and finish specifications with various levels of documentation.

Raw material specifications are developed to provide the lowest cost product that meets or exceeds the finish and elemental specification. Extensive inspection of the raw material insures a finished product that meets the specified requirements.

Mechanically polishing fittings after bending and welding provides an excellent base for the final electropolishing and passivation steps.

Controlled electropolishing and passivation provide a smooth, clean and chromium enriched corrosion resistant surface. The finished product is cleaned one last time in our ISO Class 4 clean room, tested and packaged according to specification before it is ready to ship.

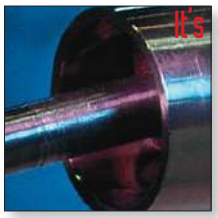
It is our consistent attention to detail at all phases from commercial review to manufacturing and sales support that turn a concept of quality into reality.



the raw material

Although traditional tubing materials like copper are adequate for some high purity applications, the material of choice in the semiconductor and biopharmaceutical markets is 316L stainless steel.

Readily available, 316L is a low carbon steel alloy, attractive because of its good weldability and inherent corrosion resistance. However, commercially available 316L may contain impurities in the form of trapped gases and non-metallic inclusions. To prevent this from becoming a problem for our customer, we select only specific grades of 316L and purchase materials to our own specifications. Cardinal UHP produces ultra high purity tubing from many materials



It's about reliability.

besides 316L. For example, we also use 304SS, Hastelloy, Monel, and copper. Prior to placing any material in production we test representative samples to determine their wall thickness, ovality, weldability and compatibility with our electropolishing process and desired RA finish.

electropolishing

Electropolishing creates a smooth clean surface that enhances corrosion resistance and reduces particle entrapment in microscopic crevices. With our innovative and proprietary ALC-300 process, Cardinal UHP greatly increases the ability to deliver quality electropolished components for dependable performance in any critical distribution system.

The Cardinal UHP system creates a leveling action so effective that an electropolished surface often has only one tenth the surface area of a mechanically or chemically polished surface. During the electropolishing process the wall thickness is carefully monitored, ensuring excellent weldability with all automatic welding equipment.

Our ALC-300 controller uses statistical process control to bring the electropolishing process into the twenty-first century. Every vital parameter is monitored and regulated with this innovative computer controlled system. Since process parameters are stored in a database, the ultimate in material tracking is available.

research & development

As part of our extensive ongoing research and development programs Cardinal UHP has funded metallurgy research at the University of Missouri's Center for Materials Research. Our surface treatment studies focused on increased standardization in the electropolishing process to achieve a predictable and consistent finished product. Two areas that have been targeted to date are the variables involved in the process and the effect that raw materials have on the final product.

The knowledge gained through our research efforts led to the creation of the first ALC-300 digitally controlled electropolish process monitoring equipment. The ALC-300 is capable of producing consistent quality products without variance from operator to operator.

Through our research efforts, we demonstrated that many inconsistencies in the final product are directly attributed to variation in microchemistry and grain size of the raw material. This is why we take special care to procure only materials providing optimal conditions for electropolishing.

Today we have improved on the industry specifications for raw stainless steel alloy, establishing our own proprietary standards for material procurement. Our continuing investigation of the effects of process variables allows Cardinal UHP to transform the art of electropolishing into a controlled science.

it's about control.

ultra high purity

tubing

Because of the high degree of purity and low surface roughness, Cardinal tubing is widely used in semiconductor, pharmaceutical, medical, food processing, biotechnology, and telecommunication industries. We produce tubing to eight different specifications providing economic solutions for everything from mission critical applications to instrumentation and bulk gas delivery systems.

Standard sizes range from 1/8" through 6" (3mm - 150mm) single wall tubing with electropolished surface roughness as low as Ra 5µin / 0.13 µm. We produce tubing with the full range of cleanliness specifications from T/C cleaning to double bagging and capping tubing to SEMI specifications in our ISO Class 4 clean room.

coaxial/dual containment tubing

Cardinal UHP coaxial dual containment tubing and fittings are specified for the safe distribution of volatile or toxic gases. In the unlikely event of a leak in the process tube the hazardous gas/fluid is contained by the outer tube and evacuated for safe disposal.

Cardinal UHP created a specially designed spacer between the process and containment tube to maintain a consistent annular space and eliminate excess vibration and noise.

Process tubes have the same surface finish and specifications as our single wall tube and fittings. Dual containment tube and fittings are available in all configurations and sizes.

fittings

Cardinal fittings are formed from material that meets the same exacting standards as our process tubing. We begin the process with a heavier wall to offset the thinning that occurs during manufacturing. Cardinal UHP fittings undergo a thorough preparation process to insure corrosion resistance as well as stringent dimensional specifications for economical installation.

Welds are mechanically polished, and when required, fittings are electropolished and passivated. All welds are 100% visually inspected and mass spectrometer helium leak tested. Finally, the fittings are cleaned, capped, and bagged to meet the required specification.

ep coil

Cardinal UHP has developed a proprietary method of electropolishing tubing in long continuous coils. The finished 10µin / 0.25µm Ra finish is comparable to our electropolished stick tubing. This new development means fewer welds, quicker validation and reduced installation labor for UHP piping systems. The process validation for Cardinal EP Coil is identical to that used for stick tubing so you know you are getting a reliable finished product.

Cardinal UHP can provide long continuous lengths of electropolished tubing in fractional sizes from 1/8" through 1/2" and in metric sizes from 3mm through 12mm with continuous lengths up to 330' or 100 meters.

EP Coil is also available in coaxial or dual containment configurations for hazardous and volatile service applications.

ep pak

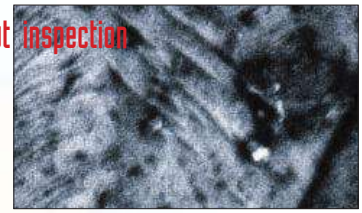
EP Pak uses the same UHP critical tubing (including dual containment configurations) Cardinal is known for in a pre-insulated and electrically heated package. EP Pak is delivered in long continuous lengths to improve utilization and reduce scrap rates.

Our factory installed electric heat tracing is applied under controlled conditions and provides heat transfer efficiency and consistency that cannot be duplicated with field constructed systems. There are no cold spots created by tubing support clamps or gapping insulation.

It's about innovation.

ultra high purity

It's about inspection

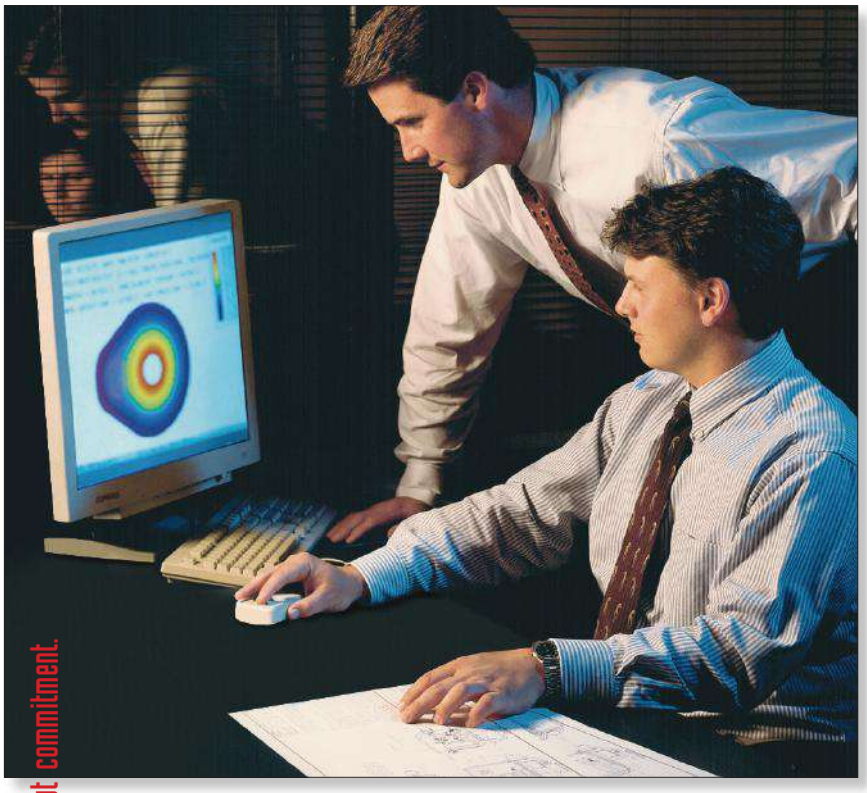


quality assurance

Cardinal UHP was the first company in the high purity tubing and fitting industry to adopt an internationally recognized ISO quality management program. Our unyielding commitment to quality is evident in every step of our manufacturing process. From the start of procurement we specify stringent material standards. When raw materials arrive at our loading dock they are quarantined until wall thickness, ovality, smoothness, surface morphology, and chemical composition have been verified to insure it will meet our rigorous electropolishing procedures.

All measuring instruments and analytical equipment are calibrated and traceable to NIST standards. Finally, every employee is empowered to declare piping and fittings unfit for sale if deviations from our standards are discovered.

Before packaging tubing and fittings are cleaned with 60°C



It's about commitment.

18 megohm-cm deionized water — produced through a reverse osmosis deionized process, surpassing SEMI guidelines for pure water. Components are then purged with heated, high purity nitrogen filtered through a 0.005 micron absolute filter. Finally, color-coded caps are placed over a non-permeable nylon film and the finished product is sealed in single or double poly bags. The final cleaning and packaging is done in our ISO Class 4 clean room.

Fittings and tubing are not only inspected visually, but stylus measurement devices and mass spectrometer helium leak detectors are utilized. Additionally, the following quality assurance options are available:

- Scanning Electron Microscope (SEM) photographs
- Auger Electron Spectroscopy (AES) tests
- Electron Spectroscopy Chemical Analysis (ESCA) tests
- Testing for presence of moisture
- Scanning Tunneling Microscope (STM) surface analysis tests
- Testing for presence of particles down to 0.1 micron
- Certification for oxygen and medical gas service
- Image processing (video probe and/or boroscoping capabilities)

With Cardinal UHP tubing and fittings, you can be sure that you are installing cleaner components so your process can be brought on line more quickly and efficiently.

It's about purity.

services

Cardinal UHP provides specialized services such as electropolishing, passivation, and clean room packaging of materials supplied by our customers. These services can be provided on an as needed or contract basis. If you need one piece or thousands of pieces Cardinal UHP can provide it.

Electropolishing

With our carefully regulated and automated electropolishing process, we can produce surface levels of less than 5 Ra. When electropolishing customer supplied material we often deliver a surface twice as smooth as received. Our in-house capabilities accommodate a wide variety of products including tanks, valve and regulator bodies, specialty fittings, filter housings, pipe and tubing, manifolds, heat exchangers and pump casings.

Passivation

Nitric acid passivation provides improved corrosion resistance, even if the part is not electropolished. We control pH, temperature, flow, suspended contaminants, and time in our passivation process to maximize the effectiveness of the passivated finished part. We can effectively passivate a wide variety of products including long lengths of coiled tubing.

Cleaning and Bagging

Cardinal UHP offers a range of cleaning services including cleaning for oxygen service and specialized cleaning to customer specifications requiring solvent and heated deionized water processing. In addition to providing cleaning services we also provide packaging services such as capping, bagging, double bagging and sealing in an ISO Class 4 clean room environment

Fabrication/Machining/Welding

Our experienced craftsmen and engineers can design and fabricate components to your specifications including special fittings, gas manifolds, face seal fittings, containment systems, tube stubs, and pipe-to-tubing transitions. With the capability to work with most metals including stainless steel, Hastelloy, Monel, tantalum, titanium, aluminum, and copper, Cardinal UHP can design and fabricate your high purity system components.

ultra high purity

product specifications

tech 10 / tech 10CR

- Surface roughness of 32µin / 0.80µm max.
- Non-electropolished high quality 316L and 304L seamless and welded stainless steel.
- Solvent cleaned, purged with nitrogen, capped, and individually bagged.
- Passivated and rinsed with DI water.
- Used in analyzer sample lines, O_2 piping (CFOS), medical gas piping, and vent lines.

tech 20

- Surface roughness of 20µin / 0.50µm max.
- Non-electropolished high quality 316L seamless and welded stainless steel.
- Chemically passivated.
- Cleaned with 18 megohm-cm DI water and purged with filtered nitrogen.
- Used in general purity gas distribution systems, such as compressed dry air, nitrogen lines, argon and other bulk inert gas services.

Specifications subject to change without notice.

tech 50 / tech 50CR

- Electropolished to Ra 10µin /0.25µm max with 7µin / 0.18µm max option.
- Produced from high quality 316L seamless and welded stainless steel.
- Produced to meet current ASTM standards.
- Subject to numerous quality tests including SEM, ESCA, and optional Auger.
- Cleaned with 60°C DI water, purged with heated and filtered nitrogen, capped, individually double bagged and then bulk bagged in an ISO Class 4 clean room.

TG-22

- Surface roughness of 20µin / 0.50µm avg.
- Produced from Hastelloy C-22 to resist pitting and crevice corrosion.
- Chemically passivated in a nitric acid bath followed by a 60°C DI rinse.
- Nitrogen purged, dried, capped and bagged in an ISO Class 4 clean room.
- Used for the distribution and transfer of corrosive gases in high purity gas systems.

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