SPFA-157

Polyurethane Foam for Concrete Lifting (Slab Jacking)

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ABOUT SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

Founded in 1987, the Spray Polyurethane Foam Alliance (SPFA) is the voice, and educational and technical resource, for the spray polyurethane foam industry. A 501(c)6 trade association, the alliance is composed of contractors, manufacturers, and distributors of polyurethane foam, related equipment, and protective coatings; and who provide inspections, surface preparations, and other services. The organization supports the best practices and the growth of the industry through a number of core initiatives, which include educational programs and events, the SPFA Professional Installer Certification Program, technical literature and guidelines, legislative advocacy, research, and networking opportunities. For more information, please use the contact information and links provided in this document.

DISCLAIMER

This document was developed to aid building construction and design professionals in choosing spray-applied polyurethane foam systems. The information provided herein, based on current customs and practices of the trade, is offered in good faith and believed to be true to the best of SPFA's knowledge and belief.

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DOCUMENT HISTORY

Date	Sections Modified	Description of Changes
January 2023		Initial Publication

GEOTECHNICAL APPLICATIONS COMMITTEE

Mission Statement

The mission of the Geotechnical Applications Committee is to provide a wide range of technical service to the SPF (spray polyurethane foam) industry such as, but not limited to:

- Providing a technical basis for expanding the use of polyurethane-foam-in-place geotechnical applications.
- Review and support the development of methods for performance evaluation of SPF, participate in activities leading to development, documentation, and dissemination of information on applications of SPF for various geotechnical applications.
- Participation in the planning, organizing, documenting, and supporting of construction and monitoring of selected demonstration projects with SPF for geotechnical applications in cooperation with the SPFA Board of Directors.
- Assisting the Board of Directors and Marketing Committees in developing and carrying out market-oriented programs.

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CONCRETE LIFTING PROCESS

The process of concrete lifting involves three steps: Drilling, Injection, and patching as shown below.

1. Drill: Hole(s) are strategically drilled through the concrete slab. The conditions below the slab are evaluated, and a proper lifting foam is selected.
2. Inject: The selected foam is then injected into the holes until the slab reaches the desired slope.
3. Patch: The holes are then patched with a concrete mixture.

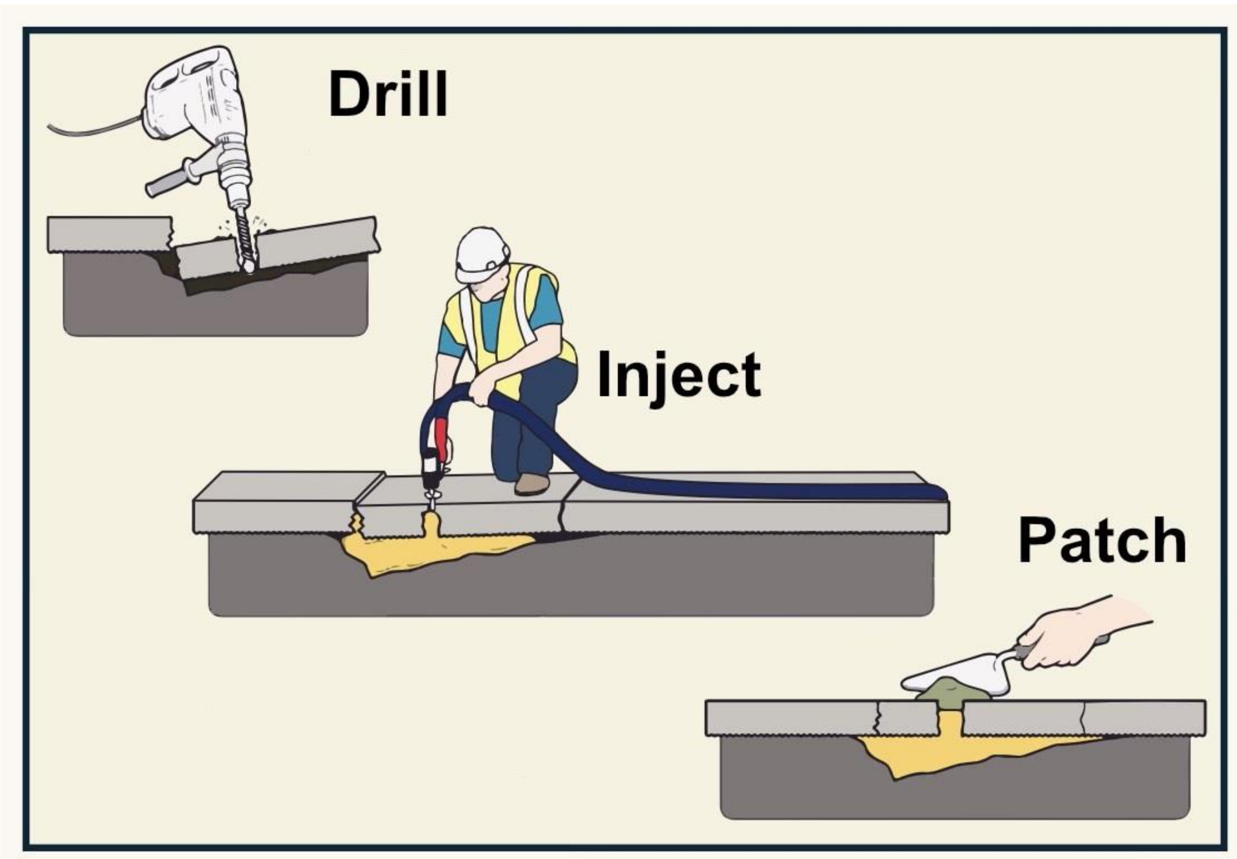

Image courtesy of ECP

FIGURE 1 – Concrete Lifting Process

GENERAL CONSIDERATIONS

To accurately submit a proposal or bid for any geotechnical related project, a thorough on-site inspection should be performed. This also includes a discussion with the building or asset owner to gather any background information on the problems or issues they may be experiencing that have led to making repairs.

Pre-project inspections should be as detailed and documented in full, which should include a site drawing or sketch and photographs, by the contractor to determine the viability of the project for the contractor and the building owner or asset owner. Important factors include:

- Is the concrete repair area suitable for using polyurethane foam?
- How long has the concrete settlement or void area been an issue?
- Have repairs been attempted previously?
- What is the estimated age of the concrete section or asset in question?
- What is the slab thickness? Are there any load considerations?
- What are possible causes slab settlement or sub-grade voids? Causes could include, poor soil compaction, poor storm water drainage, vegetation such as tree roots, water leaks or sanitary sewer leaks.

Once the preliminary inspection is performed, additional information may be required to determine the extent of the repairs needed, over and above visual inspections. Those may include.

- Drilling 5/8" or smaller test holes to probe the soils below the slab. Probing can be performed by using a steel plumbers' probe or equivalent
- When necessary, a borescope may be required to visually see under a slab to locate void areas or other sub-grade issues.
- In extreme cases the use of GPR or ground penetrating radar may be required to locate under slab utilities or possibly in-slab radiant heating.
- Do utilities need to be located? Electrical or conduit, natural gas or propane lines, water lines or sewer lines.
- In some cases, is a structural or geotechnical engineering report required prior to work commencing?
- Are there any connected adjacent structures that need to be addressed?

Following the full site inspection, the contractor can then move on to measuring and determining the necessary information to estimate for bidding or proposal purposes.

- Checking grade using properly calibrated measuring instruments such as tape measures, laser levels, zip levels or adequate equivalents.
- Is concrete saw cutting required at expansion joint, construction joints or structures within proximity of slab being lifted or repaired?
- Will secondary lifting mechanisms be required such as sidewalk jacks or equivalents?
- Is the repair area easily accessible for the contractor's polyurethane foam trailer or truck?
- Is the project within the capabilities of the contractor or applicator
- Polyurethane foam selection

- Quantity of polyurethane foam
- Ancillary costs such as inserts or packers, PPE etc.
- Patching drilled holes and clean-up
- Labor hours

A pre-project inspection not only ensures the contractor is properly prepared for submitting a bid or proposal, but the information gathered can be documented and fully explained in detail to the building or asset owner.

A contractor should understand in full the customers' expectations ahead of starting a project. Unfortunately, it is sometimes not possible to bring a concrete slab(s) back up to the exact grade or location as previously held. And this should be noted and explained in full to the building or asset owner ahead of time. Explaining the entire repair procedure in writing, verbally or both ensures that both the contractor and building or asset owner are in full agreement to proceed.

MATERIALS

General

Geotechnical Polyurethane Foam (GPF) materials are two-component systems, mixed at a ratio of 1:1 by volume using high-pressure plural-component proportioners and associated equipment. The two components consist of the A-side (MDI or methylene diphenyl diisocyanate) and the B-side (blend of polyols, blowing agents, surfactants, catalysts and other ingredients). The components are mixed and injected into cavities under concrete slabs where the reacting mass expands and lifts the slab.

When specifying Geotechnical Polyurethane Foam (GPF) materials used for concrete lifting consider the following variables:

- Moisture presence (hydrophobicity)
- Heat of reaction (exothermic properties)
- Rise and cure properties
- Physical properties (density and compressive strength)

These variables are discussed in detail in the following sections.

MOISTURE

Hydrophobicity of GPF is its ability to displace liquid water and react in the presence of high moisture levels. GPFs may be formulated as hydrophobic or non-hydrophobic.

GPFs formulated as hydrophobic are those that will react in the presence of liquid water and tend to displace that water. Where liquid water and/or high moisture levels are present under the slab, hydrophobic GPFs must be employed.

Non-hydrophobic GPFs are designed to be used in relatively dry soil conditions and not formulated to be injected into wet environments or high moisture conditions. Non-hydrophobic GPFs will react with sub-slab water resulting in poor quality foams that will not develop the intended physical properties.

When applied under the appropriate conditions, both hydrophobic and non-hydrophobic GPFs are considered closed-cell. Hydrophobic GPFs may be applied in wet or dry conditions; non-hydrophobic are limited to dry conditions.

HEAT OF REACTION (EXOTHERMIC PROPERTIES)

An exothermic reaction occurs when the two GPF chemical components generate heat as they react. Excessive exothermic heat generated during the GPF reaction can result in degraded foam and physical properties. Under extreme conditions and in the presence of oxygen, ignition and fire may occur.

Factors that tend to increase the generation of exothermic heat include higher GPF density, greater volumes applied and application procedures. Some GPF materials are formulated to minimize the exothermic heat and minimize potential problems.

Always consult your manufacturer for foam selection and application recommendations when specifying GPF materials for specific projects.

RISE AND CURE PROPERTIES

Reaction rates, flow properties, rise times and cure times determine how fast or slow a particular GPF will flow under a slab and rise and cure in place. GPF material manufacturers formulate products at various speeds. Proportioner and other equipment settings (preheater temperature, hose heat temperature, pump pressure, etc.) and project conditions (such as soil temperature, slab temperature, presence of water, etc.) will also affect the reaction rates.

Always consult your manufacturer for foam selection and application recommendations when specifying GPF materials for specific projects.

PHYSICAL PROPERTIES

Density and compressive strength are the primary physical properties to specify for GPFs. These two properties are correlated, i.e., higher density will normally yield higher compressive strength.

Density and compressive strength are normally determined using free-rise samples of GPF. In actual applications, GPF reacts and rises in confined sub-slab spaces, normally resulting in higher in-place density and compressive strength then free-rise test results.

When specifying GPF for a particular project, consider the dead load (weight of the concrete slab) and the live load (bearing capacity) of the project slab. Specify a GPF that will provide the necessary compressive strength with an appropriate safety factor.

When estimating the GPF materials required for a project, consider the estimated sub-slab void volume and the GPF yield based on density.

Property	Test Method	Value Range
Density (free rise)	ASTM D1622	3.0 – 4.0 lb/ft^3
Compressive Strength	ASTM D1621	80 psi
Tensile Strength	ASTM D1623	90 psi
Closed Cell Content		<90%
Dimensional Stability		<5%

Polyurethane foam insulation is combustible and should be treated as such. Flame spread ratings provided for polyurethane products using small scale tests are not intended to reflect the hazards presented by this or any other materials under actual fire conditions.

EQUIPMENT

GEOTECHNICAL FOAM INJECTION

The use of an air purged gun is not recommended for Geotechnical Foam Injection. The reason that these guns are not recommended is because their internal air ports allow any type of a possible backup of foam to flow unimpeded into the internal workings of the gun.

MECHANICAL PURGE GUNS

Mechanical purged guns are used in geotechnical foam application. The internal porting of a mechanical purge gun makes it much more resistant to the possibility of serious crossovers should a backup of foam occur during the application process.

MIXING CHAMBERS

The mechanical purge gun when used for Geotechnical Pour applications should be fitted with a mixing chamber designed for this specific application. The injection nozzles in the mixing chamber will be machined in such a manner as to allow a laminar flow with less velocity than would be used for spray application. It is highly recommended that spray modules not be used for Geotechnical Foam Injection. The reason for this is that spray modules are designed to mix

SPF chemicals and have the mixed chemical react quickly upon exiting the gun, such as for roof and wall applications. However, when performing Geotechnical Foam Injection, the mixed chemical must have time to flow to fill in any voids underneath the object which is being stabilized or leveled.

It is for the above stated reason Pattern Control Tips are not required for Geotechnical Foam Injection, instead the use of an injection port is substituted. The port allows foam to be injected underneath the concrete slab. The ports will be inserted into holes that have been pre-drilled into the concrete slab.

INJECTION PORTS

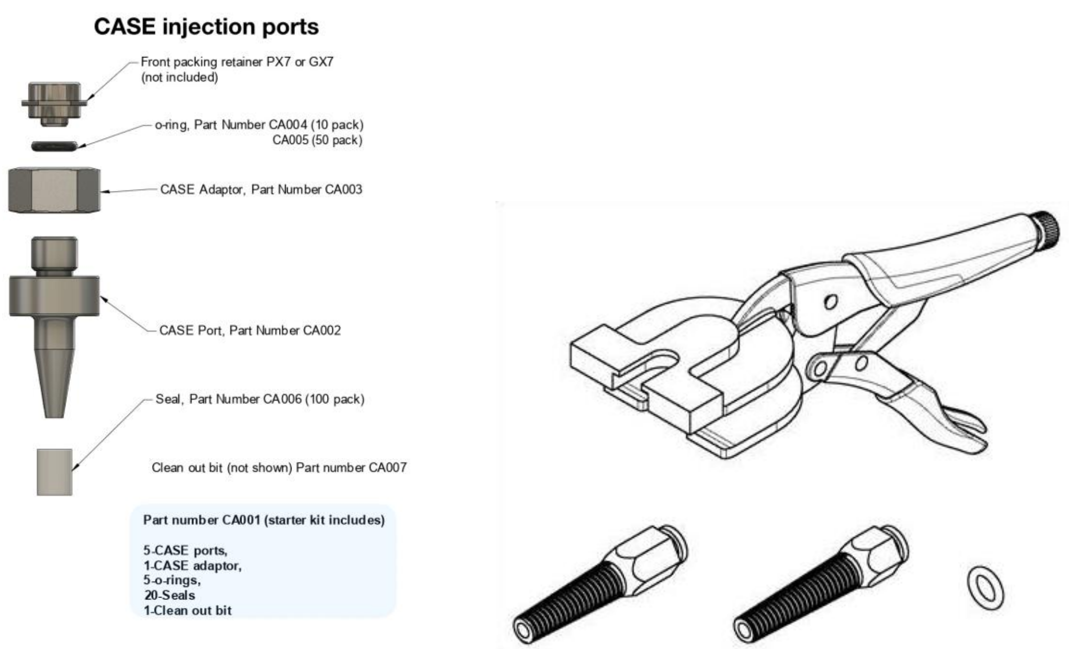

FIGURE 2 – Types of Injection Ports

Different methods are used to affix the injection port to the pour gun.

In the first example shown on the left of Figure 1, this is a screw on type adapter. The injection port is screwed onto the front of the gun by means of a screw thread which adapts it to the gun block of the mechanical purged gun. In this application port is inserted into the hole which has been drilled in the concrete.

On the second example, shown on the right of Figure 1, a modified clamp is used to affix the gun to the injection port, commonly known as a packer, which previously has been driven into the access hole drilled through the concrete. Packers are available in metal and plastic versions. In both cases reacted foam will remain in the bore of either the injection port or the packer. This reacted foam will need to be removed by the means of a clean out drill.

MECHANICAL PURGED GUN MAINTENANCE

Mechanical purge guns require daily maintenance and cleaning. Please refer to the manufacturer's suggested maintenance for the gun.   A flush pot can help with this maintenance please see an example in Figure 2 below.

FIGURE 3 – Example of a Flush Pot

SAFETY

GENERAL

All jobsite safety requirements outlined OSHA 1926 Safety and Health Regulations for Construction and, where applicable, OSHA 1910 Occupational Safety and Health Standards, shall be followed by the Contractor and their employees at all times.   The Contractor shall be aware of ALL OSHA safety requirements, specifically the general requirements of OSHA 1926, Subparts A-I.

In addition, the Contractor should possess an OSHA-compliant written safety program to document what the company's practices, rules, and guidelines are for a variety of areas.   An OSHA-compliant written safety program is required for all SPFA-PCP Accredited Contractors.   SPFA provides a model written safety program available at no cost to SPFA members.

Below are some specific sections of the OSHA safety standards that should be addressed by the Contractor.

CHEMICAL HAZARDS

Two-part polyurethane foam systems used in construction are formulated with methylene diisocyanate (MDI) in the A-side component. MDI is a chemical sensitizer and workers must use proper personal protective equipment when transporting, handling and installing these materials. The PPE requirements are listed in the Safety Data Sheet (SDS), provided by the manufacturer for both the A-side and B-side component chemicals used for polyurethane foam concrete lifting. When performing concrete lifting indoors, the SDS should state ventilation and re-occupancy requirements for workers and occupants.

HIGH-PRESSURE FLUID HAZARDS

High-pressure equipment used for installation of concrete lifting foams can be pressurized to more than 1000 psi. When servicing and troubleshooting spray-polyurethane foam (SPF) equipment, care must be taken to de-energize and de-pressurize all system components. Follow equipment manufacturer's guidelines.

SILICA DUST HAZARDS

Concrete lifting procedures require drilling and cutting of concrete. which generates crystalline silica dust that present a respiration hazard. Shrouds, vacuum systems and water should be used on all drills and saws to minimize respiratory exposure, as defined in OSHA 1926.1153.

HEARING PROTECTION

Power tools, such as drills, impact drills and saws, will generate occupational noise at levels that can be hazardous to workers. Permissible noise levels and duration, as defined in OSHA 1926.52, must be maintained for all workers. Use of ear protection may be required for certain cutting and drilling procedures.

FACE AND EYE PROTECTION

Cutting and drilling operations, as well as application of concrete lifting foams can create hazardous projectiles or airborne chemicals that can permanently damage the eyes. Approved safety glasses and/or masks must be worn when performing these operations, compliant with OSHA 1926.102.

ESTIMATING

Upon completion of a through pre-job inspection, preparing a detailed proposal for submittal to the building or facility owner is the next step.

SELECTING A GEOTECHNICAL POLYURETHANE FOAM

Product selection can be based on several factors.

- Amount of load or weight being carried
- Free Rise Density and strength values i.e., compression strength, tensile strength, shear strength etc.
- Amount of flow required or the reactivity of the polyurethane foam
- Void size or area to be filled which is typically calculated in cubic feet
- Exothermic reaction or possible heat generated based on void area and lifting or raising requirements

CALCULATING THE AMOUNT OF GEOTECHNICAL POLYURETHANE REQUIRED

Many manufacturers have detailed and useful calculators for determining the amount of polyurethane foam required for any given projection. The data, based on many factors, amount of lift, void area or square footage is entered into a spreadsheet of worksheet and the amount of polyurethane based on total pounds is determined.

- Select product density
- Amount of lift typically measured in inches
- Overall square footage of the repair area
- Void area or void area average
- Overage or packing factors
- Material cost per pound

EXAMPLE OF CALCULATING MATERIAL REQUIREMENTS

Slab Size – 10 feet x 10 feet

Square footage - 10 x 10 = 100 square feet

Slab Settlement – 2 inches, all sides

Volume in cubic feet – 10 feet x 10 feet x 2 inches = 16.7 cubic feet

Product or density selected – 4 pounds per cubic foot (pcf/Free Rise)

16.7 cubic feet x 4 pcf = 66.8 or 67 pounds of 4 pcf required. Less and overage for unforeseen voids or subgrade irregularities. Typical overages or added material can range from 10% to over 25% percent.

Total Material - 67 pounds + 25% overage = 83.75 or 84 pounds of polyurethane foam required

ADDITIONAL CONTRACTOR COSTING AND PROPOSAL CONSIDERATIONS

- Do you have a minimum charge? Many contractors will have a minimum charge to cover cost for small projects.
- Ancillary sacrificial costs can include packers or injection ports, injection rods, preparation and cleanup cost and materials
- Labor and overhead costs

- Fuel costs

PROPOSALS AND WARRANTY

Proposals and any warranty should be as detailed as possible to include drawing or photographs of the worksite, proposed injection points, detailed explanation of proposed work for start to clean up and most importantly, discussing and managing the expectations of the customer.

INSTALLATION

No two geotechnical projects are the same and several factors need to be considered to ensure for a successful project completion. Preplanning prior to the jobsite arrival is extremely important.

PREPLANNING CONSIDERATION

- Make sure all related polyurethane foam processing equipment and ancillary equipment is fully operational and properly maintained
- Make sure the injection gun and spare guns are clean and maintained. This may include having adequate spare parts on hand
- Making sure all appropriate hand tools and power tools and available and ready for use.
- Make sure the proper polyurethane foam is available and it has been properly stored in accordance with the manufacturer's storage recommendations
- Box truck or tow vehicle and or trailer are properly maintained and road worthy

TYPICAL INSTALLATION AND APPLICATION PREPARATION

- Layout an injection hole grid pattern based on predetermined settlement measurements. Injection hole spacing can vary based on amount of lift requirement and location of lift, amount of void to be filled and flow of polyurethane beneath the slab. Typical injection hole spacing can range from 2ft on center to 4ft on center based on settlement and void areas.
- If required precut using a concrete saw, any construction joints or rebar that may have an adjacent concrete slab held in a bind.
- Using an adequate hammer drill, drill the appropriate diameter injection holes. Hole diameter can vary based on packer or port diameter
- Insert the packers or ports in the predrilled holes making sure each is adequately secure in place
- Prior to polyurethane injection, make sure all surrounding structures or onsite assets are properly covered and protected from possible polyurethane blowouts or overspray.
- Any measuring devices such as levels, stringlines, dial indicators, laser level or zip levels should be set up and in place prior to injection.

TYPICAL INJECTION AND APPLICATION PROCESS

During the injection process, care and consideration should be given to maintaining awareness of the amount of polyurethane foam being injection at any given point, the amount of lift or pressure being exerted on the slab section and or surrounding slab sections. Monitoring the measuring devices for slab movement is important.

- Connect the injection to the packer or port. If applicable, be sure to use the required O-ring, placed between the injection gun and the packer or port
- Wet down the area around the injection location or use sand to keep any polyurethane foam from sticking or staining the surrounding concrete surfaces
- Using a small plastic bag or trash bag, wrap the injection gun and packer or port to restrain any polyurethane foam leaks or blowouts
- Begin injection monitoring both the amount of polyurethane foam being injected and check for any upward movement of the slab. Injection rates may vary from a few seconds to several seconds based on settlement.
- It may be necessary to inject in more than one location during the lifting process. Inject at several locations while bring up the slab as evenly as possible to reduce chances cracking of the slab.
- It may also be necessary to drill back through previously injected holes and re-inject

Once it has been determined that the slab is brought back up to its original grade the injection process can stop. In some cases, further injection may be required to fill voids between injection holes. If this is necessary, closely monitor for any unnecessary upward movement.

JOB COMPLETION

FILLING JOINTS, CRACKS AND DRILLED INJECTION HOLES

Once the injection process is completed, it is now necessary to fill any drilled injection holes with a cement-based filler. Fillers such as a cement and sand combination can be mixed on site or similar fillers can be purchased premixed.

Always consult with the customer to ensure the proposed filler meets their satisfaction. Especially if filling holes in stamped concrete, decorative concrete, or tiles.

Any saw cut joints, expansion joints or cracks should then be filled with an applicable concrete joint filler or caulking compound. Dependent on the joint or crack size it is generally necessary to use a foam backer rod or equivalent.

WORK SITE CLEAN UP AND FINAL WALK THROUGH

The entire work site should be removed and cleaned of any debris upon completing the project. Any landscaping removed or moved should be placed back as necessary. A walk through with the customer should be preformed also to ensure the completed work area meets their satisfaction and approval.

All contractor documentation should be completed at this point and submitted to the customer. This documentation can include the contractors signed proposal or project estimate, contractor warranty information and any other applicable documents.

NOTE: This guide is designed to help the specifier achieve a successful polyurethane foam insulation system. The specifier is responsible for consulting with the manufacturer of the material specified about the manufacturer’s specific recommendations.

SCOPE OF WORK FOR THE INSTALLATION OF POLYURETHANE FOAM

to Lift/Raise and or Underseal Concrete Sections

This request is for a qualified Contractor to provide services for the complete installation of polyurethane foam in a variety of subsurface conditions and to the general specifications. Verification of the Contractor's qualifications from the product manufacturer shall be submitted with this quote.

PART 1 GENERAL

The Work shall include a qualified contractor supplying and installing the polyurethane foam to meet the needs of the specific jobsite and to the criteria established herein.

1.1 References

A. ___________ Department of Transportation – _______ Standard Specifications for Highway Construction

B. ASTM D 1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.

C. ASTM D 1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.

1.2 Performance Requirements

Contractor shall provide the City design criteria for the selection of the proper strength and density as specified for each jobsite.

1.3 Submittals

A. Contractor shall submit injection drill pattern

B. Right of Way use permits and traffic control if required

C. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements by supplying manufacturers Certification of Compliance based on manufactured Lot number/system number of polyurethane used for completion of related project.

1.4 Quality Assurance

A. Manufacturer Qualifications: Company specializing in manufacturing polyurethane foam products and systems of this section with minimum ten years documented experience.

B. Installer Qualifications: Company specializing in performing Work of this section with minimum three years documented experience.

1. Installer must be a certified insulation contractor or have manufacturer's certification for the application.
2. Installer shall provide the equipment required by the manufacturer for proper installation including high pressure plural component proportioning pump, heated hoses of suitable length, gun, drum pumps or other material feeding system, and other ancillary equipment required for the Work.

1.5 Delivery, Storage, and Handling

A. Store products under cover in manufacturer's unopened and labeled packaging until ready for installation.

B. Chemical storage temperatures should be in accordance with manufacturer's storage and handling instructions.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 Coordination

Contractor shall be responsible to coordinate pre-installation meetings as necessary with the City's Representative. Ensure that the installation of products of this section is coordinated with affected trades to prevent interruption of construction progress.

PART 2 MATERIAL

2.1 Polyurethane

A. The polyurethane shall be a hydrophobic, closed cell, high density polyurethane system with the following physical characteristics and properties:

Physical Properties

• Free Rise Density, ASTM D1622	3.0 – 4.0 lbs ft^3
• Compressive Strength, min., ASTM D 1621	80 psi
• Tensile Strength, min., ASTM D 1623	90 psi
• Closed Cell Content	>90%
• Dimensional Stability	<5%

B. The material shall be hydrophobic injected product that is not significantly compromised by soil moisture or free water.

C. When requested by the City's Representative, the Contractor shall perform a product density test by injecting a sample of the unit's polyurethane material into a test cylinder of known volume. When requested by the City's Representative the Contractor, shall inject the polyurethane material into a container holding 40 gallons (150 L) of ambient temperature water at 70 F (21 C). The resulting product shall demonstrate consistent, closed cell polyurethane material.

D. All stored chemical systems shall be handled in accordance with the manufacturer's recommendations.

PART 3 INSTALLATION

3.4 Installation

A. Install the polyurethane in accordance with manufacturer's instructions.

B. Injection nozzles shall prevent leakage during injection and shall be removed at completion of the injection or driven into the injection hole to a minimum depth of 1 ¼ inches (31 mm) below the pavement surface.

C. Any excessive material on the pavement surface shall be removed from the area and the holes shall be sealed with a polyurethane or pre-approved patching material.

D. The pavement shall not be open to traffic until a minimum of 30 minutes after pumping operations have ceased.

E. The contractor shall establish a finish target profile using an elevation measuring device or string line. Each profile shall be accepted by the City's Representative prior to work being performed at that location.

F. Pumping operations shall cease when the slab has achieved the target profile.

G. The Contractor shall provide equipment capable of detecting slab lift to measurements of 0.001 inch (0.03 mm). Pavement lifted in excess of 0.125 inch (3 mm) over the accepted profile or pavement cracked as a result of the slab jacking will be unacceptable. The City's Representative may require the contractor to verify positive drainage on the lifted concrete section.

APPENDIX

SUGGESTED LIST OF EQUIPMENT

Site Evaluation / Job Documentation

- ☐ Note Pad and Pencil
- ☐ Calculator
- ☐ Camera with Still and Video Capabilities
- ☐ Tape Measure and or Measuring Wheel
- ☐ Soil Probe or a Fiber Glass Driveway Marker (for checking soil density)
- ☐ Borescope (for viewing the underside of a slab and void trough a small, drilled hole)

On-Site Job Tools

- ☐ Cordless Hammer Drill
- ☐ Hammer Drill Bits (Sizes: 12”, 18”, 24”, 36”) Dia. Determined by the port 3/8” or 5/8”
- ☐ Cordless Sawzall with Diamond Blade and Regular Blade
- ☐ Concrete Saw
- ☐ Cordless Hand Drill
- ☐ Dial Indicator, Laser Level, Transit or Zip Level (for detecting slab movement)
- ☐ Clean 5-Gallon Buckets
- ☐ Extension Cords
- ☐ Trowels with a Thin Diamond Shaped Blade
- ☐ Garden Hose
- ☐ Hand Pump Sprayer
- ☐ Channel Locks
- ☐ Pry Bar
- ☐ Miscellaneous Hand Tools and Wrenches
- ☐ Shovels
- ☐ White Lithium Grease
- ☐ Teflon Tape
- ☐ Wire Brushes (hand and drill attached)
- ☐ Port for Injection Gun
- ☐ Disposable Gloves
- ☐ Safety Glasses

Clean-Up

- Hole Patching Material
- 50-Gallon Contractor Grade Garbage Bags
- 50- Gallon Plastic Garbage Can
- Plastic Sheeting or Tarp
- Broom and Dustpan
- Rags
- Brake Cleaner or Solvent Cleaner
- Cleaning Kit for Injection Gun
- Can for Soaking Gun Parts
- Spray and Tube White Lithium Grease