Distribution Design Manual

RIVERSIDE PUBLIC UTILITIES 2014

WATER | ENERGY | LIFE

CITY OF RIVERSIDE

PUBLIC UTILITIES

INTRODUCTION

This manual is intended for promoting consistency in design and as a means for training new Senior Aides, Engineering Technicians and Engineers (designers). It outlines the design criteria and standards for system layout for the City of Riverside's electric system.

The contents of this manual are to be standards for design, not guidelines. All system additions and rebuilds will be developed in accordance with this manual. The uniform application of this design manual will assure consistent design practices among designers. Adoption of these design practices will help the City of Riverside to maintain system integrity, reliability and operability. The design manual contained herein is constructed through the collaboration of City of Riverside Engineers and Field Operations personnel.

This manual does not cover construction details (see CO and UGS construction standards) but references pages from the UGS and OH construction standards, rules and regulations (see Rates, Rules and Regulations), codes (see National Electric Code, the State of California General Orders 95 and 128, and California Code of Regulations, Title 8), material specifications (see Oracle UWAM and UGS and CO manuals), and service equipment requirements (see EUSERC Manual).

In this manual, a distinction is made between an underground ”feeder” and “subsystem” the example in **DDM-1 schematic L.2L-1** identifies that relationship.

DESIGN RESOURCES

AutoCAD – Electrical Engineering Drafting Standards.

All support files for ACAD will be under S:\Dept\Public Utilities\AutoCAD Support Files

CADME/GIS – Computer Aided Drafting, Mapping and Engineering/Geographical Information System

CENTRAL STORES STOCK CODES – Location for description and Compatible Unit number of materials for Overhead and Underground.

CIRCUIT MAPBOOK – Energy Delivery Systems, Color Coded Circuits, Overhead Switch Locations

CITY OF RIVERSIDE PUBLIC UTILITIES DISTRIBUTION TRANSFORMER THEORY

CO – Electrical Distribution and Transmission Overhead Construction Orders

ELECTRICAL ENGINEERING MAPBOOK - Electrical Facilities and Street Lights

ELECTRICAL SAFETY, HIGH, LOW VOLTAGE AND UNDERSTANDING OF NFPA 70-E

ELECTRIC RULES & RATES

ELECTRIC METER SHOP STANDARDS AND PROCEDURES

EUSERC – Electrical Utility Service Equipment Requirements Committee, http://www.euserc.com

GO 95 – General Order No. 95 - Rules for Overhead Electric Line Construction

GO 128 – General Order No. 128 - Rules for Underground Electric Line Construction

GO 165 – General Order No. 165 - Rules for Maintenance - Refer to Pole Replacement Training for G0 165 Pole Replacement Manual

JOINT POLE PROCEDURE

METER SPOT PROCEDURE

NEC - National Electrical Code Handbook

ORACLE UWAM – On line RPU computer software utilized for electrical design material and labor estimates. Also used for asset records which include condition assessments, photographs, specification sheets and other valuable reference information to be used in the design process.

SOUTHERN CALIFORNIA JOINT POLE COMMITTEE – Routine Handbook.

UCM – Underground Construction Methods

UGS – Underground Structure Standards

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Feeder Systems

1.0 Scope

This section establishes the design criteria to be used in designing feeder systems. The feeder backbone system is the “mainline” portion of the circuitry that forms the 12 kV and 4 kV network interconnecting circuits and substations. The feeder backbone system is designed with cables ranging in size from 750 to 1,000 kcmil Cross-Link Polyethylene (XLPE) on underground circuits and 336.4 Aluminum Cable Steel Reinforced (ACSR) on overhead circuits in accordance with planned growth.

The need to design a new feeder system is initiated through internal activities such as circuit planning, underground conversion projects, large new developments, etc. The effectiveness with which a distribution system fulfills this function is measured in terms of voltage regulation, service continuity, flexibility, efficiency and cost. The design process is in accordance with Riverside Public Utilities (RPU) 2009 Electric System Master Plan. The cost of distribution is an important factor in the delivered cost of electricity. Briefly, the purpose of distribution planning is to design, construct, operate and maintain a distribution system that will supply adequate electric service to the load area under consideration, both now and in the future, at the lowest possible cost.

1.1 Design Concept

The feeder system design criteria applies to the planning of a new distribution circuit, the undergrounding of sections of an existing overhead feeder, or adding a new section for extension of an existing feeder. It also applies to the rearrangement of an existing feeder section.

Based on economics, the design of feeder systems should result in capital expenditures and installation of plant being deferred when the actual need for the feeder is not required for five years and conduits/substructures are not required for seven years.

A feeder should be planned for peak-load conditions. The designer will minimize the number of switches and subsystem connections to the feeder by using the following strategies:

A. Plan the optimal number of circuit ties to perform required switching (planned and emergency). Operations of sectionalizing switches and circuit tie switches should permit all portions of the circuit, except the faulted element, to be restored by switching pad-mounted, pole-mounted or remotely operable switches during peak conditions while maintaining conductors within their emergency capacity and circuit voltage profile within emergency limits. Consult Electric System Planning (ESP) to determine circuit tie capacity and switching requirements.

B. Plan subsystems for underground commercial/industrial (C/I) and residential developments as open loop designs isolated from the feeder backbone by fuses placed as close as possible to the feeder backbone.

A subsystem can be any combination of C/I and/or residential load. Loading of subsystems is limited by the lowest rated component on the system. In the case of RPU's subsystems the lowest rated component in most cases is the 1/0 Al underground cable. Thus, the approximate range of loading for subsystems is approximately **1670 kVA**, which equates to 77 A at 12.47 kV. Open-looped subsystems should be planned to have not more than 3,340 kVA equally split between two feed points. The normally open point between the two segments should be at the mid-point of the load in a pad-mounted or surface operable location. Feed points for a subsystem should originate in two separate structures to avoid single mode of failure for both feed points. When feasible, the feed points should be isolated from each other by a feeder sectionalizing switch to avoid a single mode of failure for both feed points.

Design each subsystem so that it can be switched and isolated from the feeder without interrupting service to other subsystems. A subsystem on underground circuits may be connected to the feeder by a fused position on a pad-mounted switchgear. On overhead circuits, subsystems are connected to the feeder using fused disconnects. It should be understood that the loading on feeder circuits is established during the planning process using RPU's 2009 Electric System Master Plan loading criteria. Normal operating voltage for circuits should be 12.47 kV phase to phase and 7.2 kV phase to ground. Each new circuit shall be designed to be loaded nominally to 300 A. This equates to *6.2* MVA at 12 kV, per circuit. Based on a coincidence factor of 97% between circuits, the sum of three circuits total 18.1 MVA and five circuits total 30.2 MVA.

Loading above 300 A is allowable based on a review of:

- Continuous rating of the underground getaway as well as the remainder of the circuit.
- Adequate ties to other circuits in case of an outage.
- Adequate capacity to receive load following outage of an adjoining circuit.
- Allowable voltage regulation along the circuit.

1.2 Design Criteria

1.2A Coordination with Electric System Planning

Coordination with Electric System Planning (ESP) is critical to integrating individual project design work with the overall distribution system plan. A typical guideline for determining when this coordination is deemed necessary is: when there is potential to improve the system as part of a project, continue to coordinate with system planning even if loads are below the “trigger” points.

Listed below are the “triggers” which warrant coordination with ESP on circuit loading and project design:

- 4 kV System - 150 kVA or more (total of project transformers connected)
- 12 kV System - 300 kVA or more (total of project transformers connected)
- Addition of 100 kVA or more of single phase transformer connected load

Note: The most recent three-phase circuit amp readings will also be utilized to address circuit phase balancing where large portions of single-phase load will be served.

In addition, the following non-load related circumstances associated with a project also require coordination with ESP:

- Installation of new infrastructure along the frontage of a project.
- Existing HMPE or other aged cable, live front transformers, oil switches, submersible switches, deteriorated Buried Transformer Enclosure (BTE) Sleeves or other deteriorated equipment or structures. (Contact Asset Management for assistance in identifying deteriorated structures and equipment within the bounds of your project.)
- New design which impacts existing feeder tie points or capacitor banks.
- Load additions past a line regulator.
- Load additions past an automatic line recloser.
- Addition to a 4 kV circuit should be designed and constructed for future 12 kV conversion using 12 kV class cables for underground lines, 12 kV framing and insulation on overhead lines, dual-voltage transformers and 12 kV equipment operated at 4 kV.

1.2B Capacitor Planning

Capacitors should be installed on feeder backbone conductors only. Existing capacitors installed on branch lines should be reviewed and relocated to feeders in conjunction with other project work when feasible. Capacitor requirements are determined by ESP.

Circuit Capacitors - Sufficient capacitors are planned for each circuit to maintain the power factor at 98% or above to reduce electrical losses and provide proper customer voltage.

1.2C Reliability Improvement

Reliability improvement is determined by ESP. Reliability improvements may include the following:

- Additional line clearance tree trimming or removal of dangerous trees for tree and palm frond contact related outages.
- Replacement of deteriorated structures and equipment for equipment failure related outages.
- Replacement of high failure rate cables.
- Addition of sectionalizing and tie switches to eliminate tie deficiencies.
- Reconductoring to improve tie capacity.
- Addition of branch fuses and sectionalizing switches with faulted circuit indicators to limit exposure and speed restoration.
- Addition of an automatic recloser with SCADA.
- Addition of motor operators on existing sectionalizing or tie switches with SCADA.

1.2D Voltage Regulation

Voltage regulation is determined by ESP. Primary voltage on distribution feeders shall be maintained within the range of 11.9 kV to 12.3 kV at the substation bus through the operations of substation capacitor banks, substation transformer Load Tap Changers (LTC), on system generator voltage regulation and the Vista "A" Bank LTC voltage schedule.

ESP determines when voltage regulation guidelines are exceeded at peak or minimum load conditions, corrective action should be planned. Corrective action may include the following:

- Phase balancing
- Capacitor placement
- Automatic Line Regulator placement
- Reconductoring
- Load transfer
- Addition of a new circuit

1.2E Circuit Ties

Circuit Ties are determined by ESP. Feeder designs, including circuit ties, must be site-specific and designed in conjunction with a contingency load transfer plan. In most cases, three properly located circuit ties are sufficient to satisfy required planned and emergency operations. However, geographic conditions (i.e. mountains, flood control channels, freeways, etc.) or operating constraints (i.e., fire areas and protection requirements, etc.), may require that circuits be designed with more than three circuit ties.

These ties should allow load transfers between circuits and maintain circuit loadings that are below the relay minimum trip settings and emergency cable loading limits of the feeder (roughly 80% of overcurrent relay minimum trip setting current). A load flow study should be performed to insure that voltage profile and conductor loadings remain within emergency limits at peak load.

The number of ties with circuits out of the same substation versus circuits out of another substation must be considered in order to satisfy the criteria for load transfers during loss of one substation transformer (N-1 contingency). A minimum of three circuit ties in each feeder is needed unless certain limitations and conditions justify less than three circuit ties in a specific feeder. In the future, circuit tie switches may be designed to be automated for remote control at the discretion of the AGM. As noted previously, sectionalizing and tie switches should be designed to pick up all portions of the feeder, except the faulted segment, using pad-mounted, pole-mounted, surface operable or remote operable switches.

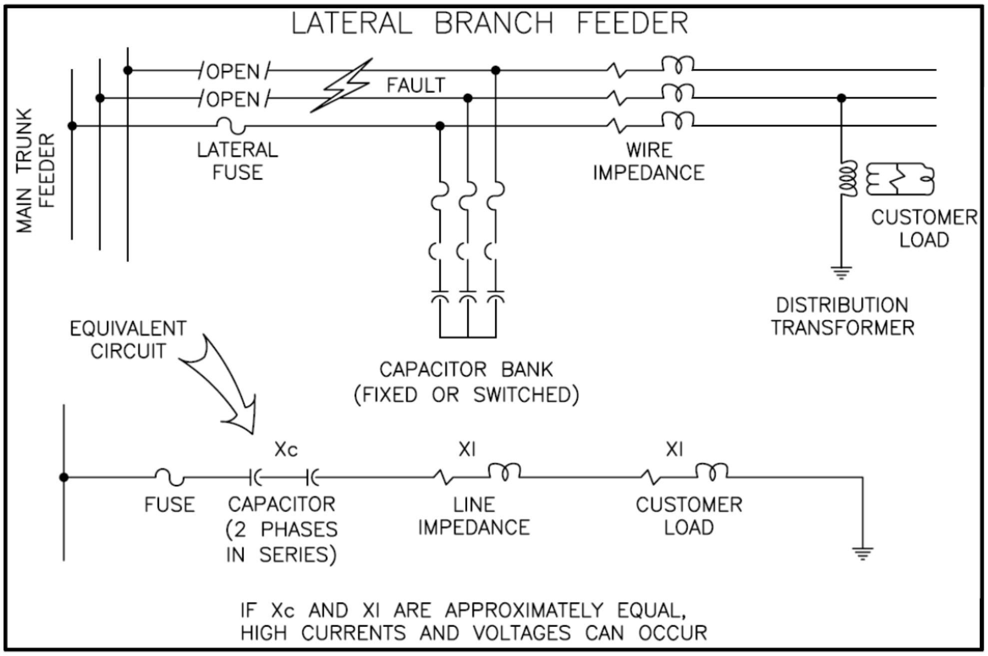
1.2F Overhead Lateral-Line Fusing

The application of overhead lateral-line fusing on 12 kV circuits shall be limited to selected locations and requires ESP approval. Lateral-line fusing will typically satisfy protection and operating requirements. ***Laterals shall not be fused if there is a capacitor bank downstream.*** Capacitor banks should only be located on the feeder backbone, never on branch lines or local subsystems.

If one or two fuses were to blow during a fault, the remaining phase (s) will remain energized through the three phase capacitor bank. If the series combination of capacitive and inductive reactance is about equal, high currents and voltages can occur. Theses currents and voltages can be high enough to damage equipment.

Fused laterals having a capacitor bank down stream should have the fuses removed from the cutout and slugged. The slugged cutouts cannot be removed without ESP approval. Design directive is not to install capacitor banks behind lateral fuses as shown in **Figure 1-2F-1** below.

Figure 1.2F-1: 4 kV and 12 kV Capacitors and Lateral Fusing



The following guidelines are to be followed for lateral fusing; all branch lines off the feeder should be fused or sectionalized as close as possible to the feeder backbone. When the branch line cannot be fused due to the presence of a capacitor bank or total connected kVA of transformer load, a sectionalizing switch and faulted circuit indicator should be installed.

1. Use lateral fusing to protect laterals of smaller conductor sizes installed close to the substation (high available short circuit) to prevent damage to the conductor.

2. Use fusing and fault indicators to aid Electric Field in trouble shooting and fault finding.

3. ESP is to review the circuit for fusing.

Table 1.2F-2:

OVERHEAD LATERAL FUSE TABLE			
CONNECTED KVA LOAD PER PHASE		RISER FUSE	STOCK NUMBER
MINIMUM	MAXIMUM		
0	500	150 QR	25687
501	700	200 QR	25689

Lateral fuses are available in much smaller sizes, but may require a change to the fuse blowing scheme. For example, a typical fuse blowing scheme would use a 150 QR fuse for 500 kVA of connected overhead transformer load. The term branch fuse or up feed riser fuse shall be used to clarify that only overhead is being protected.

Table 1.2F-3:

RISER FUSE TABLE			
CONNECTED KVA LOAD PER PHASE		RISER FUSE	STOCK NUMBER
MINIMUM	MAXIMUM		
0	166	100 QR	25685
167	333	150 QR	25687
334	700	200 QR	25689

CAUTIONS:

1. Fuse lateral must be a true lateral. Watch for and avoid fusing conductors where downstream tie points to other circuits exist.

2. Use care when fusing laterals that connect “Disaster Preparedness Sites” such as law enforcement, hospitals, radio stations, fire stations, water facilities, school facilities and sewer lift stations, or customers with large three phase motor load.

3. Use caution fusing sub laterals located close to the substation. High fault currents reduce coordination of fuses in series. A fault on the sub lateral may blow both the lateral and sub lateral fuses.

1.2G Fault Indicators

A. Description

Fault Current Indicators (FCI's) are phase-current sensing devices which are highly reliable. However, FCI's are very much dependent on the fault magnitude and duration which varies from each and every location in the circuit. Therefore, they may not work in some situations where fault duties are not high enough and/or long enough to trigger the FCI unit.

FCI's are placed on cables and overhead lines to indicate that fault current has passed through their location. Troubleshooters and crews can be guided by the FCI's in their efforts to locate faulted sections of the circuit and restore service. FCI's have an expected battery life of 15 years and are designed to trip in 1/16 of a second. FCI's trigger beyond 4 times load current on the underground and 1000A on the overhead.

B. Operation

A tripped circuit breaker or a blown fuse is the first evidence that a fault has occurred. If the circuit breaker tripped due to a fault, then the fault indicators installed on the breaker's associated circuit would trigger if the fault current passed through them. The FCI's are then used to indicate the path to the fault location.

In general, the segment of the circuit between the farthest downstream flashing FCI and the next non-flashing FCI indicate the segment where the fault has occurred. The troubleman then opens the appropriate switch or switches to sectionalize and isolate the faulted segment of the circuit. After verifying that no other source paths to the faulted segment exist, the troubleman reenergizes other un-faulted parts of the circuit to restore power to as many customers as possible.

Utility Dispatch directs and approves all isolation and restoration switching. Troubleshooters or other field personnel may operate field devices to isolate trouble without authorization from Utility Dispatch in an emergency, but should notify Utility Dispatch as soon as practicable after. No restoration switching may be performed without direction from Utility Dispatch. The FCI's are commonly made an integral part of the circuit's emergency switching procedures.

C. Placement

FCI locations will be selected to cost-effectively reduce the switching time to isolate a fault based on the established emergency switching procedures.

Special circumstances, such as problem circuits, (circuits with a history of frequent or lengthy outages), and circuits with critical loads, may warrant additional FCI locations.

Avoid placing FCI's at the following locations:

- On any normally open tie line
- On any normally de-energized circuit section
- On minor circuit tap sections and single-phase laterals
- Immediately beyond fuses
- Circuits that are open-looped

The FCI's will be placed in a readily visible and accessible location (for resetting), at or near a circuit sectionalizing point, on overhead conductors, in selected subsurface locations, or in pad-mounted equipment. FCI's may be placed on overhead conductors near underground risers to indicate faults on underground portions of the circuit.

1.2H Equipment Selection

A. Switch.

Pad-mounted switch enclosures (PSE's) refer to the underground structure on which the switch is mounted.

The air insulated (PMH) or gas insulated (PME) are the two commonly used underground pad mounted switch cabinets in our RPU Electric system. The ASF3 is an air-insulated switch fused three phase and is a PMH 9,10 or 11. The ASF1 is an air-insulated switch fused single phase and is a PMH 5.

Pad-Mounted switches PME (dead-front) gas insulated are the recommended standard for new installations requiring pad-mounted switches. They are the preferred type of installation due to ease of installation and operability. If the PME switch has a fused position, they are typically with current-limiting fuses. PME switches are available with four, five or six positions. The GSF3 is a gas switch three phase, vacuum fault interrupter (VFI) and is a PME 11F,52F,53F,64F. The GS3 is a gas switch three phase and is a PME 45.

(Refer to the Underground Construction Standards (UGS) Manual, Pages 650-651, for a detailed description of PME switches and fuses.)

1. **PMH air switch**. The H in PM(H) references the bus arrangement. They are available in series 5, 9, 10 & 11. See *UGS-660*. These air insulated switches require more real estate due to the 8 feet clearance requirement in the front and rear compartments, how ever they are less expensive than the gas insulated switches.

   Series 5: (1)-600A position and (1)-200A position
   Series 9: (2)-600A positions and (2)-200A positions
   Series 10: (4)-600A positions
   Series 11: (3)-600A positions and (1)-200A position

2. **PME gas switch**. The E in PM(E) references the bus arrangement. Available in series 11F, 45, 52F, 53F and 64F. See *UGS-661*.These gas insulated switches are front operable which is ideally suited when real estate is an issue and extra positions are available in the 52F, 53F and 64F.

   Series 11F: (3)-600A position and (1)-200A position
   Series 45: (4)-600A positions
   Series 52F: (2)-600A positions and (3)-200A positions
   Series 53F: (3)-600A positions and (2)-200A positions
   Series 64F: (4)-600A positions and (2)-200A positions

The specific project requirements and site conditions must be considered in making the most economic selection of switches. Please consult with ESP when selecting the type of switch required. **Figure 1.2H-1** on the next page illustrates potential feeder switch applications.

C. Placement/Screening

Please refer to the CADME map on the intranet displaying the Scenic and Special Boulevards along with the Parkways and Electric Work orders in Progress. Special attention should be given whenever designing above ground equipment in these areas. This information is accessible in CADME for designers. The following listed criteria should be considered when designing.

1. Avoid directly installing pads directly behind the curb on all streets.

2. Install equipment out of the line of sight for motorists at intersections. Visibility for vehicles when using pad-mounted equipment must be considered. If possible move equipment to side streets around corners. Minimum 30 feet from intersection.

3. Provide additional setbacks when City Planning or Public Works makes it necessary. This may require acquisition of rights-of-way or easements.

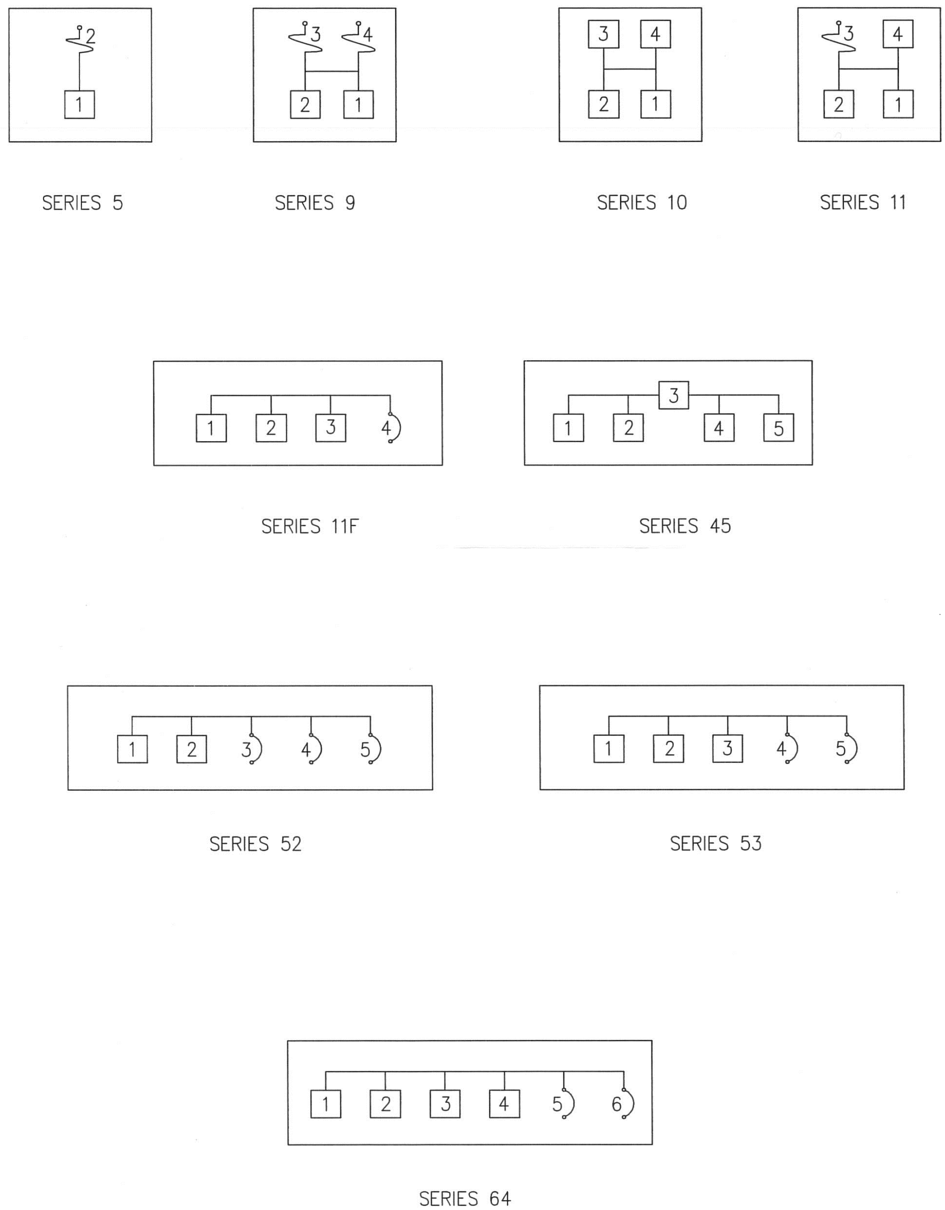
4. Clearance from other utilities' substructures. No clustering of pads in close proximity.

5. Traffic patterns and traffic control requirements

D. Aesthetics

Consideration given to the surrounding aesthetics, while ensuring that such consideration did not impact the cost of construction. Aesthetics in relation to development plans. Landscaping with irrigation and or screening walls may be required to mitigate aesthetic concerns. Review with the City Planning department or Urban Forrester for landscaping in the public right-of-way. Below grade construction may be required in historical districts or other locations where pad-mounted equipment is not permitted by City Planning.

Figure 1.2H-1: Illustrates potential feeder switch applications.



D. Aesthetics (Cont..)

Submit preliminary plans for review by the City Planning Department showing pad-mounted equipment and photographs of similar equipment locations for consideration. If appearance cannot be mitigated through landscaping or screening, City Planning Department may direct underground facilities to be installed.

E. 600A T-Body.

600A deadbreak elbows are used to connect equipment and cable on primary feeder and network circuits. De-energized a 600A T-body can be easily connected and disconnected using standard hand tools and equipment in accordance with accepted operating practices.

1.2I Structure Selection

Design and selection of substructure systems and materials shall accommodate anticipated area growth and system needs for the next ten years and should be coordinated properly with Electric System Planning.

A. Switch.

Table 1.2I-1 Switch Type

Switch Type	Dimensions	UGS Number
PMH Switch Gear Manhole Series 9, 10, & 11 Air Switch	126" X 60" X 42"	460
PME Switch Gear Manhole Series 11F, 52 & 53 Gas Switch	126" X 60" X 42"	460.1 (Right Side Opening) 460.2 (Left Side Opening)
PME Switch Gear Manhole Series 45 & 64 Gas Switch	126" X 60" X 42"	460.3 (Right Side Opening) 460.4 (Left Side Opening)

Pad-mounted or surface-operable equipment and structures are the preferred installations and utilized where conditions permit.

Structures selected should be the most optimum least expensive structures that will accommodate the anticipated ten-year need.

Tub-type structures are standard for vaults, manholes, surface-operable Enclosure used for feeder and subsystems. Tunnel or poured-in-place structures shall be installed on an exception basis only. Approval for the exception must go through your Supervisor.

B. Vault.

Structures should be spaced as far as cable-pulling lengths or reel lengths will allow and still achieve least-cost alternative to meet service to load design requirements. Refer to design manual section DDM-5 for pulling calculations.

The preferred location for structures is in the parkway or other non-traffic areas with good vehicle access. The second choice would be in light-traffic areas (parking lot not subject to truck traffic). Full-traffic locations are least desirable. Placement of new structures in intersections is prohibited. Vaults should be located 200' from an intersection. If full traffic location is the only option then the structure should be placed as close to the gutter as possible to allow continued traffic flow, when structure is being accessed but out of the flow line.

C. Riser Cable Runs

Cable should be fed from the structure up to the riser. Cable should not be fed from the top of the riser or from the base of the pole. Risers should be located in the pole quadrant toward the property side and away from traffic to avoid damage from vehicle collisions. No more than two primary risers should be planned for a single pole.

D. Duct Bank Planning

Transmission single circuit duct banks should include 4-6" conduits for Transmission cables , 1-2" conduit for neutral grounding, plus 2-5" conduits for fiber optic communications. Transmission double circuit duct banks should include 8-6" conduits for transmission cables, 2-2" conduits for neutral grounding, plus 2-5" conduits for fiber optic communications. Substation getaway duct banks should include 2-6" conduits for each circuit position plus 2-5" conduits for fiber optic communications to the first vault or manhole, Arrangement should be coordinated with Electric System Planning and Substation Engineering.

6" conduits may also be required in special duct banks such as jack and bore casings or when more than two distribution circuits are planned in a regular duct bank. Arrangement should be coordinated with Electric System Planning. Fiber optic conduits should bypass transmission and primary distribution structures using a separate fiber optic pull box.

For feeder getaways 6" conduit is required to accommodate 1000 kcmil conductors. The standard duct bank design for 12kV is 4-5" conduits for power circuits and 2-5" for City fiber optic communication circuits. This includes 2-5" conduits from substation to getaway vault.

A maximum of two 12kV feeders are permitted in any one duct bank. Deviations from the standard duct bank design to accommodate special designs will require approval of the ESP department.

D. Duct Bank Planning (Continued)

A maximum of two 12kV feeders are permitted in any one duct bank. Deviations from the standard duct bank design to accommodate special designs will require approval of the ESP department.

The preferred location for conduits is in the parkway parallel to curbs. Alternate location is in the street adjacent to the gutter. Trenches in traffic lanes should be avoided except for crossings. The existing location of other utility facilities must be researched and plotted on a base map to properly plan electric duct banks. Normally, a ten-foot separation is required for transmission and distribution duct banks. Rear property lines are the least desirable locations and shall not be used for underground duct banks unless a dedicated alley is maintained for access.

E. Joint Trench

Joint trench construction (with telephone, cable television (CATV), gas, or other utilities) should be planned according to good engineering practices and G.O. 128 clearance requirements. Joint trench provides a means to share trenching and paving costs. It can provide savings to the City, other utilities, and the customer. A joint trench agreement will be required and should be reviewed by the City Attorney's office and requires the AGM approval.

1.2J Conductor Selection

Distribution circuit ratings are based on the design limitation of the overhead or underground conductors. The conductor ratings shown in **Table 1.2J-1** were used to identify capacity issues at the existing and projected load levels for the distribution system.

The overhead conductor ratings are from the RPU distribution system model, and are based on 75°C (167°F) conductor temperature, 40°C (104°F) ambient temperature, and 2 ft/sec wind.

Underground conductor ratings, also from the RPU distribution system model, are based on three single concentric neutral cables per duct, a conductor temperature of 90°C (194°F), and a conductor load factor of 100%.

The optimum planning rating is 75% of the thermal rating to allow capacity for distribution load transfers during feeder outages. Projects are identified to relieve projected conductor loads exceeding 75%.

Primary cable for a new 12 kV feeder will be 750 kcmil, and 1,000 kcmil (for substation gateways) stranded aluminum with 220 mil of Cross-Linked Polyethylene (XLPE) insulation in a conventional conduit system.

Cable will be sized in accordance with **Table 1.2J-1.**

Table 1.2J-1: Conductor Rating

12 kV Underground Conductors	Nominal Rating (75% calculated)	Calculated Rating (amps)	Emergency Rating (amps)
1/0 AL	116	155	232
350 AL	229	305	458
750 AL	357	476	714
1000 AL	394	525	788

The above loading standards are to be used for all new cable installations including:

- Feeders through new residential or C/I developments.
- Replacement of overhead feeder with underground.
- Replacement of overloaded cables.
- New substation getaways.

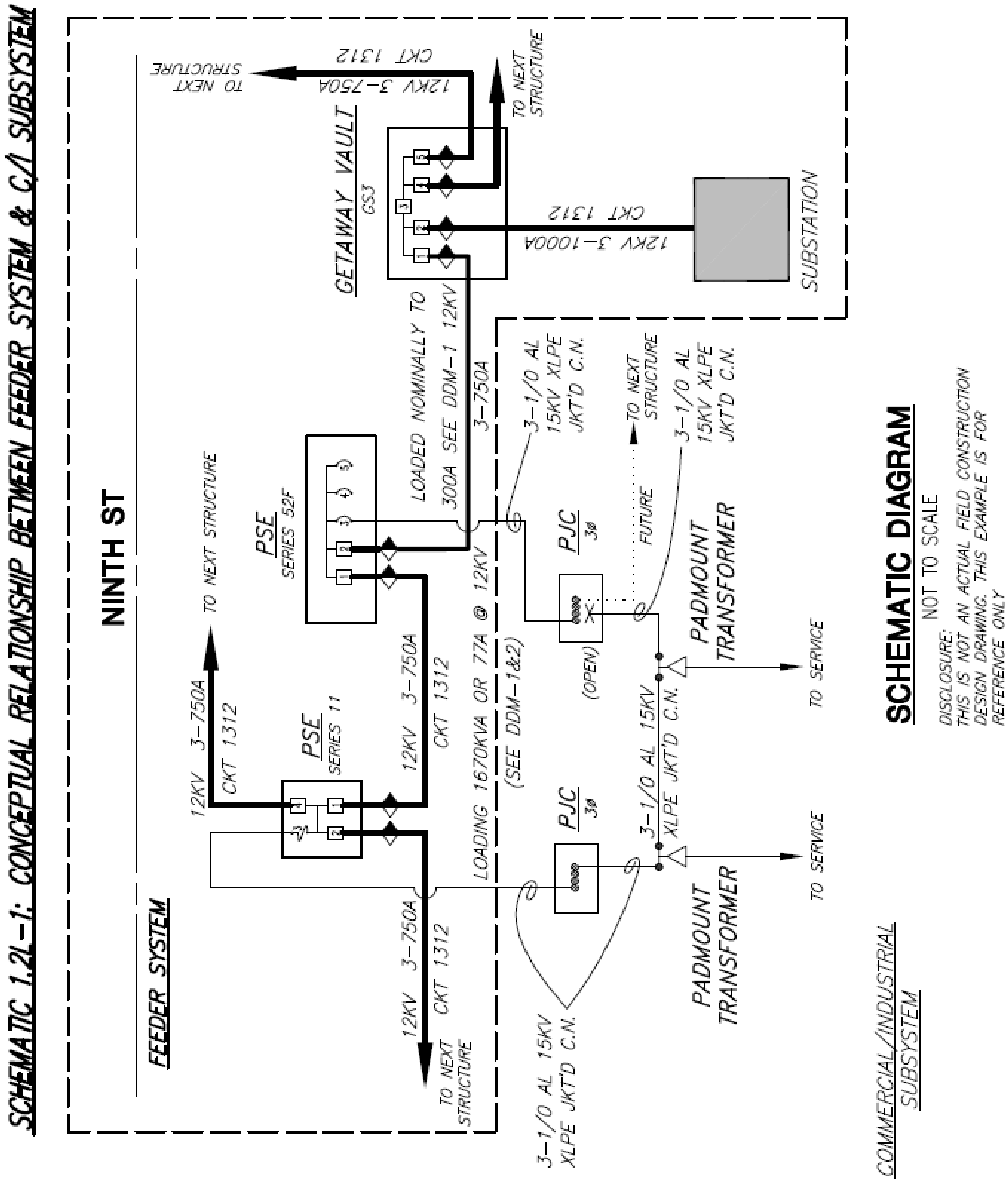
1.2K Duct Bank Loading

New circuits shall consist of 1000 kcmil Al getaways. Increasing the number of circuits placed in a duct bank which derates each individual cable must be weighed against the normal and emergency loading requirements of the circuits in the bank. Getaways should be designed with two 6" conduits for each feeder planned at a substation. 6" conduit systems and 1000 kcmil Al cable may be extended past the first underground structure if needed based on thermal loading study of the getaway duct bank as determined by ESP.

Circuits shall be planned so that the loading of individual cables in a duct bank will not exceed the planned loading limits. Circuits shall also be planned to support the load shifts required during contingencies due to the loss of substation equipment (N-1 contingency) without exceeding the emergency operating ratings.

ESP may direct Substation Engineering to install load shedding based on transformer loading, not duct bank loading. The effects of load shedding may impact the duct bank model by eliminating circuit loads from load shed circuits.

1.2L An example of the conceptual relationship between Feeder System and C/I Subsystem is shown in schematic 1.2L-1.


SCHEMATIC 1.2L-1: CONCEPTUAL RELATIONSHIP BETWEEN FEEDER SYSTEM & C/I SUBSYSTEM
FEEDER SYSTEM
NINTH ST
TO NEXT STRUCTURE
12KV 3-750A CKT 1312
GETAWAY VAULT
GS3
TO NEXT STRUCTURE
12KV 3-1000A CKT 1312
SUBSTATION
LOADED NOMINALLY TO 300A SEE DDM-1 12KV 3-750A
PSE SERIES 52F
TO NEXT STRUCTURE
12KV 3-750A CKT 1312
PSE SERIES 11
12KV 3-750A CKT 1312
LOADING 1670KVA OR 77A @ 12KV (SEE DDM-1&2)
12KV 3-750A CKT 1312
TO NEXT STRUCTURE
3-1/0 AL 15KV XLPE JKT'D C.N.
PJC 3Ø
(OPEN)
FUTURE
TO NEXT STRUCTURE
3-1/0 AL 15KV XLPE JKT'D C.N.
PJC 3Ø
3-1/0 AL 15KV XLPE JKT'D C.N.
3-1/0 AL 15KV XLPE JKT'D C.N.
PADMOUNT TRANSFORMER
TO SERVICE
PADMOUNT TRANSFORMER
TO SERVICE
SCHEMATIC DIAGRAM
NOT TO SCALE
DISCLOSURE: THIS IS NOT AN ACTUAL FIELD CONSTRUCTION DESIGN DRAWING. THIS EXAMPLE IS FOR REFERENCE ONLY
COMMERCIAL/INDUSTRIAL SUBSYSTEM