TACOMA POWER
TACOMA PUBLIC UTILITIES

Customer Requirements
Thermal Backfill for Underground Power Cable Installations

C-UG-2050

Application

Flowable Thermal Backfill (FTB) is placed around power cable conduit runs to more effectively ***dissipate heat generated by the cables*** into the surrounding environment. FTB is a uniform and efficient heat conducting medium that also provides 100% compaction, structural support, and mechanical protection for the conduit systems.

Why use FTB?

- Multiple cables in conduit installed in the same trench will experience mutual heating and run hotter.
- Multiple conduits in a common trench add air insulation which holds in heat.
- Communication duct banks parallel to the power trench insulate heat and cause the power cables to run hotter.
- Other heat sources that are either parallel or cross the power trench will reduce heat dissipation and cause the power cables to run hotter and/or create hot spots.
- All of the above conditions may require de-rating of the current carrying capacity of the power cables unless the heat can be dissipated.
- Using FTB around the power ducts helps disperse the heat from the trench line to the surrounding air.

When to Install FTB

Use FTB when a power trench has any of the following:

- 3 or more feeder conduits (include spare feeder conduits in the count).
- 4 or more feeder and distribution conduits combined.
- When a communication duct line is within 12 inches and parallels the feeder trench line (for trenches containing 2 or more feeders).
- When the power conduits are within 2 feet of a secondary heat source, such as a steam line or another underground feeder crossing. FTB use is needed only in conflict areas.

Performance vs. Cost

Industry consultants report a common ***5% to 10%*** increase in cable ampacity with the use of thermal backfills. See standard E-GR-1500, “Data for Underground Primary Cables” for cable ampacities.

Similar to Controlled Density Fill (CDF) backfill, FTB does not need to be compacted, hardens quickly so that backfill can be completed the following day, and readily fills into all trench cavities without vibration.

Expect an approximate ***10 %*** increase in cost for FTB over CDF backfill.

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FTB Selection

The approved FTB local mix designs are available for the following ***compressive strength*** ratings:

Supplier	Non-Traffic Mix (300 psi FTB)	Traffic Mix (1000 psi FTB)
Corliss	J5201FTB	J5201FTSB
Glacier	0307	3253

Other suppliers may be available if approved by the Tacoma Power Engineer. See the following "FTB Components" section for more information on FTB components.

FTB Components

Components

The proportions of all FTB components are balanced such that when the specified amount of water is added a uniform mix will be obtained that will not segregate when installed by pouring. **No substitution of materials is permitted**.

Component	Description
Cement	Normal Portland cement conforming to ASTM Designation C150. The quality of the cement determines the compressive strength.
Fluidizer	Class "C" or "F" fly ash. The amount of fly ash influences the flow.
Fine Aggregate	Concrete sand with a particle size distribution meeting ASTM C33 limits for fine aggregates. This governs thermal properties.
Medium Aggregate	The maximum aggregate gravel size shall be 3/8" minus. This also governs thermal properties.

Additives

No other additives shall be added. Any deviations may lead to problems with flow and water demand which in turn would affect soil thermal resistivity and strength.

Under no circumstances shall air entrainment additives be added. The only remedy available to the Contractor if an air entrainment additive is included in the mix is to physically remove all of the FTB from the cable trench and start over.

Installation

Water

It is recommended to add slightly less than the required amount of water at the batching plant. Should there be a need to add more water to achieve a good homogeneous flow; this can always be done at the job site prior to the pour.

Batching

Batching shall be done at a central plant and the blended FTB supplied by ready mix concrete trucks (ASTM C94). The FTB shall be supplied and transported in such a way as to minimize segregation and facilitate installation.

Installation *(continued)*

Pouring

The ends of the trench shall be secured by bulkhead or earth fill.

The FTB is to be installed by pouring into the trench and completely filling all the voids without causing excessive segregation. ***No vibration or compaction is allowed***.

At the discretion of the Contractor, the flow may be adjusted slightly by changing the amount of water slightly (as long as no segregation occurs, and the FTB fills all the voids completely when poured).

Pumping

For pumping applications the flow may have to be modified. Changes to the mixture to facilitate pumping shall be submitted to Tacoma Power 30 days prior to installation.

Bleed Water

The FTB is in a slurry form so it can flow and fill all voids. The slurry phase will quickly consolidate, resulting in excess bleed water. The Contractor shall make provisions to allow this bleed water to be contained, drained, or be pumped away in an environmentally acceptable manner.

Temperature Restrictions

FTB shall not be placed on frozen ground. At the time of placement, FTB must have a minimum temperature of 40˚F. Mixing and placing shall stop when air temperature is 38˚F or less and falling.

Conduit Buoyancy

Conduits to be encased in FTB shall be installed with spacers and hold downs (see C-UG-1100) to be adequately anchored so that they do not float during FTB placement. Tie-Downs and/or FTB piles should all be installed at regular intervals depending on quantity and size of conduits, i.e., the overall buoyancy of the duct bank. Other methods may be used if approved by the Tacoma Power Engineer.

Quality Control

With thermal backfills, the quality is in the mix. If it is properly formulated and blended, then the installation and final product performance will meet the specifications. Information for various tests and reports may be required ***should the Tacoma Power Engineer deem them necessary***.

Thermal Resistivity Test & Values

The FTB should have a thermal resistivity Rho (ρ) of less than 40°C-cm/Watt when moist and less than 100°C-cm/Watt when in place and totally dry. If testing should be required, samples shall be sent to Geotherm, Inc., or an alternate testing laboratory approved by the Tacoma Power Engineer.

Some typical values for RHO (ρ) that are commonly used:

Backfill Material	Thermal Rho (ρ) °C-cm/Watt
Moist native soil	90
Concrete	55
FTB	40

Other Factors

Other factors can change the soil thermal resistivity:

- ***Moisture*** is critical to soil thermal resistivity. Sand, for example, dries out easily resulting in high Rho values.
- ***Burial depth*** also has a small impact on cable ampacity. Tests have shown reducing depth from 36" to 30" (to top of enclosure) will increase ampacity by 1-3%.
- Soil thermal resistivity decreases with ***compaction***.

Sources

Standard	Title
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
IEEE 442	IEEE Guide For Soil Thermal Resistivity Measurements

Thermal Resistivity Consultant	Geotherm Inc. 561 E Elliot Road # 155 Chandler, AZ 85225-1119 480-892-9723 www.geotherm.net Flowable Thermal Backfill (FTB™) is a Geotherm Trade Mark