

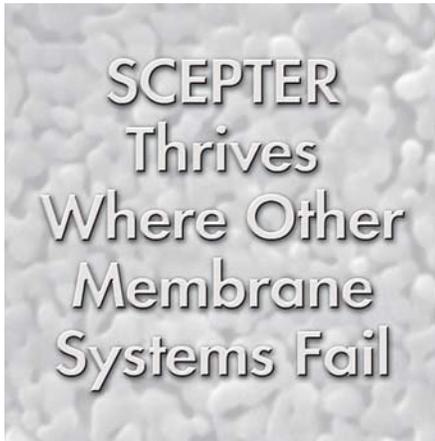
SCEPTER®

Stainless Steel Membrane

**Proven
Technology
for the Most
Challenging
Separations**



Graver Technologies



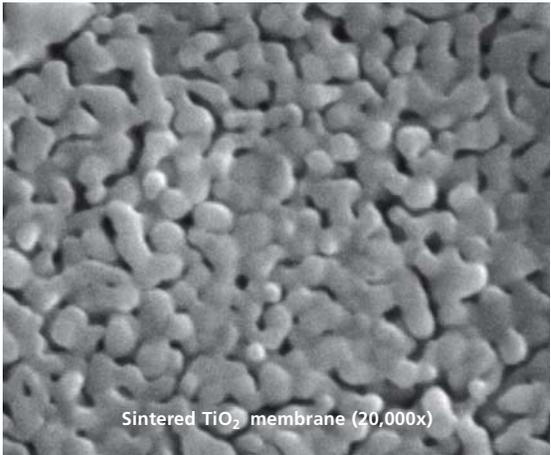
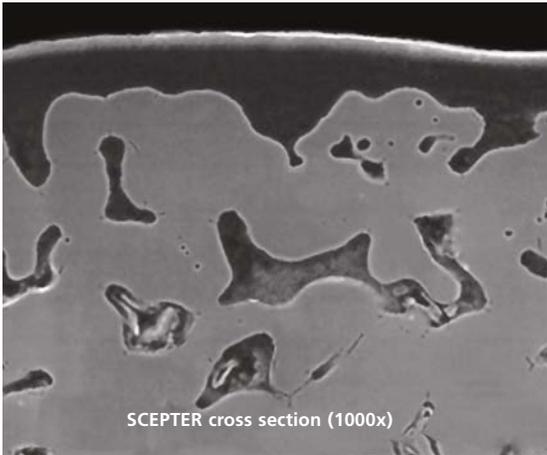
SCEPTER membrane systems are used to best advantage in demanding applications where extreme process conditions or difficult feed streams make other separation methods unsuitable. The cross-flow systems have been proven especially effective for high solids or very viscous fluids, or where processing must be done at elevated temperatures and/or pressures, or at pH extremes.

SCEPTER systems combine rugged tubular stainless steel membranes with a patented coating technology, in which a sintered titanium dioxide coating is permanently bonded to the porous stainless steel tube. This inert, highly durable filter medium provides superior separations performance and years of reliable filtration under extreme process conditions.

The tubular cross-flow technology and stainless steel construction make SCEPTER membranes practically "bullet-proof." This allows processing of a wide variety of difficult streams, including dirty or hostile fluids, over a broad range of chemical conditions, pressures and temperatures. In fact, for certain extreme applications, no other membrane device can be used.

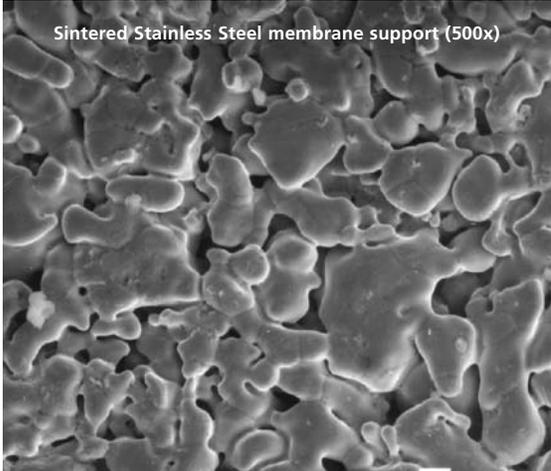
The all-stainless materials also tolerate virtually unlimited steam sanitization and even the harshest chemical cleaning procedures, with no deterioration of membrane performance or lifetime.

Because of their robust nature, SCEPTER modules are finding broad acceptance as replacements for competitive ceramic and polymeric membranes, where the demands of the application have led to process disruption, or problems with premature membrane failure or seal leakage. Standard module designs normally make the retrofit process a simple one. And because SCEPTER's efficient shell and tube design allows up to 8,600 square feet (800 square meters) of membrane in a single module, a single SCEPTER module can often replace dozens of ceramic or polymeric modules, with significant cost and operational savings.



Titanium Oxide membrane enhances performance.
Using a patented process, a titanium dioxide (TiO₂) coating is permanently sintered to the inside surface of the stainless support tube. This creates a smooth, foulant-resistant membrane with a nominal pore size of about 0.1 or 0.02 microns.

Innovative "form-in-place" membrane coatings, dynamically applied to the inside surface of the tubes, can further extend the flexibility of the SCEPTER system.



SCEPTER technology has been used successfully for over twenty years across a wide spectrum of industrial and commercial applications, including:

Agro-Food

Wet corn milling, corn syrup clarification, modified starch filtration, fructose polishing, cane sugar clarification, beet sugar clarification, scums filtration, caustic recovery and others

Textile

Synthetic warp size recovery, dye recovery, caustic recovery and others

Pharmaceutical/Biotech

Fermentation broth concentration and clarification, protein separation and recovery and others

Nuclear Power

Enriched uranium recovery, low-level radwaste concentration and others

Waste Treatment

Hazardous waste concentration, sludge dewatering, hot wash/wastewater recycle, waste oil recovery, membrane Bio-Reactors and others

Metal Finishing

Oil removal, alkaline degreaser recovery, caustic recovery and others

Chemical Processing

Solvent recovery, catalyst recovery, chemical clarification and others

Micro- and Ultra-filtration

Standard TiO₂-sintered SCEPTER tubes provide MF and UF separations. With the addition of other organic/inorganic membrane coatings, the systems can achieve a full range of separations including tight ultrafiltration, and even nano-filtration.

Won't choke on difficult streams

SCEPTER's larger diameter tubes and cross-flow design handle extremely viscous process feeds (up to 100's of centipoise), and complex mixtures of solutes and suspended solids (over 50% suspended solids by volume).

Impervious to hostile process fluids

With the dependable process durability and chemical stability of stainless steel, SCEPTER systems are unaffected by almost any process fluid, from pH 0-14.

Takes high temperatures, high pressures in stride

Membranes and modules are able to withstand continued use at elevated temperatures, over 350°F (177°C). Systems can be designed to operate at pressures over 1,000 psig (69 bars).

Withstands toughest cleaning

Durable all-stainless construction allows virtually unlimited steam and chemical sanitization, and tolerates the aggressive caustic or acid cleaning conditions necessary for difficult-to-remove foulants.

Superior mechanical durability

With gasket-free, all-welded construction, modules exhibit exceptional mechanical stability. Unlike competitive ceramic and carbon substrates, SCEPTER tubes are not affected by mechanical or thermal shock and are virtually unbreakable in use.

Long service life!

Depending upon the application, and assuming regular maintenance, SCEPTER modules can be guaranteed to have a useful service life of ten years or longer.



All-welded, no-gasket construction enhances cleanability, durability and compatibility.

Membrane tube diameters and engineered properties

Graver offers tubular membranes of different diameters and physical properties to better tailor the membrane module for the requirements of the application. Smaller diameter tubes provide greater membrane area in a smaller volume. Larger diameter tubes are the preferred choice where high solids or higher viscosities are the norm, or for the larger area systems.

The membrane production and fabrication process is designed to produce the highest purity and defect-free metallurgy and tube construction. For example, no powder binders are used in the pressing and sintering process, and all tube welds are made by automated orbital welders in an inert gas atmosphere.

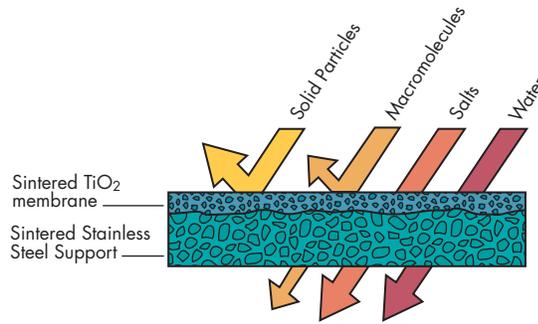


SCEPTER Technology Adapts to Your Process

Fact is, there aren't many process fluids that a SCEPTER membrane system can't handle. The rugged large diameter tube design maintains maximum cross-flow "sweeping" action at the membrane surface. This helps to minimize foulant buildup, even with viscous or very dirty process streams. Plus, the all-welded construction eliminates the need for gaskets or seals, and any concern for compatibility and bypass.

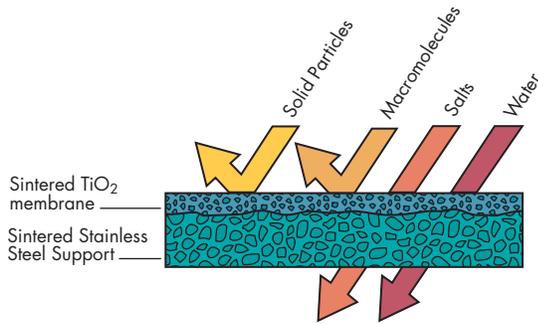
In addition to the standard permanently bonded membrane coatings, Graver can offer easily renewable form-in-place membranes. This adds a level of system versatility that is unmatched by any other large-scale process technology. For example, the form-in-place process allows a single system to be adapted to variable feed conditions, or even to be used for entirely different separations. In addition to guarding against process upset and operator error, this innovative technology provides assurance that the system can always be operated at "day one" performance.

Typically, SCEPTER tubes are welded together into all-stainless steel membrane modules, resembling shell-and-tube heat exchangers. These modules – plus associated pumps, pressure vessels, tanks, valves and instrumentation – can be fabricated into systems capable of processing tens to thousands of gallons per hour. The large area modules provide minimum void volumes, frictional energy losses, CIP volumes, and floorspace.



Microfiltration (MF)
Nominal pore size 0.1 μm

Microfiltration is used to separate suspended solids from dissolved substances in a process stream, or to concentrate fine colloidal suspensions. MF membranes separate or reject particles from about 0.05–0.1 micron to about 1 micron, such as silica, kaolin, yeasts, bacteria, dextrose "mud," granular starch and pigments.



Ultrafiltration (UF)
Nominal pore size 0.02 μm
(20 nanometers)

Ultrafiltration membranes retain high molecular weight solutes as well as suspended solids, colloids, and macromolecules; examples include proteins, polyvinyl alcohol, gelatinized starch, pectin and dispersed dyes. They readily pass water and low MW dissolved solids such as salts and sugars.



Custom-Engineered Modules and Systems

While SCEPTER stainless steel membrane modules can be supplied alone, they are generally incorporated into a custom-engineered filtration system. Membranes and modules as well as tanks, pumps, heat exchangers, valves, instrumentation and cleaning components are selected based on the needs of the particular separation. Generally, this work is done either by a customer's in-house engineering group, or by specially trained system integrators, often working closely with Graver engineers.

SCEPTER technology is broadly adaptable to a wide variety of system-configurations, from basic batch processing to more complex multi-stage continuous designs. The modules are typically configured for cross-flow operation; however, they have also been proven highly effective in certain flow-through ("dead-ended") filtration applications. Because SCEPTER systems are based on modular units, it is easy to increase capacity as need arises, just by adding additional modules or stages.

Test Modules and Systems for Lease

Most applications requiring the SCEPTER membrane will be unique and deserving of some degree of pilot testing. How much testing will depend on the project value and risks. Graver or any one of our authorized membrane system providers will work with you to provide the membrane modules or complete pilot test systems required to gather the application and system design data you need to make an informed decision. This is often a two-step process that may begin with a simple small-volume feasibility test, often at no charge, for the purpose of generating samples for lab analysis, and first-pass system economics. If this looks promising, the next step is typically on-site testing under conditions

as close to "real" as practical. If you have an existing membrane test system, it may be possible to retrofit it with a SCEPTER membrane module. Alternately, Graver and our system providers have test systems of different sizes, designs, and degrees of automation, as the application may call for. The nominal equipment rental fees will often include start-up assistance, test plan development, and test data evaluation. All or part of the rental fees may be refundable on a full-scale purchase.

Module designs to meet a variety of application needs.

SCEPTER modules can be fabricated in diameters from 1 inch (25 mm) to 48 inches (1.2 meters), in lengths from 2 feet (0.6 meters) to 20 feet (6 meters). Standard design pressure is 150 psig @ 250°F (10.3 bar @ 121°C). Single modules are available with over 8,600 ft² (800 m²) of membrane area.

The standard material of construction for tubes and substrates is 316L stainless steel. However, other alloys are also available to meet the needs of specific applications; for example, Hastalloy C or nickel alloys for low pH/chloride compatibility.

To enhance chemical and thermal compatibility, and eliminate potential failure points, modules are of all-welded construction, with no gaskets, O-rings, booties, or other elastomeric components. Standard connection designs include:

- Industrial design using Victaulic couplings
- Fully sanitary configurations for pharmaceutical and food processing applications
- ASME or EU pressure code-compliant using flange connections



Vertically installed, multi-pass membrane modules in a multi-stage system design. Vertical configuration conserves floor space.



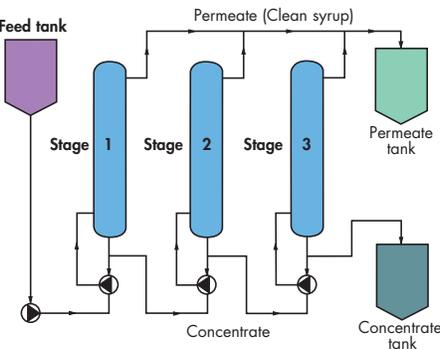
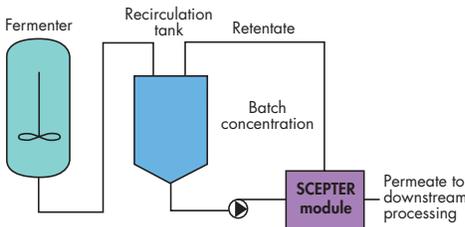
SCEPTER Systems Pay Their Own Way in Commercial Applications

For many applications, SCEPTER filtration is the only option; no other membrane is up to the job. In fact, SCEPTER modules are often specified as replacements where other membrane technologies have tried and failed. In other cases, the advantages of flexibility, reliability and long service life make SCEPTER the clear, cost-effective choice. Here are just a few of the cases where SCEPTER technology is making a measurable difference in product quality, cost savings and environmental impact.

Pharmaceutical industry: Separation and harvesting of microbial cells

The first step in a biological process that uses bacteria, yeast, or other microorganisms to produce a compound is cell harvesting – the removal of the suspended cells and suspended solids that make up the feed stock solution. Traditionally, rotary vacuum filtration or centrifugation were used for this operation. In order to be economical, particularly in large-scale production of bulk intermediate product, this removal step needs to operate on a continuous basis. The traditional processes in many facilities have been replaced by membrane separation processes, which have not only enhanced cell separation, but have achieved product recovery rates approaching 99.9%, while reducing overall operating cost and worker exposure to process materials.

SCEPTER cross-flow systems take the membrane process improvement a step farther. Because SCEPTER membranes can tolerate an extremely high concentration of suspended solids, they deliver much higher retentate solids concentration than other membrane devices. This reduces waste treatment volume, and provides higher product yields. In addition, unlike most polymeric membranes, SCEPTER systems can be vigorously and repeatedly steam-sterilized prior to processing the fermentation broth.

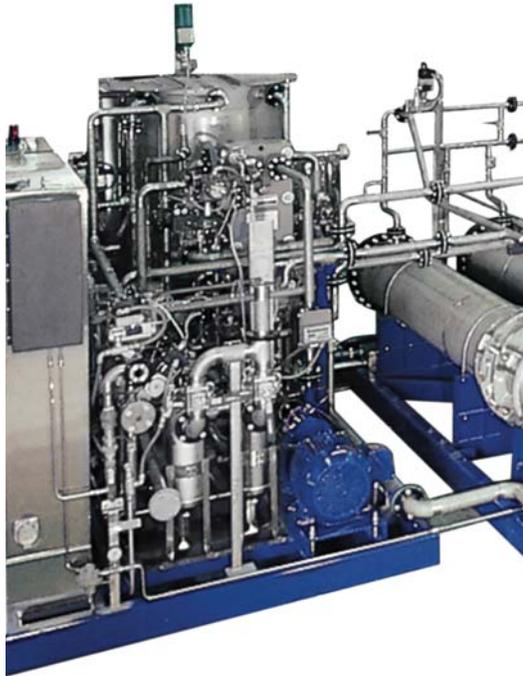


Grain industry: Corn syrup clarification (wheat, cassava, etc.)

Following conversion by acid and/or enzyme hydrolysis of starch, corn syrup must be clarified to remove undesired oil, proteins and other non-starch components, commonly known as "mud." Downstream carbon adsorption and ion exchange remove color and reduce ash content.

With SCEPTER membrane technology, the mud can be removed immediately following liquefaction without cooling the stream, without the traditional, and costly, centrifugation and rotary filtration steps. The resulting syrup exhibits crystal clarity, low color and negligible color degradation, and can be further processed without excessive buildup of adverse colors and flavors.

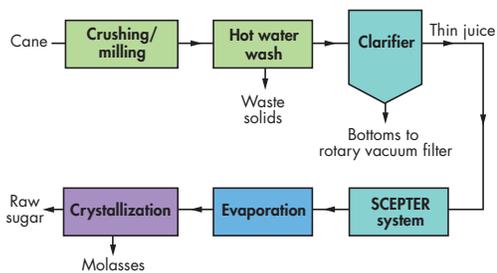
Because of the timely and effective removal of the mud, the syrup requires substantially less carbon and ion exchange refining. Carbon requirements can often be cut by as much as 60%–70% and ion exchange by 20%–30%. These reductions, along with the elimination of diatomaceous earth, result in annual savings of \$2 to \$3 million per year for a 500 gpm line.



Sugar industry: Cane sugar clarification

Raw cane juice must be clarified to remove objectionable amounts of lignins, gums, dextran, waxes, and other colloidal impurities that contribute taste and color to the crystalline form of the product. This raw juice undergoes several steps, such as clarification using lime or flocculating agents, to remove much of these contaminants prior to evaporation and crystallization steps.

SCEPTER systems are being used to improve the clarity of the thin juice immediately after the clarification step. SCEPTER processing is able to achieve a much higher level of purity than with clarification alone; this provides a significant improvement in product quality and yield of the raw crystalline sugar. And because juice quality is consistent, downstream processes can be fine tuned for maximum efficiency, resulting in lower operating costs in later refinery stages.

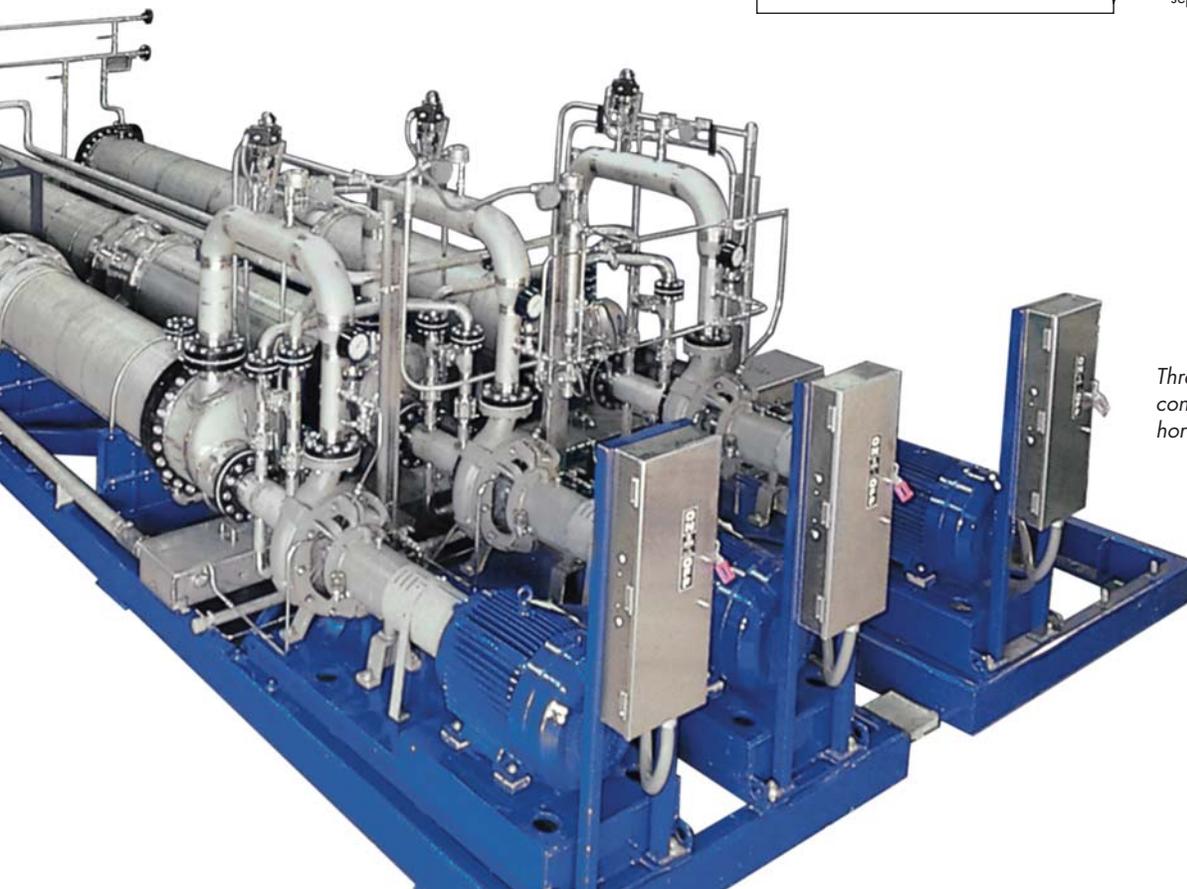
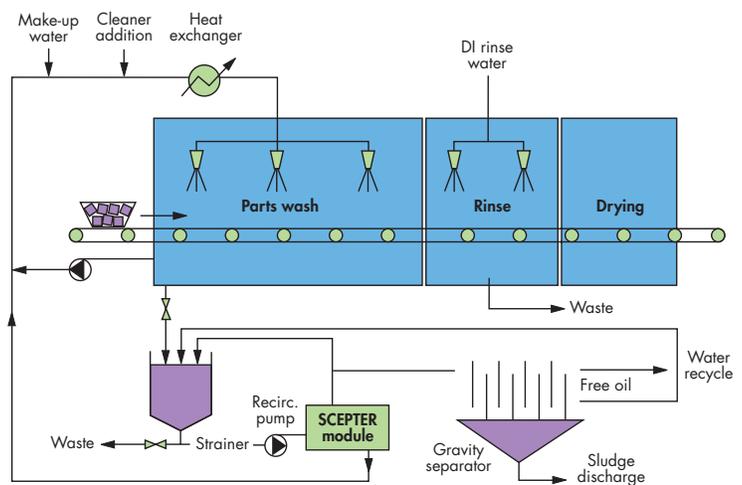


Metal finishing industry: Alkaline cleaner recycle

Metal and plastic parts, steel roll or bar stock, and other components must be chemically cleaned prior to painting, plating, or other surface treatment to ensure proper application of the coating. These parts are typically passed through a continuous, multi-stage wash/rinse/dry process. The washing normally involves a strongly alkaline detergent-based cleaner, which is sprayed from a recycled bath to remove grease, oils, and contaminants from the part's surface. These contaminants remain in the bath, and build up over time, necessitating periodic replacement of the bath solution to ensure that the

cleaning process remains effective. In addition to the expense (and downtime) of replacing the bath, this creates a significant waste burden.

SCEPTER membrane systems are able to continuously remove the contaminant load from the cleaning bath. This continuous purification extends the life of a typical bath by 10–20 times, and reduces waste discharge from the process by 95–98%. In addition, the improved cleanliness and consistency of the washing chemistry results in a more stable and steady-state process, and a higher quality end product, with fewer rejected parts.



Three-stage, 4,500 ft² (418 m²) continuous-feed system with horizontally mounted modules.



Superior Products & Global Reach

Whether your business is around the corner or around the world, Graver Technologies can support you with superior products and services. Our ion exchange, adsorbent, filtration, and membrane products deliver exceptional performance in some of the harshest process environments in North America, Europe, Asia, the Pacific Rim, South America, and Africa.

Graver Technologies, LLC is a member of The Marmon Group of companies, an international group with more than \$6 billion in annual sales. Graver Technologies is a fast-growing company with the technical resources and financial strength that make us the perfect partner for your business.

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