GA 212 Underground—Substation Getaway

Scope

This standard describes construction plans for getaway cable systems that include single and multiple cable circuits in metro areas, urban areas and rural areas. An engineered trench, conduit and vault system reduces the cost to install large-diameter feeder cables carrying the entire feeder current, and extends cable life.

Provided in this standard is information for:

- selecting materials to support installing 1000 kcmil feeder cable,
- designing a cable system that promotes safety and efficient construction procedures, and
- implementing work practices that eliminate material damage during construction.

Related Standards and Programs

The following company documents should be reviewed whenever installation of underground getaway cables is planned. Any conflicts associated with the following standards are superseded by this standard.

1. **Distribution Construction Standards**

Chapter GA, Underground—General

Chapter GB, Underground Primary Cable and Accessories

Chapter GC, Conduit and Cable Pulling

Chapter GE, Riser Poles

Chapter GV, Equipment Bases and Enclosures

DSTAR Cable Electrical Parameters Program (CEPS)

DSTAR Cable Pulling Program

2. **Material Specifications**

ZG 033, Fiberglass Conduit

ZG 071, Fluidized Thermal Backfill (FTB)

ZG 301, General Equipment Base and Enclosure Requirements

3. **Substation Construction Standards**

Division 2: Site Work

Division 3: Concrete

Division 16: Electrical

General

Substation metal-clad switchgear, municipal codes and/or overhead conflicts with transmission lines may require an underground distribution system to exit the substation. The underground distribution system can be less expensive than replacing and adding taller transmission poles to address congestion issues or clearance violations. In a congested transmission corridor, an option to control project costs is to compare underground distribution feeder extension costs against an overhead distribution line.

Figure 1——Typical Metalclad Switchgear at a Substation

The company's legacy 25 kV and higher substation design included open air bus. When expanding an open air bus in rural areas, an underground cable system should be considered if exiting the substation conflicts with transmission lines or substation equipment. The getaway conduits rise underneath the substation bus and normally attach to the switch bus structure.

Getaway System — Material

The underground getaway system shall consist of cables and accessories installed in fully integrated conduit with a calculated backfill, selected termination locations, and grounding.

1. Cable

GB 103 Cable—Primary URD

The company's preferred getaway cable configuration is three 1/C 1000 kcmil Al, 15 kV (SI# 4200016) or 25 kV (SI# 4200106), EPR insulated, shielded, jacketed power cables. The cable arrives in specified lengths of 1000' on a single reel. The company chose a conductor rating of 90° C (national cable standards allow operating temperatures of 105° C). The lower rating temperature extends the life of cable and cable accessories.

2. Cable Accessories

Bolted Terminators

GB 201 Terminator Assembly, Silicon Rubber—Primary Cable

GB 945 Connector, URD, Terminator

The cables connect with silicon rubber terminators and spade connectors to the terminator pads in a metal-clad cable bay and two-hole conductor lugs on the riser pole.

Splices

GB 251 Splice Assembly, Cold-Shrink—Primary Cable

GB 256 Splice Assembly, Heat-Shrink—Primary Cable

Cold-shrink splices are preferred for linking cables inside vaults. Cold-shrink splices do not require torches, as heat-shrink products do. At times the wider-range heat shrink splice may be required to connect cables of different conductor sizes.

T-Body, Stick Operated Elbow Terminations

GB 322 Termination — 600-Ampere, T-Body, Stick-Operable

GK 302 Switchgear Assembly — Air-Insulated, Deadfront, 600 Amp

Sometimes the getaway terminates in pad-mounted switchgear that delivers energy in multiple taps. The cable terminates to the switchgear bushing with 600-amp stick operated elbows. GK 302 issues all the material to assemble the switchgear, including the vault. Switchgear standard GK 302 issues elbow arresters for the first switchgear from the substation metal-clad.

Lightning Arresters

DQ 041 Overvoltage Protection—Surge Arresters, Underground Systems

DQ 201 Surge Arrester Assembly—Underground Equipment-Mounted

DQ 911 Surge Arrester, Riser-Pole

Lightning arresters shall be installed on the getaway terminations at:

- riser poles
- the first switchgear in an underground getaway system
- cable terminations on an open air substation bus

The riser pole assemblies in GE 502 and GE 531 issue lightning arresters. GK 302 issues lightning arresters inside compatible unit codes. The lightning arrester installed on the open air bus issues from standard DQ 911.

3. Controlled Backfills

ZG 071 Fluidized Thermal Backfill (FTB)

Substation Section Documents

- **03120 Duct Bank Concrete**
- **03121 Fluidized Thermal Backfill (FTB)**
- **03200 Controlled Density Fill**

The company's service territory includes many types of soils originating from many different minerals. Soils composed of limestone or sandstone show good thermal performance. Soils of organic matter or with air entrapment, with poor thermal performance, include:

- soils downwind of volcanic peaks
- lava flows
- lake bottoms

Moisture contact and the ambient temperature also influence soil heat transfer rates. The winter cable-loading rating is higher when the soil is wet and the soil temperature drops from an expected summer temperature of 25° C to a winter temperature of 10° C. Moisture in the soil reduces the thermal resistivity (Rho = °C-cm/W) values, increasing the rate of heat dissipation. When designing the substation, select the soil's summer Rho value. Even though the system may be designed for winter loading, the peak load may shift to the summer during the life of the substation.

Backfill designed to aid the transfer of heat shall be included in the project if the feeder loads are expected to be heavy. The complexity of soils requires that the heat transfer rate be known, and that a thermal backfill be designed for high current-carrying cables. The addition of "Fluidized Thermal Backfill" (FTB) to duct systems with multiple cable systems is critical, since materials with high heat-transfer rates displace the heat due to cable losses. The managed heat flow limits the temperature rise and can extend cable life.

The lab contracted to test the Rho values of native backfill and FTB provides a graph showing a curve of the material's percent moisture versus Rho. The company specifies a dry Rho value of 100°C-cm/W or less for 100% dry backfill. The expectation is that the FTB will never reach 100% dry. When designing the average Rho for the trench, select the 5% moisture content as the Rho value for the FTB.

Figure 2—FTB Around Conduits Prior to Concrete Foundation Placement

4. Vaults

ZG 301 General Equipment Base and Enclosure Requirements

ZG 311 Concrete Requirements

GV 402 Padvault, Switchgear, Dead-Front, SF6

GV 601 Vault, 7' × 12'

GV 651 Sleeve, Padvault, Concrete, 7' × 12' × 3.5've, Padvault, Concrete, 7′ × 12′ × 3.5′

Shallow vaults are preferred when placed outside of roadways and sidewalks. In roadways, deep vaults shall be installed to provide the crew a safe work location below the sidewalk or street surface. If more depth is required for a shallow vault, specify the same supplier for the ground sleeve. (Each vendor has different sleeve designs.)

5. Vault Racks

GV 802 Rack Assembly, Reinforced Polymer, Cable Support

GV 803 Rack, Arm, Cable Support, Polymer

DY 491 Bolt, Anchor, To be Used Inside Vaults

All cables inside a vault shall be racked. NESC requires that no cables are to lie on the floor of accessible vaults. Racking supports the splices, allows safe access to the vault, and widens the safe working space.

The racking system issued in GV 802 is preferred. To mount the rack in GV 802, holes must be drilled into the vault wall and drop-in anchors installed. Composite racks that eliminate bonding to the grounding are preferred over metallic racking systems.

6. Conduits and Sweeps

GC 201 Conduit Assembly—Below Grade

GC 411 Conduit, Schedule 40 PVC

GC 452 Elbow, Conduit, 90°

GC 462 Elbow, Conduit, Fiberglass, 45°

GC 576 Coupler, PVC, 5°

GC 651 Plug, Expandable, PVC Conduit

GC 651 Plug, Expandable, PVC Conduit

GC 701 Sealant, Foam Spray

GC 911 Lubricant, Cable-Pulling

Conduit and Sweep Requirements:

i. All large conduits and elbows material shall be 6" in diameter (6" ID) fiberglass. Fiberglass eases pulling tension for long runs and extracting failed cables.

ii. Two-inch conduit for fiber optic cable can be PVC.

iii. The maximum cable pulling distance through fiberglass conduit when pulling through a 90° riser sweep is 800 feet.

iv. All sweeps to a terminal pole shall have a 48" radius.

v. Horizontal sweeps in the underground conduit system shall have a 60" radius.

vi. Animal intrusion is a concern. Conduits with cables shall be sealed with steel wool and foam. Empty conduits shall be sealed with steel wool and foam, or a plug (issued in standards GC 651 and GC 712).

vii. “Cable Pulling Assistant” (CPA) software should be utilized to determine allowable pulling tensions for each design.

Getaway System — Design

1. General

The critical links between the substation and distribution system are the underground getaways that must be designed with the highest degree of integrity. Failure of one of these crucial segments can result in a major outage. The segments of the getaway run should always be minimized.

The accessibility of the getaway system (particularly the terminal locations) is critical for construction, operation and maintenance activities. Getaway vaults and riser poles should always be located to provide easy access and ensure safe work zones.

2. Cable Route

The substation, field and transmission engineers will evaluate the potential getaway routes based on:

i. Substation equipment placement

ii. Transmission line routes to the substation

iii. Right-of-way or easement restrictions

iv. Potential failure encumbrances

Distribution termination locations should be selected to:

i. Minimize transmission line conflicts

ii. Comply with maximum pulling tension for segment lengths

iii. Minimize the installation of expensive equipment like distribution vaults

iv. Provide enough room for cable pulling and feeding equipment setup

v. Minimize auto and pedestrian traffic control conflicts

The route of the getaway through the substation yard must be coordinated with the substation design. Getaways may run through the substation yard at an angle to minimize segment length, provided no conflicts occur with substation equipment foundations. Minimizing the getaway length reduces vault additions and splices, lowering costs and increasing the reliability of the circuit.

3. Terminal Pole Location

The location of terminal poles can be distributed in many directions and distances from the substation, depending on the maturity of the distribution system. The field engineer's plan describes how feeder lines are to be split to accept the substation capacity. The location of the terminal poles can be designated from the distribution plan. Attempts should be made to install the termination on an existing pole. If a clean pole is not near the substation, add a new termination pole.

In rural locations where the substation load is transforming to urban demand, selecting poles for cable terminations is normally trouble-free, without requirements to install vaults. Where the urban formation is shifting to metro density, finding poles close to the substation that accept cable terminations requires many compromises. The preferred locations for a terminal are:

i. The shortest route between the metal-clad and pole,

ii. A location not exceeding the cable pulling tension,

iii. A site that minimizes the volume of spoil to dig the trenches,

iv. A location accessible for construction, observation and switching, and

v. A location using an existing pole.

4. Vault Location

A vault is required to divide the underground cable getaway segment when a pulling calculation shows unacceptable tensions or the cable volume on the reel is too short to span the segment. Select a vault site that:

i. Adjusts to minimize cable pull tensions in all directions,

ii. Can be located outside of road and sidewalk paths,

iii. Accepts installing a shallow vault,

iv. Permits access for safe cable installation and repair, and

v. Allows space for pulling equipment placement.

5. Supplemental Neutral

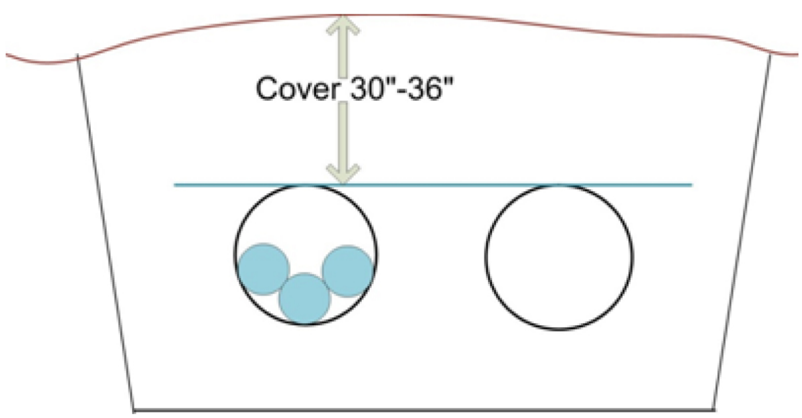
The 1000 kcmil cables (SI #4200016 and SI#4200106) purchased by the company are specified with a neutral sized such that a supplemental neutral is not required. For the cable circuits, the copper shield wires (concentric neutral) shall be attached and grounded at the same terminal locations.

6. Duct Bank Configuration

All conduits extended from switchgear feeder bays terminate at a getaway/riser pole or getaway vault. There shall be two (2) conduits extended for each feeder getaway: one conduit for cable installation, and one conduit as a spare. In no instance shall a non-locatable conduit be extended where conduit is not terminated at a riser pole or vault. A conduit can be located if a metallic conductor or a pulling tape with a metallic thread is pulled into the conduit and the distribution end is marked with a marker shown in GA 501.

The draft of the duct system requires more than just selecting the path and material. The backfill in a duct bank also needs to be arranged such that it will accelerate the heat transfer from the cables. Where the backfill heat transfer rate is low, certain design activities improve heat transfer rates:

i. Sketching the top of the conduit at 30″ below the surface meets NESC cover requirements for conduit burial depth. Less soil cover transfers the cable generated heat to the surface faster than deeper conduits.



Note: 30″ soil cover configuration will have higher ampacity than 36″.

Figure 3—Soil Cover Configuration

ii. Constructing a duct system with a wider trench and greater separation between conduits improves heat transfer.

iii. Replacing native backfill with higher Rho-value Fluidized Thermal Backfill (FTB) can improve thermal performance. (See Figure 4.)

This shallow trench filled with 2000 psi FTB set in soil of high thermal resistivity met PacifiCorp's specified ampacity, while other approaches were prohibitively expensive.

Figure 4—Trench Filled with 2000 psi Fluidized Thermal Backfill (FTB)

iv. Obtain easements that provide space to erect the duct structure in a horizontal orientation. Only install ducts in a vertical orientation in restricted easements and roadways to reduce the disrupted surface area.

v. Install high-tensile FTB with more cement in the mix to meet NESC reduced burial depth. Concrete with high psi-strength qualifies for reduced cover depth for cable, and improves heat transfer rates of aggregates that test with high thermal resistivity values.

7. Duct Bank Encasement and Backfill

The underground getaway is the most critical part of the distribution cable system. The radial cable system is normally not looped and may carry currents near the cable ampacity rating. A cable failure in the getaway leads to power loss for many customers.

The cable temperature must remain below the conductor rating to extend the life of the cable. A backfill designed to aid the transfer of heat should be included in the project if the designer finds it necessary. For a multiple duct system of three or more runs, the FTB and trench cover shall be integrated to conform to the project's stated average trench resistivity (Rho).

PacifiCorp Material Specification ZG 071 and Substation Construction Standard 03121 both provide information for designing a fluidized thermal backfill.

The duct system should be a flat design with a spare conduit at each terminal location. Flat design accelerates the transfer of heat away from the cables. The soil heat transfer rate shall be measured, and FTB shall be designed for the duct system to keep resistivity below 90°C-cm/W.

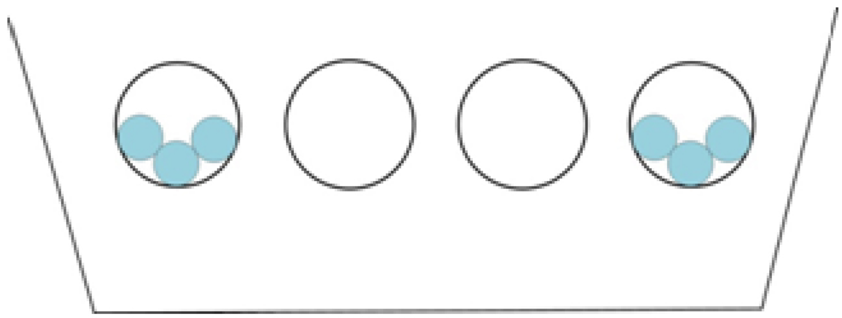


Figure 5—Flat Duct System Design

Heat transfer rates improve with materials of higher density and higher moisture content. The worst case for cable loading is when the soil is dry and the soil temperature has increased from the sun. Winter temperatures increase acceptable cable loading when the soil absorbs water and soil temperature drops. (See GC 011 for information on winter loading.)

If the trench must be dug into a roadway, then the FTB performs like a Controlled Density Backfill (CDF). The road administrators normally have ordinances controlling the compaction of the fill. CDF and FTB are advantageous since they meet county and city compaction requirements when hardened and promote heat transfer. Sand and gravel require labor for compaction. The extra labor cost for compaction along with the traffic disruption most likely will not offset the extra material cost of a low-psi concrete mix.

Figure 6—FTB Pour

CDF and FTB also act as trench markers for getaways and express feeder runs. This is particularly important outside the substation fence, where future construction activities may occur. Even though the easy flow slurries are easy to break, the concrete marks the cable route, especially when dyed red. The utility's trench can be easily identified by a contractor digging near the getaway trench.

Duct Bank Ampacity Rating

A duct bank plan specifies a system that exceeds a minimum cable summer rating of 480 amps. The average Rho of all the materials covering the duct shall be reviewed and the volume of FTB shall be stated in the project.

The average Rho of a backfill can be determined by calculating the percentage of the height of each fill above the top conduit multiplied by the Rho of each component and adding the value. Even for substation getaways with low soil heat resistivity, all the conduits should be covered with an FTB. The FTB cover assures that any air near the conduits is eliminated.

Getaway System — Construction

1. Duct Bank Framing

a. The duct system shall be constructed straight. Small curves and bends will naturally arise during the framing of the duct bank. The project material includes 5° couplers to align the direction of the conduits.

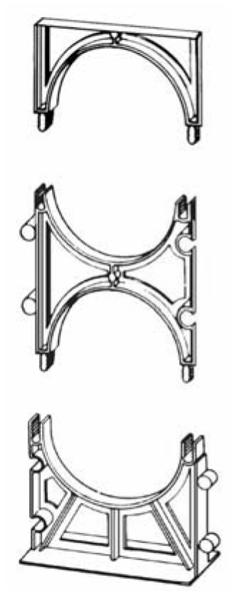


Figure 7—Duct Spacer Trees

b. Spacer trees attached every 12' (maximum) hold the conduits in place when the FTB is poured into the trench. The trees are pinned in place by steel rods driven at angles into the bottom of the trench. The pins prevent the duct system from floating during pouring of the FTB. An alternative to pinning is pouring a small volume of FTB and allowing it to harden before laying the final volume.

c. Horizontal sweeps in the underground conduit system shall have a 60″ radius. When cables are pulled, larger radius elbows reduce compression on the cable’s walls.

d. Duct runs cross each other at different elevations. The material list may issue sweeps with a 48″ and 60″ radius. Review the plans to arrange the different radius sweeps at the identified locations.

e. All conduits and sweeps shall be joined by specified glues, couplers and collars. The material list shows the proper epoxy and applicator guns.

f. All conduits entering a vault shall be glued to the terminal duct entrance to prevent water ingress.

g. Animal intrusion is a concern. Conduits with cables are sealed with steel wool and foam. Empty conduits can be sealed with foam and steel wool or a plug issued in standards GC 651 and GC 712.

2. Vault Setting

The site shall be inspected prior to selecting the equipment base or determining the installation details. The following items should be included in the inspection:

a. **Soil class**: Excavation equipment and drainage requirements are determined by soil class. Soil stability, including the consequences of inclement weather, shall be determined, and recommendations shall be made on shoring or sloping according to requirements.

b. **Final grade**: If the final grade has not yet been established, measures shall be made to allow for anticipated grade changes. Where radical changes in grade are anticipated, installation should be delayed until a near-final grade has been achieved.

c. **Site accessibility**: The site location for a vault shall be within 15' of a gravel or paved surface. Future access requirements for operation and maintenance of equipment shall be considered when determining equipment location. (For example, if the site is in or near a traffic area, loading issues or barriers should be considered.)

Padvaults are designed to be set such that the top of the pad is 2" above the final grade in non-pedestrian areas, and flush with the final grade in pedestrian areas.

a. Excavations should be no deeper than necessary to install conduits and set the vault.

b. All soil beneath the vault shall be compacted in 6" lifts and leveled to within a 2% slope prior to setting the vault.

c. A 6" base of ¾"-minus gravel is compacted to 90% of dry density under the vault.

d. Avoid marshy soils where an adequate foundation cannot be created through normal methods.

All openings and conduits shall be sealed. Precautions shall be taken to prevent flooding from affecting adjacent or substation structures.

During construction, the approach to the vault shall be covered to prevent personnel from falling. Plywood or other flat covers are acceptable for safety and for preventing water or debris from covering the vault floor.

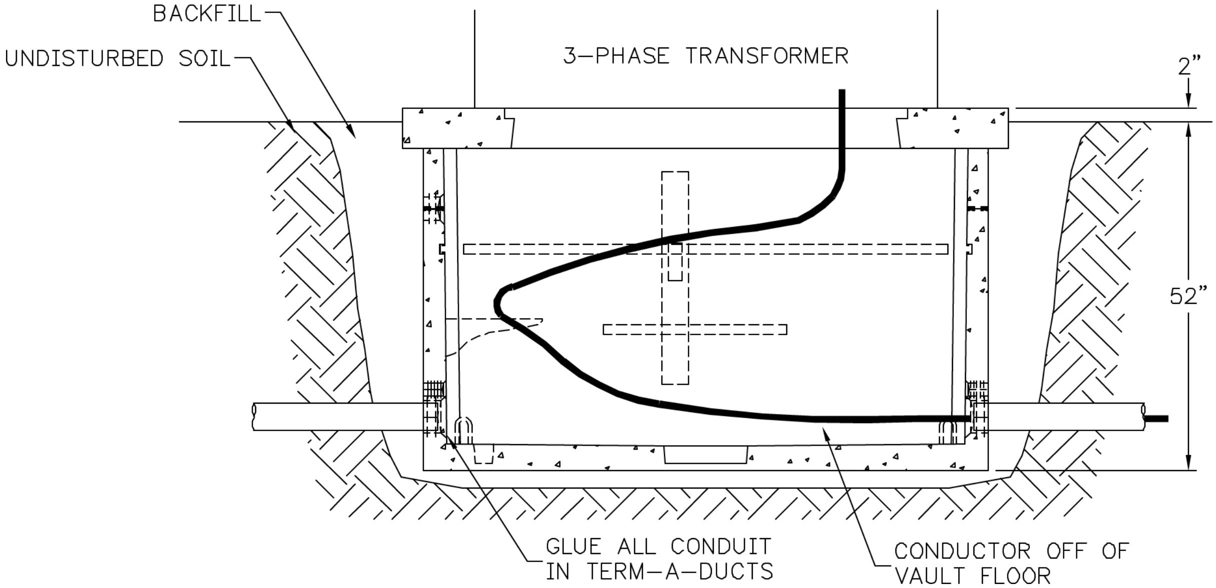


Figure 8—Typical Three-Phase Transformer Base Installation (from GV 021)

3. Vault Grounding and Bonding

Vaults with internal Ufer grounds do not require driven ground rods to meet NESC grounding requirements. Grounding inserts installed on internal and external vault walls connect the bonding conductors to the internal ground grid. Bond the units together when setting a vault with multiple sections. All splices and terminations shall be bonded to the ground grid. The bonding reduces the step-and-touch potential in the work zone.

Any metallic objects within six feet of the vault should be bonded to the vault's external ground grid. Standard DG 601 issues grounding lugs that rotate into the grounding inserts and compress the grounding conductor.

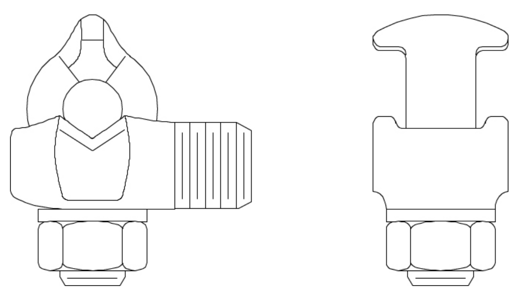


Figure 9—Grounding Lugs (from DG 601)

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4. Align Vaults and Duct System

The design of the vault includes numerous terminal duct entrances for attaching ducts into the vault wall at the intended burial depth. The position of vaults and conduits must align such that a conduit enters a vault's duct entrance in-line. The straight alignment and bonding maintain dry vaults, eliminating pumping water from vaults prior to entering to replace failed components.

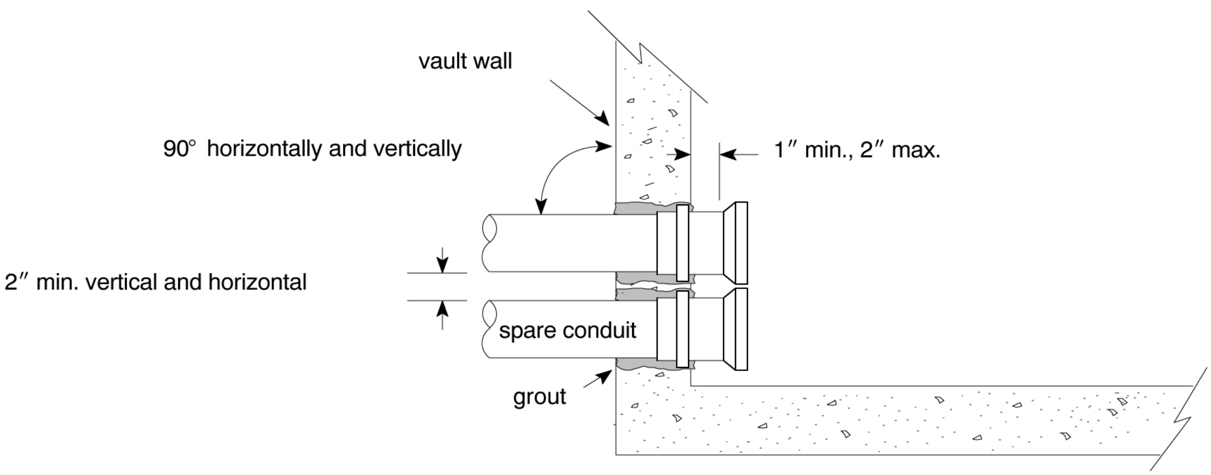

Figure 10—Typical Conduit Entrance for Concrete Vaults (from GC 101)

At constricted sites, the ducts may not align with the duct entrances. Always endeavor to insert ducts through the terminal duct entrances without an elbow, just outside of the duct. When necessary, sweeps near the vault wall may be installed shifting the angle of the duct. In extreme cases, a vault wall is cored and bell ends are installed for bonding conduit (the grout that seats the bell ends shall be sealed to prevent water ingress).

5. Fluidized Thermal Backfill

FTB is a material engineered to meet specific thermal resistivity, thermal stability, strength, and flow criteria. The FTB material and pouring shall comply with Substation Construction Standard 03121.

FTB is a concrete-like backfill consisting of medium stone aggregate, sand, a small amount of cement for strength, and fly ash to enhance flow. The proportions shall be chosen to reduce thermal resistivity and maximize flow without segregation of the components. The mix flows readily to fill all voids and hardens quickly to a uniform density. Hardened FTB shall result in negligible settlement, offer adequate mechanical protection for the conduits and provide support for underground and surface facilities.

FTB is supplied mixed in concrete trucks. It may be installed by pouring or pumping and does not require specific shoring or bulk heading. FTB solidifies quickly; the ground surface may be reinstated the next day. The hardened FTB shall be low-strength, to allow easy removal if the conduits must be accessed in the future.

6. Cleaning and Certifying Conduits

a. After the conduit has been laid and the trench backfilled, the entire run shall have a non-flexible, wooden mandrel pulled through it in order to proof the conduit run. If an obstruction is found, that section of conduit shall be replaced. For proofing 6" ID duct, the mandrel shall be 5.5" in diameter and approximately 6.25" in length.

b. Ducts shall be cleaned by drawing a stiff bristle brush and swab through each conduit to remove any foreign materials.

c. After mandrel proofing and cleaning, a non-biodegradable, minimum 700# pulling line shall be installed in all ducts.

d. Written verification that all conduits have been tested, cleaned and proofed “good” shall be provided by the contractor to the project inspector.

7. Cable Pulling

(Also see GC 161 Conduit and Cable Pulling—Cable Pulling Instructions.)

Cable should be pulled in one continuous motion from feed point to a riser or a vault. Stopping the cable during a pull results in a momentary increase in friction and a corresponding increase in tension required to restart the pull.

a. Terminal Pole

Always pull directly to the terminal pole if possible. If the conduit and sweep are fiberglass, the cables can be pulled in lengths of 800' and up the terminal pole. An 800' run leaves 200' of cable left on the reel. The extra cable allows spare cable for training and for trimming the cable’s ends, to eliminate any damaged sections that may be compressed by the pulling attachments.

b. Getaway Vault

Cable should always be pulled into the vault along the long (12-foot) side of the vault. In cases where the vault cannot be oriented in this fashion, use 60″ sweeps to bring cables into the vault along the long side.

c. Cable Pulling Diagrams

Figure 11 shows examples of pulling cable from switchgear into the getaway vault to provide proper training, racking and splicing locations.

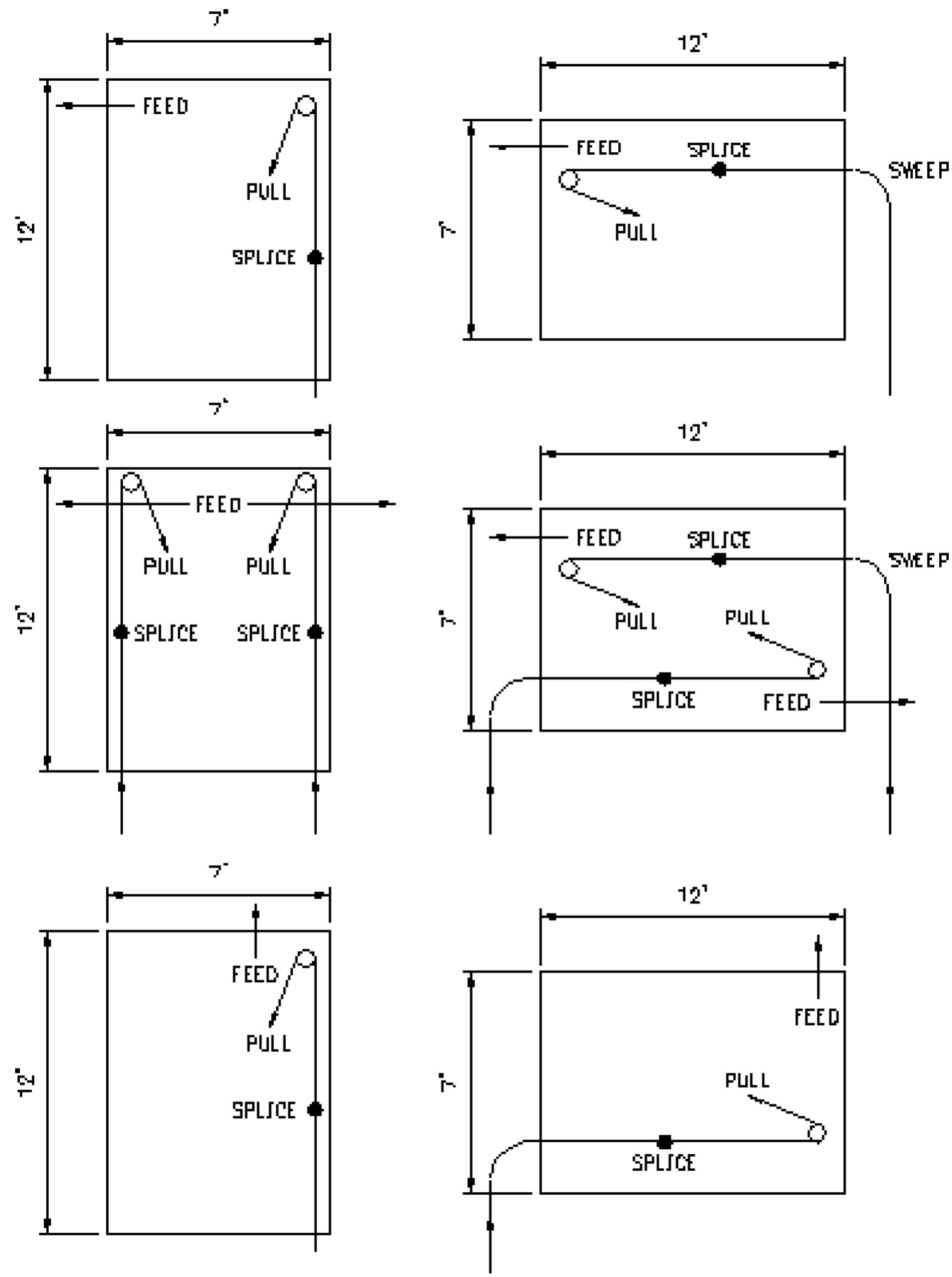

Figure 11—Cable Pulling Diagrams

8. Cable Training and Racking

a. General

Personnel entering a vault shall have a safe work environment with cables racked and trained along the vault walls. In no case shall cables be racked or trained improperly, or be laid on the vault floor. Vaults are not intended to provide slack for future cable splicing or termination. An organized vault is essential to providing a well-organized and safe work environment for future construction, maintenance and operational activities

In a suburban environment, four getaway cables would be the most expected in a vault. When four circuits are extended to a vault, they shall be racked two to each wall. The field engineer or operations manager shall also be contacted regarding work practices.

In high-density urban installations, more than four circuits may be extended into the same vault. These installations, as discussed, will typically require duct bank exits from the switchgear location. Consult company distribution engineering staff in these situations.

b. Racking

Cables shall be racked close to the vault wall. A 12-inch hanger or bracket is usually sufficient. Horizontal spacing between these brackets should not exceed 3 feet when racking 1000 kcmil power cable.

Cables shall be trained and racked above and/or below the duct/conduit entrance, to prevent cables from interfering with future cable installations. Cables racked on the same wall shall be 12 to 24 inches apart at the midpoint of the vault wall. All cables shall be bundled and tied to the hanger or bracket with plastic tie straps. Cables shall be racked horizontally with gradual elevation changes to meet separation requirements.

Always curve cables up or down from the duct entrance. The curve enables the cables in the conduit to expand and contract without compressing and stretching splices.

Allow a minimum of 6 inches of straight cable out of the duct before starting a curve. New cables tend to creep after installation, and all cables shift under heat cycling. If the bend is too close to the duct, these movements can damage the cable sheath at the duct edge.

c. Splicing Considerations

During splice construction, splicing components are slipped along the cables, back from either side of the splice. To facilitate this, cables shall be trained and racked along the vault wall with 48″ of straight cable lying horizontally, or at a gradual slope, on either side of the centerline of the splice location.

d. Cable Racking Drawings

i. Plan Views

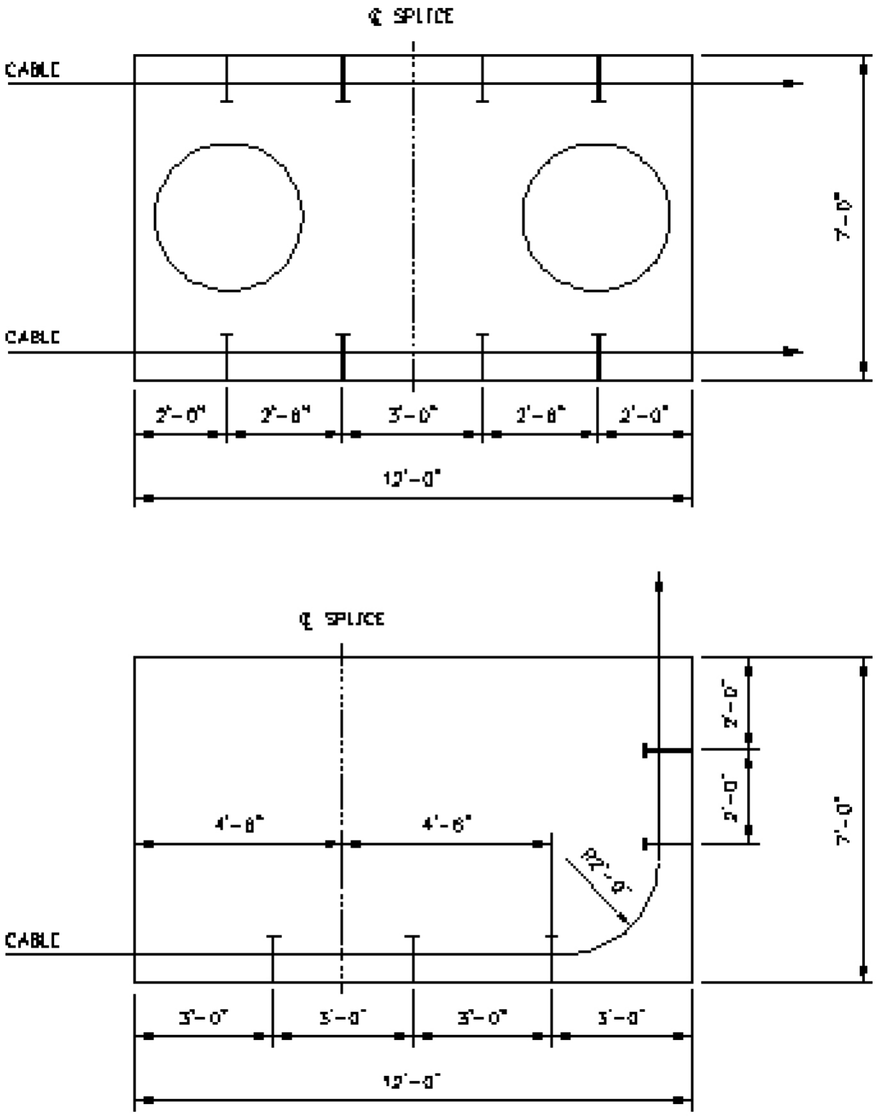

Figure 12—Cable Racking

Notes:

1. Racks are 12" on 2'-3' centers.
2. The cable bend radius is assumed to be 24".
3. When cable is trained 90° in a vault, rack placement may need adjustment, and longer cable hangers may be needed at/near the bend.

ii. Profile Views

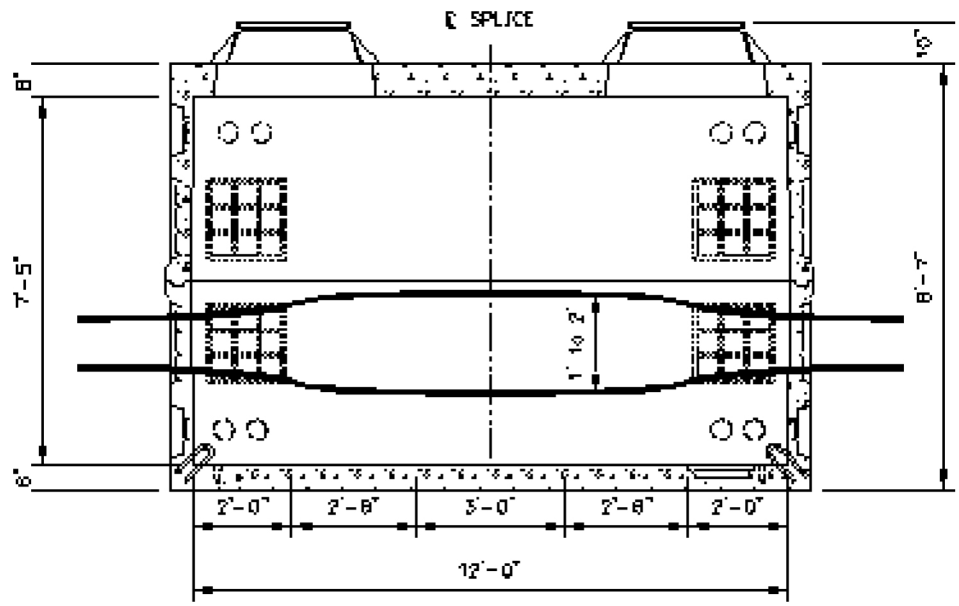

Figure 13—Cable Racking (Side View, from Engineering Handbook Document 2L.1)

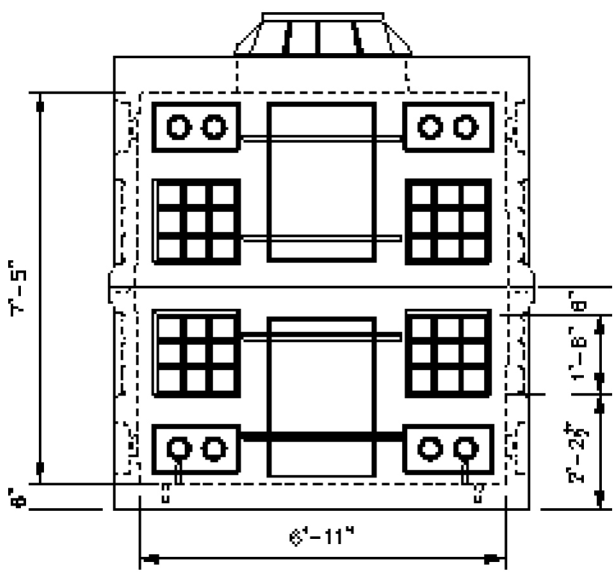

Figure 14—Cable Racking

Company vaults have upper and lower "knockouts," or terminal duct entrances, for conduit installation. Upper-level entrance is preferred to reduce the cover on the conduits. Trench depths from the finished grade will align closer to the upper section.

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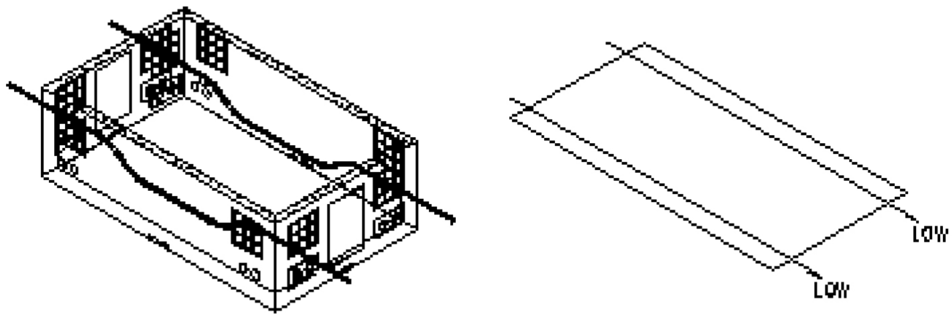
iii. Racking Configurations (3D)

The following drawings show several cable racking scenarios in three dimensions. Conduit entrances and exits shall be designed so that cables can be pulled and fed properly, and don't need to loop around the inside of the vault. Cables shall be racked above or below conduit entrances and exits to keep them clear for future use.

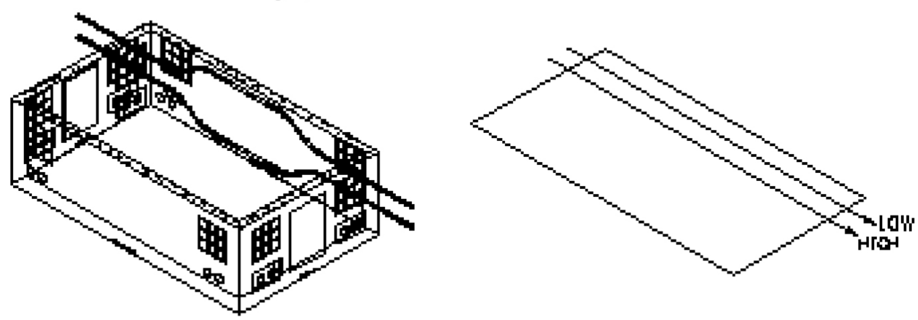
(1) 2 Circuits, One on Each Side

Circuits can be racked high or low.



(2) 2 Circuits, on Same Side

One circuit is racked high, one low.



(3) 3 or 4 Circuits, 2 on Each Side

Two circuits are racked high; two are racked low.

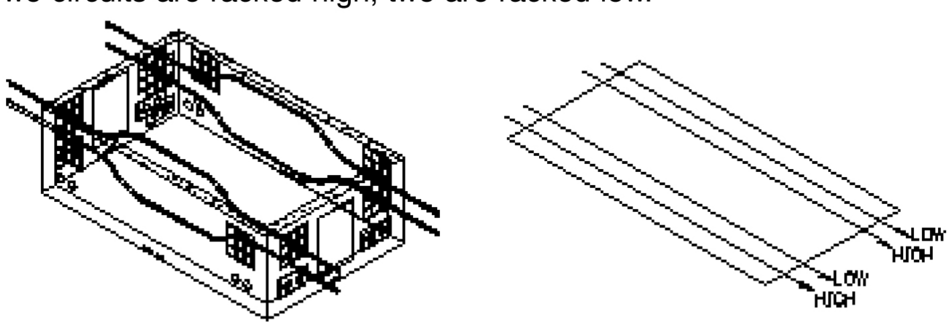


Figure 15—Cable Racking Configurations

Construction Coordination

The substation design/bid package shall include design of the getaway cable system including the duct structure, termination assemblies, cable and accessories.

This system shall be designed by the distribution engineer, in conjunction with the company substation design and transmission departments. Conduits shall be extended to the riser pole or getaway vault. Conduit encasement and trench backfill shall conform to Getaway System—Design, earlier in this document.

Underground extensions such as express underground feeders extended from the getaway vault should be addressed under a separate project.

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GV 601 Vault, 7' × 12'

RCMS Code: BA

		GV 601	_
Application	**SI #**	**Code**	•
Full Traffic	7992596	A	
Incidental Traffic	7992597	B	

Note

1. Use standard DS 601 when compliance with Buy America is required.

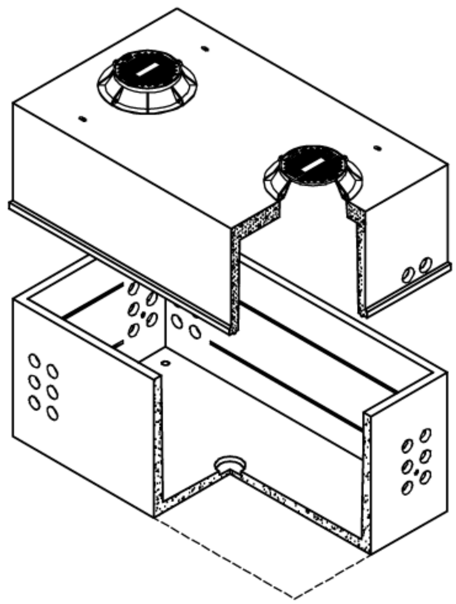

Figure 1—Full-Traffic Manhole (SI# 7992596)

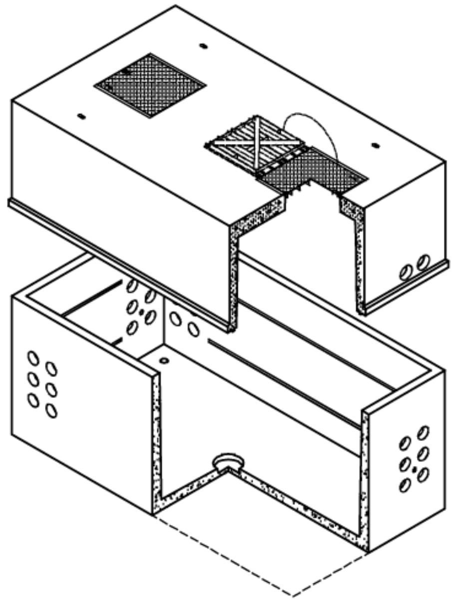

Figure 2—Incidental-Traffic Manhole (SI# 7992597)