



FIVE STAR PRODUCTS, INC.

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DESIGN-A-SPEC™ GUIDELINES FIVE STAR DP EPOXY GROUT PG

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This document is provided for informational purposes only and as a general guideline for consideration by contractors and engineers. While every reasonable effort has been made to ensure that this information is accurate and authoritative, Five Star Products does not warrant the accuracy or completeness of this information, or for its appropriateness for any particular purpose. The user of this document remains solely responsible for the specification of all methods, materials and practices.

GENERAL CONDITIONS - EPOXY GROUTING

1.01 SCOPE

The work covered by this document consists of furnishing all equipment, materials, labor and performing all operations required for the installation of precision nonshrink epoxy grouts as directed by the engineer or owner.

1.02 QUALITY ASSURANCE

- A. The manufacturer shall have been in the business of manufacturing similar products for over ten years, maintain a strict quality assurance program, offer technical services and provide a representative at the jobsite for product training, prior to product installation, upon written request.
- B. The contractor shall submit to the engineer or owner, at least three job references where the contractor has successfully completed similar applications.

1.03 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered to the jobsite in their original, unopened packages, clearly labeled with the manufacturer's identification, printed instructions and batch code.
- B. Store and condition the specified product in accordance with the appropriate product data sheet.
- C. For handling instructions, refer to the Material Safety Data Sheet.

1.04 PROJECT/SITE CONDITIONS

Refer to PART C - PREPARATION, ENVIRONMENTAL CONDITIONS, or contact the manufacturer directly for any physical or environmental limitations required by the product.

1.05 MEASUREMENT AND PAYMENT

- A. Measurement of the grouting work shall be on a cubic foot (liter) basis of material in place.
- B. Payment for the grouting work shall be at the unit price bid on a cubic foot (liter) basis. This payment shall constitute full compensation for all labor, materials, tools, equipment and other items as necessary to complete the work as described in the contract documents. Progress payments will be made on the percentage of the work satisfactorily completed during each payment period in accordance with the provisions of the contract documents.

MATERIAL SPECIFICATIONS - EPOXY GROUT

2.01 MATERIALS

- A. Nonshrink epoxy grout shall be a 100% solids, pumpable, pre-packaged system containing thermosetting epoxy resins, expansive additives and inert fillers. The manufacturer shall be ISO 9001 certified and have at least 10 years experience in the manufacture of nonshrink epoxy grouts. The manufacturer shall offer technical services and provide a representative at the jobsite for product training prior to product installation upon five days advance notice.
- B. The grout material shall be pumpable and meet all the following typical performance criteria when post cured at 73°F (23°C):

1. Compressive Strength, ASTM C 579 B*

Aggregate Content	5 Bags/Unit		4 Bags/Unit	
	Comp. Strength psi (MPa)	Comp. Modulus psi (MPa)	Comp. Strength psi (MPa)	Comp. Modulus psi (MPa)
1 Day	10,000 (69.0)	1.5×10^6 (10.4×10^3)	9,000 (62.1)	1.4×10^6 (9.7×10^3)
7 Days	14,000 (96.6)	2.0×10^6 (13.8×10^3)	13,000 (89.7)	1.9×10^6 (13.1×10^3)
Post cured 140°F (60°C)	16,500 (113.8)	2.2×10^6 (15.2×10^3)	15,500 (106.0)	2.0×10^6 (13.8×10^3)

2. Height Change, 90°F (32°C),
ASTM C 827 Positive Expansion Positive Expansion

3. Effective Bearing Area 95% 95%

4. Tensile Strength,
ASTM C 307 2,300 psi (15.9 MPa) 2,300 psi (15.9 MPa)

5. Creep, ASTM C 1181
1 year, 400 psi (2.8 MPa),
140°F (60°C) 4.0×10^{-3} in/in (mm/mm) 4.7×10^{-3} in/in (mm/mm)

6. Flexural Strength,
ASTM C 580 4,500 psi (31.2 MPa) 5,000 psi (34.6 MPa)

7. Bond to Concrete,
ASTM C 882 Concrete Failure Concrete Failure

8.	Coefficient of Expansion,		
	ASTM C 531	$20 \times 10^{-6} \text{ in/in/}^{\circ}\text{F}$	$22 \times 10^{-6} \text{ in/in/}^{\circ}\text{F}$
		$(36 \times 10^{-6} \text{ mm/mm/}^{\circ}\text{C})$	$(40 \times 10^{-6} \text{ mm/mm/}^{\circ}\text{C})$

**Rate of loading 0.25 inches per minute.*

The data shown above reflect typical results based on laboratory testing under controlled conditions.

Reasonable variations from the data shown above may result in the field. Test methods are modified where applicable.

- C. An acceptable product which meets these criteria is:

Five Star[®] DP Epoxy Grout PG

As manufactured by Five Star Products, Inc., Fairfield, CT 06824 (203) 336-7900.

- D. Subject to meeting the performance criteria stated above, other products may be formally submitted to the engineer for approval up to three days prior to the bid date. All requests for approval shall contain certified test data verifying conformance with the specification. Three references of successfully completed projects of similar nature and scope of the work detailed in this specification shall be provided as well as a minimum ten year history of use in the industry. The testing laboratory shall certify to any modifications made to the test performed and provide details of modifications.

2.02 AGGREGATE REDUCTION

- A. Aggregate content of the epoxy grout shall not be reduced beyond manufacturer's recommendations.
- B. Manufacturer shall submit data for epoxy grout at reduced aggregate content for engineer's approval.

2.03 CLEARANCES

- A. The grout shall be placed from 1/2 to 9 inches (12 mm to 229 mm) in depth. For baseplate clearances less than one-half inch (13 mm) or greater than 9 inches (229 mm), contact manufacturer.

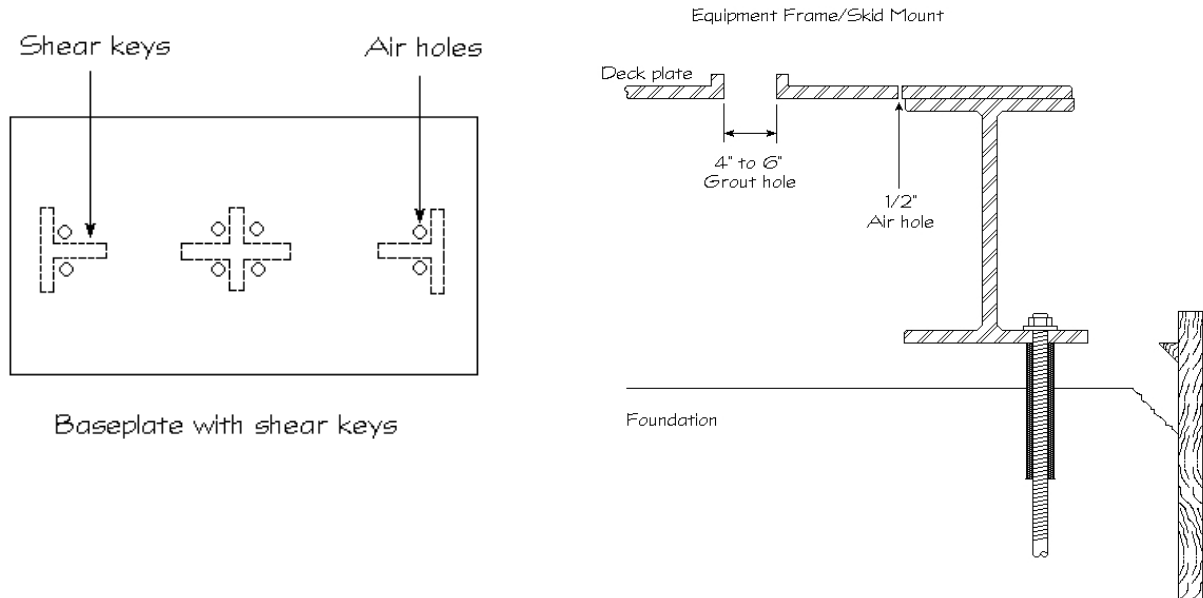
PREPARATION - EPOXY GROUTING

3.01 CONCRETE SURFACES

- A. Concrete surfaces shall be dimensionally stable, free of oil, grease, laitance and other contaminants. Mechanically roughen surfaces to obtain clean, sound concrete by acceptable mechanical means, exposing coarse aggregate.
- B. Prior to placement, concrete surfaces shall be visibly dry.

3.02 METAL SURFACES

- A. Where bond to metal surfaces is not required, coat with a bond breaker such as paste wax or duct tape.
- B. Where bond to metal surfaces is required, the surface shall be clean, free of oil, grease, rust and other contaminants. Sandblasting to a SSPC-SP6* commercial finish will optimize bond development of epoxy to steel.
- C. Provide 1/4 to 1/2 inch (6 to 12 mm) air relief holes where baseplate configuration and high spots will entrap air.



- D. When grouting skid mounted equipment or frames, provide a four to six inch diameter (100 to 150 mm) grout filling hole in the center of each bulkhead section.

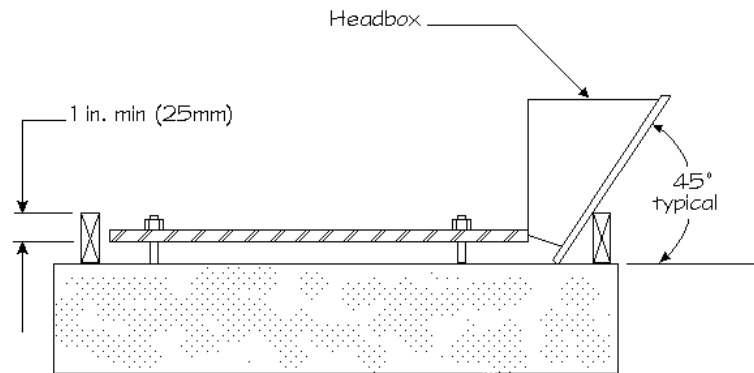
*SSPC-SP6

Commercial blast cleaned surface is defined as one in which all oil, grease, dirt, mill scale, rust and old paint have been completely removed from the blast cleaned surface, except that slight streaks, or discolorations caused by rust stain, mill scale oxides, or slight tightly adherent residues of paint or coating may remain. If the surface is pitted, slight residues of rust or paint may remain in the bottom of the pits. The slight discolorations mentioned above are limited to one-third of every square inch.

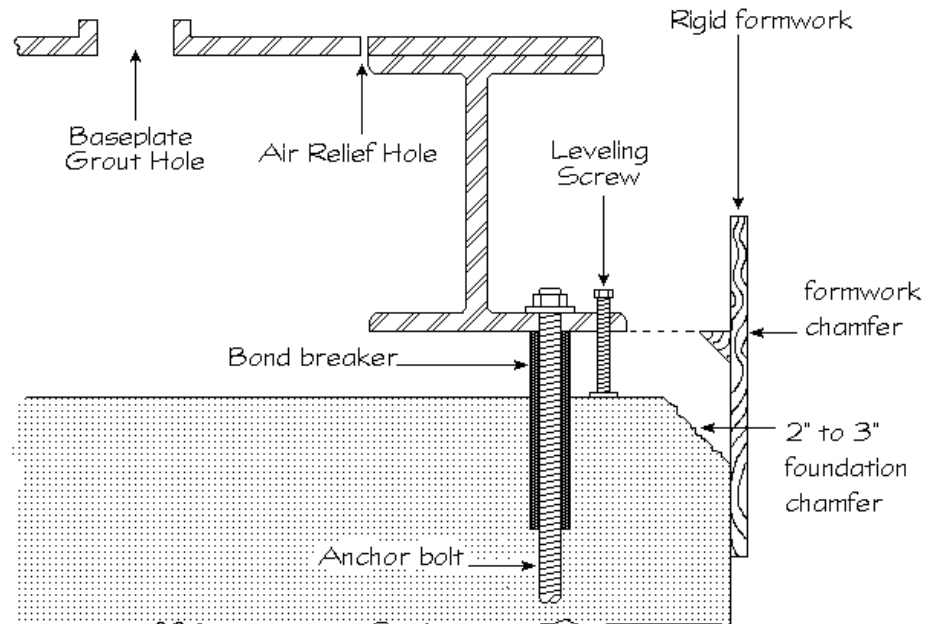
3.03 FORMWORK

- A. Formwork shall be constructed of rigid nonabsorbent materials, securely anchored, caulked liquid tight and strong enough to resist forces developed during grout placement. Chamfer edges shall be built into forms before grout placement.
- B. Formwork shall be constructed so that grout is placed across the shortest distance whenever possible. The clearance between formwork and baseplate shall be sufficient to allow for headbox. The clearance for remaining sides shall be one to three inches (25 to 75 mm).

Epoxy grout shoulders should not exceed 3 inches without additional mechanical anchoring.

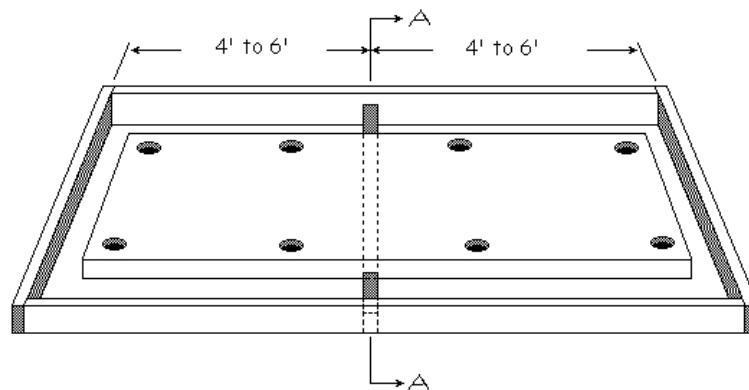


- C. Height of formwork shall extend a minimum of one inch (25 mm) above bottom edge of the baseplate. Grout forms shall have one inch (25 mm) chamfer strips at all vertical corners and top edges of grout shoulders.



- D. All formwork shall be coated with a bond breaker such as two coats of paste wax or polyethylene. Form release oil is not acceptable. Caution: Care should be taken not to contaminate grouting surfaces where bond is required.

[Isolation joints are recommended. Joint material can be closed cell styrofoam, redwood or rubber properly waxed or coated to prevent a bond. Joints may typically be placed at 4 to 6 foot intervals depending upon application and equipment footprint. For proper spacing, refer to manufacturer's recommendation for the specified product. Calculate the volume between joints using joint spacing and depth. Insure that the volume of each pour does not exceed the maximum allowable volume for the selected product.]

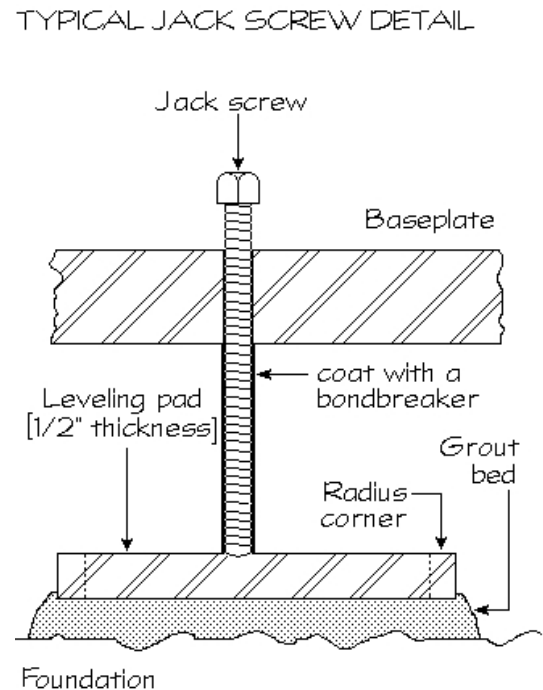
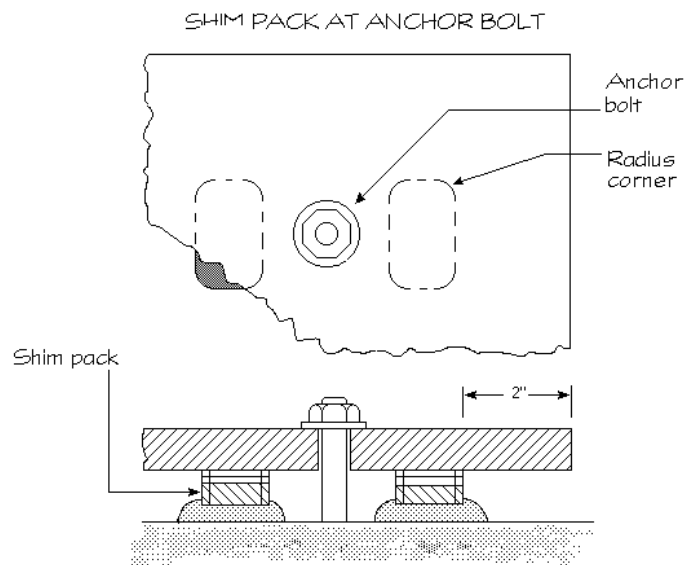


3.04 ENVIRONMENTAL CONDITIONS

- A. Condition and maintain materials to between 70°F and 80°F (21°C and 27°C) and all surfaces that contact grout to between 60°F and 90°F (15°C and 32°C). Shade from direct sunlight as necessary.
[For detailed conditioning procedures for Cold Weather or Hot Weather Grouting, refer to PART F – EXTREME WEATHER CONDITIONS.]

3.05 CLEARANCES

- A. All baseplates shall be set to final alignment before grouting using leveling devices such as shim packs, wedges, leveling nuts or jack screws. Shims and wedges that are to be removed shall be covered with a bond breaker such as paste wax or duct tape. When shims and wedges are to remain in place, their distance from plate edges shall be a minimum of two inches (50 mm). Provide a minimum radius of two inches (50 mm) on all shims and wedge corners.
[Clearances beneath baseplates are dependent on specified product, environmental conditions, obstructions and flow distance.]



3.06 EQUIPMENT AND MATERIALS

- A. All necessary tools, equipment and materials shall be as close as possible to the area being grouted, such as mixers, trowels and grout. Provide an adequate number of mixers, in good operating condition, for uninterrupted placement. Equipment shall be clean and dry.
- B. Appropriate clothing and safety equipment shall be worn to avoid breathing dust and prevent eye and skin contact with components and mixed grout.
- C. Wheelbarrows and buckets shall be clean and available for transporting mixed grout.
- D. Provide headbox and plunger when pouring grout.
- E. An appropriate material shall be available for clean up. Refer to data sheet of the grout specified.

3.07 MIXING

Mortar Mixer (Stationary Barrel with Moving Paddles)

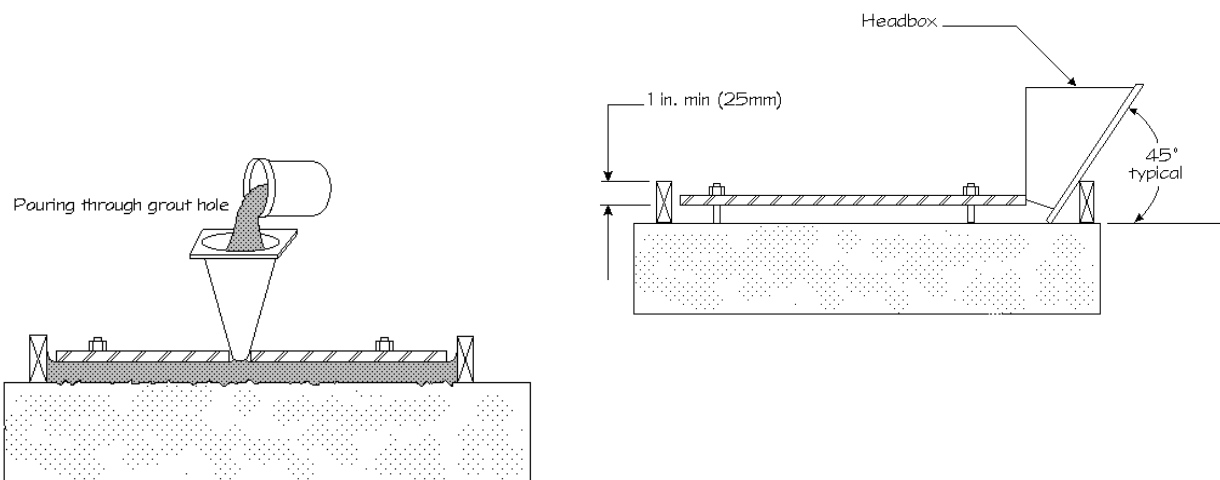
- A. Always use at least one-half the capacity of mixer when mixing grout.
- B. Combine Component A (resin) and Component B (hardener) by pouring Component B (hardener) into pail containing Component A (resin). Mix thoroughly by hand with a paddle or by slow speed mixer until a uniform color is obtained (no streaks); avoid air entrapment. Immediately pour all mixed liquids into mortar mixer. While mixing at a slow speed (approximately 20RPM), slowly add Component C (aggregate) without delay and mix only until aggregate is completely wet.
- C. Do not mix more material than can be placed within the working time of the grout.

APPLICATION - EPOXY GROUTING

4.01 PLACEMENT PROCEDURES

POURING

- A. Grout must be placed without interruption. Should a delay occur beyond the working time of the material, all equipment used in mixing and placing the epoxy grout, shall be cleaned.
- B. A headbox or similar device is required for a continuous pour to avoid air pockets under the baseplate. All grouting shall be placed from one side to the other, maintaining contact with the bottom of the baseplate at all times, maximizing effective bearing area (EBA).
- C. When installing grout under long baseplates, start pouring from one end across the short dimension and work down the longer side as the material fills under the baseplate.
- D. When pouring through grout holes, placement shall proceed continuously with a headbox until the grout has risen in the next hole. Maintain head pressure at initial hole so that grout stays in contact with the bottom of the baseplate at all times. Commence grouting at the next hole with an additional headbox. Continue process, alternating headboxes until grouting is complete.
- E. When pouring, the headbox shall be kept at least half full and filled in a manner to avoid air entrapment. If necessary to assist the flow, a plunger may be used. This procedure shall continue until the grout rises above the bottom edge of the baseplate on the opposite side.
- F. Throughout the pour, forms shall be constantly checked for leaks. All leaks shall be sealed immediately.
- G. If two or more layers are necessary, rake or scarify the surface of the initial pour. The surface temperature of the initial pour shall have cooled to 90°F (32°C) maximum prior to placing additional layers. Additional layers shall be placed within 24 hours.



PUMPING

- A. Epoxy grouts must be pumped using a peristaltic pump. Normal grout pumps used for pumping cement-based grouts are not recommended for pumping epoxy grouts. Contact Five Star Products for pump recommendations.
- B. Prime pump and pump lines with epoxy resin or similar material. Do not prime with a material that may contaminate epoxy grout. DO NOT prime pump with water. Discard all priming material prior to pumping epoxy grout into place.
- C. Commence pumping through grout holes or through formwork. Where pump line is put directly under equipment, keep line submerged in grout and slowly withdraw as grout fills under application area. Continuously add grout to pump and ensure pump does not run out of grout at anytime.
- D. As grout fills across area and can be seen at the next grout hole or at edge of formwork on opposite side, move pump line down from starting point to next grout hole or down formwork and continue pumping.
- E. Breakdown pump immediately after completion of grouting and clean up with high pressure water and liquid detergent.

FINISHING AND CURING - EPOXY GROUTING

5.01 FINISHING

- A. Prior to hardening, epoxy grout can be finished with a solvent wiped steel trowel. Maintaining a sufficient solvent coat is important as epoxy grout will adhere to dry trowel.
- B. Joint materials may be removed after the grout has cured and filled with a flexible compound.
- C. Epoxy grouts cannot be trimmed after set except by mechanical means. Final level in the forms should be brought to the finished elevation before hardening.

5.02 CURING

- A. Protect grout from temperature extremes, rain and water after placement. Do not wet cure epoxy grout.
- B. The grout shall be protected from temperatures below 45°F (7°C) until required minimum compressive strength is achieved.
- C. In-service operation may begin immediately after minimum required grout strength and modulus have been achieved.

REFERENCES

ACI 351.1-R93
"Grouting for Support of Equipment and Machinery"

PIP/API RP-686
Machinery Installation Mounting Plate Grouting

API 610
Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services

EXTREME WEATHER CONDITIONS - EPOXY GROUTING

6.01 COLD WEATHER GROUTING

[Low temperatures decrease flow, delay set and strength development of epoxy products. The procedures below may compensate for these conditions.]

- A. All epoxy grout components (resin, hardener and aggregate) shall be pre-conditioned so that placed grout is between 70°F and 90°F (21°C and 32°C). Due to the mass of palletized material (aggregate component), up to 72 hours of pre-conditioning may be required. Store epoxy grout components in an enclosed, warm or heated area where necessary.
- B. Indirect heating of surfaces (steel, concrete) will also help compensate for cold temperatures. During mixing, the barrel of the mortar mixer may be heated using an appropriate heater to keep the grout mix temperature within an acceptable range.
- C. When necessary, heating shall be accomplished by indirect exposure. Heated enclosures must be windproof and weatherproof. Heaters shall not be permitted to unevenly heat concrete. *Caution: Exhaust gases of unvented heaters may contaminate or cause carbonation of concrete within the enclosed environment.*
- D. Grout temperature shall be maintained above 50°F (16°C) until grout reaches required strength.
[Specify minimum required strength.]
- E. Gradually allow grout temperature to cool to ambient to avoid thermal shock.

REFERENCES

ACI 351.1 - R93

"Grouting for Support of Equipment and Machinery"

PIP/API RP-686

Machinery Installation Mounting Plate Grouting

API 610

Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services

PART F – EXTREME WEATHER CONDITIONS - EPOXY GROUTING

6.01 HOT WEATHER GROUTING

[High temperatures accelerate set, decrease working time, and accelerate strength gain of epoxy products. The procedures below may compensate for these conditions.]

- A. All epoxy grout components (resin, hardener and aggregate) should be pre-conditioned so that the mixed material is between 60°F and 90°F (16°C and 32°C). Due to the mass of palletized material (aggregate) up to 72 hours of pre-conditioning may be required. Store all epoxy grout components in a cool, shaded area out of direct sunlight.
- B. All surfaces, equipment and tools in contact with epoxy grout should be shaded and kept at temperatures between 60°F and 90°F (16°C and 32°C). **Do not** use water to cool surfaces or equipment in contact with epoxy grout.
- C. Shade application area from direct sunlight and where feasible, place epoxy grout when temperatures are decreasing, at night or during early morning.
- D. Place epoxy grout immediately after mixing, do not allow epoxy grout to sit for extended periods of time in buckets or wheelbarrows.
- E. Maintain shading of application area for 24 hours after placement.

REFERENCES

ACI 351.1 - R93

"Grouting for Support of Equipment and Machinery"

PIP/API RP-686

Machinery Installation Mounting Plate Grouting

API 610

Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services