J-LOK® RESIN
STATE-OF-THE-ART RESIN ANCHORAGE SYSTEMS

J-LOK® is the trusted source in resin anchorage systems. In the last decade J-LOK® has provided the very best in resin technology and manufacturing to its customers. When quality and safety are paramount, why would you settle for anything less? J-LOK’s products compliment our affiliate company JENNMAR and its more than 40 year service to the mining industry.
The Story of J-LOK

J-LOK started production in April, 2006 in Cresson, PA. The facility was designed to eventually have four production lines, but initially only two were installed. Production got underway with one 8-hour shift per day producing three gel times; 10-sec, 30-sec and 60-sec; and two diameter products, 23mm and 32mm. From the outset, confidence in the product and the market was high and within months, ownership followed through on their initial plans and installed the two additional production lines. As product acceptance and brand recognition grew, demand increased dramatically and very quickly a 2nd shift was added, and then a 3rd, and soon the plant was operating 24 hours a day, five days a week. Eventually, a 5th and finally a 6th production line was added to keep up with the strong demand.

With the Cresson plant at full capacity, a second plant was built in Earlington, KY to more efficiently supply J-LOK resin to the coal mines in the region. This facility was designed for six production lines and all six were producing resin when the plant began production in June 2008, operating 24 hours a day, 5 days a week.

Both plants utilize the same raw materials, have the same production equipment and follow all the same operating and quality procedures so that products produced in both plants are identical. Both plants are also ISO 9001 registered.

As the J-LOK brand took hold, J-LOK’s product portfolio expanded to accommodate the needs of the mines. J-LOK now makes products in 14 different diameters from 20mm to 40mm, J-LOK cartridge lengths range from 10 in. to 65 in., gel times range from 10 seconds to 30 minutes, and viscosities can be customized for specific applications.

J-LOK initially only produced resin for domestic coal mines. Today, products are shipped globally for coal mines, hard rock mines, and civil & tunneling applications.
J-LOK® equipment is the most modern and technologically advanced in the resin business, equipped with the most accurate system for ratio control of the resin/limestone mixture ensuring that resin/catalyst proportions are consistent. The entire plant is interconnected to provide coordinated control of the entire process. Operators utilize PLC touch screens to enter product recipes and to make operational adjustments. Quality control testing encompasses everything from raw material testing, in-process testing and final product quality and performance testing.

The labs at J-LOK have custom designed equipment such as the automated gel time tester that takes all the technician variation out of the test providing consistent results every time. Both J-LOK plants as well as the R&D lab in Pittsburgh have modified roof bolting machines to measure parameters such as pull strength and insertion force allowing products to be customized as necessary.

J-LOK personnel work with key suppliers to optimize raw material specifications. J-LOK has created many innovations such as TWIN-LOK® 2-speed resin cartridges for torque-tension applications, J-LOK LIF, Low Insertion Force resin where bolter thrust is an issue and J-LOK P™, pumpable resin for grouting from a distance. Several of these products have been patented.

J-LOK produces resin products to complement JENNMAR products and provide an optimum system of bolt and resin. J-LOK's R&D capability utilizing product formulation expertise from the resin plants in conjunction with the mining expertise of JENNMAR's engineering affiliate, Keystone Mining Services is unmatched.
The J-LOK® resin in the cartridge is used to anchor bolts to the surrounding strata. This unification of the resin, bolt and strata layers provides the necessary strength and rigidity to prevent sag by acting as a reinforcement which anchors the individual stratified layers of rock into a single high strength beam.

The two-compartment cartridge shown in illustration A above consists of a heat-sealed tube of polyester film clipped at both ends. One compartment contains a dark gray resin; the other, a light gray catalyst. A cross section of the cartridge is shown in illustration B.

A film barrier of heat sealed polyester film prevents migration between the resin and the catalyst to provide optimum shelf life. The excellent chemical resistance of the film minimizes migration from the inside and the absorption of contaminants from the outside.

The lightweight, dimensionally stable casing of film is strong enough to withstand rough handling, but shreds quickly and thoroughly during the installation procedure. J-LOK is thixotropic and fast setting. This reduces viscosity during insertion of the bolt and permits relatively low installation force and torque. The results are fast installation, rapid achievement of full strength, and a minimum tendency for ungelled resin to drip from the holes during installation.

Storage Recommendations
For maximum shelf life, J-LOK cartridges should be stored away from direct sunlight in a reasonably cool, well-ventilated, dry area. Storage life is up to 1 year, depending on ambient temperature conditions. Under adverse conditions shelf-life is reduced. To ensure proper storage, the product should not be subjected to temperatures in excess of 85°F for prolonged periods. Storage is recommended under cover, on original pallets with adequate ventilation. If stored in trailers in hot weather, door should be left ajar or a sun screen erected over the trailer. Conversely, while cold storage does not adversely affect the shelf-life of J-LOK, it should be warmed to a range of 50°–60°F before using to assure gel times within the specified range (see Figure 2).

The time required for cases of J-LOK to warm or cool to ambient temperature is dependent on both the initial temperature and how the cases are stacked. Where the initial temperature is anywhere between 25° and 85°F, cases will come within 5° of ambient temperature in 48 hours when stacked in single columns with 4 sides of each case exposed to the air. Multiple columns should be separated by at least 2” to assist air circulation between columns.
Performance Data

1. Figure 1 represents the range of anchorage strengths for estimating requirements.

2. Depending upon the compressive strength of the rock being considered, the diameter of the hole may affect the anchorage strength — the larger the diameter, the larger the contact area.

3. Pull test under field conditions should be used to determine actual requirements.

4. Gel times are faster when temperatures exceed 55°F and slower when temperatures are below 55°F.

5. For RPM not shown in the Mix Table, determine minimum spin time based on 30 revolutions.

6. For 1 minute and lower gel times, the spin times indicated exceed the minimum 30 revolutions necessary for mixing. The additional spin times generates heat to achieve the stated gel times.

7. Mixing the resin and catalyst components in a cartridge creates a strong three dimensional polymer matrix that is reinforced with limestone filters. Most of the anchorage strength is reached in 5 to 10 times the product gel time.

General Installation Instructions

- The installation procedures should be followed carefully to ensure successful application of J-LOK® resin grouting
- Various factors affect installation. These instructions are general guidelines. Mine tests must be conducted with bolts to determine actual “mix” and “hold” times
- Bolts should be installed as soon as possible in newly-exposed roof. Roof that has shifted or sagged offers least chance for successful support
- Do not use ruptured or broken cartridges
- Refer to M.S.D. sheets and Product Bulletin for additional technical and safety data

<table>
<thead>
<tr>
<th>Gel Time @ 55°F</th>
<th>Mix Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin Times, Sec.</td>
<td>50 RPM</td>
</tr>
<tr>
<td>10 Seconds</td>
<td>N.R.</td>
</tr>
<tr>
<td>20 Seconds</td>
<td>N.R.</td>
</tr>
<tr>
<td>1/2 Minute</td>
<td>12–15</td>
</tr>
<tr>
<td>1 Minute</td>
<td>12–15</td>
</tr>
<tr>
<td>1-1/2 Minutes</td>
<td>12–15</td>
</tr>
<tr>
<td>2 Minutes</td>
<td>12–15</td>
</tr>
<tr>
<td>2-4 Minutes</td>
<td>12–15</td>
</tr>
<tr>
<td>7 Minutes</td>
<td>12–15</td>
</tr>
</tbody>
</table>

N.R. = Not recommended.
Safe Handling Precautions

Caution: Do not open or puncture cartridge. Physical contact with liquid contained in cartridge may cause mild irritation. Safety glasses or eye shield should always be used when roof bolting is done. In case of eye contact, immediately flush with plenty of water for at least 15 minutes. Call a physician.

In case of skin contact, flush skin with water. Prolonged contact with skin may cause mild irritation. Irritation should subside when material is removed.

For complete safety information, refer to the Safety Data Sheets. Copies will be furnished upon request.

Cartridges are filled with inert fillers, water, polyester resin and activator (active ingredients include low levels of styrene and modified benzoyl peroxide). J-LOK® cartridges are for industrial use only and are intended for use in conjunction with bolts. The relationship between hole dimensions, bolt size and the size and number of cartridges is critical to good performance. Your DSI representative will be glad to assist in determining the proper combinations for specific applications.

Uses

J-LOK has been a leading supplier of polyester resin cartridges to the mining industry for over 10 years. J-LOK resin cartridges allow for quick and reproducible anchoring of many varieties of bolts and cables. In mine roof support, J-LOK systems reinforce strata, providing strength and rigidity in untensioned systems, and ensure a durable anchorage for J-LOK resin grouted tensioned bolts. The reinforcement technique bonds the individual stratified layers of rock into a single, high strength beam. J-LOK resin cartridge can also be used in many other reinforcement, stabilization, and anchoring applications. The reliability of the anchorage system, plus ease of use and minimal resin setting times, will increase productivity and safety.

1 Insert necessary J-LOK cartridges into the hole.

2 Push the bolt into the hole to a point just below the roof line. Slow rotation of the bolt during insertion is optional.

3 Rotate the bolt as indicated above.

4a Fully Grouted Bolts
Push the bolt upward with the maximum thrust available from the machine and hold until J-LOK hardens. Do not rotate after Step 3. Damage to partially gelled resin may result.

4b Tension Rebar & Combination Bolts
Hold the bolt until the resin has hardened. This period of strength development will vary depending on gel time, product temp. and mine conditions. When resin has hardened, rotate the bolt until the desired torque is developed.

4c Resin Point Anchor Bolts
When J-LOK is used to supplement mechanical shell anchors, spin-to-lock.
**J-LOK® Resin**

**GEL, Spin and Hold Times**

**Gel Time**

Generally, the sum of the Spin Time and Hold Time is the Gel Time. The time from the start of mixing until the resin starts to harden is the Gel Time. Gel Time is influenced by temperature of resin, strata and bolt. Additionally, the amount of heat generated in mixing during the spin time also affects Gel Time. Field trials are recommended.

**Spin Time**

Cartridge contents should be completely mixed to achieve maximum anchorage. The generally accepted mix standard is a minimum of 30 revolutions of the bolt. Spin Time is the time required, at typical bolter rotation of 400 – 600 rpm, to achieve the complete mix.

**Hold Time**

After the cartridge contents are mixed, the resin must harden to achieve strength. The time required after mixing is completed and the bolt has achieved a firm anchorage is referred to as Hold Time.

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**Resin Cartridge Size**

The diameter and length of the J-LOK cartridge depends on the dimensions of the specific bolt and borehole. Cartridges are available in lengths from 12" to 60". The diameter and length of cartridges employed in USA coal mines are specified by ASTM F-432-10. The systems developed by J-LOK engineers following ASTM F-432-10 are summarized in the following table:

### Technical Data – J-LOK Resin Cartridges

<table>
<thead>
<tr>
<th>Cartridge Diameter, in. (mm)</th>
<th>Hole Diameter, in. (mm)</th>
<th>Bolt Type</th>
<th>Bolt Diameter, in. (mm)</th>
<th>J-Lok System*</th>
<th>Product Use Class</th>
<th>Strength Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>#6 Rebar</td>
<td>3/4 (19)</td>
<td>A</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>Point Anchor #6 Tension</td>
<td>3/4 (19)</td>
<td>A-TA</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>#5 Rebar</td>
<td>5/8 (16)</td>
<td>B</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>Cable</td>
<td>0.5, 0.6, 0.7 (13, 15, 18)</td>
<td>CA, A, B</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>INSTaL Resin</td>
<td>5/8 (16)</td>
<td>BI</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>1.25 (32)</td>
<td>1-3/8 (35)</td>
<td>#7 Rebar</td>
<td>7/8 (22)</td>
<td>J, CJ, Ji</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>1.25 (32)</td>
<td>1-3/8 (35)</td>
<td>Cable</td>
<td>0.5, 0.6, 0.7 (13, 15, 18)</td>
<td>CJ</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>1.25 (32)</td>
<td>1-3/8 (35)</td>
<td>Combination</td>
<td>7/8 (22)</td>
<td>CBJ, J</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>#6 Rebar</td>
<td>3/4 (19)</td>
<td>TA</td>
<td>I, II, III</td>
<td>10</td>
</tr>
<tr>
<td>0.9 (23)</td>
<td>1 (25)</td>
<td>#5 Rebar</td>
<td>5/8 (16)</td>
<td>TB</td>
<td>I, II, III</td>
<td>10</td>
</tr>
</tbody>
</table>

* Designated J-LOK Systems are shown for typical applications and can be used for other bolt types and sizes.
J-LOK® Resin Cartridge Drill Hole and Fill Charts

Mining Applications

The required diameter and length of J-LOK cartridges for civil and tunneling applications, not governed by ASTM F-432-10, is calculated by estimating the volume of the annulus between the bolt and the borehole. J-LOK cartridges are manufactured in diameters of 23, 28, 32, 35, and 40 mm. Cartridges may be manufactured in lengths to suit specific bolt and borehole combinations. However, it is generally more efficient to employ multiple standard one foot (305 mm) long cartridges to anchor each bolt.

The following English and metric tables, with 15% excess for borehole irregularities, assist in the selection and ordering J-LOK cartridges. The English unit table estimates the inches grouted by a standard one foot long cartridge. The metric unit table estimates the millimeters grouted by a standard 305 mm long cartridge.

For Example: a project requires a 3 meter long 22 millimeter diameter rebar, anchored with a one meter long resin anchor. The metric table indicates that this rebar may be installed in a 28, 33, or 35 mm borehole. Assume available equipment is best suited to drill a 33 mm borehole. A 28 mm diameter cartridge is best suited for this rebar and borehole combination. A 305 mm long 28 mm cartridge grouts 344 mm. Therefore, three 305 mm cartridges would be required per bolt. Typically a fast cartridge would be followed by two slow set cartridges, to provide for efficient insertion and rapid tensioning.

Civil & Tunneling Applications

<table>
<thead>
<tr>
<th>Grade 75 All-Thread Rebar</th>
<th>Drill Hole Diameter, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 in. (25)</td>
<td>15/16 (24)</td>
</tr>
<tr>
<td>1-1/4 in. (32)</td>
<td>1-1/32 (32)</td>
</tr>
<tr>
<td>1-1/2 in. (38)</td>
<td>1-1/38 (38)</td>
</tr>
<tr>
<td>1-9/16 in. (40)</td>
<td>1-9/16 (40)</td>
</tr>
<tr>
<td>1-3/4 in. (44)</td>
<td>1-3/4 (44)</td>
</tr>
</tbody>
</table>

Resin Cartridge Diameter, in. (mm)

#6, 3/4 in. (19 mm) 20 (508) 13 (330)
#7, 7/8 in. (22 mm) 16 (406)
#8, 1 in. (25 mm) 23 (584) 15 (381)
#9, 1-1/8 in. (29 mm) 16 (406) 14 (356) 20 (508) 16 (406)
1-3/16 in. (30 mm) 19 (483) 15 (381) 23 (584) 18 (457) 15 (381)
#10, 1-1/4 in. (32 mm) 18 (457) 22 (559) 17 (432)
#11, 1-3/8 in. (35 mm) 21 (533) 15 (381) 12 (305)
#14, 1-3/4 in. (44 mm) 14 (356)
150 KSI All-Thread Bar
1 in. (25 mm) 15 (381) 12 (305) 18 (457) 15 (381)
1-1/4 in. (32 mm) 23 (584) 16 (406) 12 (305)
1-3/8 in. (35 mm) 19 (483) 14 (356)
1-3/4 in. (44 mm) 18 (457) 12 (305)

The Resin Cartridge Drill Hole Fill Chart shows the length of drill hole that will be encapsulated by a 12 in. (305 mm) resin cartridge. This chart can be used as a guide for the most common combinations of hole, bolt, and resin diameters. Other combinations are possible as long as the annular space does not exceed 1/4 to 3/8 in. (6 to 10 mm). Due to difficulty in overcoming drag of the bar through the resin cartridges during insertion, encapsulated resin drill holes are most practical with shorter anchorages.
Pumbable J-LOK P™

- Uses a specialized pump and J-LOK™ formulation
- Injects J-LOK into the drill hole to anchor the bolts
- Designed for hard rock mines with the end goal of reaching a 100% automated process
- Specialized pump attached to bolter
- Completely automated injection process from cab
- Can be adapted for rebar or cable bolts

Two Methods

- **A** - Pre-Injection
  - Inject J-LokP into drillhole
  - Insert bolt and spin to mix
- **B** - Post-Injection
  - Install bolt with grout tube
  - J-LokP mixes in grout tube to anchor bolt

Component system can be skid-mounted or bolter-mounted.

The J-LOK P Pumpable Resin System can operate as a skid-mounted unit (left) or the components can be mounted directly to a bolter (right).

* The Pumbable J-LOK P System (including resin) is the subject of pending U.S. patent applications issued to FCI Holdings Delaware, Inc.
Pourable Resin Grout

- Fine aggregate filled liquid resin supplied in a mixing pail with a tube of cream hardener.
- Once cured, the product forms an effective corrosion barrier from a pH of 2 through a pH of 11.
- Uses include grouting dowels and anchor bolts in concrete, rock or masonry.

Specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength</td>
<td>ASTM C578-01: At 2 hours - 55 MPa (8,000 psi); At 7 days - 83 MPa (12,000 psi)</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>ASTM C307-03: At 7 days – 7.5 MPa (1,100 psi)</td>
</tr>
<tr>
<td>Typical pull strength</td>
<td>305 mm (12&quot;) of grouted #7 bar in a 32 mm hole has a pull strength of 13.6 metric tons (30,000 lbs.)</td>
</tr>
<tr>
<td>Shelf Life</td>
<td>Four months under good storage conditions</td>
</tr>
<tr>
<td>Packaging</td>
<td>Pail of resin grout, tube of cream hardener, mixing paddle</td>
</tr>
<tr>
<td>Kit Size</td>
<td>3.3 L (200 cubic inches) of grout</td>
</tr>
<tr>
<td>Pot Life</td>
<td>20 minutes at 25 degrees C . (Lower temperatures slow pot life)</td>
</tr>
</tbody>
</table>