

# GROUTING PLAN

Jamaica ER BRF 013-1 (16)

Jamaica, Vermont

Vermont Agency of Transportation

**RECEIVED**

Jamaica ER BRF 013-1(16) Grouting Plan Review.pdf

CK'D BY VHB OK'D BY \_\_\_\_\_

June 7, 2013

RESUBMIT YES **Rejected**  
BY JTS DATE 6-21-2013

Submitted for Approval

6-5-2013

## SUBMITTAL REVIEW

- Reviewed and approved but only for conformance to the Construction Contract Documents.
- Revise and Resubmit (*Pages 1-28 of the attached*)

Corrections or comments made during this review do not relieve the Contractor or his Designer from compliance with professional requirements or for responsibility for the adequacy of the submittal information. This check is only for review of general conformance with industry standards and general compliance with the information given in the Contract Documents. VHB has not conducted a detailed review of the submittal and has not performed calculations or assessed the adequacy of loads, design criteria, quantities, dimensions, etc. Approval of the submittal does not constitute VHB's approval of any construction means, methods or techniques. These remain the responsibility of the Contractor.

**VHB**

Vanasse Hangen Brustlin, Inc.

Job Number: 57550.00

Reviewed By: G.S. Goodrich

Date: 6-21-2013



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**INTRODUCTION**

The purpose of this Grout Operational Plan is to specifying correct installation, inspection, and documentation methods for compliance with the project specifications and ensure the adequacy of the corrosion protection of the prestressing steel and the bond between the prestressing steel and surrounding concrete (if applicable).

The plan is based on the Contract Documents, DSI Post-Tensioning Drawings, Project Specifications, PTI Guide Specification for Grouted Post-Tensioned Structures, and past experience and the requirements of the specific project specifications.

The plan is divided into six major sections:

**Material**

**Equipment**

**Personnel**

**Procedures**

**Testing**

**Documentation**

Appendices are included for additional details, record keeping, and field use, and will include specific materials or equipment for the project.



## MATERIAL

- REQUIREMENTS
- TYPE
- QUANTITY



**MATERIAL REQUIREMENTS**

Grout shall be a commercial, prepackaged, cement-based grout meeting the requirements of the Special Provisions and subject to the approval of the Engineer.

Grout Material will be provided with the following information on the bag:

- Date of Manufacture
- Lot Number
- Mixing Instructions

Quality Control Data Sheets for each lot number and shipment of material which is delivered to the project will be provided to the Contractor and furnished to the Engineer as required.

The date of manufacture of the grout shall not exceed six months.

Grout shall be mixed according to the manufacturers recommendations.

Grout shall have non-bleeding characteristics.

Grout shall contain no aluminum powder.



MATERIAL QUANTITY

Below are to grout calculations for longitudinal tendons:

Grout Quantities

Tendon	Description	# Tendons	Length ft	Bar per Tendon	Bar	Bar Area Sq-in	Duct Area Sq-in	Net Duct Area per Tendon Sq-in per ft.	Net Duct Volume per Tendon CF	Total Volume CF
T1-T5	Straight	5	31.42	1	1-3/8"	1.58	4.227	56.35	1.02	5.12
T1-T12	Straight	10	32.67	1	1-3/8"	1.58	4.227	56.35	1.06	10.64



## **EQUIPMENT**

- REQUIREMENTS
- TYPE
- QUANTITY

# DYWIDAG-SYSTEMS INTERNATIONAL



## EQUIPMENT REQUIREMENTS

The Contract Documents require the use of a high speed shear colloidal mixer and pump which will provide continuous mechanical mixing. Mixing duration shall be adequate to obtain a uniform, thoroughly blended grout without excessive temperature increase.

The grout pump shall be a positive displacement type pump, capable of producing a minimum outlet pressure of 145 psi, with seals adequate to prevent oil, air or other foreign substances entering into the grout and to prevent the loss of grout or water.

The maximum grouting pressure shall not exceed 145 psi at the inlet.

Normal grouting operations shall be performed at approximately 75 psi.

*10-50 psi per  
72(e)(4) of the spec.*

A pressure gauge with a full-scale reading not exceeding 300 psi shall be located in the grout injection line between the pump and the grout injection port.

Screens shall be used to prevent entry of lumps, etc. into the pump. Maximum screen openings shall not exceed 1/8-inch or 3/16-inch is a grout with thixotropic properties.

The grouting equipment shall be capable of maintaining the specified maximum grouting rate of 50 linear feet per minute.

A calibrated water reservoir and/or water meter shall be present to provide accurate measurement of batch water.

The tendons will be grouted in less than thirty minutes.

Flow cones shall be used to measure the efflux time at the mixer prior to injection and at the terminating outlet.

Standby grouting equipment shall be present during all grouting operations.

Vacuum grouting equipment shall be readily available to the site in the event voids are detected after grouting within 48 hours of detection.

# DYWIDAG-SYSTEMS INTERNATIONAL



## EQUIPMENT TYPE

### GROUT PLANT:

DSI will provide a modified CG-600 series grout plant manufactured by Chemgrout for all grouting operations. The plant features the following:

- High Shear Colloidal Mixer (13 CF)
- Agitated Storage Tank (13 CF)
- 20 GPM Grout Pump

The high shear colloidal mixer is centrifugal diffuser-type pump which circulates the grout mixture in excess of 1500 RPM providing a mixture with superior physical properties.

The 13 cubic foot storage tank provides continuous agitation of the grout prior to injection as well as uninterrupted mixing and pumping.

The grout pump is a progressive cavity, positive displacement, rotor-stator pump or piston pump.

A gauge will be present on the pump and / or inlet if hose is in excess of 100 feet, to allow monitoring of pressure.

A screen will be installed at the upper portion of the storage tank to prevent lumps, etc. from entering into the pump.

50ft x 1-1/4" inside diameter hose will be utilized during grouting to transfer the grout from the pump to the point of injection. If necessary, additional 1-1/4" diameter hoses may be used to extend the length of the injection hose.

Under normal conditions, the grout equipment is capable of continuously grouting the longest tendon on the project in 30 minutes or less.

# DYWIDAG-SYSTEMS INTERNATIONAL



## EQUIPMENT TYPE (cont.)

### ACCESSORIES:

A water meter and/or calibrated water reservoir will be present to provide accurate liquid measurements of batch materials.

The water reservoir, if used, will be capable of measuring from 2 to 45 gallons of water. A clear sight-tube on the exterior of the reservoir will be calibrated on site.

Standard 1-1/4" diameter rubber hoses with quick coupler disconnect will be used for extending the length of the grouting hose as required.

If there is a possibility of stage grouting, all grouting hoses will be placed along tendon paths as deemed necessary prior to production grouting.

The end of the grout hose may be fitted with a ball valve to stop the flow of grout at the injection location as required.

*Also Required testing every 2 hours of grouting.*  
Flow cones will be used to measure the efflux time of the grout at the plant prior to injection of the first tendon each day. A flow cone will also be present at the tendon outlet to measure the efflux time of the grout which has been exhausted at each outlet.

Thermometers will be used to measure the ambient temperature and the temperature of liquid and solid grout materials. *90° Max @ inlet end of grout hose. Temp to be checked hourly.*

Standard five gallons buckets will be used to assist in efflux test and containing waste grout.

Plastic sheathing and tarps will be used to protect the surrounding area from the grout.

**See Appendix B** for Equipment Details.



EQUIPMENT QUANTITY

The following table provides the minimum quantity of equipment required to properly execute the grouting of the post-tensioned tendons.

DESCRIPTION		PURPOSE
Colloidal Grout Plant / Standby		Grout Plant
Water Meter / Water Reservoir		Water Measurement
50ft x 1 1/4" Grout Hoses		Primary Grout Hoses
50ft x 1 1/4" Grout Hoses		Stage Grouting Hoses
3/4" Ball Valve		Grout Injection Nozzle
3/4" Ball Valve		Stage Grouting Injection Nozzle
Flow Cones		Measurement of Efflux Time
Thermometers		Temperature Measurement
375 cfm Air Compressor		Power for Grout Plant
5 Gallon Buckets		Waste Grout and Testing
Plastic Sheathing		Weather Protection for Grout



# PERSONNEL

- Requirements



## PERSONNEL REQUIREMENTS

Grouting personnel that are responsible for direct supervision of grouting operations in the field, such as the foreman of the grouting crew, shall have a minimum of three years of experience on previous projects involving similar grouting. A written experience record or training certificate for each supervisor involved in grouting operations shall be submitted to the Engineer for approval.

**Grouting certifications will be provided approximately 2 weeks before commencement of grouting activities.**



## PROCEDURES

- PRE-GROUTING
- PRODUCTION GROUTING
- POST GROUTING



**PRE-GROUTING PROCEDURES**

All OSHA standards shall be followed. Safety glasses, gloves, dust mask, and other protective equipment shall be used as required.

After Engineer's approval of stressing operations, the strand shall be cut 3/4 inches from the wedge with an abrasive saw or other acceptable means.

Inspect anchorage bolt holes and grout tube ports for obstructions and re-tap if necessary. Check surface of anchor and clean if necessary for cap sealing.

Install permanent non-metallic grout caps and grout vents at anchorage locations.

Install plugs or valves at vent locations.

Purge all tendons with oil-free compressed air to remove water and debris.

Air pressure test each tendon as detailed in the Contract Documents.

Check all locations and grouting accessories with oil-free compressed air to locate leaks within the tendons or grouting accessories. If found, repair all leaks to the satisfaction of the Engineer.

Set up grout plant, power unit, grout materials, water supply, back-up equipment, measuring devices, grout hoses, and testing apparatuses.

Calibrate water reservoir and / or other measuring devices as required.

Protect all grout material from the elements with plastic sheathing or tarps.

PRODUCTION GROUTING

In general, tendons shall be grouted as follows: Grout will be injected into the tendon from the live end anchor and vented at the dead end anchor for all tendons. In the event stage grouting is necessary, grout will be injected into an intermediate vent, provided grout has been ejected from the vent.

*Clarify: which end is low end vs. which end is "live" end... Are these the same?*

FIELD GROUTING PROCEDURES :

All OSHA standards shall be followed. Safety glasses, gloves, dust mask, and other protective equipment shall be used as required.

Grouting shall not occur when the air temperature is below 40 degrees (F). The temperature of the grout material shall not reach less than 45 degrees (F).

Open all vents prior to initial grout injection (with the exception of low point drains if present).

Add water to the mixing tank followed by the grout and mix until a uniform, thoroughly blended mixture is obtained. Do not over-mix. Mixing time should be approximately three minutes.

Take a sample of the mixture and perform the applicable efflux test as required.

If efflux time falls within the required range, proceed with injection. Should efflux time be greater than 20 seconds, adjust mix by adding water. Should efflux time be less than 9 seconds, waste all mixed material, clean grout plant, and re-batch with adjusted water content. Water may be added only in accordance with the manufacturer's recommendations.

Monitor grout flow by manually checking air displacement at the vents.

*See Spec.: Efflux times to be within 5 seconds of the values established during lab. testing.*

*\* Pre-Grout Meeting: w/Contractor, Grouting Crew, and Agency to discuss and understand grouting operation plan, required testing, and corrective procedures.*

PRODUCTION GROUTING (cont.)

FIELD GROUTING PROCEDURES (cont.)

Control grout flow by adjusting the operating speed of the grout pump. The flow of grout should be maintained such that the tendons are grouted at a rate of 16 to 50 linear feet of duct per minute and the pressure stays between the range of 10 to 50 psi.

Sequence of grout valve closures

Close grout cap vent and grout port at the terminating anchorage(end opposite the grout pump) after air and/or water, and acceptable grout has been wasted from the vent and anchorage grout port.

Close intermediate grout vent(s) in sequence (working backward toward the grout pump) after air and/or water have been expelled and acceptable grout has been wasted from the vent.

If required, take a sample of the grout that has been wasted from the final outlet and perform an efflux test in accordance with the Contract Documents. The efflux time shall be within or exceed the maximum efflux time allowed. If the efflux time is not acceptable, additional grout shall be discharged and tested until the efflux time falls within or exceeds the maximum efflux time allowed.

After closing the grout vent at the final outlet, the tendon shall be pressurized with additional grout to a minimum pressure of 50psi and wait two minutes to determine if any leaks exist. If no leaks are present, bleed the pressure to 50 psi and wait ten minutes for any entrapment of air to flow to the high points. After the ten minute period has expired, increase as needed to discharge grout at each high point to eliminate any entrapped air or water. Complete the process by locking the pressure of 30 psi into the tendon.

5 min.  
per  
Spec

Close injection vent while the tendon is under pressure.

If flow of grout cannot be maintained, the tendon shall be adequately flushed with water and/or compressed air. The pressures during the flushing operation shall not exceed 145 psi.

## POST GROUTING

Grout valves, plugs, or other accessories shall not be opened or removed until the grout has set.

There shall be no loading or other operations on the structure that will subject the grout to shock or vibration for a period of 24 hours.

After grout has set, generally 24 to 48 hours, and in the presence of the Engineer, the grout caps shall be sounded in order to detect possible voids within the grout cap.

The anchorage grout vents shall be cut flush with the anchorages and inspected for possible voids in the trumpet area immediately adjacent to grout port.

All intermediate vents shall be cut flush with the concrete and inspected for voids.

If voids are present in either the cap or vent locations remedial work shall not be performed without approval from the Engineer.

In the event that grouting is aborted or interrupted for any reason, the duct shall be flushed with water at the discretion of the Engineer and immediately air dried using oil-free compressed air. Grouting will re-commence once the reason for interruption is resolved.

If voids are located after grouting is completed, vacuum grouting shall be performed. Vacuum grouting equipment will be on-site in case of this occurrence within 48 hours.

# TESTING

## TESTING

*Req'd. @ mixer & duct outlet every 2 hours of grouting: see spec section 72 (f) (4)*

Perform fluidity test on initial grout mix to determine the efflux time and the allowable water content.

Fluidity testing shall be in accordance with the Contract Documents.

Ambient and grout temperature shall be measured.

The maximum grout temperature shall not exceed 90 degrees Fahrenheit.

Grouting shall not be performed if the ambient temperature is less than 40 deg Fahrenheit.

*Special Prov. Section 7*

- Also need:*
- *Two Density tests per day (72 (f) (2))*
  - *One strength test per day (72 (f) (3))*
  - *One pressure bleeding test per day (72 (f) (1))*

# DOCUMENTATION

## DOCUMENTATION

*within 72 hours*

A grouting record shall be submitted to the Engineer after the completion of grouting operations.

The grouting record shall include, but not be limited to the following:

- A) Tendon Identification
- B) Date Grouted
- C) Water / Cement Ratio
- D) Injection Location(s)
- E) Ambient Temperature
- F) Grout Temperature
- G) Efflux Times
- H) Maximum Grouting Pressure
- I) Grouting Duration
- J) Quantity of Grout Injected, To be determined by the number of grout bags actually used in grouting operation.

*Missing info*  
*See Special Prov.*  
*SECTION 72 (j)(1-12)*  
*- Theoretical Grout vol.*  
*per size/type of tendon*  
*- Additions*

See Appendix D for Grouting Record details.



# APPENDIX A

## Euco Cable Grout PTX TECHNICAL DATA

### EUCO CABLE GROUT PTX

#### HIGH PERFORMANCE CABLE GROUT

#### DESCRIPTION

EUCO CABLE GROUT PTX is formulated to produce a pumpable, non-shrink, high strength grout. It provides unparalleled corrosion protection for steel cables, anchorages and rods. EUCO CABLE GROUT PTX is extremely fluid, and cured grout is similar in appearance to concrete. EUCO CABLE GROUT PTX exhibits thixotropic properties defined in PTI specifications, and can be used to repair previously grouted cables.

#### PRIMARY APPLICATIONS

- Post-tensioned cables and ducts
- Grouting of tight clearances

#### FEATURES/BENEFITS

- Superior corrosion protection
- High fluidity for easy placement
- Non-shrink
- Exceptional strength
- Aggregate free
- Pumpable for a minimum of 2 hrs @ 90°F (32°C)

#### TECHNICAL INFORMATION

PROPERTY	RESULT @ 1.5 gal/50 lb (5.7 L/22.7 kg) mix water (unless otherwise noted)
Flow Rate ASTM C 839 modified	9 to 20 seconds initial flow *9 to 30 seconds at 30 minutes
Initial Setting Time at 70°F (21°C) ASTM C 833	8 to 12 hours (depending on material and ambient temperature)
Compressive Strength ASTM C 842	7 days: > 3,000 psi (20.7 MPa) 28 days: > 7,000 psi (48.3 MPa)
Hardened Height Change ASTM C 1090	24 hours: 0.0% to 0.1% 28 days: 0.0% to 0.2%
Plastic Expansion ASTM C 840	0.0% to 2.0% for up to 3 hours
Wick Induced Bleed ASTM C 840 Modified according to C.4.4.6.1 of the PTI Guide Specification	0.0% at 5 minutes 0.0% at 3 hours
Schupack Pressure Bleed Test @1.5 gal/50 lb (5.7 L/22.7 kg) mix water	0.0% (5 minutes @ 100 psi)
Schupack Pressure Bleed Test @1.7 gal/50 lb (6.4 L/22.7 kg) mix water	0.0% (5 minutes @ 50 psi)
Chloride Permeability ASTM C 1202	28 days (30V for 6 hrs): < 2,500 coulombs

\*Tested under laboratory conditions with a 30 second re-mix prior to measuring the flow.

EUCO CABLE GROUT PTX is a free flowing powder designed to be mixed with water. After mixing and placing, the color may initially appear much darker than the surrounding concrete. While this color will lighten up substantially as the grout cures, the grout may always appear somewhat darker than the surrounding concrete.

GROUTS

EUCO CABLE GROUT PTX

Master Format #: 03 62 13



**The Euclid Chemical Company**

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An **FDIM** Company





## AVAILABILITY & SHELF LIFE

**\*\*EUCCO CABLE GROUT PTX is Made To Order (MTO) and has a 10 day lead time.** It has a 6 month shelf life in the original, properly stored, unopened package.

## PACKAGING/YIELD

EUCCO CABLE GROUT PTX is packaged in 50 lb (22.7 kg) bags or pails and yields 0.54 ft<sup>3</sup> (0.015 m<sup>3</sup>) of fluid grout when mixed with 1.5 gal (5.7 L) of potable water. Yield is 0.56 ft<sup>3</sup> (0.016 m<sup>3</sup>) when mixed with 1.7 gal (6.4 L) of potable water.

## DIRECTIONS FOR USE

If the contractor is not familiar with standard grout placement techniques, a pre-job meeting is suggested to review the project details unique to the particular job. Refer to the PTI Guide Specification for Post-Tensioned Structures for proper mixing, pumping and placement practices.

### Mixing:

Consistency	Estimated Water Content*
Fluid	1.5 to 1.7 gal/50 lb (5.7 to 6.4 L/22.7kg)
Flowable	1.3 to 1.5 gal/50 lb (4.9 to 5.7 L/22.7kg)

\* Do not add water in an amount that will cause bleeding. Do not add aggregate or cement to the grout since this action will change its precision grouting characteristics.

**Curing and Sealing:** Cure all exposed grout by wet curing for 24 hours, then with a high solids curing and sealing compound, such as Super Diamond Clear or Super Diamond Clear VOX.

## PRECAUTIONS/LIMITATIONS

- To minimize bleeding in vertical applications greater than twenty feet, The Euclid Chemical Company recommends a water dosage no greater than 1.50 gal/50 lb (5.7 L/22.7 kg).
- Clean tools and equipment with water before the material hardens.
- Do not add any admixture or fluidifiers.
- Do not use any more or less water than what is specified above.
- Store materials in a dry place.
- Application temperature must be 40° F (4° C) or above and remain so for 24 hours after placement.
- Employ cold weather or hot weather grouting practices as the temperature dictates.
- Rate of strength gain and setting times are significantly affected at temperature extremes.
- The Euclid Chemical Company is not responsible for stress corrosion caused by ingredients in the flushout, saturation, or mixing water, or for contaminants either in the space being grouted or from other materials used in the system.
- In all cases, consult the Material Safety Data Sheet before use.

Rev. 11.12

WARRANTY: The Euclid Chemical Company ("Euclid") solely and expressly warrants that its products shall be free from defects in materials and workmanship for one (1) year from the date of purchase. Unless authorized in writing by an officer of Euclid, no other representations or statements made by Euclid or its representatives, in writing or orally, shall alter this warranty. EUCLID MAKES NO WARRANTIES, IMPLIED OR OTHERWISE, AS TO THE MERCHANTABILITY OR FITNESS FOR ORDINARY OR PARTICULAR PURPOSES OF ITS PRODUCTS AND EXCLUDES THE SAME. Every Euclid product fails to conform with this warranty, Euclid will replace the product at no cost to Buyer. Replacement of any product shall be the sole and exclusive remedy available and buyer shall have no claim for incidental or consequential damages. Any warranty claim must be made within one (1) year from the date of the claimed breach. Euclid does not authorize anyone on its behalf to make any written or oral statements which in any way alter Euclid's installation information or instructions in its product literature or on its packaging labels. Any installation of Euclid products which fails to conform with such installation information or instructions shall void this warranty. Product demonstrations, if any, are done for illustrative purposes only and do not constitute a warranty or warranty extension of any kind. Buyer shall be solely responsible for determining the suitability of Euclid's products for the Buyer's intended purposes.

## DYWIDAG-SYSTEMS INTERNATIONAL



The tentative Grout Mix Designs will be as follows:

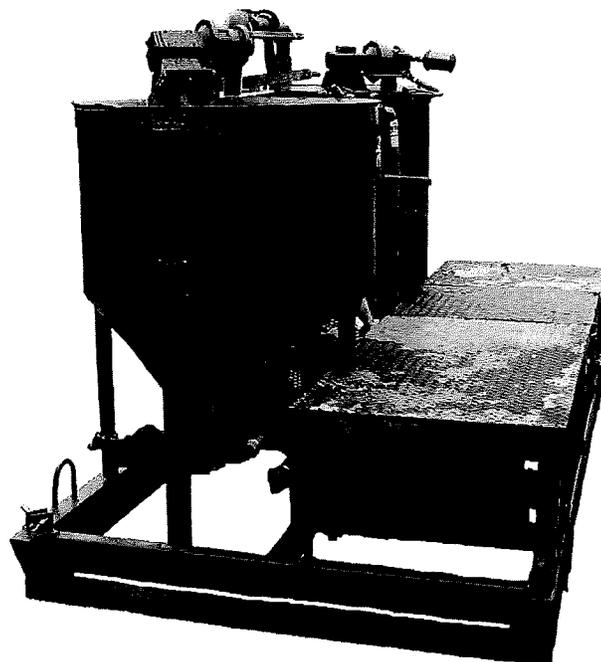
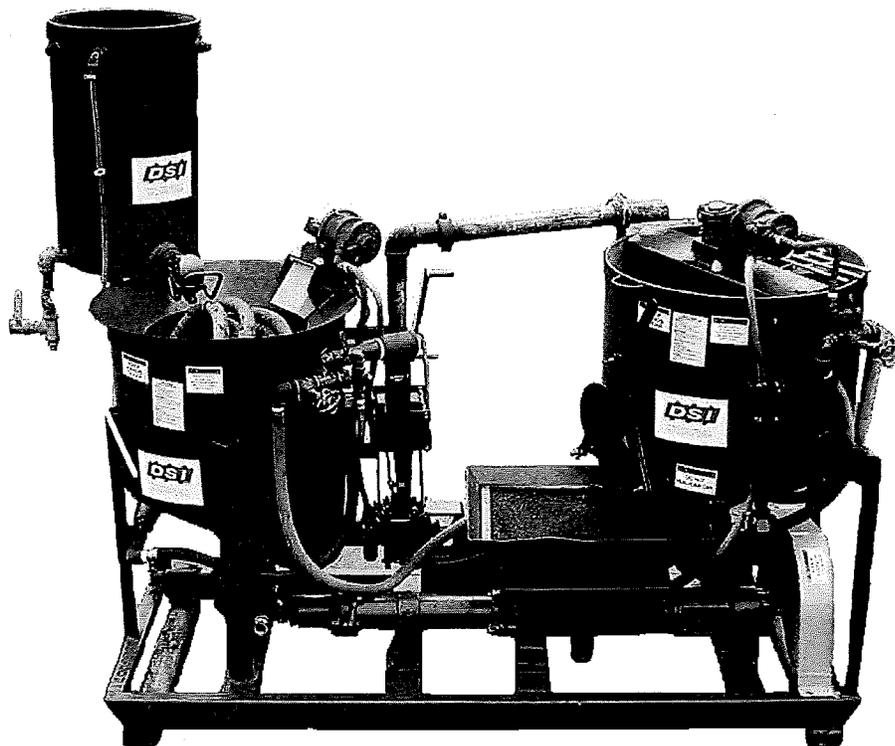
Euco Cable Grout PTX	50 lbs.
Potable water	1.50 gallons
Percentage of water	26%

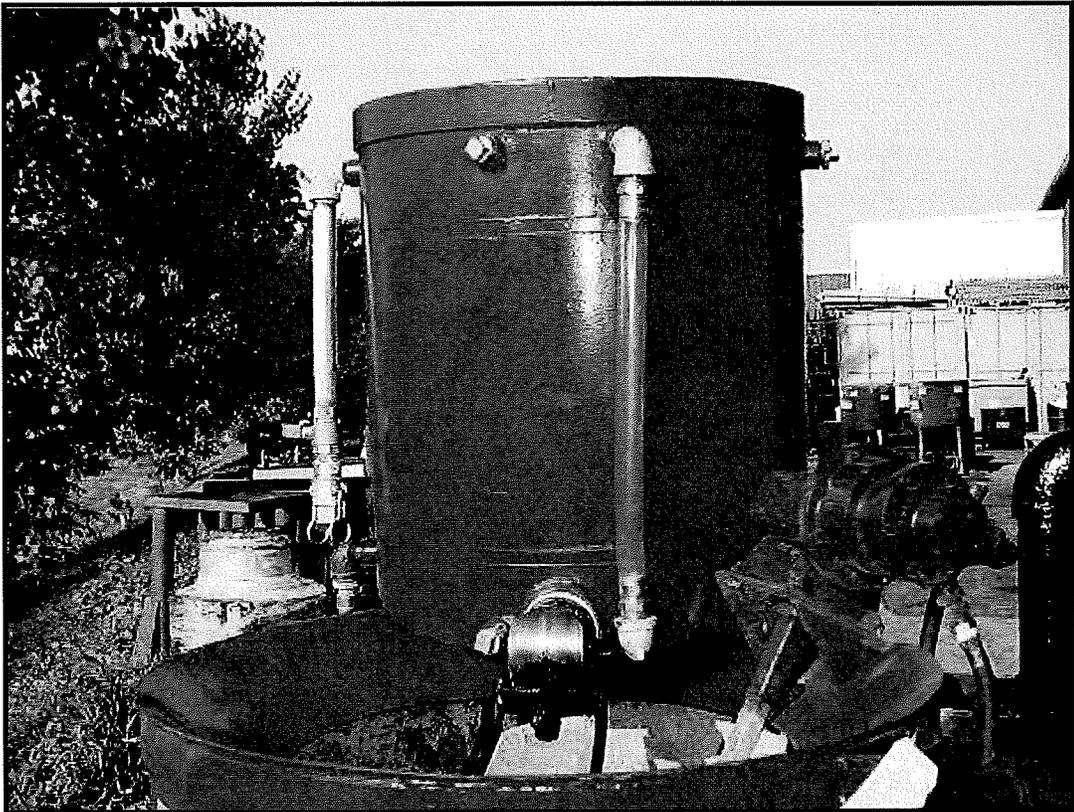
Grout and water shall be mixed for approximately 3 minutes after the addition of the last bag of grout or until a homogeneous mixture is achieved.

# APPENDIX B

EQUIPMENT & ACCESSORY DETAILS

## COLLOIDAL PLANT





DYWIDAG-SYSTEMS INTERNATIONAL



# APPENDIX C

## GROUTING RECORD

