USA, INC.
Subsidiary of Greenstreak, Inc.

PROJECT: BROOKHAVEN NATIONAL LABORATORIES

Objective: **To propose and gain approval for the grouting techniques and waterproofing barrier criteria (means and methods) required to stop the leakage through the walls and ceilings and concrete substrate areas identified at the jobsite inspection conducted on 1/17/2001 at the Brookhaven National Laboratories.**

Structural Repairs, Spalling, Drainage, etc. @ Roof Exterior Retaining Walls
It was agreed during the jobsite meeting that the structural repairs at the roof retaining walls would be addressed prior to any injection procedures. It was also agreed that further investigation of structural instability (i.e. rebar corrosion) would be coordinated through Brookhaven Laboratories A&E Division, prior to attempting to address leak remediation and crack repair.

Selecting a Repair Strategy
When cracking within the structure occurs, the potential exists for strength of the structure to fall below its design capacity, in which case repair will be required to regain this strength. In this situation, it is usually necessary to determine the interconnectivity of the cracks, to determine, for example, whether they are only on the surface, or whether they penetrate the structure, before the repair is attempted.

Before a strategy or combination of strategies can be agreed upon, the extent of damage and/or deterioration should be assessed.

There are many repair materials available, which are engineered for specific repairs and applications. In order to determine what material would be the most cost effective and long term performance assured, we need to see the extent of the repair required.

The cracking observed on the exterior of the wall facing south illustrated classic signs of freeze-thaw damage. In cold climates, joint leaks in water-retaining structures can saturate exposed concrete surfaces, resulting in freeze-thaw damage. Rebar corrosion can also be accelerated, resulting in further damage as was visible at this area.

Exterior Roof Retaining Wall
The exterior walls need to be cleaned off and the cracks and cracking patterns exposed in order to determine the best approach. Extent of rebar corrosion should be identified prior to commencing any repair activity.

The most common repair strategy for leaking joints is to stop or reduce the flow of liquid by grouting or installing surface seals. Other methods include reducing the pressure head, collecting the flow, or a combination of each. Each strategy has benefits and limitations.

In many situations, where groundwater buildup causes leakage through foundation joints, relieving pressure by diversion can solve leakage problems. Drilling holes through foundation walls, installing drains and routing flow to acceptable locations may reduce pressure significantly. However, positive side can be difficult, depending on the extent of dewatering and excavation required.

Several options are available, however, we would recommend a "belt and suspenders" approach, which would stop the leak if one of the systems utilized fail. Combination systems can be designed to withstand both negative and positive pressure heads.

<u>Option No. #1</u> – Complete structural repairs, excavate and install a new drainage system. Wait and monitor structure for subsequent leakage.

<u>Option No. #2</u> – Complete structural repairs, drill through the wall to intersect the soil concrete wall interface and inject an acrylate-ester swelling grout to create an impermeable waterproofing barrier between the backfilled earth soil and wall interface.

<u>Option No. #3</u> – Complete structural repairs, install a new drainage system or repair existing drainage system, and spot inject cracks and critical areas by drilling at 45° degree angle to a depth of half the thickness of the wall and inject a two component acrylate ester swelling polymer grout sealing the cracks and interconnectivity of cracking patterns within the wall structure.

<u>T-Beams – Interior Walls/Floor/Joints and Ceiling/Walls/Beam Interface Joints</u>
All interior wall, floor, ceiling and joint connections and cracks need to be cleaned off, chipped paint and stains removed to expose the cracks and reveal extent of damage.

Some of the cracks that are dry and dormant can be grouted with epoxies or mircofine cement materials, sanded and re-painted. Cracks and joints subject to water intrusion should be injected either into the joint itself or into the cracks at a 45°degree angle to completely fill and seal the cracks and the interconnectivity of crack within the compromised member.

An option, which was discussed at the inspection, was the use of surface seals and topically applied waterproofing products. There are many materials on the market which claim to be able to stop leaks and bridge cracks. Experience has proven that with the type of leakage and deterioration which was visibly evident in the Target Rooms, it is the writer's opinion that surface seals would not be a long-term solution in the critical areas of wall-ceiling and beam-wall interface.

<u>Surface Seals</u>
Negative side seals. In many applications – due to the service conditions or methods of construction – seals must be installed on the negative side of the joint. Negative side systems must resist the forces crated by fluid build-up beneath the seal.

There are many methods and materials available to construct negative-side seals. All systems require careful consideration for termination and end details. Fluid pressure

will build up behind negative-side seals and fluid *will* exit wherever connections to the structure are weak or nonexistent.

Leakage through seals usually occurs at the end or termination area; any point of discontinuity will render the seal worthless. Fluid allowed to enter the seal will track behind it, traveling through the conduit formed by the seal. Water control materials which are applied on inside surfaces often fail quickly because they depend on their bond strength to the substrate.

Injection procedures allow placement of sealant on the outside and into the cracks while working from the inside. Surfaces can be finished off with a mortar or polymer concrete overlay.

Option No. #1 – Clean walls, ceilings, joints, and visible cracked areas free of debris and chipped paint. Drill and inject dormant cracks with epoxy and/or microfine cement. This will increase the strength and reduce the shrinkage. Grind, sand and re-paint.

Option No. #2 – Clean walls, ceilings, joints, and visible cracked areas free of debris and chipped paint. Drill and inject all cracks with an hydrophilic acrylate ester resin. In this case, the grout fills the voids and stops the leaks.

Option No. #3 – Cleans walls, ceilings, joints, and visible cracked areas free of debris and chipped paint. Utilize a combination of Option No. #1 and Option No. #2.

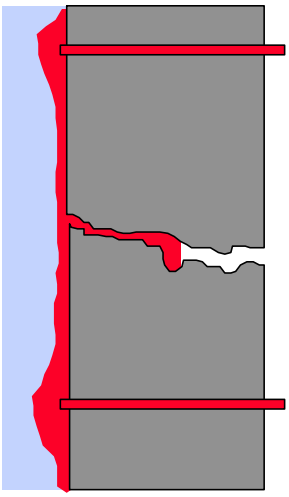
Walls or columns weakened by cracks and structural movement may need a strong material which also stretches to restore some strength while keeping out the water.

The BBZ Certified Applicator is to utilize a rehabilitation technique which consists of injection through the concrete walls, ceilings and joints walls with the use of a low viscosity, acrylate-ester resin injection grouts called, Duro Soil and Duroseal Inject 2000.

Duroseal Inject 2000

Application:

- **Sealing of the entire defective areas against water pressure, moisture an non-active cracks**
- **Packer injections of systematically set drillings**



Duro Soil

Application:

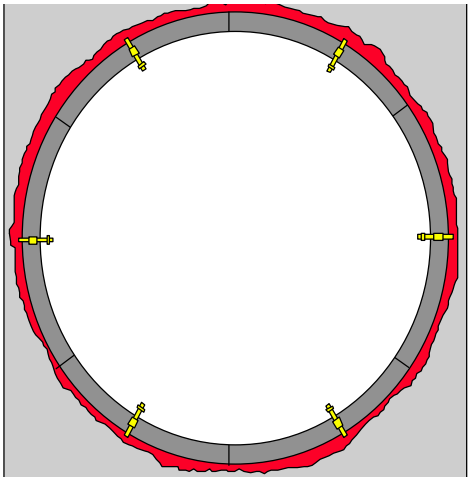
- **Soil stabilization and impermeable waterproofing Barrier for below grade civil engineering projects**
- **Mixing ratio**
  - **1:02 for high compressive strengths**
  - **1:1 for sealing and filling voids**

Duroseal Inject 2000 **is a solvent-free, water-soluble injection gel for use with two-component injection pumps.**

Inject 2000 is used for the injection and sealing of joints and cracks in concrete and stone against pressing and non- pressing water using an injection packer. Due to its low viscosity and therefore low flow resistance *Duroseal Inject 2000* is able to penetrate into the smallest of hairline cracks and capillaries, sealing them reliably and permanently. *Duroseal Inject 2000* is perfect for sealing surfaces, for example, as an injection application between structural concrete and soil in defective areas.

Even if the injected structure subsides or the dimensions change, the seal created by the *Duroseal Inject 2000* remains in tact, because the material is able to swell up to a factor of 2 (double its volume) on contact with water. The swelling is reversible, meaning that the self-healing properties remain even after dry periods. The swelling and re-swelling is solely dependant on the availability of water or liquid. In a wet or damp environment a state of equilibrium is set up between the water content of the surrounding medium and that of the *Duroseal Inject 2000*. Due to the moisture in the concrete, the material remains in a swollen state.

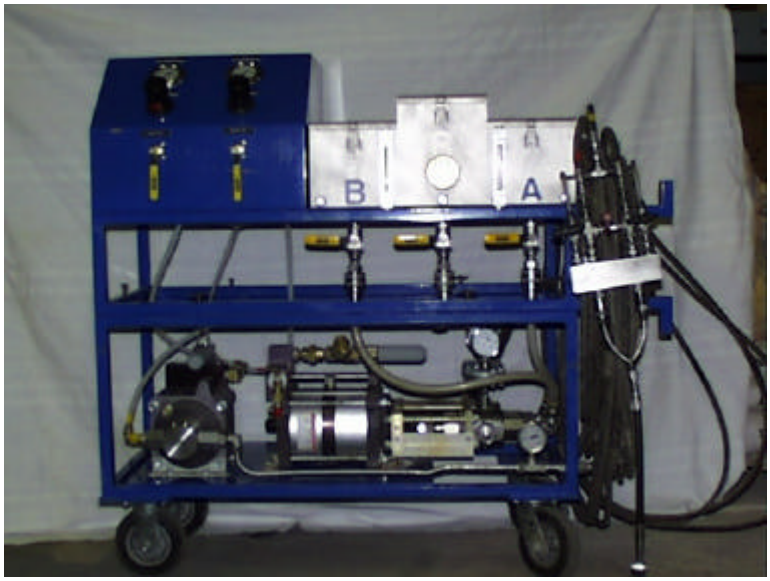
Duroseal Inject 2000 **as a result of its hydrophilic components, is able to respond even to damp surfaces (as opposed to other products, such as, polyurethane resins. Because *Duroseal Inject 2000* does not chemically react with water, a foam layer which would reduce adhesion is not produced. *Duroseal Inject 2000* has Standard 61 NSF approval for drinking water use.This material has been successfully utilized in creating swelling membranes as shown below:**



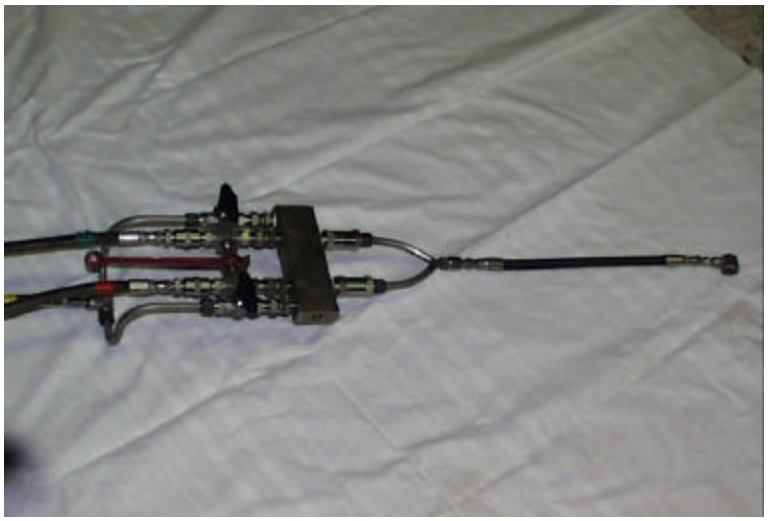
EQUIPMENT - TWO COMPONENT INJECTION PUMP:

Two component injection pumps are utilized to inject highly reactive grout materials. Materials that have reaction times within the range of seconds now become possible to work with. Duro Soil and Duroseal Inject 2000 are typical materials that are injected with the use of a two-component pump. Injecting highly reactive materials with a two-component pump is the only suitable technique to seal a crack with hydrostatic pressure.

Another benefit of two-component pumps is the probability to constantly inject large quantities of grout over a long period of time.



Two component pumps eliminate the need of pre-mixing material. The material is mixed in the "head" by the static mixer prior to injection into the injection packer. The cleaning of the static mixer will run automatically when injection is stopped, therefore, making it possible to inject resins and gels with very short reaction (cure) times.



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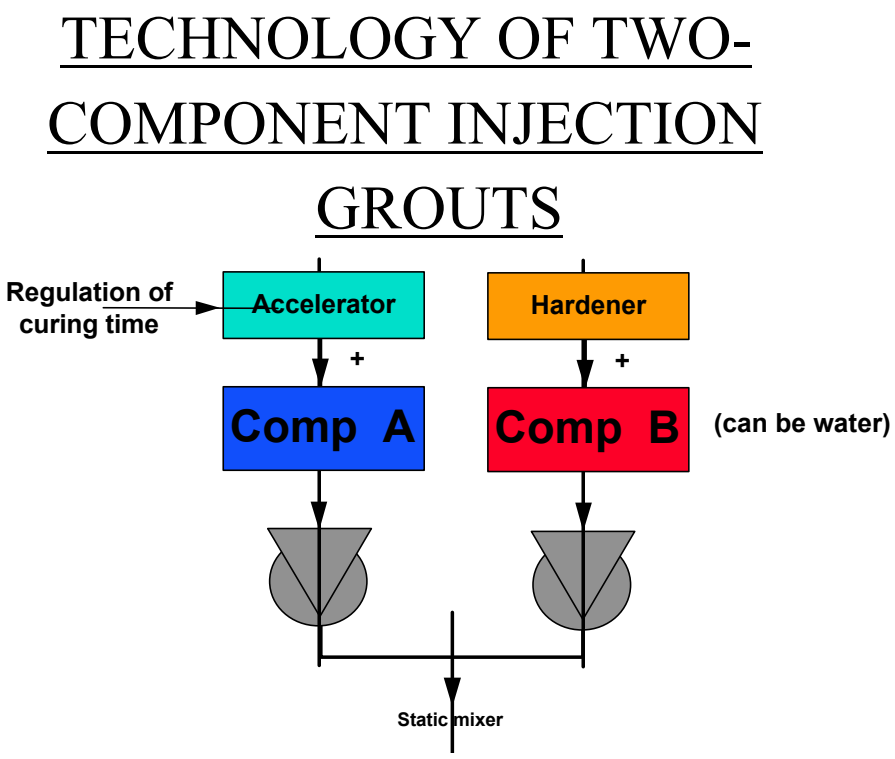

Applications for two component materials would be sealing of the entire defective areas of the structure against water pressure, moisture (dampness/weeping) at active and non-active cracks. Packer injection of systematically set drillings to permanently seal medium-to-high water pressure.

Filling of large cracks and voids utilizing a method of systematic drilling with distances calculated in accordance with actual test performances and materials mixing with ratios that reflect actual test results for cured material.