Fluidized Thermal Backfill

1. Scope

This standard covers the requirements for the formulation of thermally conductive concrete and low strength material used in the construction of encased electrical conduits (duct banks) including high strength Fluidized Thermal Backfill (FTB) and low strength Fluidized Thermal Backfill. Because FTB is a mixed-to-order product, it is not stocked in Seattle City Light (SCL) inventory.

This standard applies to the following SCL stock numbers:

Stock No.	Description	Unit
013711	High strength FTB	CYU
013712	Low strength FTB	CYU

2. Application

Fluidized Thermal Backfill (FTB) is used to encase and cover underground power conduits that will contain transmission or distribution cables which may operate at or above normal ampere capacity (ampacity). FTB transfers heat away from power cables, allowing them to conduct more power.

Low-Strength FTB is used like controlled density fill (CDF) to backfill trenches over the high-strength FTB duct banks, and also for encasement where high-strength is not desired. It provides superior thermal properties to other backfills, and is self-compacting.

High-Strength FTB is used like concrete for duct bank encasement. It provides maximum protection against dig-ins and undermining during future excavations. As a rule, high-strength FTB is more thermally conductive than low-strength FTB, but it is much more difficult to remove in future excavations.

FTB is normally not required for vault, manhole, or handhole backfill.

Admixtures must be pre-approved by SCL.

3. Industry Standards

Backfill shall meet the requirements of the latest revisions of the following industry standards:

ASTM C31/C31M; Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C39/C39M; Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C136; Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C143; Standard Test Method for Slump of Hydraulic Cement Concrete

ASTM C150; Standard Specification for Portland Cement

ASTM C618; Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C989; Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.

4. Mix Design & Requirements

4.1 General Requirements

The contractor shall provide a FTB mix design which meets the performance requirements outlined in Table 4.

FTB mix designs must specify the source of all FTB component materials, including the source pit for aggregate materials. The maximum aggregate is 3/8 in.

FTB mix designs must be engineered by a Seattle City Light-approved consultant.

FTB component materials may include:

- 3/8-in minus (medium) aggregate – ASTM C136 Sieve Analysis required for approval
- Building sand (fine aggregate) – ASTM C136 Sieve Analysis required for approval
- Portland Cement – type I per ASTM C150
- Fly Ash – Class F as per ASTM C618-05
- Ground Granulated Blast Furnace Slag – ASTM C989-05
- Water – clean potable water required, or as approved by SCL
- Red concrete dye, where specified by Seattle City Light engineering. Red dye should be added at the equivalent of 4 pounds of red oxide per cubic yard.

Table 4. Performance Requirements

		Low Strength FTB		High Strength FTB		
Criteria	**Unit**	**Mix Design**	**Field Test**	**Mix Design**	**Field Test**	**Testing Method**
Thermal Resistivity						
Maximum at 0% Moisture Content	(°C-cm)/W	100	100	75	75	Consultant
Maximum at Critical Moisture Content	(°C-cm)/W	70	80	60	65	Consultant
Minimum 28-Day Compressive Strength	lb/sq-in	100	100	3000	3000	ASTM C873
Maximum 28-Day Compressive Strength	lb/sq-in	130	150	none	none	ASTM C873
Minimum Slump	in	6	6	6	6	ASTM C143
Maximum Slump	in	9	9	9	9	ASTM C143

4.2 Mix Design Criteria

FTB mix designs shall meet or exceed the performance requirements cited in Table 4.

4.3 Air Content

The total air content of any FTB mix shall not exceed 2% by volume. No air entraining admixtures will be permitted.

4.4 Substitutions

No substitutions allowed for any component material without permission of Seattle City Light.

4.5 Withdrawal of Mix Design Approval

SCL reserves the right to temporarily suspend or permanently withdrawal approval of any mix design.

4.6 Admixtures

Admixtures must be approved for use in FTB by Seattle City Light. When allowed, the admixture shall be added per manufacturer recommendation.

4.7 Accelerating Admixture

The following accelerating admixture is approved for use in Seattle City Light FTB: Pozzolith NC 534, manufactured by BASF Admixtures, Inc.

4.8 Fluidizers

Seattle City Light-approved fluidizers may be used interchangeably where produced under the same ASTM specification. Unapproved fluidizers are not interchangeable with approved fluidizers.

For example, approved fly ash (ASTM C618) may be used in any mix design that specifies fly ash but it may not be substituted for blast furnace slag (ASTM 989) in another mix design. Also, an unapproved fly ash may not be substituted for an approved fly ash.

Fluidizer approval requires formulation of a mix design through an approved consultant, and two compliance certification reports that demonstrate consistent physical properties over a six-month period. Seattle City Light may withdraw approval at any time.

High-strength FTB mix designs may be formulated without fluidizer. Low-strength FTB mix designs must be formulated with fluidizer.

5. Producers Identification Codes

FTB mix designs must be designated as follows on all mix designs, submittals and delivery tickets:

- High Strength FTB – SCLHSFTB
- Low Strength FTB – SCLLSFTB

The addition of red dye must also be indicated.

Product codes and mix ID codes of individual suppliers will not be accepted.

6. Approval of FTB Mix Design

6.1 Submittals

The Contractor shall submit a mix design to SCL for all classes of concrete specified.

The Contractor's submittal of a mix design shall contain a unique identification, as per section 5, for each mix design, and shall include the mix proportions per cubic yard, the proposed sources, admixtures, the average 28-day compressive strength (as per ASTM C873), thermal resistivity testing including thermal dry graphs and the water cement ratio.

Test results for compressive strength and thermal resistivity included in the mix design submittal shall not be more than 60 days old.

The Contractor shall notify SCL in writing of any mix design modifications.

6.2 Expiration

Mix designs are approved for a period of one year from the date of SCL approval.

Expired mix designs will not be permitted for use on Seattle City Light projects.

A mix design may be renewed by resubmitting the mix design, including up to date strength and thermal resistivity test results.

7. Approved Suppliers and Mix Designs

	Stock No. 013711		Stock No. 013712	
Supplier	**High Strength FTB Mix ID**	**Expiration Date**	**Low Strength FTB Mix ID**	**Expiration Date**
Salmon Bay Sand and Gravel	SCLHSFTB	3/30/2017	SCLLSFTB	3/30/2017
Stoneway Concrete (Plant 11)	SCLHSFTB	5/17/2017	SCLLSFTB	5/17/2017
Stoneway Concrete (Plant 14)	SCLHSFTB	5/17/2017	SCLLSFTB	5/17/2017
Cadman, Inc.	SCLHSFTB	3/30/2017	SCLLSFTB	7/28/2017
CalPortland	SCLHSFTB/505	6/15/2017	SCLLSFTB	9/9/2016

8. Sources

Detter, Chris; SCL Engineer and originator of 7150.00 (chris.detter@seattle.gov)

Lu, Curtis; SCL Standards Engineer and subject matter expert for 7150.00 (curtis.lu@seattle.gov)

Read, Steven; SPU Materials Engineering Supervisor and subject matter expert for 7150.00 (steven.read@seattle.gov)

SCL Construction Standard 0226.06; "Fluidized Thermal Backfill"

SCL Design Standard 9266.06; "Understanding Fluidized Thermal Backfill" *(not yet published)*

Stewart, Bob; SCL Civil Inspector, subject matter expert and major contributor to 7150.00 (bob.stewart@seattle.gov)