

# Mining and Minerals

LIGHTNIN MIXERS



A World Leader In Industrial Mixing Since 1923. Lightnin has 90 years of unrivaled experience in industrial mixing technology, process knowledge, and technological innovation. Lightnin enjoys a global reputation for durable, long-lasting mixers, agitators, aerators, and flocculators for fluid process systems. We offer a full spectrum of impeller designs for diverse applications. In addition, we offer a worldwide service network, mixer repair, gearbox repair, and replacement parts programs. Look to Lightnin for knowledge, technology and service excellence.

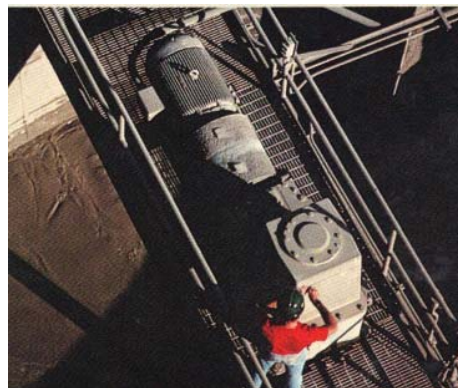
Based in Charlotte, North Carolina, SPX Corporation (NYSE: SPW) is a global Fortune 500 multi-industry manufacturing leader with over \$5 billion in annual revenue, operations in more than 35 countries and over 15,000 employees. The company's highly-specialized, engineered products and technologies are concentrated in Flow Technology and energy infrastructure. Many of SPX's innovative solutions are playing a role in helping to meet rising global demand for electricity and processed foods and beverages, particularly in emerging markets. The company's products include food processing systems for the food and beverage industry, critical Flow components for oil and gas processing, power transformers for utility companies, and cooling systems for power plants. For more information, please visit [www.spx.com](http://www.spx.com).

## Lightnin Mixers - Getting the Job Done Right

### In Mining and Minerals

Lightnin has developed many of the mixing techniques considered standard for minerals recovery. Innovative research and testing for thousands of mixing applications continue to maximize process efficiency. We employ a fully integrated laser lab that simultaneously measures flow and power. Mechanical loads can be measured on our test tanks. The result is more efficient, less expensive impeller designs. Our extensive testing facilities allow us to model gold, silver, copper, and phosphoric acid processes from preparation to purification. Our Ø2.5m (Ø8ft) and Ø3m (Ø10ft) test tanks allow us to test slurries for other mining and minerals processes. Our proven scale-up techniques ensure that in production our mixers perform as promised. Our sales engineers, located in over 80 cities around the world, are able to handle any sales or service needs.

Just about every step in minerals processing depends on suspending solids or a stream mixed uniformly with a liquid. We can help you manage the many variables that influence the throughput of your entire process. Our laboratories are available for pilot testing, allowing us to scale up and design the full-scale mixer required. Results are guaranteed, of course.



# Lightnin Technology

With Lightnin products, SPX has pioneered many of the mixing techniques now considered standard for minerals recovery. From individual agitators for simple solids suspension applications; to the exacting demands of High Pressure Oxidative leaching and to the design of complex systems for counter-current solvent extraction; our unique understanding of minerals processing and mixing requirements coupled with purpose designed agitators ensure optimum process performance and long term reliability.

## Process expertise from Al to Zn

- Leaching
- Carbon in Leach
- Carbon in Pulp
- Resin in Pulp
- Bio-Leach (Bio-Oxidation)
- High Pressure Oxidative Leach (POX)
- High Pressure Acid Leach (HPAL)
- Precipitation
- Crystallization
- Digestion
- Solvent Extraction Mixer Settlers
- Attrition Scrubbing
- Flotation



Select SPX Mixing equipment and you get more than an efficient and cost effective process. You get 90 years of experience in processing technology. We were one of the first to use computational fluid dynamics (CFD) in mixing research. This experience has enabled us to design and develop products specifically for the mining and minerals industry into the 21st century.

Our laboratory allows us to optimize your process, from pilot to full-scale testing. Your benefits can include higher reliability, lower production costs, greater output, resulting in higher profits.

Processing.....we perfected it. Lightnin offers mixing equipment and extensive market knowledge for the mining and Minerals industry.

## Typical product applications

SPX has a process solution for a wide variety of mixing applications. Mixing applications can be broken down into the following mixing duties: liquid-liquid, liquid-solid, gas-liquid-solid and fluid motion. Many applications are often a combination of these duties and thus having a full understanding of each of these areas is crucial to recommending an optimized design that is also economical.

### Liquid - Liquid

- Solvent Extraction of Copper and other Metals
- Continuous pH control in potable water or effluent treatment
- Blending of additives and flocculants



### Liquid - Solid

- Draft Tube Crystallizers, used in the production of Alumina
- Suspension of Slurries in large tanks at Slurry Pipeline facilities
- Petroleum blending and drilling mud suspension



### Gas - Liquid - Solid

- Pressure Oxidation and High Pressure Acid Leach Autoclave Mixers
- Biological Oxidation reactors and slurry oxidation



### Fluid Motion

- Homogenization of storage tanks
- Flocculant tanks



# Gold Recovery

## GOLD

**Carbon-in-pulp (CIP)** is the sequential leach and adsorption of gold from ore. During the leach, pulp flows through agitated tanks where sodium cyanide and oxygen dissolve the gold into solution. The solution then flows through agitated tanks, where the gold adsorbs onto activated carbon, flowing counter-current to the pulp.

**Carbon-in-leach (CIL)**, however, involves simultaneous leach and adsorption. It is used to minimize gold loss where preg robbing materials are present in the ore. Both CIP and CIL mixers must provide high flow to enhance reaction kinetics, and low shear to minimize carbon degradation.

**Pressure Oxidation.** Developed for refractory ores where gold is occluded in sulphide minerals, pressure oxidation frees the gold, allowing economic recovery by conventional CIL or CIP processes.

**Biological Oxidation.** This is a bacterial alternative to pressure oxidation in which bacteria oxidize and break down sulphide materials.

Both pressure oxidation and biological oxidation require mixers designed to provide the necessary mass transfer.



For Pressure Oxidation (POX) Autoclave applications, SPX's Lightnin brand has one of the largest successful agitator installed base in the world. POX applications not only cover gold but also other metals such as copper and platinum. Through the use of lab testing and computational fluid dynamics, we offer process optimization for POX autoclave applications, which includes optimized impeller designs. The Lightnin A340 Up Pumping Technology offers the following benefits over more traditional radial flow systems:

- The up pumping flow pattern generated by the A340 impeller system improves blending and temperature uniformity in each stage over a more traditional radial system. Improved blending can improve conversion/yield as well as improved temperature uniformity.
- The A340 impeller system creates a unique flow pattern at the liquid surface, allowing for improved gas hold up and surface gas induction.
- Considering A340 impeller technology in conjunction with an underflow inter-stage wall design increases liquid volume within the autoclave, allowing for increased residence time. This can lead to improved conversion/yield or higher production rates.



**Lightnin  
A315 Axial Flow Impeller**

For biological leaching applications, we can design a test program to obtain sufficient data for scale-up, as well as guarantee mass transfer in your full-scale tanks.

The A315 Axial Flow Impeller is used for Higher Gas and Liquid Mass Transfer. With the A315 Impeller, you can get up to 30% greater mass transfer when compared with a radial flow Rushton turbines at identical power levels and gas rates. The A315 is the result of our extensive experience in mass transfer and the fluid mechanics of mixing impellers. It is specifically designed for high gas applications, such as pressure oxidation and biological leaching, where high flow is required.

Our 90 years of mixing experience and the most rugged, efficient equipment available are two reasons why our customers get higher productivity from their gold recovery process. Our mixer drives are designed to be rugged as well as easy to maintain. Our laser-designed impellers are unsurpassed for process productivity. By running thorough agitation studies on your ore samples, we make sure we recommend the right equipment for your process – including for refractory ore processes like pressure oxidation and biological leaching.

# Alumina Precipitators

SPX's Lightnin Draft Tube Circulator has become a common method of suspending alumina hydrate solids during agglomeration and precipitation in modern alumina plants.

Uniform solids suspension maximizes the mass of alumina solids held in the tank. The hydraulic efficiency of the draft tube and the impeller minimizes power consumption. Scale formation is minimized to provide maximum on-line time between tank cleaning. The system is designed for process upsets and restarts.



**Lightnin C200 Axial Flow  
Draft Tube Circulator Impeller**

Precipitators require that the solids are uniformly suspended to avoid them cementing together and to help prevent scale growth.

Power consumption with traditional open impeller systems can be high when compared with Lightnin's Draft Tube Impellers. The Lightnin C200 is a high efficiency impeller designed specifically for draft tube applications.

The C200 Impeller has the following features:

- True aerofoil section for high efficiency
- Thick skins for maximum life
- Available as a single piece or with bolted construction to ease installation and retrofits

While being simple, the Lightnin Circulator includes a number of design features:

- A bell mouth inlet to the draft tube minimizes the entrance losses to the draft tube. Inlet baffles and straightening vanes prevent swirl losses.
- The specifically designed, C200, draft tube impeller provides efficient flow generation. A conical diffuser below the impeller smoothly decelerates the flow around the hub reducing losses.
- The Lightnin notch minimizes the effective hydraulic clearance between the impeller and the draft tube while providing a physical clearance at the blade tip to accommodate deflection of the shaft and drive support structure.
- The Lightnin Draft tube slots permit restarting after a stoppage has allowed a settled solid bed to block the tube. On restarting flow through the slots erodes the settled bed until it is re-suspended.

## ALUMINA

Ground bauxite is mixed with recycled caustic soda solution ("spent liquor") and fed into digesters. With proper agitation, the alumina goes into solution as sodium aluminate.

In the precipitation train, seed particles of alumina trihydrate are introduced to precipitate relatively pure alumina trihydrate crystals from the cooled, super-saturated solution. A low shear draft tube mixer maintains slurry homogeneity at minimum power while minimizing crystal degradation.

The Lightnin model C200 circulator impeller achieves design flow against draft tube head requirements with minimum power and wear. A true airfoil shape provides steeper head/flow curves. Steep head flow curves assure stable operation, even during process upsets, while minimizing horsepower.

We design the draft tube to optimize results and the tank process result while limiting maintenance and wear.



Other applications include:

- Digestion
- Desilication
- Bauxite Storage
- Causticization Reactors
- Seed Slurry Handling
- Hydrate Storage
- Oxalate Crystalizers
- Calcine Treatment



# Solvent Extraction

## COPPER

Lightnin has redefined copper solvent extraction methods by improving the technology while sparing the need for costly capital improvements.

Our Solvent Extraction System increases productivity while eliminating the excessive shear and air entrainment common to the higher power levels needed to meet today's high production demands.

Our pumping technology is the key to the Lightnin Solvent Extraction System. The Lightnin R320 family of pumper impellers produces high head and flow per power input that exceeds the mass transfer and copper recovery of traditional impeller designs.

Improved Auxiliary Mixing in the auxiliary tank using a Lightnin A310 metal or A6000 composite axial flow impellers maintain the uniform dispersions created by the R320 impeller. The A310 or A6000 provide gentle mixing, and enhance phase disengagement in the settler at lowest power available.

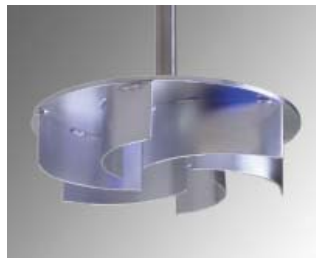
A choice of materials is available for seawater leaching and other high-chloride applications, Derakane® vinyl ester composite materials as an alternative to higher alloy materials such as 316, Duplex or titanium.

*Derakane(R) is a Register Trademark of Ashland Inc.*



Lightnin operates modern and technologically advanced laboratories in which we can test your actual materials to determine optimal flow, head, power, and other factors. Our proprietary computer software predicts performance for your specific process conditions and allows us to select the proper mixing box and impeller configuration.

Once we recommend an impeller, our customers can study its operation in a mixing vessel at Lightnin during a variety of lab-scale tests. Simultaneously, you witness all of the relevant parameters measured. All of this is recorded on our computer systems for immediate or future analysis.



**Lightnin  
R320 Pumper Impeller**

The R320 Pumper Impeller has been developed specifically for pumping operations in solvent extraction systems. Using our specialty impellers helps our customers all over the world achieve their process needs.

- **Lower capital cost** - Increased hydraulic efficiency means higher performance with smaller impeller diameters and lower torque.
- **Lower operating cost** - Reduced installed horsepower for lower energy costs and easier maintenance.
- **Less extractant loss from entrainment** - Organic losses are minimized by higher efficiency, lower-power flow patterns and minimum shear characteristics.

Benefit: big savings from using less chemicals.

- **Confidence in design** - Proven performance from 150mm (6") lab-scale to 2695mm (106") full-scale. Our proprietary design program enables Lightnin to guarantee head, flow and hydraulic efficiency.



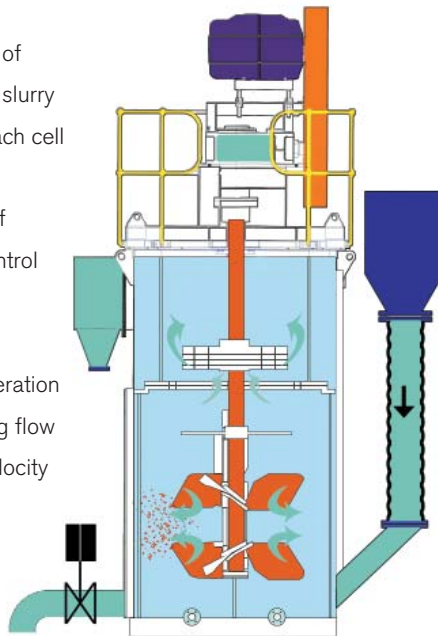
# Attrition Scrubbers

With 90 years of experience, Lightnin is constantly developing new methods of mineral processing to offer innovative solutions and advanced technology to the industry. Attrition Scrubbers have been accepted in the minerals industry for many years, removing surface particles and contamination from a wide range of materials including: Platinum and Palladium, Glass, Sand, Phosphate, Coal, Slaked Lime, Copper, Nickel, Kaolin and Plastic Recycling.

Lightnin has an internationally respected reputation in the industries it serves. It is known for efficient, robust products that offer good operating value.

Lightnin Attrition Scrubbers consist of identical cells with inter-connecting slurry pipes and bolt on transfer boxes. Each cell incorporates an identical attritioning mechanism. At the discharge side of each cell are adjustable weirs to control head, flow and freeboard.

Attrition Impellers are a vital consideration for optimal attritioning. The opposing flow impellers offer maximum particle velocity between Lightnin's high efficiency A320 blades and controls retention time and provides the high power input needed for optimal attritioning. Computational modelling has been used to place the impellers to ensure the flow patterns minimize abrasion while maximising shear and eliminating any short circuit. The cell has three impellers on a single shaft with two impellers in the attritioning chamber. The upper impeller provides controlled pumping to the following stage. Baffles in the attritioning chamber allow for a controlled pattern and predictable power.



## ATTRITION SCRUBBERS

Lightnin is the world leader in fluid mixing technology. We've taken this expertise and applied it to Attrition Scrubbing. Through the use of computation modelling and field installations, the Lightnin Attrition Scrubber offers unparalleled process performance.

### Controlled Retention Time:

- Insures Optimum Attritioning
- Deflector Plate Prevents Short Circuiting

### Controlled Flow Rate:

- High Efficiency Pumper Impeller
- Adjustable Weir Slats at Outlet

### Controlled Intensity Mixing:

- Two Engineered Impellers Optimally Spaced
- Fully Baffled Attrition Chamber
- High Shear Rate

### The Lightnin Advantage:

- No Vortexing
- Improved Process Results
- Minimum Erosion
- Proper Solids Suspension
- Improved Mechanical Reliability



# Nickel

## NICKEL HPAL AUTOCLAVES

Lightnin has pioneered the agitation in HPAL autoclaves with the use of A313 impellers for the blending of sulphuric acid with the slurry. This material needs to be uniformly blended into the slurry for two reasons.

First and foremost, maximum extraction is reached with uniform concentration throughout each compartment and short circuiting of the acid must be avoided. A secondary concern is material corrosion. The titanium used for autoclave and agitator construction is attacked by high local concentrations of hot sulphuric acid and feed dispersion is an important requirement.

Laboratory scale autoclave test work in the Lightnin Laboratory will validate the proposed mixer configuration by experimental validation. The residence time distribution test work is carried out in Lightnin's state of the art laboratory.

CFD modelling is also recommended:

- To visualize and help confirm the experimental results due to the complex rheology of the lateritic slurry
- To confirm that localized concentration of sulphuric acid is avoided

Nickel is found in sulphide or in laterite deposits. Hydrometallurgical processes for nickel sulphide use the ammonia leach process and either the Caron Process or the High Pressure Acid Leach (HPAL) for the nickel laterites.

High Pressure Acid Leach (HPAL) autoclaves dissolve the nickel contained in the laterite ore by adding sulphuric acid at high temperatures, typically 265 - 275°C (510 – 525°F) and pressure. The resulting solution is washed in a CCD circuit and then neutralized. Precipitation and then re-dissolution follow with purification and recovery of the nickel and cobalt.

Lightnin has been heavily involved in most of the new generation HPAL plants.

Autoclave duties:

- HPAL
- Ammonia leach
- Sulphide leach with oxygen of nickel intermediates
- Nickel reduction with hydrogen to produce >99% purity nickel
- Cobalt reduction with hydrogen to produce >99% purity cobalt

Other applications:

- HPAL autoclave feed area
- CCD circuit
- Precipitation seed handling of sulphides and mixed hydroxide intermediate product (MHP)
- Precipitation of iron, copper and zinc
- Neutralization of tailings
- Seed slurry handling
- Nickel purification
- Cobalt purification
- Solvent extraction

Lightnin has supplied hundreds of agitators for whole nickel processing plants where operating conditions are known to be particularly arduous. Using knowledge gained from operating installations together with continuous product development you can count on Lightnin to supply reliable cost effective solutions.





## PHOSPHATES & FERTILIZER

Phosphates, Phosphoric Acid and Fertilizer production processes are recognized as some of the most arduous mixing applications requiring exceptionally rugged equipment design and a high level of process expertise. SPX has supplied hundreds of Lightnin brand agitators for general Phosphoric Acid Attack Tank and Reactor duties and is the largest supplier of the highly sophisticated draft tube type circulators for Isothermal reactors. Working closely with process licensors, SPX is a key supplier of agitation systems for both hot and cold crystallizers for the production of Potash and other specialized fertilizers.

Ground up rock slurry is mixed with sulfuric acid and recycled phosphoric acid in either a series of "attack tanks" or in larger volume tanks with draft tube mixers. A mixer must not only suspend phosphate rock and blend acids; it must also create sufficient velocity to discourage by-product gypsum from building up on the tank walls.

- Attack Tanks
- Isothermal Reactors
- Digesters
- Rock Slurry Tanks
- Acid Storage
- Pre-flotation Conditioners
- DAP Reactor

## BOTTOM-ENTRY DRAFT TUBE CRYSTALLIZERS

Crystallizers are used to produce solids from purified liquors. The saturated solution is pumped up through a draft tube under a mild vacuum to form crystalline particles. As crystal size grows, the momentum of the larger crystals carries it to an overflow where slurry containing desired particle size is drawn off. Water is then removed to form the final product. Soda ash and potash are good examples. Lightnin supplies bottom entry units utilizing circulator impellers for this duty. The predictable flow rates and head performance of these mixers are critical to achieve successful final results.

## CARBONATES & CLAY SLURRY

Dry clay powders are mixed with water to form slurries used in various applications ranging from pulp and paper to ceramics. Clay slurries are hindered settling that can have high viscosity. There are three basic services for clay mixing: storage, make-down and prep for shipment.

Storage tanks normally require low power per unit volume to keep slurry blended and prevent solids from settling out. Sizing is based on our extensive installation list around the world, our scale-up and scale-down proven practices, supported by our minerals processing laboratory.

Make-down of any fine powder is always a difficult application with high power requirements. Sizing is based on installed base and lab tests. An upper impeller is used to draw a surface vortex, drawing solids into a lower radial impeller to disperse solids. Tank modifications are required to ensure correct process results.

## COAL SLURRIES

Typical coal applications include slurry storage, pipeline transfer, and gasification. Some of the present SPX coal slurry installations found in the power generation market are now the largest in the world.

Lightnin's knowledge of solid suspension and mixing of hindered slurry ensures the optimum mixer installation for these duties. Axial impellers designed using the different available tip cord angles of the A510's are used to ensure the final process results. Lightnin also has the "cluster design" allowing mixing in large diameter slurry tanks.



# Reliability By Design

SPX understands that when it comes to efficient process plant operations, equipment reliability is of paramount importance. As a long-standing member of AGMA (American Gear Manufacturers Association) SPX's Lightnin brand recognizes that multi-purpose commercial gearboxes are often poorly suited to Agitator service. For more than 50 years the Lightnin products have utilized proprietary, purpose designed agitator gear drives to ensure dependability and lowest cost of ownership. With more than 1 million units in the field our operating experience is unsurpassed. SPX's agitator drive designs which are continually evolving to take advantage of latest materials technologies and manufacturing techniques, range from 125 W (0.17 HP) to units greater than 2500 kW (3350 HP).



### Series 70/80

The workhorse of the Lightnin mixer drive range with over 40,000 placed in service since its introduction in 1970, the 70 series mechanical design technology is the industry's most proven agitator drive technology.

### Series 98

A parallel shaft all helical gear design provides enhanced installation flexibility where there are space limitations on top of the vessel

### Series 780/880

From 15 kW (20HP) to 1000 kW (1350HP) the 780/880 series drive range is designed specifically for the most arduous large scale mixing applications. With thousands of drives operating globally on some of the most demanding duties, reliability is assured.

### Series 7000

Series 7000 custom designed agitator gear drives can be found on some of the world's largest and most complex mixing applications with power requirements in excess of 2500kW (3350HP).

## IMPELLER TECHNOLOGY

Lightnin has a full range of impellers for each mixing step of the process. We match our impellers to the specific duty, accomplishing optimized and guaranteed results.



*Lightnin  
A310-A510 Impeller*



*Lightnin  
A315 Axial Flow Impeller*



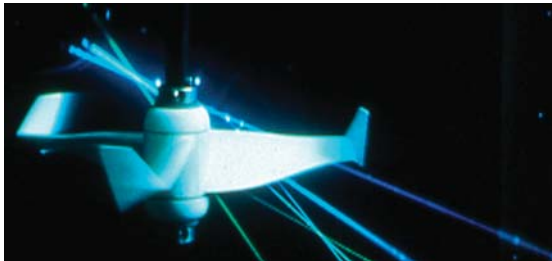
*Lightnin C200 Axial Flow  
Draft Tube Circulator  
Impeller*



*Lightnin  
R320 Pumper Impeller*

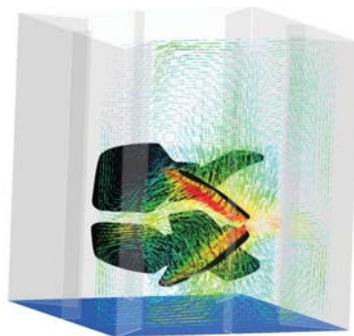
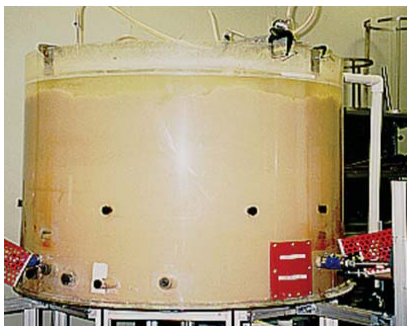
## Consulting Services

SPX's Lightnin brand has long supported the need of providing full service mixing support to our valued customers. In today's business environment of "doing more with less," local resources at your operation have been stretched or eliminated. At SPX, we recognized this and have increased the level of process support available to our customers. Evaluation and resolution of our customer's mixing issues has been a core strength for many years at our Lightnin facilities.



You can leverage the resources and knowledge base of Lightnin by optimizing your mixing processes and solving any mixing problems. Lightnin's Process Technology Laboratory enables this support to be efficiently executed to minimize your costs. Lightnin's team will evaluate your existing mixer design and process goals to determine opportunities for improvement. Lightnin will team with your technical group to reduce the time and expense for developing new mixing applications. Lightnin's experts can assist in the specification of mixer design, tank internals, feed stream locations and product drawoff position to optimize your operation. Lightnin has extensive experience in scaling up lab designs and achieving guaranteed full-scale performance.

Lightnin's consulting work starts with a discussion of your needs and process information. Then a proposal is created to define the project scope, responsibilities, deliverables, cost and schedule. A path forward is then concisely and clearly written, and agreed to by both parties. Bi-directional confidentiality agreements are frequently a necessary and common course for doing business.



### 3 Ways to Test for the Best

As the world's premier mixing expert, we serve a tremendous variety of industries and applications - everything from pharmaceuticals to minerals extraction operations. The testing involved with each of these applications is just as diverse. Flexibility is key to success. That's why we specifically designed the lab to accommodate a broad range of tests.

- 1. We'll test your actual materials.** We'll perform a variety of scaled-down tests using your actual materials. No matter what your mixing process is - gas dispersion, slurry suspension, paper stock agitation, blending, or nearly anything else - we'll analyze it for optimal flow and shear. That's the best way to find out in advance which impeller will maximize not only mixing, but also the process itself. If your materials are hazardous, we'll run tests in the lab's Explosion-Proof Testing Area.
- 2. We'll test an acceptable simulant of your material.** While actual materials testing is preferable to ensure optimum mixing performance, we realize it isn't always possible. So, at the Lightnin Process Technology Laboratory we offer a number of options for materials and process simulation, or computational fluid dynamics (CFD) modelling. We also conduct tests in water to measure mass transfer coefficients and flow/shear ratios and then scale to suit your process.
- 3. We'll run full-scale performance tests for you on or off-site.** If your application demands it, Lightnin provides scale up testing capabilities in our test tanks. Or, if necessary, we'll come to your location for full-scale testing to determine the best configuration for your actual process.

# SPX<sup>®</sup> INDUSTRIAL PROCESSES

## Global locations

### AMERICAS

#### SPX FLOW TECHNOLOGY

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SPX reserves the right to incorporate our latest design and material changes without notice or obligation.

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or use your SmartPhone and the QR Code

