Purpose and Scope

This gas design standard (GDS) provides general trench requirements for Pacific Gas and Electric Company (PG&E or Company) gas transmission and distribution facilities. It includes dimensions, acceptable materials to place in the trench, and damage prevention requirements. This GDS does not apply to pipe installed with trenchless construction methods.

1 General Information

1.1. PG&E has an obligation to repair and pave public streets and roads to the same conditions as found. PG&E trenches must meet the requirements of the local permitting agency unless the requirements are determined to be arbitrary, unreasonable, or pose a potential risk to the integrity of the facilities or safety of the public and PG&E crews during construction and routine maintenance.

1.2. Due to the large number of local permitting agencies within the PG&E service territory, it is outside of the scope of this GDS to address all possible local agency trench and backfill requirements. When this GDS differs from local agency requirements it is the responsibility of the local leadership, design and asset engineering and corrosion services teams to evaluate the agency requirements and/or coordinate with the local agency to develop a local trench design that is acceptable to both PG&E and the local agency.

1.3. This GDS provides the recommended minimum requirements for trench configuration and backfill requirements. The project team, responsible asset engineer and corrosion services should evaluate each location and determine if a site specific trench design is required and has final authority to approve any deviation from the Issued for Construction (IFC) drawings.

1.4. For joint trench requirements refer to Utility Standard S5453, “Joint Trench.”

1.5. For required cover and clearances refer to Gas Design Standard A-04, “Cover and Clearance Requirements for Transmission Lines, Distribution Mains, and Service Lines.”

2 Trench Configuration

2.1. A typical gas only trench is shown in Figure 1.

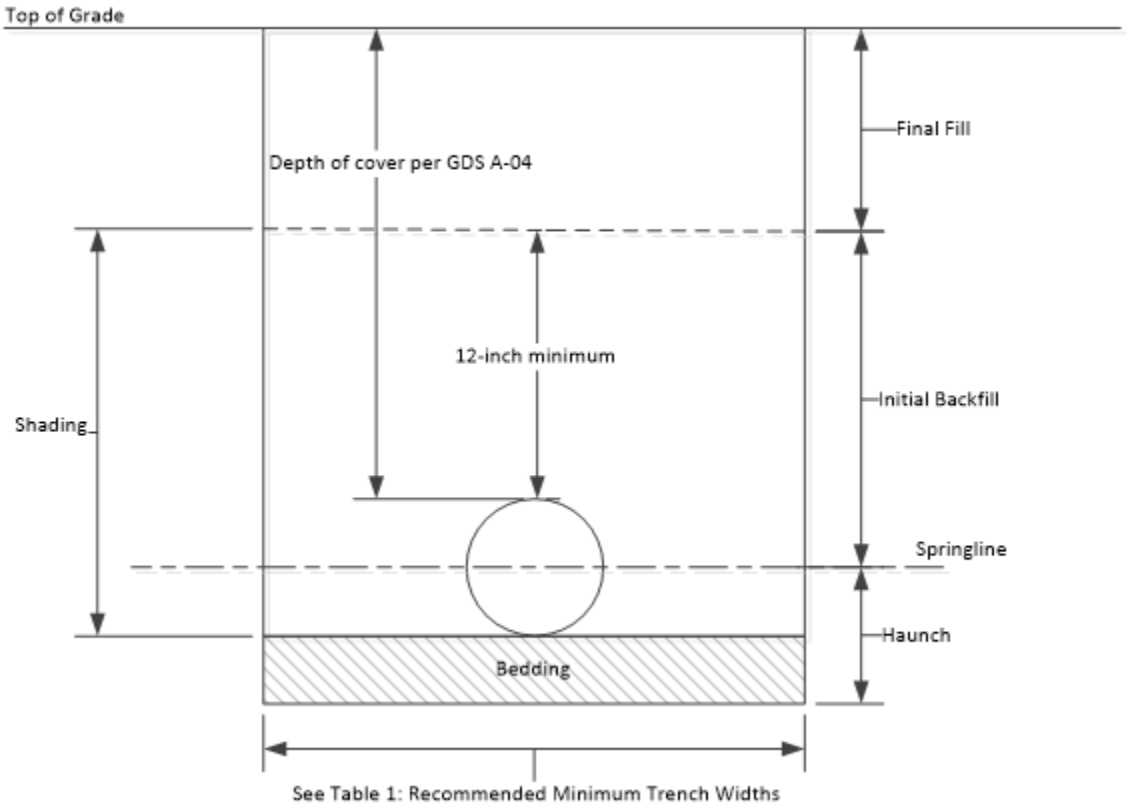

Figure 1. Typical Gas Only Trench Configuration

2.2. Basic Trench Design Construction and Terminology

A. Bedding: The bottom of the trench must be cleared of rocks, skid blocks, or other hard substances to provide a continuous smooth base for the pipe to rest on without damage to the coating. A padding of fine earth or sand can be provided to cushion the pipe. The thickness of the padding should be ⅓ the outside diameter of the pipe, but not less than 4 inches.

B. Haunch: The backfill material under the pipe haunches supports the pipe and helps to distribute the load evenly. The quality and placement of the haunching backfill is the most important factor in pipe settlement.

C. Shading: Material that provides support from lateral displacement, distributes overhead loads, and protects the pipe during final backfilling and paving operations.

2.2 (continued)

D. Initial Backfill: A backfill of fine materials must be placed to a minimum elevation of 12 inches over the top of the pipe, to prevent damage from rocks while backfilling above this level.

E. Final Backfill/Paving: In most cases, competent native fill is acceptable and preferred for final backfill. Paving must match any existing paving that was removed in the construction of the pipe.

2.3. Trench Width

A. Trench must be wide enough to allow for the installation of the pipe without damaging coating or inducing unnecessary stresses and to safely and conveniently compact backfill material on either side of the pipe.

B. At horizontal angles, the trench must have sufficient width to accommodate the welding elbow or bend and provide clearance between the side of the trench and the pipe.

C. At locations where welding is to occur in the trench, it must be wide enough to also safely accommodate welding personnel.

D. According to *The Performance Pipe™ Engineering Manual, 2013*, the recommended minimum trench widths are listed in Table 1.

Table 1. Recommended Minimum Trench Widths

Nominal Pipe OD (in.)	Minimum Trench Width (in.)
< 3	12
3–16	Pipe OD + 12
18–34	Pipe OD + 18
36–63	Pipe OD + 24

2.4. Trench Depth

A. Personnel performing excavations must follow safety guidelines provided in Utility Procedure TD-4412P-05, “Excavation Procedures for Damage Prevention,” and Utility Manual TD-4621M, “Excavation Safety Manual.”

B. The trench must be deep enough to provide the minimum cover as outlined in GDS A-04.

2.5. Warning Tape

A. A 6 inch warning tape must be installed above the pipe per Gas Design Standard L-16, “Gas Pipeline Underground Warning Tape.”

3 Trench Backfill Material

3.1. General

A. From a corrosion, logistical, and affordability perspective, competent native soil is preferred for bedding, shading, and backfilling material throughout the trench.

B. When native material is determined to be unsuitable for bedding and shading, a PG&E approved import of fine material or sand is required for the bedding and shading material.

C. Import sand used as bedding and shading material must meet the requirements in Engineering Material Specification (EMS)-4123, “Backfill Sand.”

3.2. Competent Native or Import Material Specifications

A. General

(1) Do not use organic soils (including peat, humus, topsoil, swamp soils, mulch, and soils containing leaves), grass, branches, or other fibrous vegetable matter as bedding and shading material.

B. Distribution

(1) Bedding and Shading Material

a) Native or import material used for bedding or shading must meet the following criteria: Gradation requirements as determined by American Society for Testing and Materials (ASTM) C136M-14, “Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates,” are shown in Table 2.

Table 2. Bedding and Shading Material Gradation Requirements

Sieve U.S.	Particle Size (in)	Spec
½	0.5	100%
#4	0.187	75%

b) The material must not contain rocks with sharp edges or that may be abrasive. In general, rocks can be round to sub-round as shown in Figure 2, “Angularity Example.”

3.2 (continued)

(2) Final Backfill Material

a) Native or import final backfill material must meet the following criteria:

b) The soil must not contain large rocks, clods, or lumps of soil greater than 3 inches.

c) The soil must be free of construction debris, sticks, stumps, garbage, or other organic materials.

C. Transmission

(1) Bedding and Shading

a) The material must not contain rocks with sharp edges or that may be abrasive. In general, round to sub-round rocks are acceptable as shown in Figure 2.

b) The material must be screened for rocks and clods of soil greater than 1 inch.

(2) Final Backfill Material

a) Native or import final backfill material must meet the following criteria: The soils must not contain large rocks, clods, or lumps of soil greater than 3 inches.

b) The soil must be free of construction debris, sticks, stumps, garbage, or other organic materials.

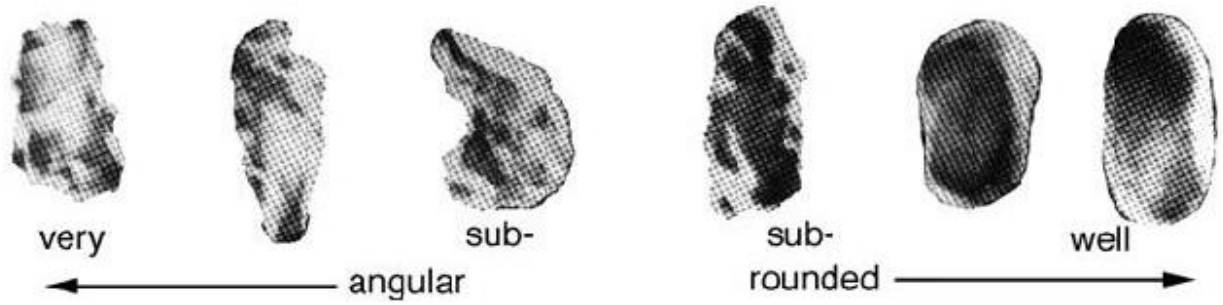

Figure 2. Angularity Example

4 Other Design Considerations

4.1. Corrosion Potential

A. Although the coating and cathodic protection are the primary methods of protecting steel pipe from corrosion, it is recommended that the native or import soil be evaluated for corrosion potential before being used as bedding or shading backfill. Tests and recommended limits are listed below:

(1) pH must be between 4.5 and 9.

(2) Contact corrosion engineering services personnel for additional information and/or approved tests.

4.2. Above Ground Piping

A. Soil with low compaction around above group piping can cause settlement and additional stress to pipe at air to soil transitions.

(1) Consider providing site-specific compaction requirements of at least 90%, appropriate methods of placement and compaction, and testing requirements and intervals.

4.3. Site Specific Design

A. Consider providing a site specific trench design and construction method at locations where there is the potential for the following.

(1) Areas where ground settlement is a concern.

(2) Water transmission in trench that could potentially cause trench settlement and failure.

(3) Locations of known or potential landslides.

(4) High ground water table.

B. For assistance with the identification of potential issues and site evaluation contact the following.

(1) Identification of known geologic hazards:

a) Transmission Integrity Management Program (TIMP) engineering geohazard personnel.

b) Distribution Integrity Management Program (DIMP) engineering personnel.

(2) Geotechnical support personnel.

5 Placement and Compaction

Note: It is extremely important that PG&E meet the minimum performance requirements for compaction required by the local permitting agency. Settlement and trench failures due to poor workmanship in public roads are public safety hazards.

5.1. General

A. Trench backfill compaction must meet local agency permit requirements or IFC drawings, whichever is more conservative.

B. Outside of public roads and franchise, backfill compaction is not required unless specified by the responsible design or asset engineer in the IFC drawings.

(1) It is recommended that backfill be compacted where ground settlement is a concern or potential risk.

5.2. Placement

A. Avoid damaging the pipe and pipe coating when placing the shading material.

B. Use caution when placing shading material on top of pipe service connections and transition fittings.

5.3. Compaction

A. Bedding

(1) The trench bottom needs to provide firm, uniform, and adequate support for the pipe.

a) In a trench that contains voids, consider using a concrete vibrator to assist with consolidation when using wet sand for bedding.

B. Shading

(1) No compaction operations that could damage the pipe coating are allowed. Protect the pipe in place during compaction operations.

(2) Compaction operations of shading backfill should take place adjacent to the pipe. Do not compact directly over the pipe until there are at least 12 inches of cover over the pipe.

5.3 (continued)

C. Final Fill

(1) Lift heights must be of sufficient depth to attain the required compaction based on the type of material and method of compaction, for example:

a) Sandy fill must be placed in lifts no greater than 6 to 9 inches and compacted using a vibrating plate compactor.

b) Clayey fill must be placed in 6 to 9 inch lifts and compacted using a rammer (jumping jack).

D. Consult the responsible design or asset engineer for minimum cover or additional protection requirements for pipe when using large compaction equipment such as a sheep's foot roller or vibrating compaction roller.

5.4. Testing

A. Testing requirements and intervals are required by the permitting agency or as specified in the IFC drawings. In absence of specific guidance, Caltrans provides a conservative approach.

(1) ASTM D1557, "Laboratory Compaction Characteristics of Soil Using Modified Effort," or equivalent:

a) One sample every 2000 cubic yards.

(2) ASTM D6938-15, "Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)"

a) One test every 8 inches of thickness.

6 Slurry and Controlled Low Strength Material (CLSM) Backfill

Note: Due to difficulties with quality control of mixture, safety, and time concerns related to accessing the pipeline for future maintenance, it is not recommended that a cement slurry or CLSM be used as pipe shading material.

6.1. Slurry Cement and/or CLSM (including soil cement CLSM)

A. Slurry cement or CLSM must not be used as a shading material unless approved by the responsible design or asset engineer in the IFC drawing or through the field change control process.

B. **Do not** allow cement additives such as calcium oxide (quicklime) to come into contact with PE pipe, tubing, or fittings.

6.1 (continued)

C. The design engineer can work with concrete vendors or construction contractors to develop suitable low strength slurry mix design and quality control requirements.

(1) In order to allow for manual excavation of buried facilities, a mix with a maximum design compressive strength of 50 pounds per square inch (psi) is required.

(2) Refer to American Concrete Institute (ACI) 229R-99, “Controlled Low-Strength Materials” for examples of CLSM mixture portions.

D. The responsible design or asset engineer working with the project team and corrosion services has sole authority to approve a slurry or concrete with a compressive strength over 50 psi used as a protective cap for shallow pipe.

(1) Place a minimum of 12 inches of sand or fine material between the pipe and concrete cap.

(2) Redline as-built drawing or GSR where the pipe has a slurry backfill or concrete cap.

6.2. 0-Sack Slurry (a.k.a. wet sand)

A. When using wet sand (0-sack slurry) for backfill, a minimum dry time of 24 hours is required before placing final fill.

B. The use of wet sand (0-sack slurry) as a backfill in the following locations requires design or asset engineer approval:

(1) Locations with a high groundwater table or high hydraulic gradient.

(2) Locations where ground settlement over time is a concern.

(3) In trenches where the native material is not free-draining, for example, soils with high clay and silt content.

C. Sand used in 0-sack slurry must meet the requirements in EMS-4123 with the following additions:

(1) The sand must be washed and free of fine organic silts and clays.

(2) Sand equivalent equal to or greater than 20 per ASTM D-2419-14, “Standard Test Method for Sand Equivalent Value of Solid and Fine Aggregate.”

D. In a trench that contains voids, consider using a concrete vibrator to assist with consolidation under pipe and voids created by shoring removal, etc.

6.2 (continued)

E. Testing

(1) When required to be tested, 0-sack slurry must be tested using the following tests:

a) ASTM D-1557, “Laboratory Compaction Characteristics of Soil Using Modified Effort” or equivalent.

b) ASTM D6938-15, “Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).”

Target Audience

The following personnel: gas transmission and distribution (T&D) construction, gas T&D general construction, gas engineering and design, gas transmission engineering and design, gas distribution engineering and design, gas maintenance and construction, gas T&D pipeline operations and maintenance, DIMP engineering, TIMP pipeline services, and facility integrity management program (FIMP) plant services.

Definitions

NA

Compliance Requirement / Regulatory Commitment

California Public Utilities Code, Article 3, Equipment, Practices, and Facilities, Section 787

Code of Federal Regulations (CFR) Title 49, Transportation, Part 192—Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, Section 192.319, “Installation of pipe in a ditch.”

References

American Concrete Institute (ACI) 229R-99 Controlled Low-Strength Materials

American Society for Testing and Materials (ASTM) D2488-09a, “Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)”

ASTM D698-12, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”

ASTM D1557-12, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort”

ASTM C136-14, “Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates”

ASTM D2487-11, “Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)”

ASTM G51-95, “Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing”

ASTM D4972-13, “Standard Test Method for pH of Soils”

ASTM D6938-15, “Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)”

A.W. Peabody, Control of Pipeline Corrosion, Second Edition (National Association of Corrosion, 2001)

Caltrans Construction Manual – 2014

California Department of Transportation (Caltrans) Corrosion Guidelines Version 2.0, November 2012

Engineering Material Specification EMS-4123, “Backfill Sand”

Gas Design Standard A-04, “Cover and Clearance Requirements for Transmission Lines, Distribution Mains and Service Lines”

Gas Design Standard L-16, “Gas Pipeline Underground Warning Tape”

Performance Pipe Engineering Manual, Chevron Phillips Chemical Company, 2003

Utility Manual TD-4621M, “Excavation Safety Manual”

Utility Procedure TD-4412P-05, “Excavation Procedures for Damage Prevention”

Utility Standard S5453, “Joint Trench”

Appendices

NA

Attachments

NA

Revision Notes

Revision 0a has the following changes:

1. For Placement and Compaction, updated guidance for bedding compaction and added specific guidance for plastic installations.

2. For Slurry and Controlled Low Strength Material (CLSM), updated the approval requirements for the use of CLSM as shading. Added specific guidance for plastic installations. Clarified the requirements for CLSM to have a maximum design compressive strength of 50 pounds per square inch. Added the requirement for a minimum dry time of 24 hours for wet send (0-sack slurry) use. Clarified the guidance for locations that require approval for the use of wet sand as a backfill material.

Revision 0 (Publication Date: 08/16/2017, Effective Date: 08/30/2017) has the following changes:

1. This is a new GDS.

Asset Type: Storage, Compression & Processing, Measurement & Control, Transmission Pipe, Distribution Mains, Distribution Services, Customer Connected Equipment, CNG/LNG.

Function: Design, Construction, Maintenance, Operation, and Emergency Response

Document Contact: Gas Design Standard Responsibility List