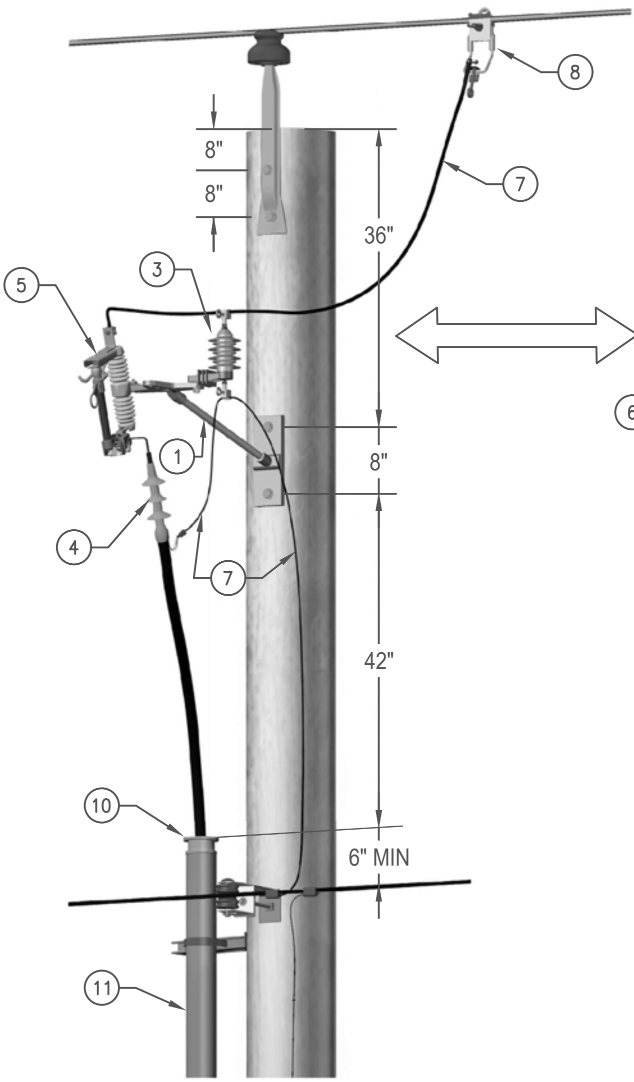
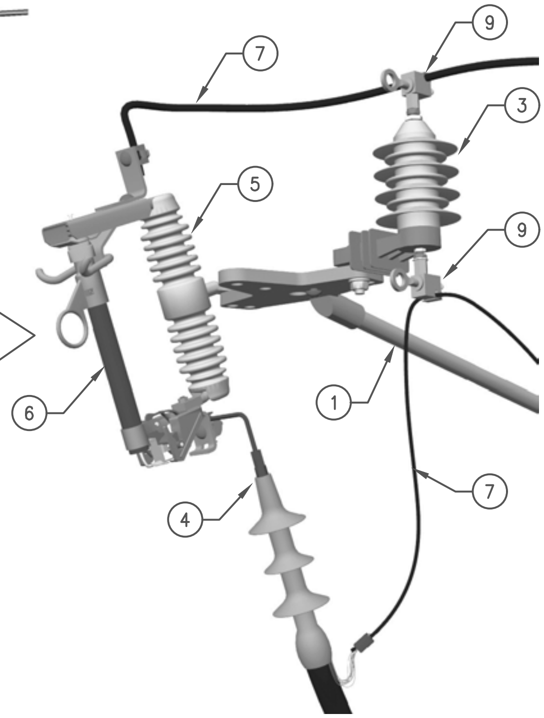
Appendix B: <u>SERVICE CONNECTION UNDERGROUND CONSTRUCTION STANDARDS</u>

The following section of the underground service connection requirements will apply to all CLP underground electrical distribution systems. All construction will be required to meet CLP and Industry Standards.

> PLEASE NOTE: AS THIS MANUAL IS CURRENTLY A WORKING DOCUMENT AND STILL IN DEVELOPMENT, THIS SECTION WILL BE EXPANDED TO INCLUDE RELEVANT SECTIONS FROM UNIFIED FACILITIES GUIDE SPECIFICATIONS (https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs) AS WELL AS LOCAL UTILITIES (TACOMA POWER AND PUGET SOUND ENERGY) AS SUCH STANDARDS CAN BE ADAPTED, MODIFIED AND INCORPORATED.





BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	ARM, FIBERGLASS, 24"	TBD	1
3	ARRESTER, SURGE 10kV	TBD	1
4	TERMINATION KIT, #2-#4/0, OUTDOOR WITH STINGER #2 AND #1/0 CU OR AL	TBD	1
5	CUTOUT, DROPOUT, 100A, 15kV	TBD	1
6	FUSE, DROPOUT, "T" LINK	TBD	1
7	WIRE #4 STR SD CU BARE	TBD	12
8	CLAMP, HOT LINE	TBD	1
8	CLAMP, STIRRUP	TBD	1
9	CONNECTOR, SURE ARRESTER, #6 - #1/0 CU	TBD	2
10	GRIP, CONDUIT RISER, 2-1/2" CONDUIT	TBD	1
11	POLE RISER, 2-1/2", PVC CONDUIT	TBD	1

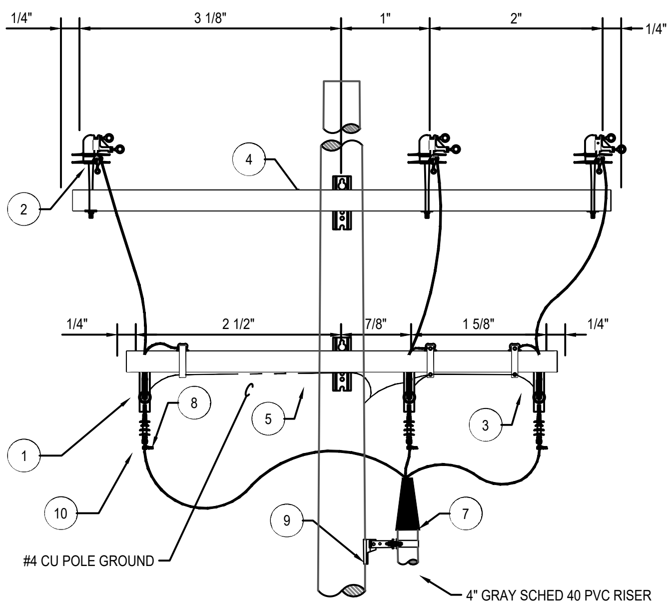
NOTES:

1. Mount cutouts for easy operation from pole or man-lift equipment.
2. Train cable so open cutout door does not contact termination.
3. Carry the line and ground connections to the surge arrester terminals first as shown in the figure above.
4. Leave enough “slack” on surge arrester high side and ground side connections to facilitate easy removal and/or installation with hot stick.
5. Move the cable termination away from the expulsion path of the fuse tube.
6. Install cable grip on short or downhill cable runs.
7. For fuse sizes above 100T, contact the CLP Project Manager or Engineer.

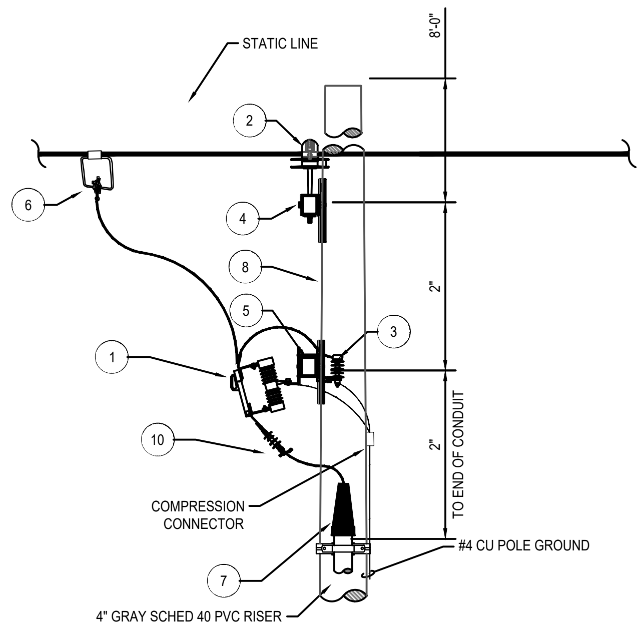
CITY LIGHT & POWER

SC5.1	TYPICAL 1-PHASE 200 AMP TERMINATION	APPROVED AS OF 5/31/2019

BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	CUTOUT, DROPOUT, 100A, 15kV	TBD	3
2	VISE TOP PIN INSULATOR	TBD	3
3	ARRESTER, SURGE 10kV	TBD	3
4	10' FIBERGLASS TANGENT CROSSARM ASSEMBLY	PUPI	1
5	8' FIBERGLASS TANGENT CROSSARM ASSEMBLY	PUPI	3
6	CLAMP, HOT LINE	TBD	3
6	CLAMP, STIRRUP	TBD	3
7	HEAT SHRINK BREAKOUT BOOT	3M #HDBB-345-250	6
8	WIRE #4 STR SD CU BARE	TBD	A/R
9	6" STAND-OFF CONDUIT SUPPORT BRACKET	TBD	A/R
10	3M COLD SHRINK QT-II TERMINATION KIT	TBD	3
11	GRIP, CONDUIT RISER, 4" CONDUIT	TBD	1
12	POLE RISER, 4", PVC CONDUIT	TBD	1



RISER POLE-TOP FRONT VIEW



RISER POLE-TOP SIDE VIEW

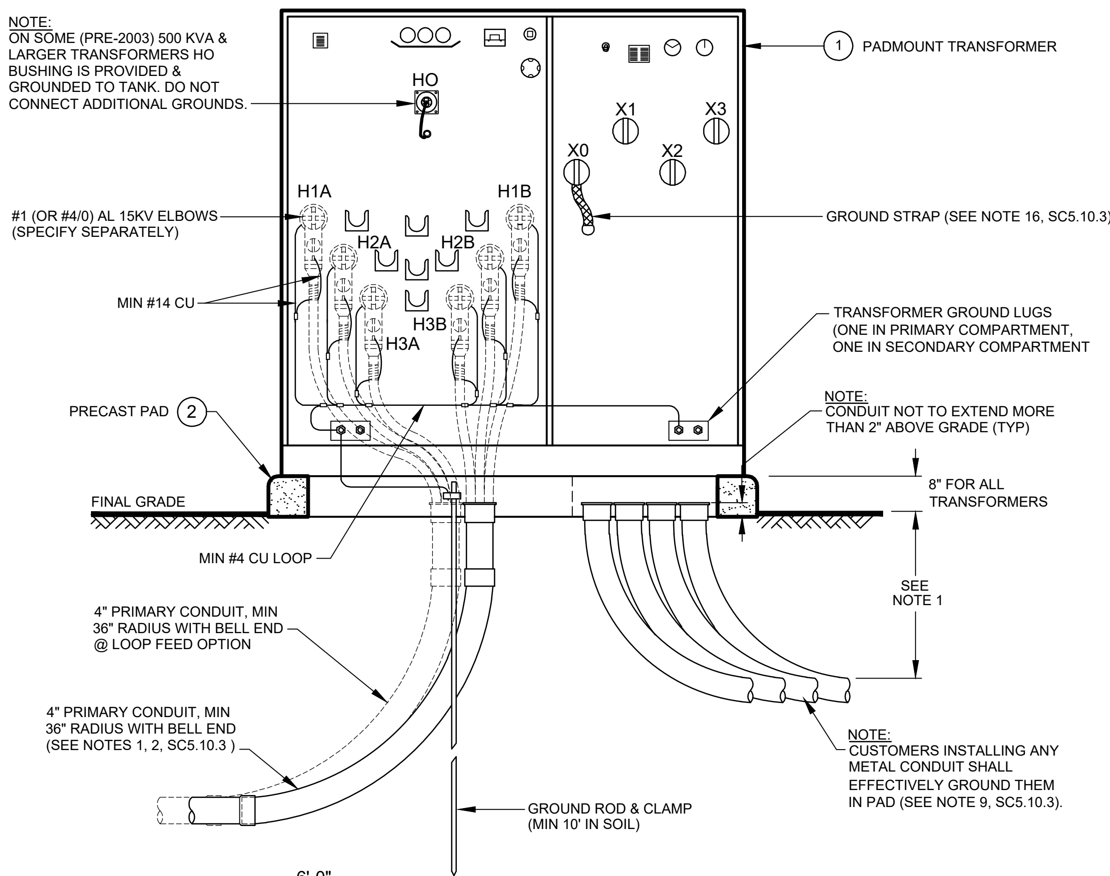
NOTES:

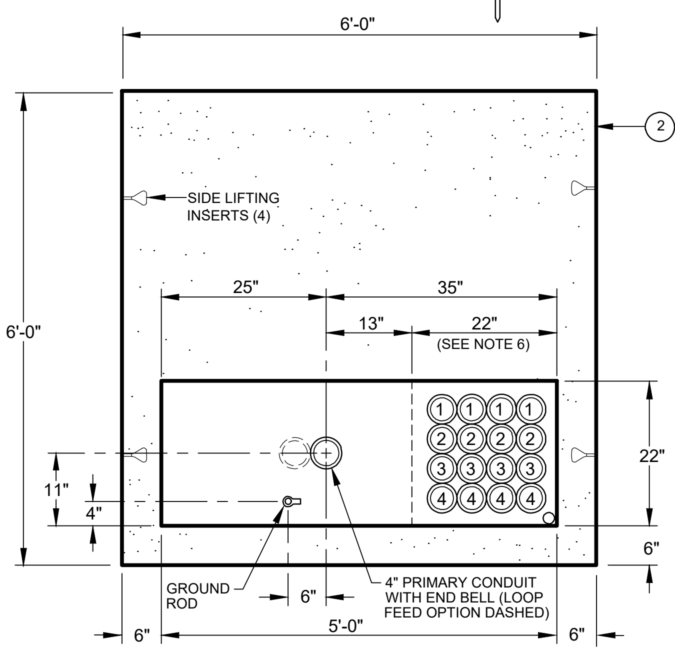
1. When common neutral is located on primary crossarm, an appropriate size conductor will be connected to the common neutral, and brought down pole to lightning arrester mounting arm.
2. Contact a #4 copper lead wire continuous through to the bottom on each lightning arrester to common neutral, and then to the pole ground.
3. Connect the "A" set of concentric neutral wires from stress cones to the #4 copper lead wire at the bottom of the lightning arresters, and continue to the common neutral connect the "B" set of concentric neutral wires in the same manner, and continue to the "A" set of concentric neutral wires. Connect the "C" set of concentric neutral wires in the same manner, and continue to the "B" set of concentric neutral wires.
4. Kellems grips shall be used whenever needed to support cable.
5. End bushing shall be used on upper end of conduit.
6. Conduit shall be gray PVC Schedule 40. Underground sweep (elbow) and first 10-ft (stick) of vertical conduit measured from the top of the sweep shall be RGS. Wrap entire RGS conduit with corrosion tape.
7. 12-ft of cable shall extend out of the riser conduit to ensure enough cable for termination.
8. Install conduit riser on the same side of the pole as the lightning arrester.
9. Install insulators as needed to support conductor between cutouts and phase wires.
10. Install cable grip on short and downhill cable runs.
11. For fuse sizes above 100T, contact the CLP Project Manager or Engineer.

CITY LIGHT & POWER

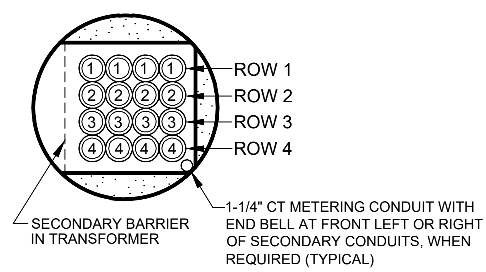
SC5.2	TYPICAL 3-PHASE 200 AMP TERMINATION	APPROVED AS OF 5/31/2019

LOOP FEED OPTION





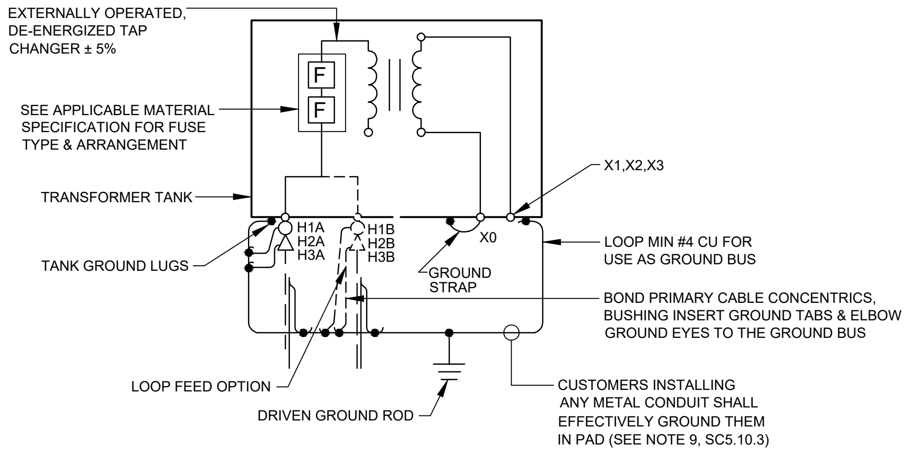
TOP VIEW
300-2500 KVA (208-480V)
PAD & CONDUIT DETAILS



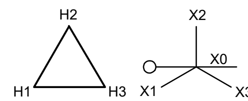
SECONDARY CONDUIT DETAIL
DETAIL SHOWN IS BASED ON MAXIMUM (16) 4" DUCTS WITH BELL ENDS (SEE NOTE 3, SC5.10.3)

CITY LIGHT & POWER

SC5.3.1	TYPICAL 3-PHASE PADMOUNT TRANSFORMER INSTALLATION	APPROVED AS OF 5/31/2019



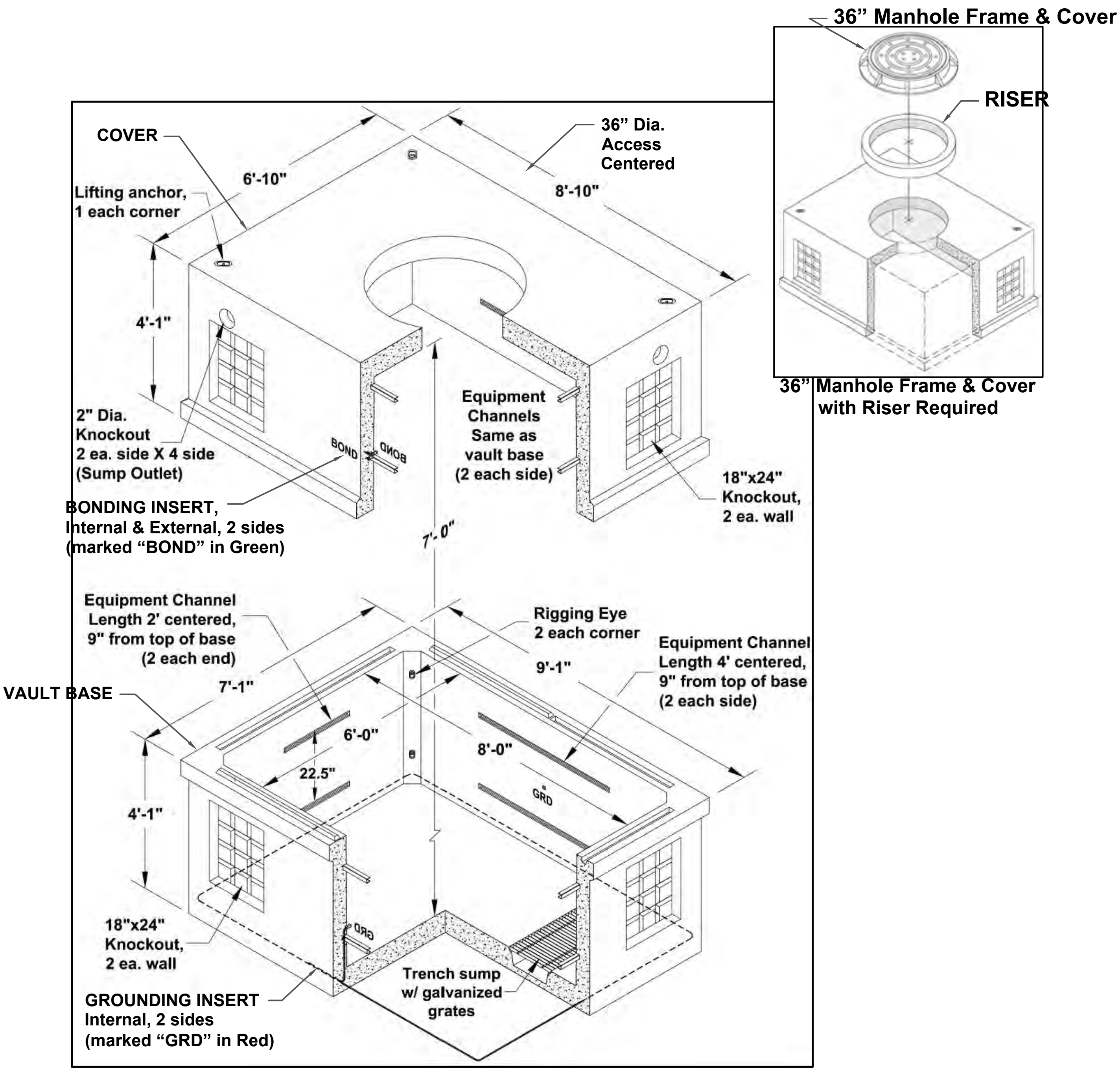
ONE LINE SCHEMATIC



PHASOR DIAGRAM

NOTES:

1. All conduits shall be installed per City Light and Power service connection manual. Refer to the primary conduit and primary/secondary conduit depths sections for trenching, compaction, and pad requirements.
2. For a radial feed installation of a loop-type transformer, both primary conduits shall be installed. If one is not used, it shall be stubbed and capped at least 2 out from the front edge of the pad with an 8-in UG marker installed above the end.
3. Placement of multiple secondary conduits shall be by rows from back to front, example: row 1 first, then row 2, etc. Fill back row first prior to starting the next row forward, filling front row last or used for future use.
4. Do not pour concrete in the conduit window opening unless an older style transformer is used. Pea gravel may routinely be used as filler if needed.
5. For 45-150kVA transformers, frame 9 secondary conduits maximum (3 rows of 3 conduits). Each row to fit within 15-in maximum width from right side of window opening, and within 16-in maximum depth from back side of window opening. The distance from the secondary compartment to the center of the primary conduit shall be 22-in maximum, 10-in minimum. This framing arrangement works with both current and older style transformer secondary compartment dimensions.
6. For 300-2500kVA older style transformers, frame 16 secondary conduits maximum (4 rows of 4 conduits). Each row to fit within 22" maximum width from right side of window opening, and within 22-in maximum depth from back side window opening. This framing arrangement works with current style transformer secondary compartment dimensions.
7. Minimum radius of 4-in primary conduit vertical bend shall be 36-in. Utility inspector may require 48-in radius GRC bend if necessary for longer pulling length.
8. CLP engineer to specify for pads poured-in-place when access to precast pad is not available.
9. Conductive-material ducts and riser guards that enclose electric supply lines, or are exposed to contact with open supply conductors shall be effectively grounded.
10. When terminating three phase loop feed transformers, cables using conduit on the left side shall be terminated by the HxA bushings. Cables using conduit on the right side shall be terminated to HxB bushings to prevent crossing of primary cables.
11. Leave slack in secondary and primary cables to permit transformer removal and replacement for maintenance, train primary cables to permit parking elbows.
12. Leave sufficient slack on concentric neutrals to allow removing elbows without disconnecting neutrals.
13. Ground loop in all cases shall be installed in front of primary cables.
14. CAUTION: Ground strap on neutral bushings shall remain connected to tank in all cases (except X0 bushing in special cases, such as 2400V motor loads), tank will be energized to primary voltage if primary neutral tank grounds are disconnected and one open primary phase exists on the source side of the transformer without H0 bushings.
15. Bond all above ground metallic supply and communication enclosures that are separated by 6-ft or less. Use minimum #6 bare copper wire direct buried a minimum 18-in below grade, to a suitable bolted or screw connection that can be temporarily opened when locating cables. Treat open ground connections as energized!



DESCRIPTION: Vault with cover, concrete, 9ft-1in x 7ft-1in x 8ft-2in, 36in manhole access

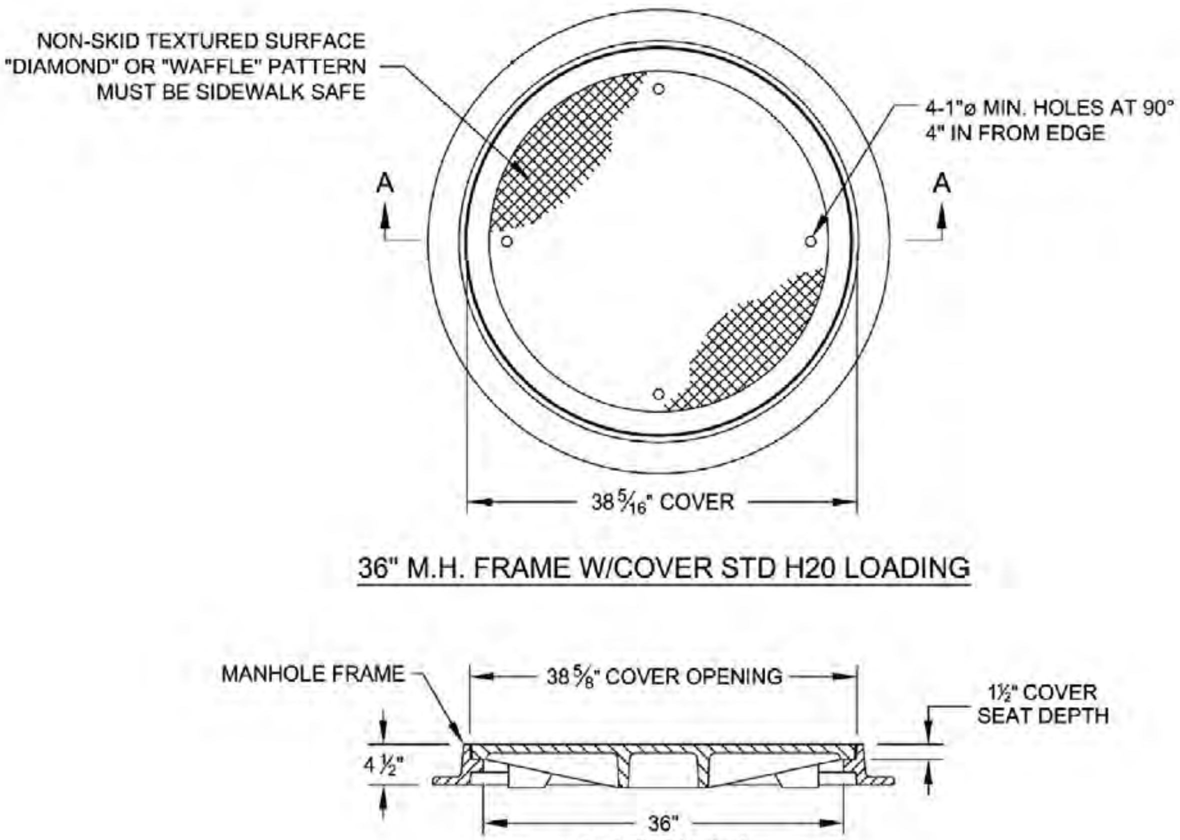
APPLICATION: Feeder splice/pull-box for multiple circuits for traffic locations.

NOTES:

1. CONCRETE 28 DAY COMPRESSIVE STRENGTH 4,500 PSI
2. REBAR ASTM A-615 GRADE 60, MESH ASTM A-185 GRADE 65
3. ASTM C-857 MINIMUM STRUCTURAL DESIGN LOADING FOR UNDERGROUND PRECAST CONCRETE STRUCTURES.
4. H-20 LOAD RATING FOR INCIDENTAL TRAFFIC.

CITY LIGHT & POWER

SC5.4.1	TYPICAL 15KV VAULT	APPROVED AS OF 5/31/2019



36" M.H. FRAME W/COVER STD H20 LOADING

SECTION A-A

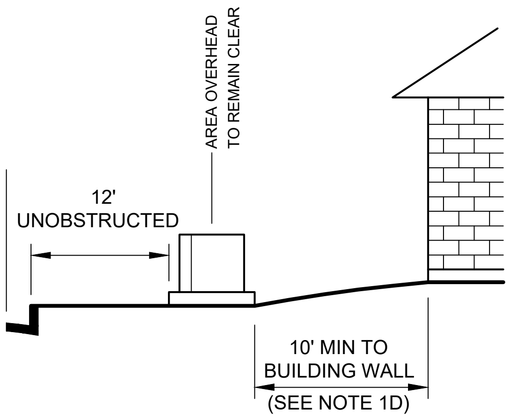
NOTES:

1. CONCRETE 28 DAY COMPRESSIVE STRENGTH 4,500 PSI
2. REBAR ASTM A-615 GRADE 60, MESH ASTM A-185 GRADE 65
3. ASTM C-857 MINIMUM STRUCTURAL DESIGN LOADING FOR UNDERGROUND PRECAST CONCRETE STRUCTURES.
4. H-20 LOAD RATING FOR INCIDENTAL TRAFFIC.

CITY LIGHT & POWER

SC5.4.2	TYPICAL 15KV VAULT	APPROVED AS OF 5/31/2019

PLACEMENT FOR PADMOUNTED OIL-FILLED EQUIPMENT



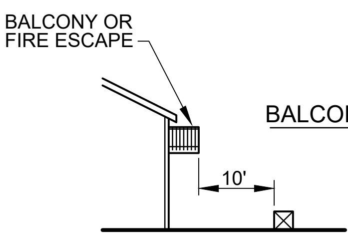
NOTES:

1. Clearance requirements for oil filled transformers or other oil filled equipment:
   * A. 12-ft clear area in front (door opening).
   * B. 3-ft clear area on both sides.
   * C. Equipment is to be clear of all overhead obstructions.

2. Transformer Rating: Recommended Minimum Distance From Buildings for Mineral-Oil Filled Transformers
(If distances do not meet below requirements, specify FR3 fluid.)
75 kVA or Less: 10-ft
76-333 kVA: 20-ft
More Than 333 KVA: 30-FT

COMBUSTIBLE WALLS

The basic minimum clearance from a combustible wall to padmounted oil filled equipment is 10 feet. If it is impossible to meet this clearance, the construction of a fire resistant barrier either physically attached to the wall or free-standing and separating the equipment from the wall is permissible.

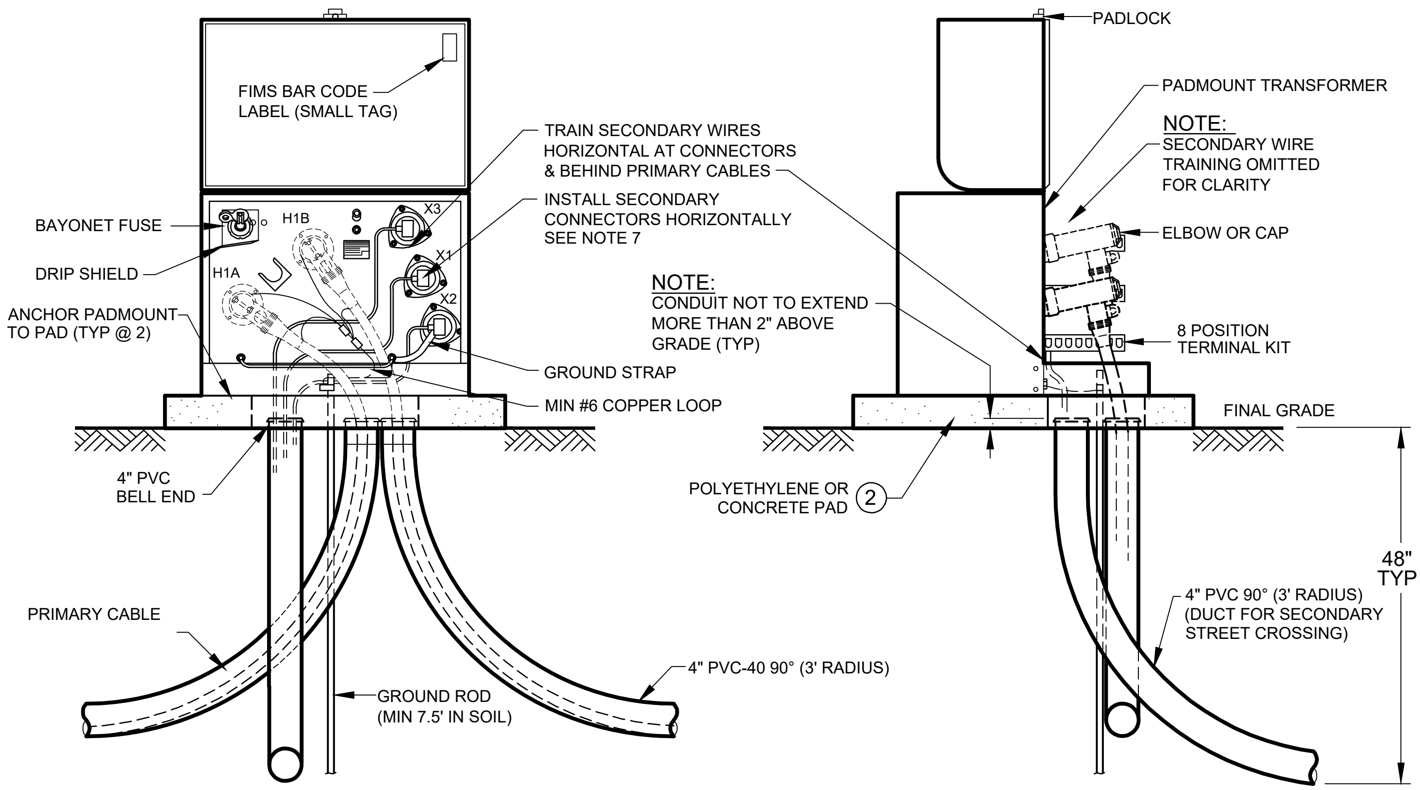


BALCONIES, FIRE ESCAPES OR OTHER OVERHANGS

For a balcony, fire escape, or overhang, the minimum clearance shall be 10 feet from the farthest projection of the overhang to the ground. No padmounted device shall be located under any overhang that will prevent the use of equipment normally used for installation or changeouts.

NOTES:

1. For optimal performance (cooling, reliability, economics, safety) CLP prefers to install padmount transformers in the open with minimal obstructions to airflow and away from occupied buildings as detailed on the previous pages. However, to accommodate a customer's desire for aesthetic screening, CLP allows enclosures to be built around padmount installations when the following guidelines are met:
   - 1.1. Fences/enclosures along 2 or more sides of a padmount transformer, a minimum clear space measuring 3-ft horizontally from the edge of the pad will be required to the side of the enclosure walls on the sides and back of the transformer. There is a 12-ft requirement for the front of the transformer for CLP worker safety.
   - 1.2. When constructed of conductive materials, walls/gates shall be bonded to the transformer LV neutral/ground with a minimum #6 bare copper buried at least 6-in below grade.
   - 1.3. For adequate air circulation and cooling of the transformer, the top of the enclosure shall remain open.
   - 1.4. Customers shall maintain/clear the area immediately adjacent to any transformer radiator cooling fins.
   - 1.5. Trash dumpsters/bins shall not share the same enclosures with padmount transformers, i.e. they will have a wall between and separate gate/access opening.
   - 1.6. Maximum distance from pad and opening to paved access drive area shall be 12-ft for small KVA sizes and proportionally closer for larger transformers. This shall provide clear access for boom truck for transformer removal and replacement through the opening.
   - 1.7. The following distances from buildings shall be met unless less flammable FR3 insulating liquid is specified.
     - 1.7.1. 75 KVA or less: 10-ft
     - 1.7.2. 76-333 KVA: 20-ft
     - 1.7.3. More than 333 KVA: 30-ft



FRONT VIEW

SIDE VIEW

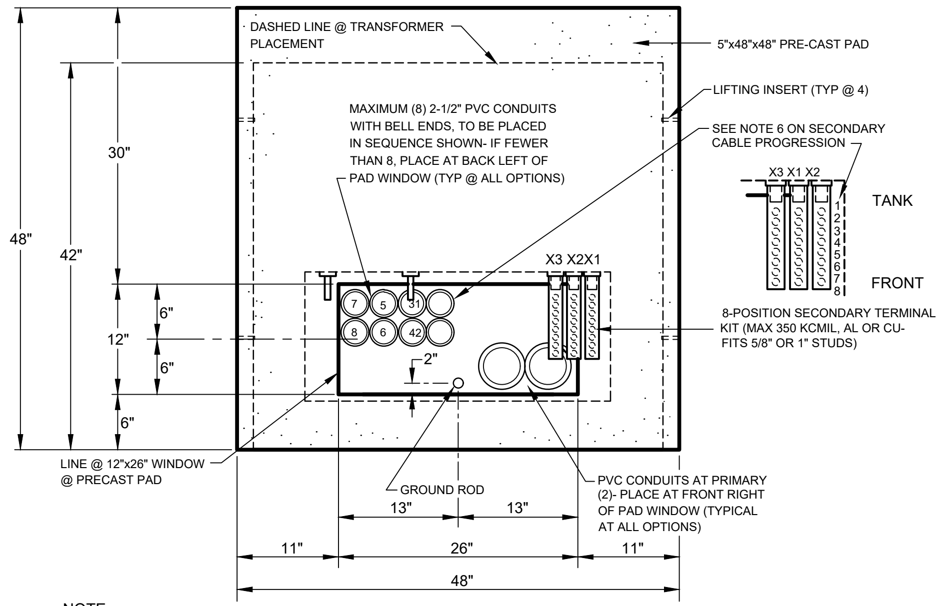
NOTES:

1. All loop-feed type transformer shall have a second 90-deg bend installed even when initially radially fed. Stub and cap second duct a minimum of 2-ft beyond edge of pad and place 8-in UG marker above end for future location.
2. Level pad with collar when needed.
3. Install primary and secondary ducts as shown in the Figures on the next page. Install ground rod near center of pad opening.
4. Maximum secondary conductor size shall be 350MCM CU. 500MCM sized conductors shall be used with approved equipment adapter and shall be suitably insulated at 600V with shrink tubing. All burrs must be filed smooth on crimped connectors.
5. Secondary cable progression into the 6 or 8-position terminals shall be from tank to front with the largest size cables first (routed sequentially from the right side ducts as numbered in the Figure above to the corresponding terminal position number or from the back as numbered on the Figures on the next page to the corresponding terminal position number or from the back).
6. Leave slack in secondary and primary cables to permit removal and replacement for maintenance.
7. When terminating single phase transformers, the cable using conduit on the left side shall be terminated to the H1A bushing. Cable using conduit on the right side shall be terminated to H1B bushing to prevent crossing of primary cables.
8. CAUTION: Ground strap on neutral bushing shall remain connected to tank in all cases. Tank will be energized to primary voltage if primary neutral tank ground is disconnected.
9. Leave sufficient slack on concentric neutrals to allow removal of elbows without disconnecting neutrals.
10. Bond all above ground metallic supply and communication enclosures that are separated by 6-ft or less. Use minimum #6 bare copper wire direct buried a minimum 18-in below grade, to a suitable bolted or screw connection that can be temporarily opened when locating cables. Treat open ground connections as energized!

CITY LIGHT & POWER

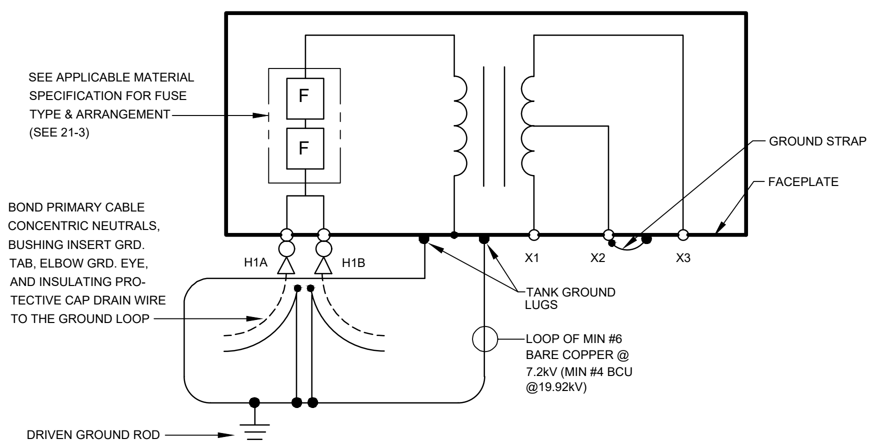
SC5.6.1	TYPICAL 1-PHASE PADMOUNTED TRANSFORMER INSTALLATION	APPROVED AS OF 5/31/2019

DUCT PLACEMENT IN CONCRETE PAD



NOTE:
TRANSFORMER TO BE BOLTED TO TOP OF PAD.

ONE LINE SCHEMATIC DIAGRAM PADMOUNTS



PADMOUNT LEVELING GUIDE

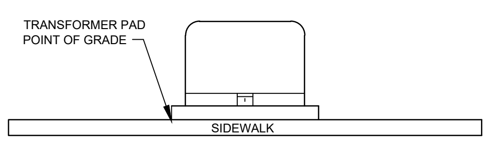


FIGURE A

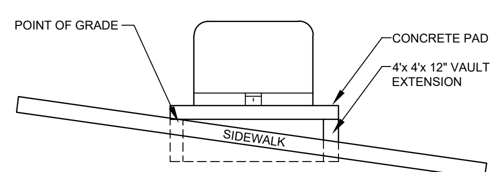


FIGURE B

NOTES:

1. Transformer pad shall be installed on level and compacted earth if terrain slope is 5% or less in any direction.
2. If terrain slope is greater than 5%, a 4x4x12-ft vault extension shall be installed level in all directions from point of grade.
3. Vault extension shall be filled with earth and compacted to provide a solid base for the transformer pad.
4. 'For installation uniformity, 5% grade is interpreted to be 5/8-in vertical rise or fall per each 12-in of horizontal run.

CITY LIGHT & POWER

SC5.6.2	TYPICAL 1-PHASE PADMOUNTED TRANSFORMER INSTALLATION	APPROVED AS OF 5/31/2019

Application

This standard lists the fuse links used in the Bay-O-Net fuseholders in 1Φ padmount transformers.

Table 1 1Φ Padmount Transformer Fuse Link

Primary Voltage (V)	Transformer kVA	Eaton/Cooper Fuse #	Fuse Rating (Amp)	Fuse Type	MID
7200	25	4000358C05	8	Dual Sensing	19813
	37.5	4000358C08	15	Dual Sensing	19814
	50	4000358C08	15	Dual Sensing	19814
	75	4000358C10	25	Dual Sensing	19815
	100	4000358C10	25	Dual Sensing	19815
	167	4000358C12	50	Dual Sensing	19816
13800	25	4000358C03	3	Dual Sensing	34712
	50	4000358C05	8	Dual Sensing	19813
	100	4000358C08	15	Dual Sensing	19814
2400	25	4000358C10	25	Dual Sensing	19815
	37.5	4000358C12	50	Dual Sensing	19816
	50	4000358C12	50	Dual Sensing	19816
	75	4000358C14	65	Dual Sensing	19817
	100	4000358C14	65	Dual Sensing	19817
	167	4000358C18	140	Dual Sensing	19818

Construction Notes

- See Cooper catalog S240-40-3 “Bay-O-Net Fuse Re-fusing Installation Instructions” for information on refusing transformer.

References

- Cooper catalog CA132010EN “Dual sensing Bay-O-Net fuse link”
- Cooper catalog S240-40-3 “Bay-O-Net Fuse Re-fusing Installation Instructions”

Application

This standard lists the fuse links used in the Bay-O-Net fuseholders in 3Φ padmount transformers.

Table 1 3Φ Padmount Transformer Fuse Link 12.47 kV and 13.8 kV

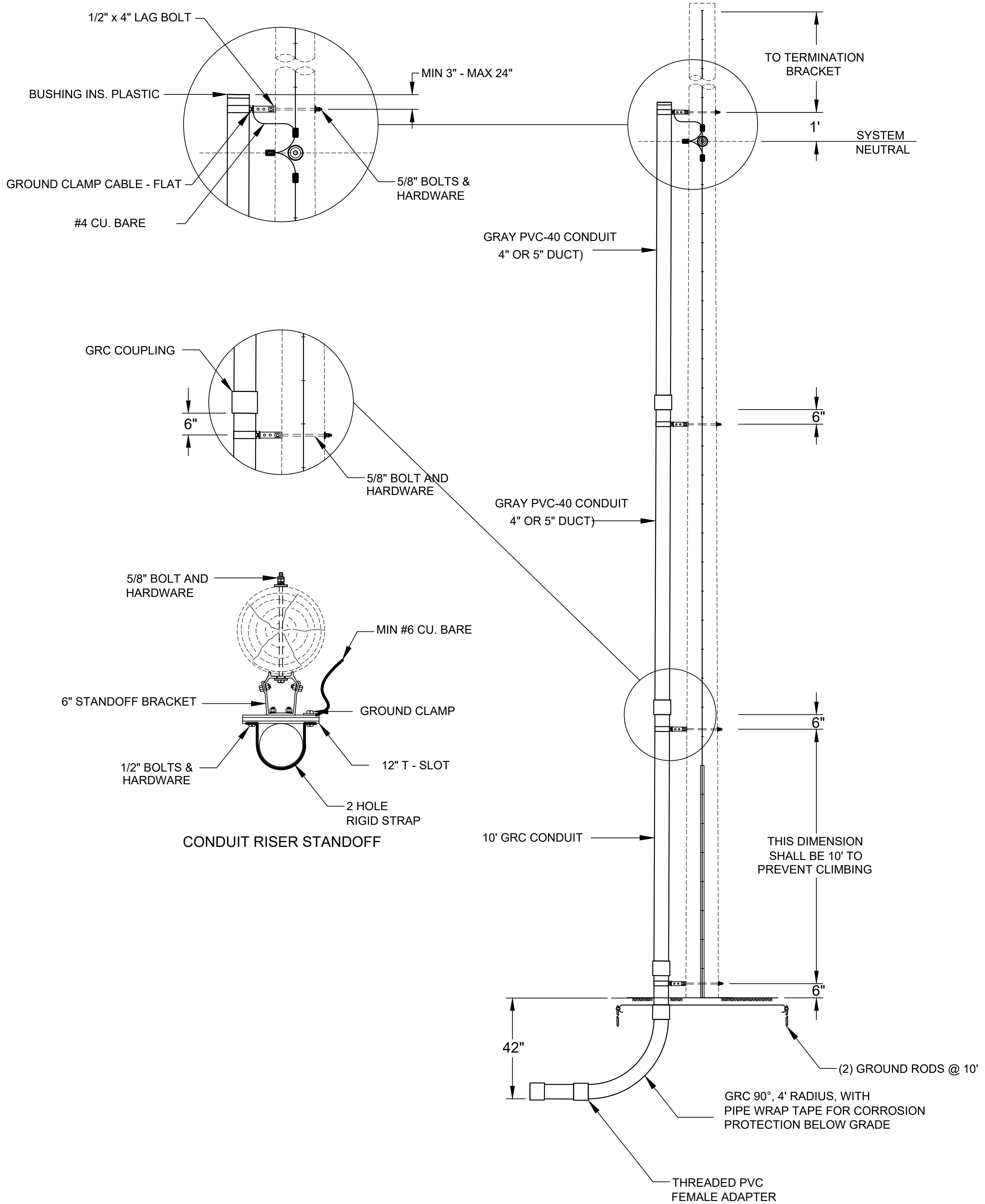
Transformer kVA	Eaton/Cooper Fuse #	Fuse Rating (Amp)	Fuse Type	MID
30	4000358C03	3	Dual Sensing	34712
45	4000358C03	3	Dual Sensing	34712
75	4000358C05	8	Dual Sensing	19813
112.5	4000358C08	15	Dual Sensing	19814
150	4000358C08	15	Dual Sensing	19814
225	4000358C10	25	Dual Sensing	19815
300	4000358C10	25	Dual Sensing	19815
500	4000358C12	50	Dual Sensing	19816
750	4000358C14	65	Dual Sensing	19817
1000	4000358C14	65	Dual Sensing	19817
1500	4038361C04CB	100	High Amp OL	43324
2000	4038361C05CB	125	High Amp OL	43325
2500	4038361C05CB	125	High Amp OL	43325

Construction Notes

- See Cooper catalog S240-40-3 “Bay-O-Net Fuse Re-fusing Installation Instructions” for information on refusing transformer.

References

- Cooper catalog CA132010EN “Dual sensing Bay-O-Net fuse link”
- Cooper catalog CA132007EN “High ampere overload Bay-O-Net fuse link”
- Cooper catalog S240-40-3 “Bay-O-Net Fuse Re-fusing Installation Instructions”



SC5.9	UNDERGROUND CONDUIT STANDOFF RISER	APPROVED AS OF 5/31/2019

TRENCHING GUIDE

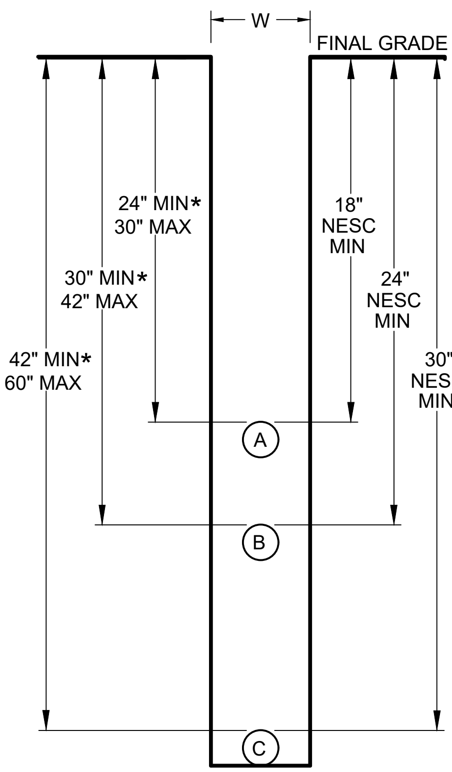


FIGURE- A
TYPICAL TRENCH DEPTHS

NESC MINIMUM COVER ABOVE TOP OF CABLES (OR DIRECT BURIED DUCT)

PER NESC RULE 353D2 (WITHOUT SUPPLEMENTAL PROTECTION- SEE NOTE 2, REQUIRES WRITTEN AUTHORIZATION FROM A CITY LIGHT AND POWER REPRESENTATIVE).

NESC MINIMUM COVER IS 24" (CITY LIGHT AND POWER ADOPTED A 30" MINIMUM COVER FOR PROPER CLEARANCE OF GAS LINES AND OTHER UNDERGROUND UTILITIES).

NOTE:
SEE NOTES 6 & 7 FOR DEPTH INSPECTION REQUIREMENTS

* CITY LIGHT AND POWER REQUIRED STANDARD MINIMUM CONDUIT/ CABLE COVER

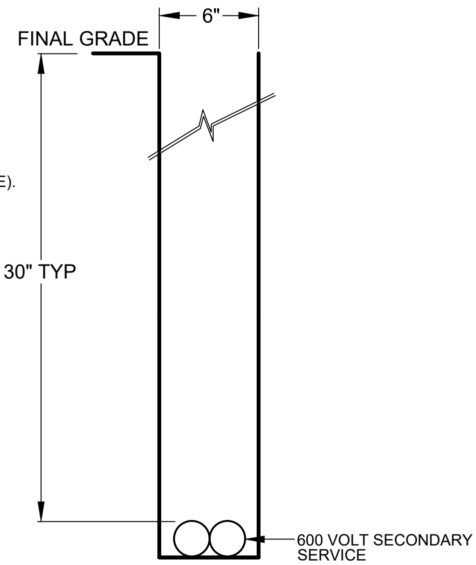


FIGURE- B
TYPICAL TRENCH CROSSING DEPTHS

CABLE/ CIRCUIT TYPE	TYPICAL TRENCH WIDTH		MAXIMUM VOLTAGE
A	STREETLIGHT FEEDS	6"	MAX. 150 VOLTS PHASE TO GROUND
B	SECONDARY	6"	0-600 VOLTS PHASE-TO-PHASE
C	PRIMARY	24"	601-50,000 VOLTS PHASE-TO-PHASE

TRANSITION COUPLINGS PROVIDED BY CITY LIGHT AND POWER	
SIZE AND TYPE	
2" E-LOK	✓
4" E-LOK	✓
6" E-LOK	✓
4" FLEX, 2-CLAMP	✓
6" FLEX, 2-CLAMP	✓

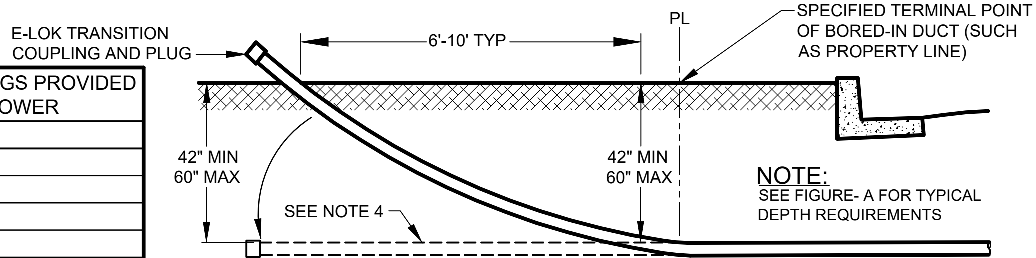


FIGURE- C
BORED-IN STUB CONFIGURATION

NOTES:

1. Trench width to be a minimum 3–in on each side of conduit or conductor, to provide for proper compaction.
2. Duct shall have a 3–in minimum concrete envelope when CLP minimum cover depths are not achieved. Ducts shall also be installed with plastic base spacers to maintain a consistent 3–in of concrete below duct.
3. All underground for clearances required by NESC from UG electric conduit/cable to other UG facilities (communication, water, sewer, foundations, sub–structures, etc).
4. City Light and Power requires an E–LOK type transition coupling at plugged end of bore, to be relocated to nearest 42–in depth of stub (typically within 6–10–ft) and used for attachment of contractor supplied pipe, Contractor has the option of picking up bore pipe at 42–in depth or digging parallel and lower end of stub if direction of contractors's ditch allows.
5. If required depth of trench or bore–in conduit cannot be met, a new proposed depth must be approved in advance of CLP representative. CLP representative must be notified a minimum of three days in advance of bore start time. Potholling may be required at any time, at the discretion of the CLP representative, to prove any bore depth. Conduit will be required for any installation that exceeds CLP minimum or maximum depth as shown above.
6. CLP contractor to submit bore log to CLP representative within 7 days of completion of bore installation.

CITY LIGHT & POWER

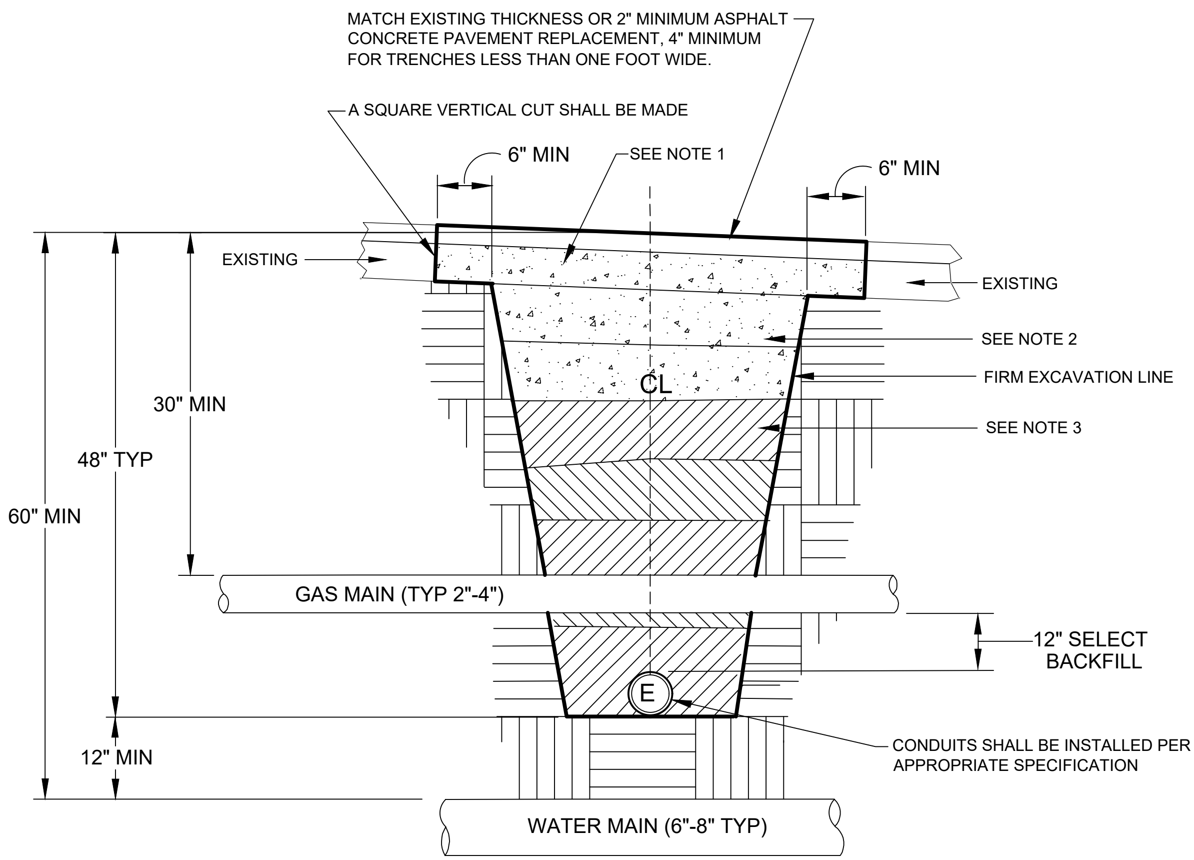
TRENCH BACKFILL AND COMPACTION GUIDE:

1. Before any backfilling operations are started, make an inspection of all trenches.
2. If soil materials in the bottom of a trench might cause unequal settlement, the unsatisfactory materials shall be removed and backfilled with selected materials.
3. Check for cable placement, conduit integrity, concrete encasement of conduit when required, adequate bedding/cover over direct buried cables, proper minimum depth, pole and pad risers, cable entrance to and from vaults and pads, secondary pull boxes and service stubs marked with electronic markers to determine that the work has been done in accordance with construction standards and job print specifications.
4. NESC Rule 352A requires the following:
   a. The bottom of the trench receiving direct-buried cable should be relatively smooth, undisturbed earth; well tamped earth; or sand. When excavation is in rock or rocky soils, the cable should be laid on a protective layer of well-tamped backfill. backfill within 100mm (4 inches) of the cable should be free of materials that may damage the cable. Backfill should be adequately compacted. Machine compaction should not be used within 150mm (6 inches) of the cable.
   b. For cable installed in a duct, the bottom of the trench should be in undisturbed, tamped, or relatively smooth earth. Where the excavation is in rock, the duct should be laid on a protective layer of clean tamped backfill. All backfill should be free of materials that may damage the duct.
5. The first twelve inches of backfill shall be free from stones, rock, or other material that might damage the cable or conduit. Selected backfill shall contain no soil material larger than 1/2" in diameter.
6. Final backfill shall be done in equal increments the length and girth of the trench line.
7. When suitable, as determined by soils test, use native material compacted in accordance with the following:
   a. For cohesive soils, compact to 95% maximum Standard Proctor dry density (ASTM D698) at ±2% of optimum moisture content.
   b. For cohesiveness soils, compact to 95% maximum Modified Proctor dry density (ASTM D1557) at ±2% of optimum moisture content (or 100% maximum Standard Proctor dry density (ASTM D698) at ±2% of optimum moisture content). Prior to and during compaction, materials shall have a moisture content as required to obtain the specified density. Thickness of horizontal layers after compacting shall not be more than 9 inches.
   c. Thickness of horizontal layers after compacting shall not be more than 6 inches. For highly expansive soils (swell potential is greater than 2.00% under 200 psf surcharge pressure), contact City Light and Power. If native soils are not suitable for trench backfill and compaction (heavy clay or expansive soil, rock-filled, etc.), use flowable fill, T&D d. Underground mix #3, installed as specified on SC5.5.5 or Class 5 or 6 base course or similar graded material compacted to the test values specified above (see gradation specifications on SC5.5.5). NOTE: CLP Inspectors routinely obtain compaction results from test labs using the Modified Proctor method and as a practical approach based on historical values or maximum density for native soils in the vicinity (not site specific) when native backfill is employed. When deemed necessary by the test lab and Utility Inspector, the site specific maximum density may need to be verified by test. Any independent contractor tests should be done using the same (Modified Proctor) test method for compaction of results or else ***the limits for the Standard Proctor method shall be referenced. Backfill & compaction of all trenches shall meet the requirements of the City Light and Power SC5.5 and all other applicable Local, State, and Federal requirements.***
8. *The density tests shall be performed at various depths in the trench to ensure that the required compaction is obtained throughout. For trenches less than 30" in depth, compaction tests shall be taken at the surface and within 18" above the top of conduit or cable. For trenches greater than 30" in depth, density tests shall be taken within 18" of the top of the conduit or cable and at 24" vertical intervals to the top of the trench with the final test at the surface.*
9. *The frequency of density tests shall be a minimum of 250 linear feet of mainline trench and at each service installed. The number of density tests may be increased if directed by the Utility Inspector. If flowable fill is installed as specified on page 4, compaction and density tests are not required.*
10. *All trench lines shall be restored to the original grade. Any excess soil shall be piled on top of the trench and shall be well compacted. The top surface of the trench backfill shall be relatively smooth. The premises should be left in clean condition and all rock and debris shall be removed from the site. Pavement or walk cuts shall be repaved with material identical to the original surfaces in accordance with Local Codes and Standards.*

CITY LIGHT & POWER

FOUNDATION COMPACTION SPECIFICATION FOR PADMOUNTED EQUIPMENT

1. City Light and Power recommends experienced personnel who understand the importance of moisture for compacting soils and the characteristics of expansive soils.
2. Before any backfilling or compaction operations are started, inspect all conduit spacings and riser heights. Make sure they meet the construction standard specified for the equipment to be installed.
3. All pads pre-cast or poured on site shall project a minimum of 4" above grade.
4. Excavate a minimum of twelve inches beyond perimeter of pad and a minimum of 36" deep.
5. The first twelve inches of backfill shall be free from stones, rock, or other material that might damage the cable or conduit. Selected backfill shall contain no soil material larger than 1/2" in diameter.
6. When suitable, as determined by soils test, use native material compacted in accordance with the following:
    a. For cohesive soils, compact to 87% maximum Modified Proctor dry density at ± 2% of optimum moisture content (or 92% maximum Standard Proctor dry density at ±2% of optimum moisture content).
    b. For cohesionless soils, compact to 85% maximum Modified Proctor dry density at -5% to +3% of optimum moisture content (or 90% maximum Standard Proctor dry density at -5% to +3% of optimum moisture content). Prior to and during compaction, materials shall have a moisture content as required to obtain the specified density. Thickness of horizontal layers after compacting shall not be more than 9".
    c. For expansive soils, remove and replace with DOT Class 5 or 6 soil and compact per 6b above
7. After successful completion of the above steps, call the City Light and Power representative who will arrange for compaction tests. This shall be done and approved before a concrete pad will be poured or a precast pad installed.



PAVEMENT REPLACEMENT AND BACKFILL DETAIL

STREET CROSSING NOTES:

1.
   a. For streets with existing concrete subsurface: Use Portland cement, 3000 psi compressive strength, 6" minimum thickness.
   b. For new or recently overlayed streets (less than 3 years old): Use Portland cement, 3000 psi compressive strength, 6" minimum thickness.
   c. For typical streets: Replace with new base course to match existing or 6" depth, whichever is greater.
2.
   a. For streets with existing concrete subsurface: Use select gravel compacted to 95% of maximum Standard Proctor, 12" minimum thickness.
   b. For new or recently overlayed streets (less than 3 years old): New base course compacted to 95% of maximum Standard Proctor, 6" minimum thickness.
3. When suitable, use native material compacted as specified on page 2. If native soils are not suitable, install flowable fill as specified on page 5.
4. Flowable fill is required for street crossing trenches one foot or less in width.
5. Utilize the boring crew/contractor when appropriate for recently re-paved streets, etc.

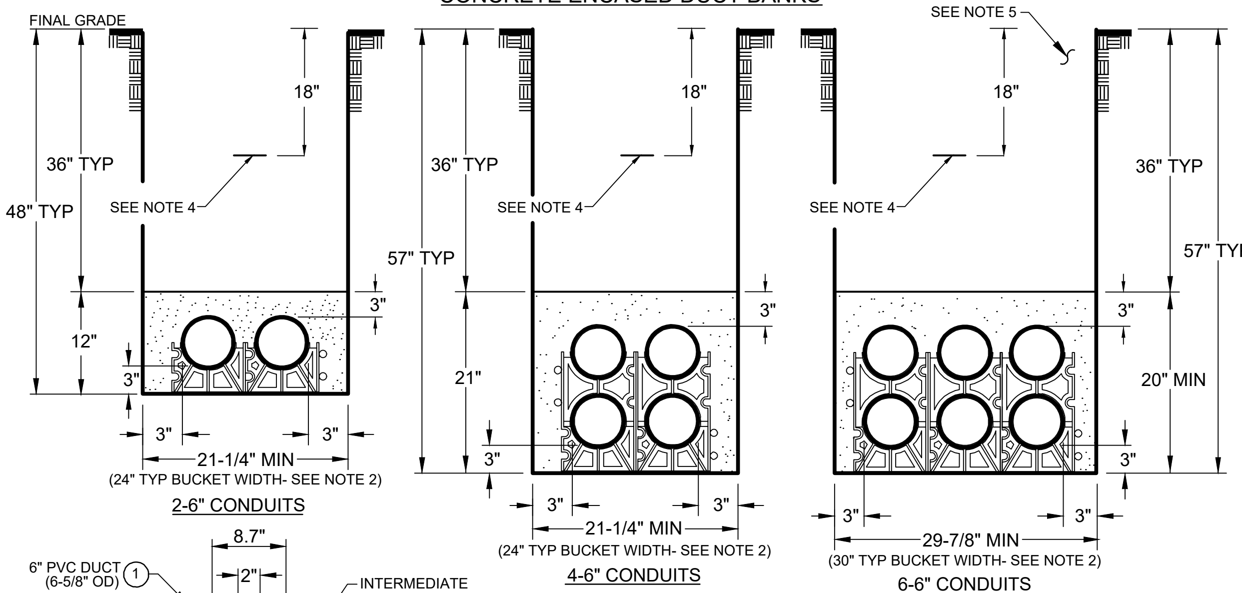
FLOWABLE FILL INSTALLATION GUIDE:

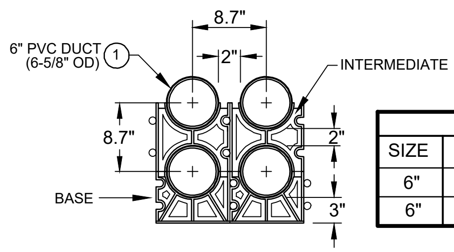
Flowable fill for utility trench restoration is to be used only as an alternative when native soil is not suitable for backfill. It will set up and provide compaction for quick trench closure.

It shall be installed as follows:

1. As the cement truck begins pouring fill mix into the trench, the crew shall start vibrating the mix immediately.
2. To achieve proper hydration of the flowable fill mix, vibrators shall be used in all cases. The use of vibrators is extremely important as it removes excess water from the mix. If vibrators are not used, the flowable fill will not hydrate properly. For proper installation, the use of one vibrator minimum is required for each concrete truck pouring concrete into a trench.
3. All concrete encased ducts using "T&D Underground Mix #1" shall be allowed sufficient time to set up before the flowable fill mix is installed. This is to avoid any intermixing of the two different types of concrete. See chart for estimating flowable fill quantity when used to cover concrete encased duct banks.
4. The normal set-up time for the flowable fill mix to withstand traffic is approximately one hour after installation. Depending upon soil conditions, weather, and temperature, this time may vary. The mix will completely set up in 28 days at approximately 90-120 PSI, when properly hydrated. The set-up time required to resume normal traffic shall be determined by the City Light and Power/Representative on the job site.

CONCRETE ENCASED DUCT BANKS





SPACERS	
SIZE	TYPE
6"	BASE
6"	INTERMEDIATE

NOTES:

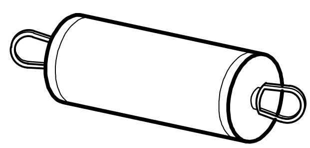
1. Install spacers every 7'. Base spacer and/or intermediate spacers and conduits shall be tied together using line pull polyolefin. Survey stakes shall be used at every base spacer as a tie down to prevent ducts from floating.
2. Duct is to have a minimum of 3" concrete envelope above and below, and 3" on each side. Dimensions of trench width shall be maintained as shown to keep concrete envelope volume within specification. Any trenches exceeding this limit shall be formed on one side (at contractor's expense) to minimize cost of encasement and excess trench width shall be backfilled at contractor's expense, including all material, labor and equipment costs. Bottom of trench shall be uniform, compact and free of debris.
3. Concrete used for duct encasement shall be used Portland cement, 3000psi compressive strength. Concrete shall be properly vibrated when installed to assure complete flow under, around, and between all ducts and to eliminate any air pockets.
4. All underground electrical ductbank shall provide warning tape (3" wide by 5 mil. thick) above ductbanks along the entire route within the the backfill. The warning tape shall be located approximately 18 inches below the final grade.
5. After concrete has taken firm set, the first 12 inches of backfill shall be free from stones, rock, or other material that might damage the ductbanks, cables, or conduits. Selected backfill shall contain no soil material larger than 1/2 " in diameter. For final backfill and compaction using native soils, compact to 92% maximum Standard Proctor dry density at ±2% of optimum moisture content. Backfill of trenches in existing paved streets shall be native soil whenever economical (mechanically compacted to 95% of maximum Standard Protor with new base course to match existing or 6" depth, whichever is greater).
6. NESC Rule 352D requires a minimum of 30" cover above primary cables (601 volts to 50kV); see NESC rules for shallower burial depth requirements.
7. Encasement should be used for 1) 600 amp mainlines, 15kV 2) multiple-duct banks (vertically stacked) 3) installations that require flowable fill or 4) in cases where minimum cover is not met.

NOTES:

1. The intent of this specification is to establish the guidelines on materials acceptable for underground primary installations as governed by City Light and Power. The size of duct primary cable run (4-in or 5-in) shall be specified by City Light and Power on the design drawings.
2. All approved direct buried plastic ducts sued for installations for primary cable runs shall have a minimum cover of 36-in compacted backfill over the top of the ducts and a minimum of 3-in from side of the ducts to trench walls. Vertical measurements shall meet or exceed the requirements both at the time of installation and subsequent thereto. A minimum of 3-in of concrete encasement shall be used when adequate depth cannot be achieved. Authorization from a CLP inspector is required before any installation with less than minimum specified cover is installed.
3. All plastic utility duct for underground installations shall conform to either NEMA Standards for Electric Duct or ASTM specifications and be installed per NEMA/ASTM guidelines. The following typees of conduits are acceptable for Electric Raceways when installed as noted:
   - 3.1. EPC-40-PVC or HDPE: Suitable for direct bury without concrete encasement. Requires CLP approval.
   - 3.2. PVC Schedule 40: Suitable for underground applications encased in concrete.
   - 3.3. All conduits, 90-deg bends and fittings shall be rated for 90-deg Celsius cable without exception.
4. Fittings, couplings, and bends shall be of the type designed for the duct being used.
5. Refer to PVC duct manufacturer recommendations for solvent cement to be used on their product. Caution shall be taken to ensure fittings and duct are compatible. For installation below 32-deg Fahrenheit, proper PVC cement shall be specified.
6. City Light and Power policy for underground service risers to the meter socket specifies GRC without exception for all exposed lengths above grade. All ducts of conductive material, such as GRC, which enclose electric supply lines, shall be effectively grounded in accordance with NESC rules. Grounding bushings shall be installed on all exposed GRC conduits above grade.
7. All rigid steel sweeps and 90-deg bends shall conmply to AANSI Standard C80.1.
8. All galvanized conduit, 90-deg bends, or long radius sweeps that are direct buried shall be coated with tar or taped with suitable material for corrosion protection. All horizontal 90-deg bends in primary conduit runs shall be 48-in long-radius GRC.
9. All primary riser conduits shall be isntalled with bushings or bell ends to avoid cable abrasion against sharp conduit edges. Conduit riser into padmount equipment shall project 2-in above grade or as shown in the specified in the design drawings.
10. After trench is backfilled and compacted, primary cable ducts shall be clean internally and proven to be free of obstructions by passing a mandrel of the following minimum outside diameter and length.

4" duct = 3.56" OD, 6" long mandrel

6" duct = 5.69" OD, 11-1/2" long mandrel



11. CT metering conduits, when required, shall be 1-1/4-in size from the transformer pad or CT cabinet to the meter socket, either GRC or schedule 40 PVC, with all exposed above ground lengths to be GRC terminated with grounding bushings bonded to local ground electrodes.

CITY LIGHT & POWER

SC5.12	DUCT REQUIREMENTS FOR PRIMARY CABLE	APPROVED AS OF 5/31/2019

HIGH VOLTAGE CABLE HANDLING AND STORAGE GUIDE

1. Unloading of cable should be accomplished so that equipment used does not contact either the cable surfaces or the protective wrapping. If unloading is accomplished by crane, either the cradle supporting the reel flanges or a shaft through the arbor hole should be used. If a fork is utilized, the forks must lift the reel at 90 degrees to the flange and must be long enough to make complete lifting contact with both flanges. Under no circumstances should the forks contact the cable surface or protective wrapping. For the same reason, a web-sling arrangement should not be used around the conductor as the weight could damage the cable.
2. Under no circumstances should reels be dropped from the delivering vehicle to the ground.
3. Reels should be stored on a hard surface so that the flanges do not sink into the earth, allowing the weight of the reel and cable to rest on the cable surface. In storing, never turn the reel on the flange side for this will result in cable damage. The reels should be stored upright in a rolling position.
4. Cable should be stored in an area where chemical or petroleum products will not be spilled or sprayed on the cable.
5. When a reel of cable is rolled from one point to another, care must be taken to see that there are no objects on the surface area which could contact or damage the cable surface or protective wrapping.
6. If a length of cable has been cut from a reel, the cable end should be immediately resealed to prevent the entrance of moisture. Use cable seal caps (mastic and vinyl tape (see SC5.13.5).
   Installed cable that is not immediately terminated should be sealed, especially if left overnight.
7. Cable should be stored in an area away from open flame or other sources of high heat.
8. Reels should be stored in an area where construction equipment, falling or flying objects, or other materials will not contact the cable.
9. If an inclined ramp is used for unloading, the ramp must be wide enough to contact both flanges completely, and stopping of the reels at the bottom shall be accomplished by using the reel flanges, and not the surface of the cable.

INSTALLATION TEMPERATURE GUIDE FOR PRIMARY CABLES

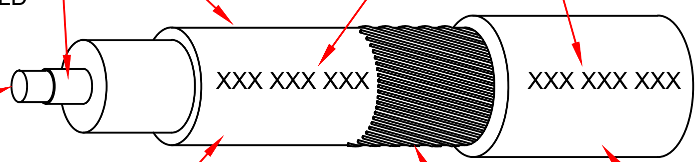
1. The low temperature weakness of primary cables is the semi-conducting strand and insulation shield compounds, which have a much higher brittleness temperature than the TRXLPE insulation. If a crack initiating in the shield does not propagate through the insulation as might be expected, then immediate failure may not occur and the cable could operate for some time before failure. However, to avoid any possible damage to primary cables while installing or operating cables with elbows at extremely low temperatures, the following guidelines should be used:
   A. Minimum temperature of cable during installation for primary TRXLP with thermosetting semicon shield is -25°C (-13°F).
   B. For splicing or terminating primary cables, warm cable ends up to at least 32°F.
   C. Primary cables may be operated, such as moving elbows onto a parking stand down to the same low temperature given in "A" above.
   D. If any cable damage is suspected during installation, then an additional 12-15 feet of cable should be pulled and delivered to the Standards Laboratory for analysis. The sample must be cut from the leading section of cable to determine if any damage occurred during the pull.

MINIMUM BENDING RADIUS

1. The minimum bending radius of primary cable shall be twelve times the overall diameter of the cable.
2. The minimum radius specified is measured to the surface of the cable on the inside of the bend.
3. These bending radii are to be considered minimum recommended dimensions and are for static bends such as manhole training bends, etc., and do not apply where pulling tensions and sidewall pressures are involved.
4. To visualize a bending radius, determine the diameter of the cable and multiply by twelve. Use this dimension as the minimum bending radius. Scribe a circle on the floor or in the dirt and form the cable around it. See cable bending radius in the tables on SC5.4.2.

ENERGIZING NEW CABLE

1. Since DC Hipot testing of cable and accessories can lead to insulation damage, this method is NOT reccommended for testing cables. A TDR (Time Domain Reflectometry) test set should be used to verify continuity and the integrity of the circuit. It is recommended, if possible, to energize new cable for one day at rated line voltage, prior to loading.



15 KV UD CABLES

Insulated (133% level, 220 mil thick TRXLPE) single conductor cables, compressed stranding or solid, with copper concentric neutral wires. Specify total quantity in feet.

PHASE CONDUCTOR SIZE, TYPE	NEUTRAL CONDUCTOR NO. & SIZE WIRES	AMPACITY[1] DB/DUCT	DUCT SIZE	CONDUCTOR AREA IN² / (MM²)
#2 AL	6 #14	175/126 (3PH)	3" OR 4"	0.0616 / (39.6)
#1/0 AL	6 #14	225/163 (3PH)	4"	0.1006 / (65.0)
#4/0 AL	11 #14	320/241 (3PH)	4"	0.2018 / (130.6)
250 KCMIL AL	13 #14	345/265 (3PH)	6"	0.2392 / (153.9)
500 KCMIL AL	25 #14	451/385 (3PH)	6"	0.4788 / (307.8)
750 KCMIL AL	24 #12	507/468 (3PH)	6"	0.7204 / (463.5)
1000 KCMIL AL	31 #12	1098/1058 (3PH) [2]	6"	0.9602 / (619.8)

DIMENSIONS/ WEIGHTS OF 15KV CABLES

ITEM DESCRIPTION	CONDUCTOR OD (IN)	INSULATION OD NOMINAL (IN)	OVERALL CABLE OD (IN) / WGT (LBS/FT)	MINIMUM BENDING RADIUS
#2 AL	0.280	0.77	1.08 / 0.486	13"
#1/0 AL	0.358	0.85	1.15 / 0.563	14"
#4/0 AL	0.507	1.0	1.30 / 0.803	16"
250 KCMIL AL	0.552	1.06	1.38 / 0.917	17"
500 KCMIL AL	0.781	1.29	1.66 / 1.534	20"
750 KCMIL AL	0.958	1.48	1.90 / 2.043	23"
1000 KCMIL AL	1.106	1.62	2.02 / 2.626	25"

15 KV UD CABLES

Insulated (133% level, 220 mil thick TRXLPE) single conductor cables, compressed stranding or solid, with copper concentric neutral wires. Specify total quantity in feet.

PHASE CONDUCTOR SIZE, TYPE	NEUTRAL CONDUCTOR NO. & SIZE WIRES	AMPACITY[1] DB/DUCT	DUCT SIZE	CONDUCTOR AREA IN^2 / (MM^2)
#2 CU	6 #14	224/162 (3PH)	3" OR 4"	0.0616 / (39.6)
#1/0 CU	9 #14	284/210 (3PH)	4"	0.1006 / (65.0)
#4/0 CU	18 #14	385/307 (3PH)	4"	0.2018 / (130.6)
250 KCMIL CU	21 #14	410/336 (3PH)	6"	0.2392 / (153.9)
500 KCMIL CU	26 #12	501/471 (3PH)	6"	0.4788 / (307.8)
750 KCMIL CU	25 #10	559/548 (3PH)	6"	0.7204 / (463.5)
1000 KCMIL CU	32 #10	1338/1192 (3PH)[2]	6"	0.9602 / (619.8)

DIMENSIONS/ WEIGHTS OF 15KV CABLES

ITEM DESCRIPTION	CONDUCTOR OD (IN)	INSULATION OD NOMINAL (IN)	OVERALL CABLE OD (IN) / WGT (LBS/FT)	MINIMUM BENDING RADIUS
#2 CU	0.280	0.77	1.08 / 0.638	13"
#1/0 CU	0.358	0.85	1.15 / 0.837	14"
#4/0 CU	0.507	1.0	1.30 / 1.358	16"
250 KCMIL CU	0.552	1.06	1.38 / 1.572	17"
500 KCMIL CU	0.781	1.29	1.66 / 2.902	20"
750 KCMIL CU	0.958	1.48	1.90 / 4.102	23"
1000 KCMIL CU	1.106	1.62	2.02 / 5.281	25"

TEMPORARY CABLE END CAPS FOR WATER SEALING PRIMARY CABLES

Aluminum strands can be seriously affected by water. Oxidation takes place, pitting and eroding the aluminum and in some cases, completely oxidizing the strands leaving only a residue. Moisture in cable has been found to be one of the principal causes of "treeing" in the insulation, leading directly to cable failure. Moisture can also migrate to the termination device causing intermittant feeder tripping prior to failure.

Once a small amount of moisture has entered the cable, the damage has begun. Therefore, it is imperative that cable ends never be left exposed to the elements when cable terminations or splices are not immediately going to be made. Every effort must be made to seal exposed cable ends at once to prevent moisture entry.

The cold shrink end caps shown below are for temporarily sealing the ends of aluminum cable during installation and storage to prevent the entry of moisture. In all cases, the cable end must be clean and dry before the cap is installed. Cables shall not be left exposed overnight during installation work.

All cable manufacturers are required by industry standards to seal the ends of all primary underground cable leaving their factory. Cable shipments must be inspected upon arrival for cable damage or loss of the seal caps. Replacement caps shall be installed where missing, to prevent further entry of moisture. Notify CLP Engineering to followup with the supplier.

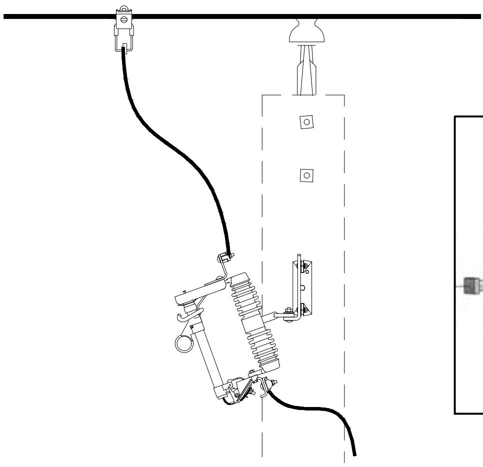
When installing primary cable end caps that are not prefilled with mastic, wrap the cable area to be sealed with several wraps of mastic tape. Finish by installing the cable end cap per manufacturer's instructions.

Appendix C: SERVICE CONNECTION OVERHEAD CONSTRUCTION STANDARDS

The following section of the overhead service connection requirements will apply to all CLP overhead electrical distribution systems. All construction will be required to meet CLP and Industry Standards.

> PLEASE NOTE: AS THIS MANUAL IS CURRENTLY A WORKING DOCUMENT AND STILL IN DEVELOPMENT, THIS SECTION WILL BE EXPANDED TO INCLUDE RELEVANT SECTIONS FROM UNIFIED FACILITIES GUIDE SPECIFICATIONS (https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs) AS WELL AS LOCAL UTILITIES (TACOMA POWER AND PUGET SOUND ENERGY) AS SUCH STANDARDS CAN BE ADAPTED, MODIFIED AND INCORPORATED.

Figure A Distribution Cutout, Polemount



Detail A

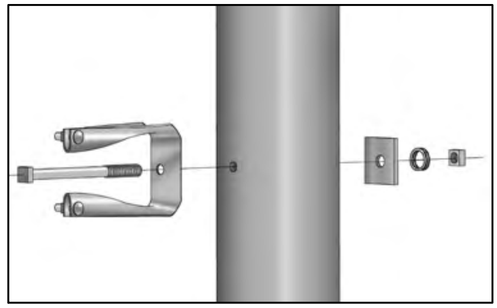
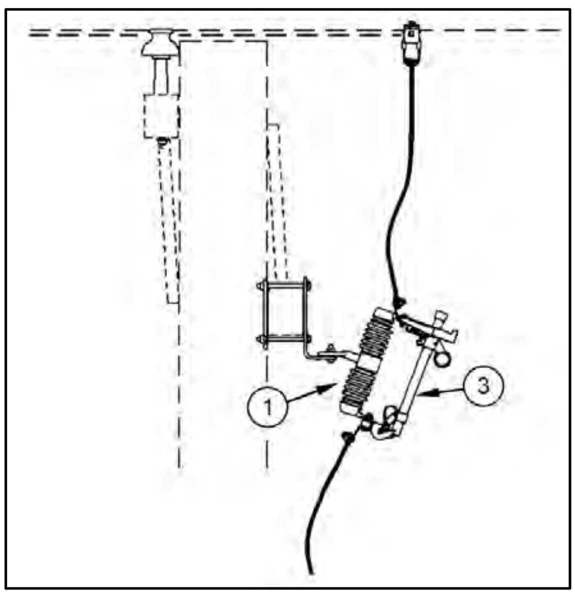


Figure B Distribution Cutout, Arm-mount



NOTES:

1. 100A cutouts used primarily to fuse equipment and laterals on loads up to 100A.
2. 200A cutouts used primarily to fuse equipment and laterals on loads up to 200A.
3. The 100A cutout may be used as a disconnect switch up to 300A with a solid blade.
4. For fuse sizes above 100T and 125E Slow, contact CLP Engineering for sizing.
5. Mount cutouts so exhaust blast of arc is directed away from pole and climbing space.

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This standard lists the “T” link and “E” rated fuses to use for polemount transformers and 3Ø transformer banks in the 13.8kV system.

- “T” link fuses are used in 100A cutouts.
- “E” rated SMU-20 fuses are used in SMD-20 200A cutouts.

VOLTAGE	TRANSFORMER		STANDARD FUSE TYPE RATING		
	RATED kVA	FULL LOAD AMPS	TYPE T	SMU-20*	SM-4 Maintenance Only
13.8kV 1Ø TRANSFORMER	10.0	.72	3 STD	-	-
	15.0	1.09	6T	5E STD.	-
	25.0	1.81	6T	5E STD.	-
	37.5	2.72	8T	7E STD.	7E STD.
	50.0	3.62	10T	7E STD.	7E STD.
	75.0	5.43	12T	10E STD.	10E STD.
	100.0	7.25	12T	10E STD.	10E STD.
	150.0	10.87	20T	15E SLOW	20E STD.
	167.0	12.10	20T	15E SLOW	20E STD.
13.8kV 3Ø BANK (TOTAL kVA OF BANK)	9.0	.38	2 STD	-	-
	30.0	1.26	6T	5E STD.	-
	45.0	1.88	6T	5E STD.	-
	75.0	3.14	8T	7E STD.	7E STD.
	112.5	4.71	12T	10E STD.	10E STD.
	150.0	6.28	15T	15E SLOW	15E STD.
	225.0	9.41	20T	15E SLOW	20E STD.
	300.0	12.55	20T	15E SLOW	20E STD.
	500.0	20.91	30T	30E SLOW	30E STD.

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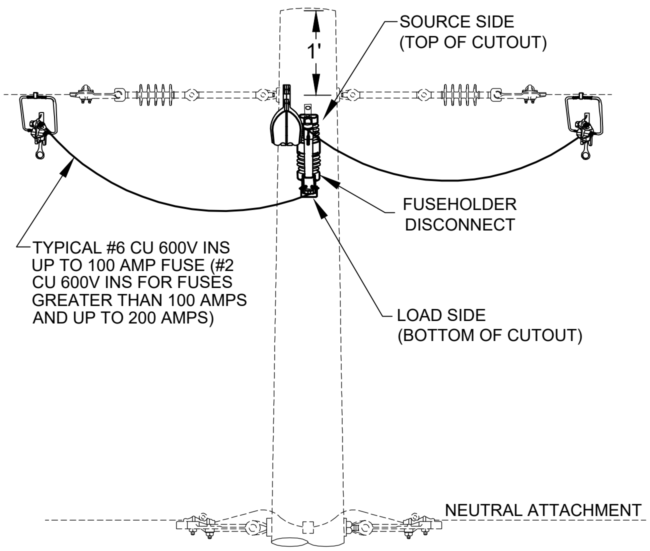
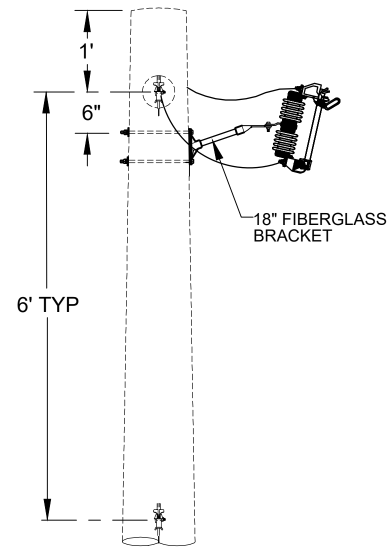
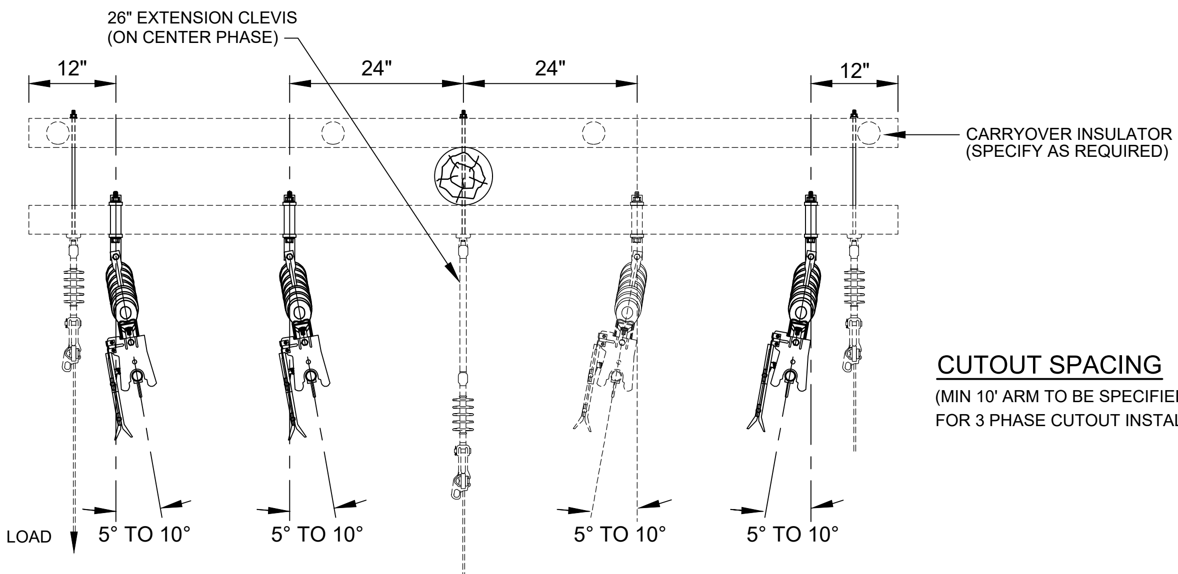


CUTOUT ON SINGLE- PHASE VERTICAL 15kV

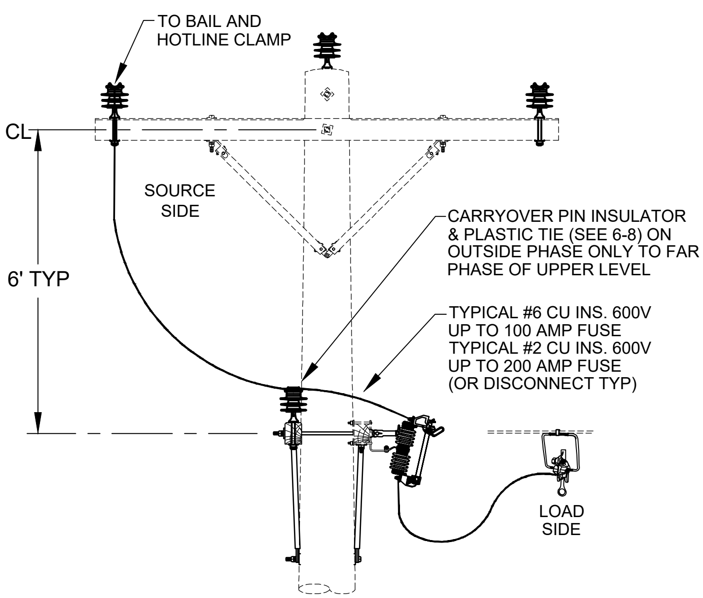


SIDE VIEW - 18" BRACKET WITH CUTOUT 15kV



NOTE:
CUTOUTS TO
FACE LOAD SIDE

CUTOUT SPACING
(MIN 10' ARM TO BE SPECIFIED
FOR 3 PHASE CUTOUT INSTALLATION)



VERTICAL CUTOUT SPACING FOR BRANCH LINE

NOTES:
1. Above spacing for cutouts can be applied in-line or on buckarm construction.
2. Mount on lower buckarm unless otherwise noted on job print.
3. Adhere to local wildlife protection guidelines.

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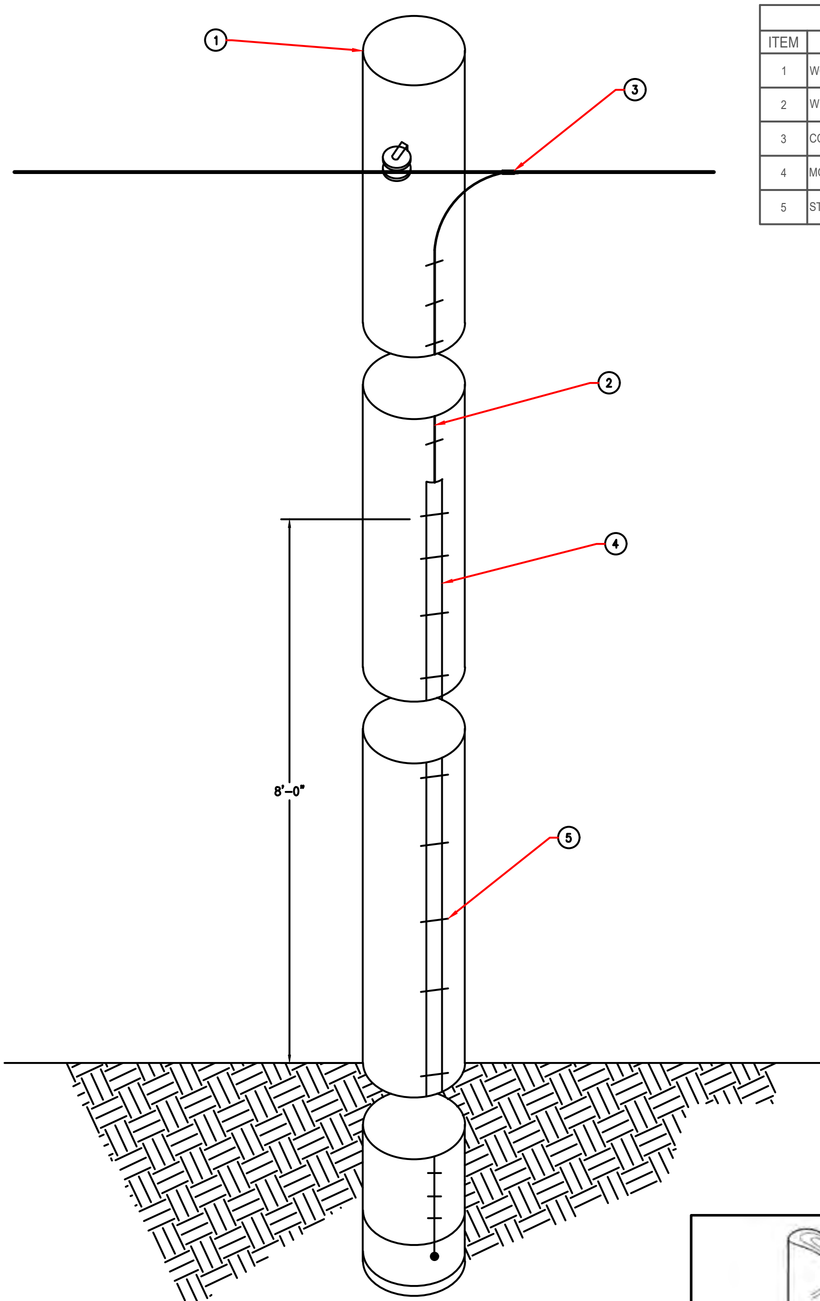
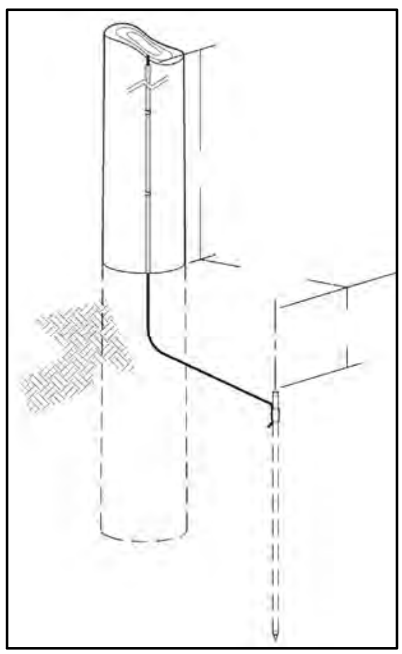
SC6.2	POLE MOUNTED CUTOUT TYPICAL CONSTRUCTION	APPROVED AS OF 5/31/2019



BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	WOOD POLE		1
2	WIRE, #4 COPPER-CLAD, BARE, SOLID (FT)		2
3	CONNECTOR, CRIMPIT		1
4	MOLDING, PLASTIC, 1/2" x 1/2" x 8'		1
5	STAPLES, 1/2" MOLDING		A/R



CITY LIGHT & POWER

SC6.3.1	TYPICAL POLE GROUNDING	APPROVED AS OF 5/31/2019

NOTES:

1. Size of Grounding Electrode Conductor: A bare #6 copper clad steel (CCS) conductor is the minimum size grounding conductor to be used from the earth grounding electrode to City Light and Power OH system neutral conductor (up to a maximum of 4/0 ACSR or 312 kcmil AAAC neutral size, based on NESC 93C2 requirements for multi-grounded system grounding conductors, having at least 20% of the ampacity rating of the conductors to which they are connected). A bare #6 CU is also the minimum size to be installed from the earth grounding electrode to an underground primary circuit neutral (1000kcmil AL cables and smaller). See note 3 for ground conductor sizes with static neutrals.
2. Size of Equipment Grounding Conductor: The following table provides the normal size OH primary tap conductor or UG cable sizes used to connect various types of equipment and the appropriate size of conductor to be used to connect tank/ground terminals to the system neutral conductor.

CAUTION: These ground conductor sizes are adequate for the fault current experienced during equipment failure, but may burn open in the event a fallen primary conductor lands on a tank (resulting in an energized tank), or due to lightning backflash from a phase conductor to the pole grounding conductor on static shielded lines. Safe approach distances and energized work practices shall be followed during work whenever grounding conductors may have melted open.

TYPE OF OH/UG/PD EQUIPMENT	PHASE OH (TAP) CONDUCTOR OR UG PRIMARY CABLE SIZE	MINIMUM RECOMMENDED EQUIPMENT GROUNDING CONDUCTOR SIZE (TO SYSTEM NEUTRAL)
OH ARRESTER	#4 CU (600V INS)	#4 CCS
OH TRANSFORMER	#4 CU (600V INS)	#4 CCS
OH CAPACITOR BANK	#4 CU (600V INS)	#4 CCS
RISER CABLES (#1 AL. 15KV 1 & 3 PH)	#4 CU (600V INS)	#4 CCS
PD / UG 1-PH TRANSFORMER / 4-WAY	#1 AL (15KV CABLE)	#4 CU (BARE) OR LOOP #6 CU
PD / UG 3-PH TRANSFORMER / 4-WAYS	#1 OR #4/0 AL (15KV)	#2 CU (BARE) OR LOOP #4 CU
OH / PD RECLOSER (225-AMP)	#2 CU (600V INS)	#2 CU (BARE) OR LOOP #4 CU (IF PAD)
OH PRIMARY METER (200-AMP)	#2 CU (600V INS)	#2 CU (BARE)
RISER CABLES (#4/0 & #1/0 AL.)	#2 CU (600V INS)	#2 CU (BARE)
RISER CABLES (1000KCMIL AL.)	#477 AL. (600V INS)	#2/0 CU (BARE)
PD PRIMARY METER (600-AMP)	1000KCMIL AL CABLES	#2/0 CU (BARE) OR LOOP #2 CU
SWITCH 600-AMP WITH METAL BASE/TANK (PREFER INSULATED BASE AND INSULATED SECTION IN OH OPERATING MECHANISM)	#477 (600V INS) OR 1000KCMIL CABLES	#2/0 CU (BARE) OR LOOP #2 CU (TO PROVIDE 2 RETURN PATHS)

The above sizing continues system neutrals at cable riser poles as well as limits temperature rise to the 250C limit of compression and mechanical connectors for CLP. "Loop" ground connections are defined as those where one wire is connected to two attachment points on the piece of equipment being grounded.

3. Size of Pole Ground Conductor from Static to Neutral: Pole ground conductor between static and lower neutral level should be at least #6 CCS unless otherwise stated by the table above for the equipment installed. This #6 CCS ground wire is adequate where available fault current is 10kA or less and the fault current return following lightning backflash includes two metallic paths (static neutral and neutral at secondary level). Where available fault current is higher than 10kA or on lines where only a static neutral is present, minimum #2 CU is recommended for the pole grounding conductor.

System & Equipment Grounds by Primary Voltage:

A. Install two ground rods or two alternate electrodes on all 4.16kV delta-system equipment grounds.
B. Install at least one ground rod or alternate electrode on all 12.47, 13.8 and 34.5kV multi-grounded 4-wire system and equipment grounds.
C. Install at least 2 ground rods at any site where the system neutral is not available. Install two ground rods/electrodes at all primary cable riser poles and all OH switch poles with arresters.
D. Besides grounds at every equipment site, NESC requires at least 4 grounds in each mile of line for multi-grounded 4-wire systems (CLP 12.47, 13.8 and 34.5kV), not counting those at service entrances.

5. Overhead Pole Ground:

A. Route the lowest 8' of pole ground conductor above grade on one side to avoid vehicle damage and cover that length with guard/moulding on all 4.16kV delta systems/equipment grounds (guard is optional per NESC on 12.47, 13.8 and 34.5kV multi-grounded 4-wire systems). Locate the pole ground beyond 8' on the same side as the neutral conductor and in the quadrant opposite from the pole climbing space.
B. Keep a minimum 2" clearance between ground conductors and unbonded hardware to avoid Radio Frequency Inteference / Television Interference (RFI/TVI).
C. Ground rods shall be driven and not placed in the pole hole.
D. Route pole grounds between static and lower neutral on cthe side of the pole opposite from center phases.
E. Pole line hardware shall remain unbonded for lightning performance (except on circuits underbuilt on transmission poles where hardware shall be bonded to avoid pole fires).

6. Alternate Earth Grounding Electrode: An alternate electrode to a driven ground rod is a buried counterpoise wire; at least 100-feet in length and a minimum #6 bare CCS buried 18" to 30" deep in either a straight line or in a star pattern radiating from the pole or vault. This is typically used in rocky areas where driving a ground rod is impossible. Pole butt plates do not count as an equivalent electrode. Internal vault rebar electrodes count as an equivalent of one electrode.

7. Grounding Resistance Requirements: Resistance testing shall be performed on the grounding system. A minimum requirement for single and multi-grounded systems at any point in the grounding system throughout a overhead grounding system with apparatus is 5 ohms. All others is 25 ohms.

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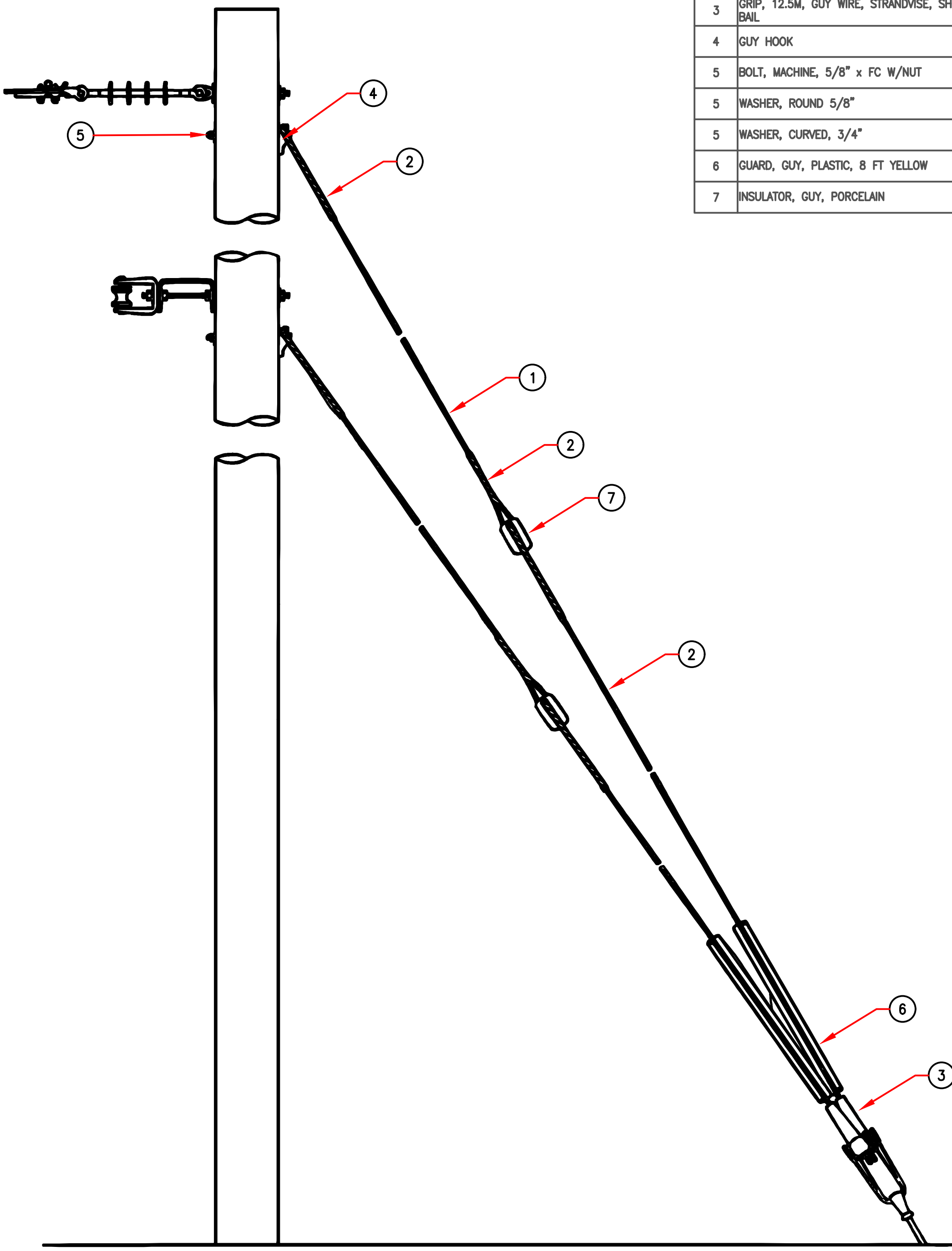
BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	GUY WIRE, 12.5 ALUMOWELD		A/R
2	GRIP, 12.5M, GUY WIRE, PREFORM, YELLOW		3
3	GRIP, 12.5M, GUY WIRE, STRANDVISE, SHORT BAIL		1
4	GUY HOOK		1
5	BOLT, MACHINE, 5/8" x FC W/NUT		1
5	WASHER, ROUND 5/8"		2
5	WASHER, CURVED, 3/4"		1
6	GUARD, GUY, PLASTIC, 8 FT YELLOW		1
7	INSULATOR, GUY, PORCELAIN		1

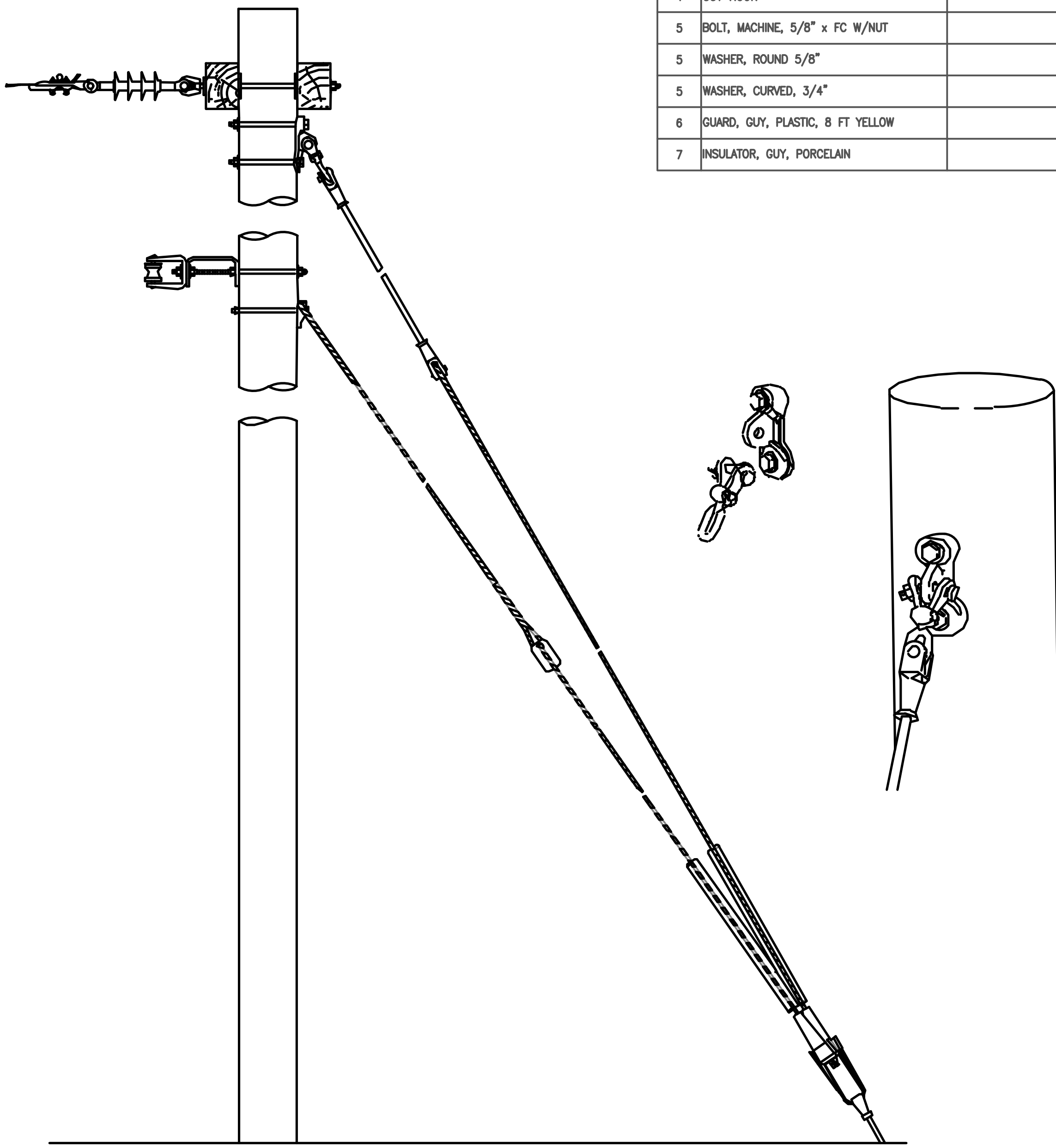


NOTES:
1. Single Phase 2–Wire configuration.

CITY LIGHT & POWER

SC6.5.1	TYPICAL DOWN GUY ASSEMBLIES	APPROVED AS OF 5/31/2019

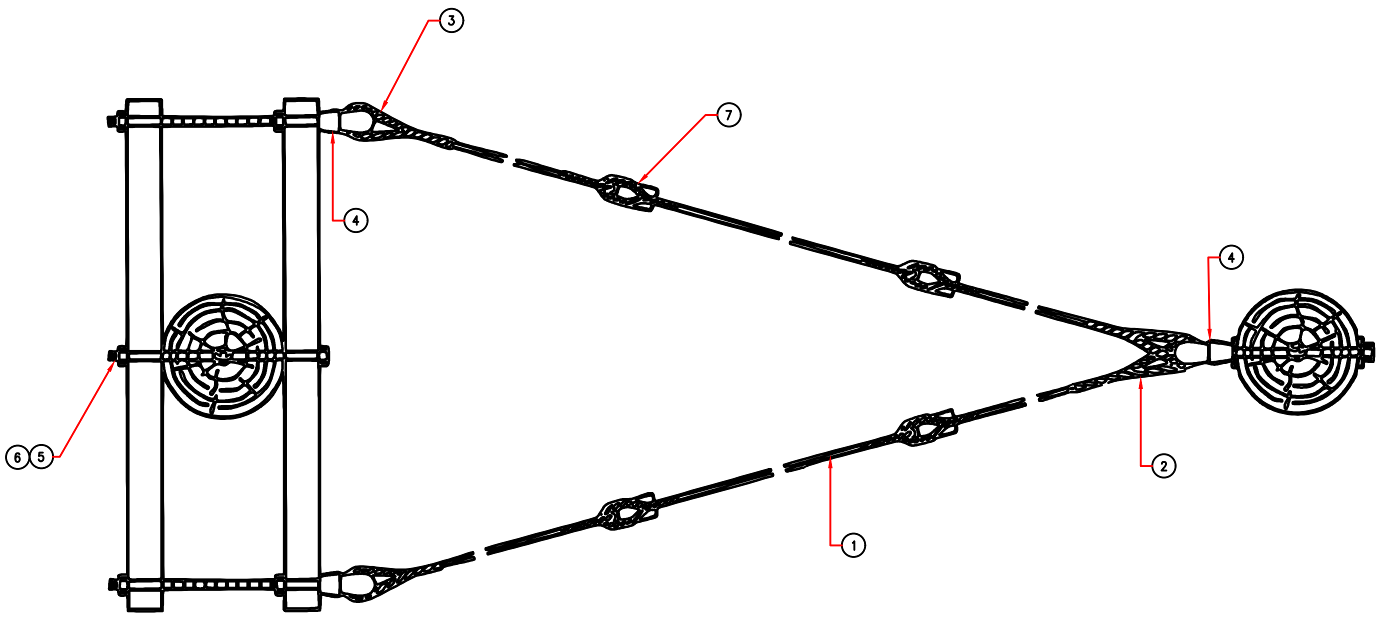
BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	GUY WIRE, 12.5 ALUMOWELD		A/R
2	GRIP, 12.5M, GUY WIRE, PREFORM, YELLOW		3
3	GRIP, 12.5M, GUY WIRE, STRANDVISE, SHORT BAIL		1
4	GUY HOOK		1
5	BOLT, MACHINE, 5/8" x FC W/NUT		1
5	WASHER, ROUND 5/8"		2
5	WASHER, CURVED, 3/4"		1
6	GUARD, GUY, PLASTIC, 8 FT YELLOW		1
7	INSULATOR, GUY, PORCELAIN		1



NOTES:
1. Three Phase 4–Wire configuration.

SC6.5.1	TYPICAL DOWN GUY ASSEMBLIES	APPROVED AS OF 5/31/2019

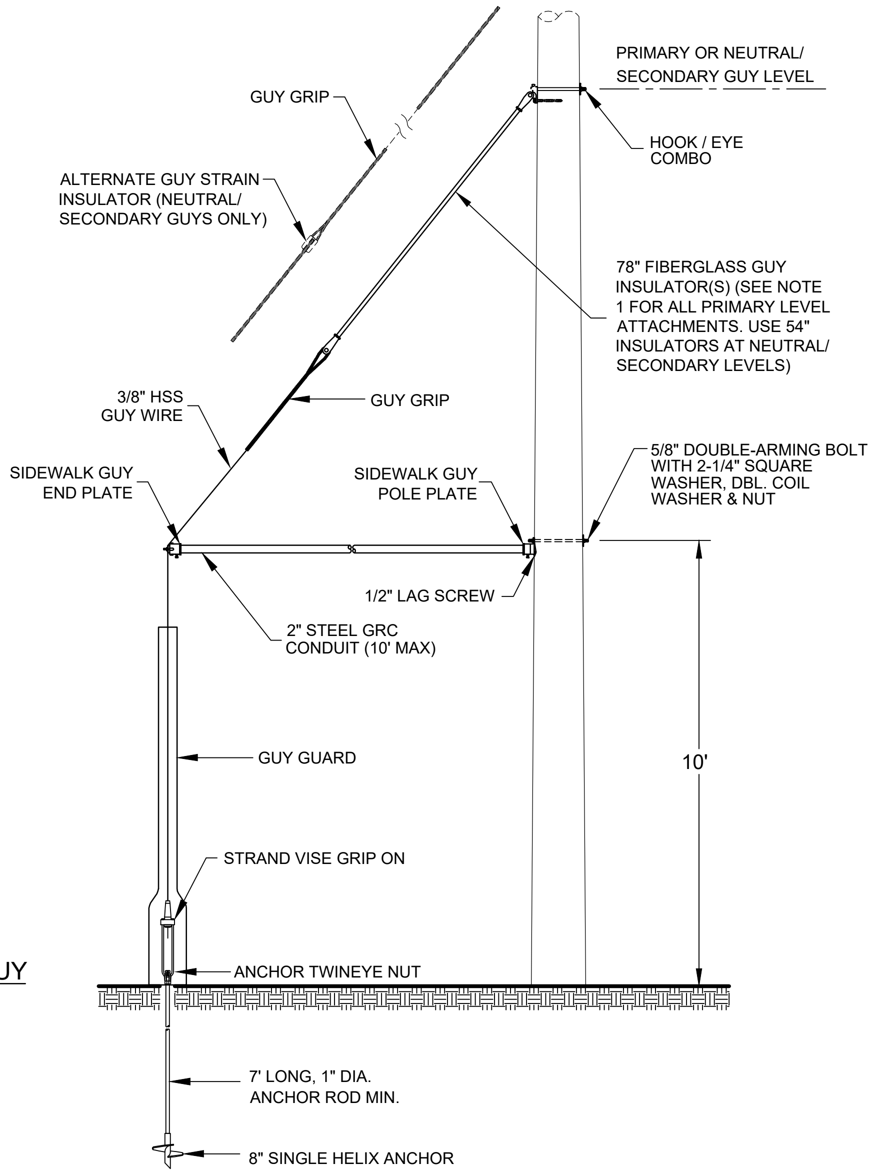
BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	GUY WIRE, 12M, ALUMO WELD		TBD
2	GRIP, 12.5M, 7 STRAND, GUY WIRE		5
3	GRIP, GUY WIRE, STRANDVISE, 12M, SHORT BAIL		1
4	NUT, GUY, THIMBLE–EYE, 3/4"		2
5	WASHER, CURVED, 3/4"		2
6	BOLT, MACHINE, GALVANIZED, 3/4" x FC W/NUT		2
7	INSULATOR, STRAIN, GUY, FIBERGLASS		2



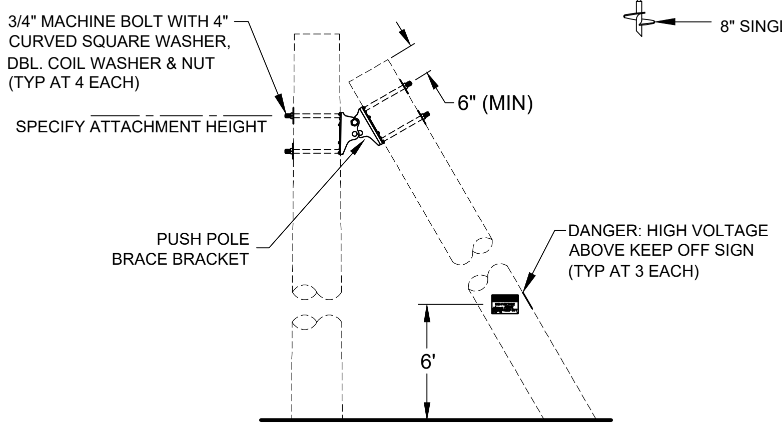
NOTES:
1. Typical arm guy, for unbalanced stresses on crossarms.

NOTES:

1. Insulate each primary (and higher) level guy with enough 78" fiberglass guy strain insulators in series to maintain insulation on guy conductor at 8' above grade in the event of a broken guy and to avoid transfer of voltage to other equipment/facilities on pole. For additional primary equipment/risers or circuits, add 78" fiberglass guy insulators as necessary to maintain this NESC requirement (min. 1' length of fiberglass insulation length from lowest 15 kV conductors on pole to broken guy wire).
2. Do not attach primary voltage to guy stub pole.
3. Length of 2" pipe to be determined by field conditions. Maximum length of pipe is 10', cut to fit in the field.
4. Length of guy wire is based on primary at 35' and neutral/ conductor at 29' above grade with 10' pipe (minus 1 - 78" guy insulator for primary).



3/8" PRIMARY AND
SECONDARY SIDEWALK GUY



PUSH BRACE

NOTES:

1. Length and class of push pole to be specified by CLP Engineering.
2. Attach danger signs with rust resistant nails to 3 sides of the pole.
3. Minimum breaking strength of pole brace bracket is 8000lbs.

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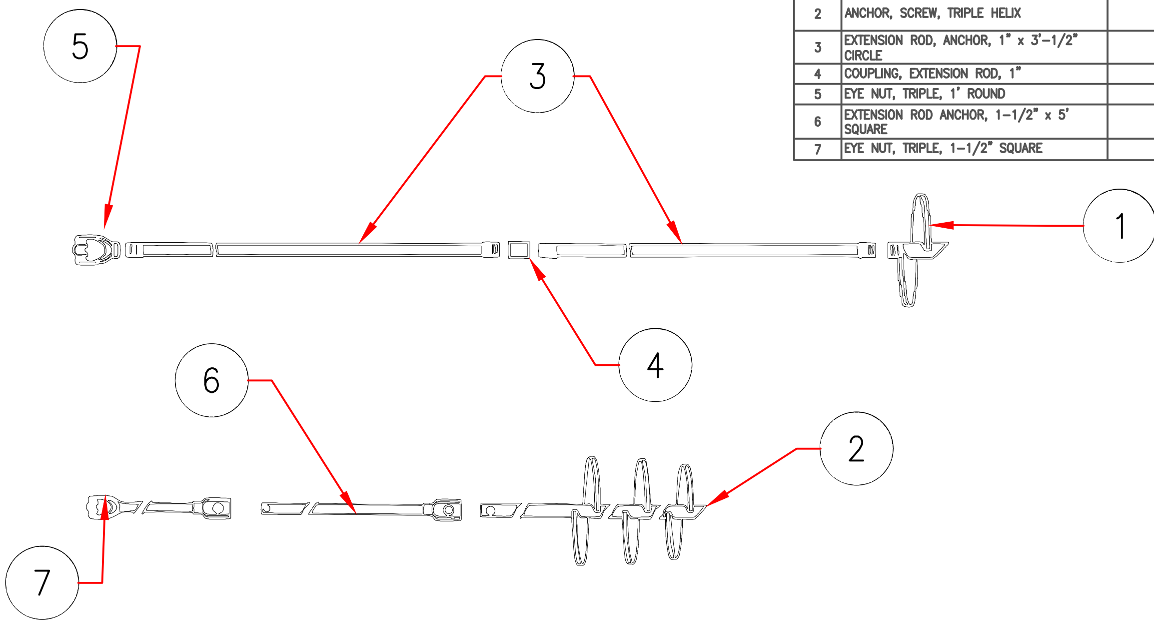
SC6.5.4	TYPICAL SIDEWALK TIE AND PUSH BRACE	APPROVED AS OF 5/31/2019

BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	ANCHOR, SCREW, HELIX		1
2	ANCHOR, SCREW, TRIPLE HELIX		1
3	EXTENSION ROD, ANCHOR, 1" x 3'-1/2" CIRCLE		1
4	COUPLING, EXTENSION ROD, 1"		2
5	EYE NUT, TRIPLE, 1' ROUND		4
6	EXTENSION ROD ANCHOR, 1-1/2" x 5' SQUARE		1
7	EYE NUT, TRIPLE, 1-1/2" SQUARE		1



Soil Class	Soil Description	Ultimate Holding Strength of Anchor in This Soil Type (lbs.)						
		"A1" Screw	"A2" Triple Helix	"A3" Plate	"A4" Plate	MR-1	MR-2	MR-SR
1	Very dense and/or cemented sands; coarse gravel and cobbles	36,000[1]	N/A	23,000[1]	45,000	36,000[1]	36,000[1]	N/A
2	Dense fine sands; very hard silts and clays	28,000	69,000	23,000[1]	45,000	36,000[1]	28,000	36,000[1]
3	Dense sands and gravel; hard silts and clays; glacial till	24,000	61,000	23,000[1]	45,000	36,000[1]	22,000	36,000[1]
4	Medium dense sand and gravel; very stiff to hard silts and clays; glacial till; hardpan **(typical of most of the Tacoma Power service territory)**	20,000	53,000	23,000[1]	37,000	20,000	18,000	34,000
5	Medium dense coarse sands and sandy gravels; stiff to very stiff silts and clays	16,000	45,000	23,000[1]	30,000	20,000	12,000	24,000
6	Loose to medium dense fine to coarse sands to stiff clays and silts; dense hydraulic or compacted fill **(typical of the Tideflats and City of Fife soils)**	12,000	37,000	23,000[1]	23,500	15,000	10,000	18,000
7[2]	Loose fine sands; medium-stiff and varied clays; fill; flood plain soils **(typical of the Tideflats and City of Fife soils)**	9,000	29,000	18,000	18,000	12,000	8,000	14,000

[1] Holding strength limited by anchor rod

[2] Install anchors deep enough to penetrate Class 5 or 6 soil underlying the Class 7 soil.

NOTES:

1. Install anchors no closer than 6-ft to another anchor.
2. Holding strength of anchor assemblies apply to properly installed anchors only. Failure to install the anchor rod within 10-deg of alignment with the guy load may significantly lower the holding strength of the anchor assembly.

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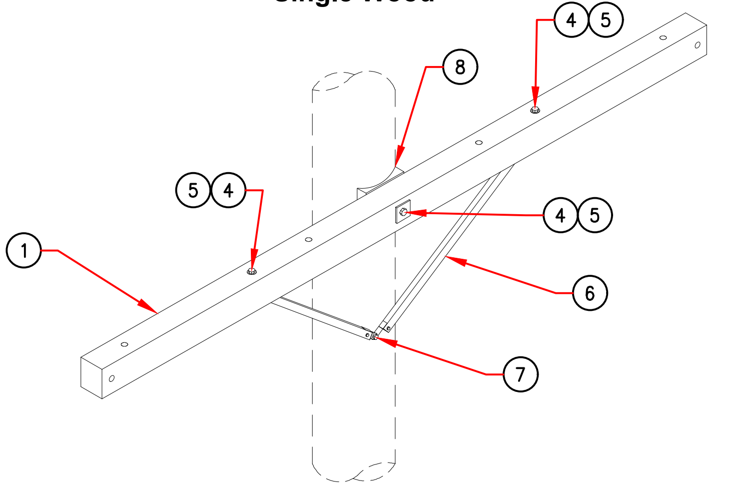
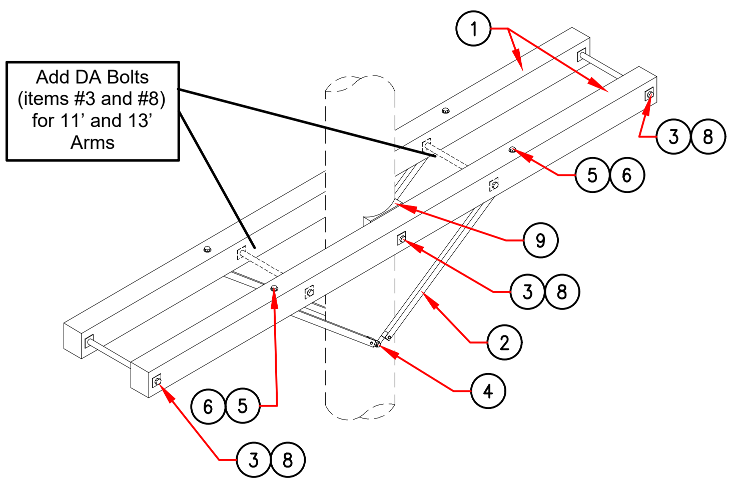
SC6.5.5	TYPICAL ANCHORS	APPROVED AS OF 5/31/2019

Crossarms Single Wood



BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	CROSSARM, SINGLE, STANDARD 8', 11' OR 13'		1
2	BOLT, MACHINE, 5/8" x FC OR 3/4 x FC W/ NUT		1
3	WASHER, CURVED OR SQUARE, 3/4"		1
4	BOLT, MACHINE, 1/2" x FC W/NUT		2
5	WASHER, ROUND, 1/2"		4
6	BRACE, CROSSARM, WOOD, 5', 6' OR 10' SPAN (PAIR)		1
7	BOLT, LAG 1/2" x 4"		1
8	GAIN, POLE, 4"		1

Crossarm Double Wood



BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	CROSSARM, DOUBLE, STANDARD OR HEAVY (8', 11' OR 13' LENGTHS)		2
2	BRACE, CROSSARM, WOOD, 5', 6' OR 10' SPAN (PAIR)		2
3	WASHER, SQUARE, 3/4"		TBD
4	BOLT, LAG 1/2" X 4"		2
5	WASHER, ROUND, 1/2"		8
6	BOLT, MACHINE, 1/2" X 6" OR 1/2" X 8" W/ NUT		4
7	BOLT, DOUBLEARM, 5/8" X FC OR 3/4" X FC W/ NUTS		TBD
8	GAIN, POLE, 4"		1

NOTES:

1. NONE.

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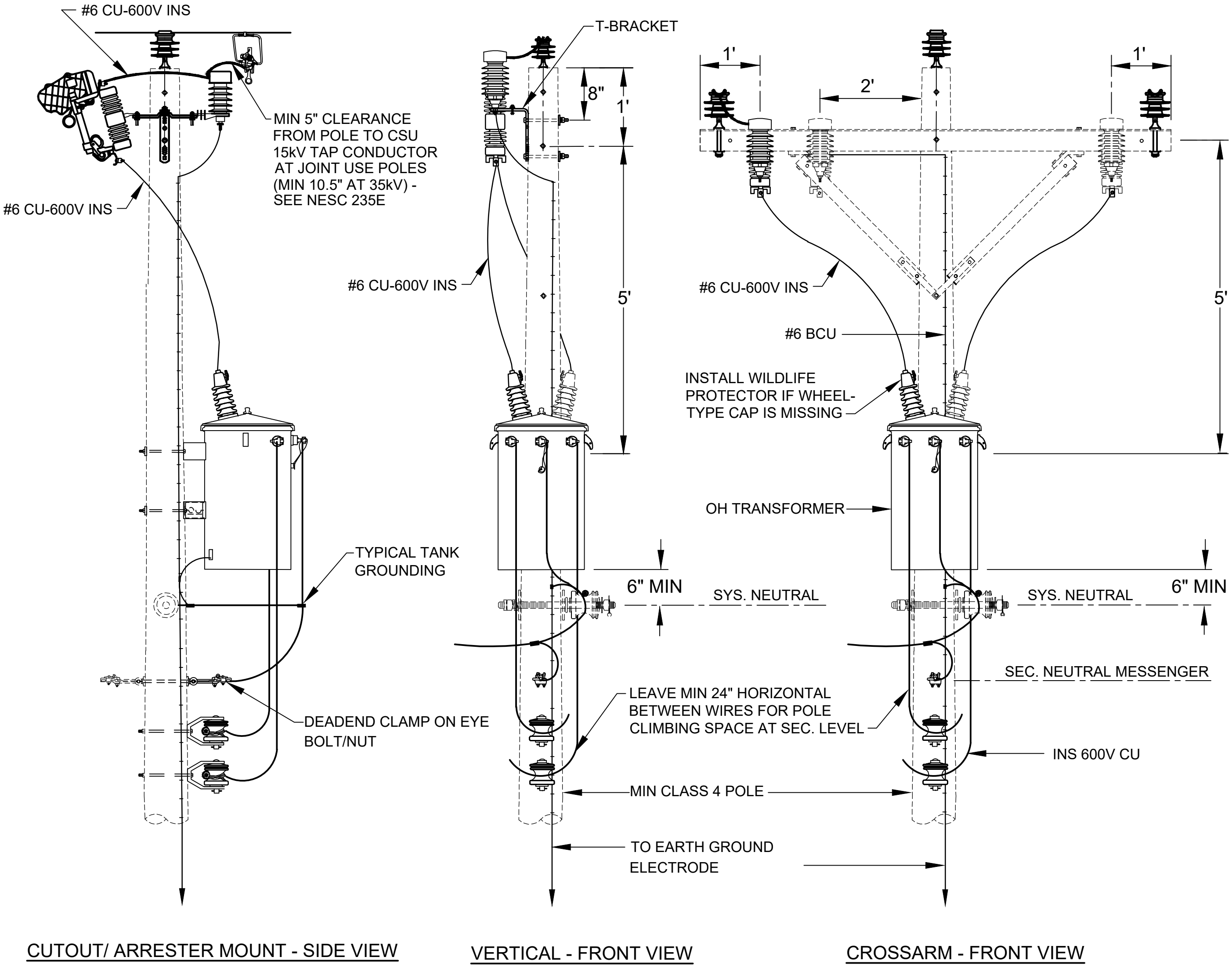
SC6.5	TYPICAL CROSSARM MOUNTING	APPROVED AS OF 5/31/2019



NOTES:

1. This standard may be used on either tangent or deadend structures, existing, or new.
2. Keep arrester lead lengths as short as possible on both lines and ground leads (across transformer).
3. Mount cutout so arc blast exhaust is directly away from pole.
4. Connect transformer ground lug to system primary neutral or pole ground if neutral not available.

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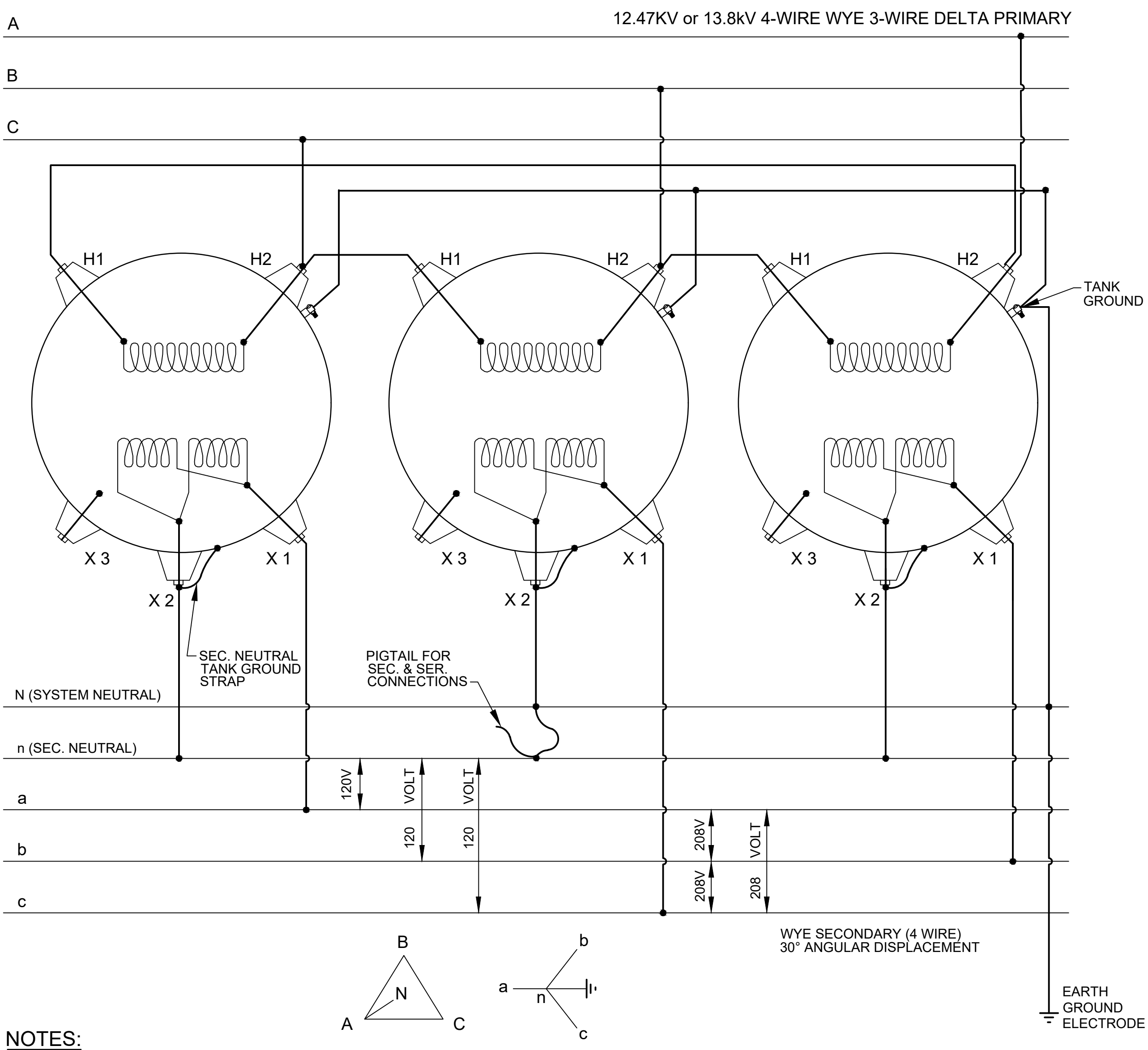
SC6.6	TYPICAL OVERHEAD 1-PHASE TRANSFORMER INSTALLATION	APPROVED AS OF 5/31/2019

OVERHEAD THREE-PHASE 120/208 WYE VOLT SERVICE
DELTA CONNECTED PRIMARY - WYE CONNECTED SECONDARY



NOTES:

1. Connect 12.47kV or 13.8kV Transformer in DELTA on high voltage side on 12.47kV or 13.8kV system.
2. All transformers in a bank shall be the same type and same kVA size.
3. Secondary terminals may not be arranged as shown- X1 & X3 will swap positions for transformers that have primary coils at 12kV & higher.

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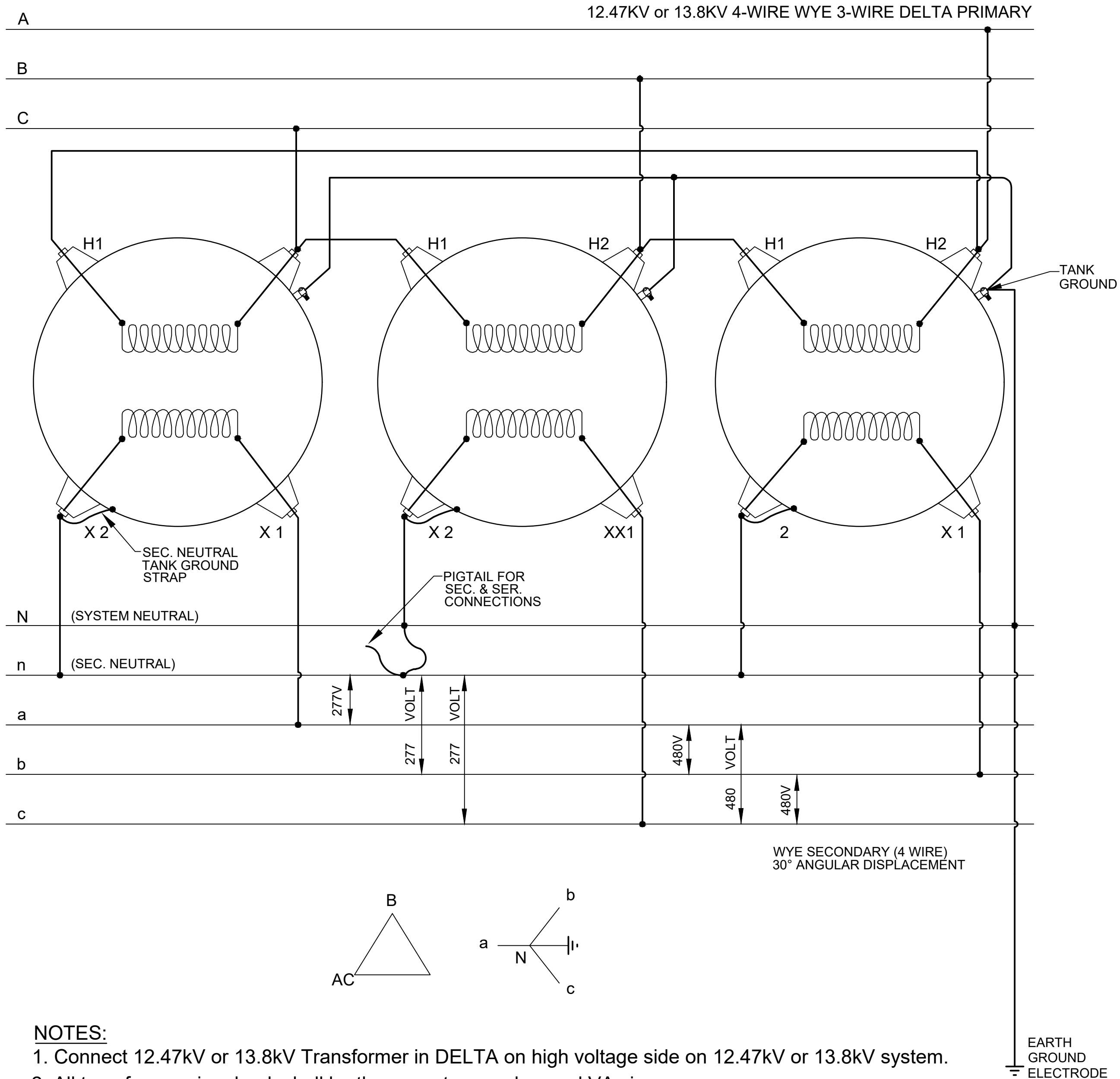
SC6.7.1	3-PHASE TRANSFORMER BANK CONNECTION DIAGRAM (D-Y, 120/208V SERVICE)	APPROVED AS OF 5/31/2019

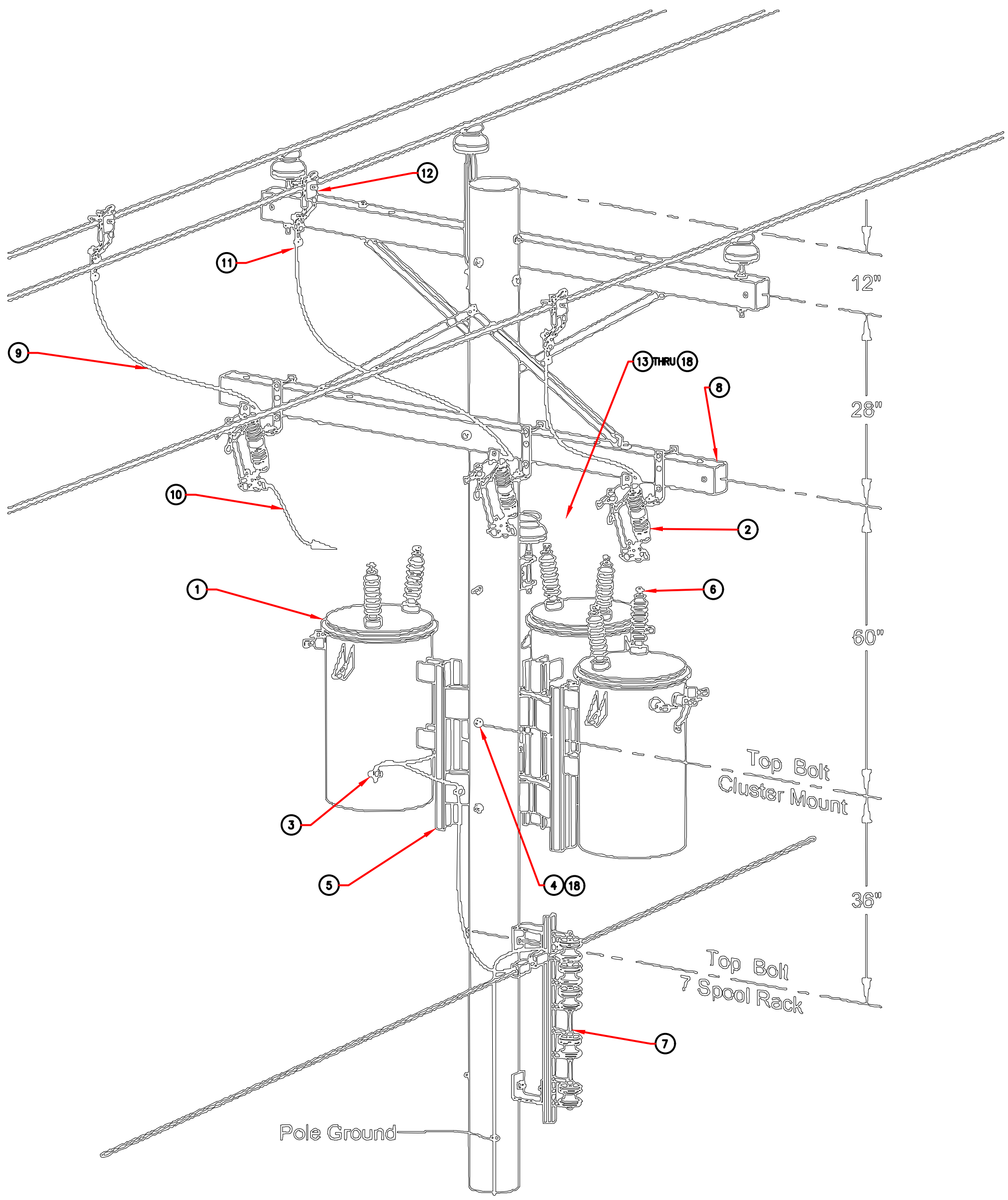
OVERHEAD THREE-PHASE 277/480 VOLT SERVICE
DELTA CONNECTED PRIMARY - WYE CONNECTED SECONDARY



NOTES:
1. Connect 12.47kV or 13.8kV Transformer in DELTA on high voltage side on 12.47kV or 13.8kV system.
2. All transformers in a bank shall be the same type and same kVA size.
3. Secondary terminals may not be arranged as shown- X1 & X3 will swap positions for transformers that have primary coils at 12kV & higher.

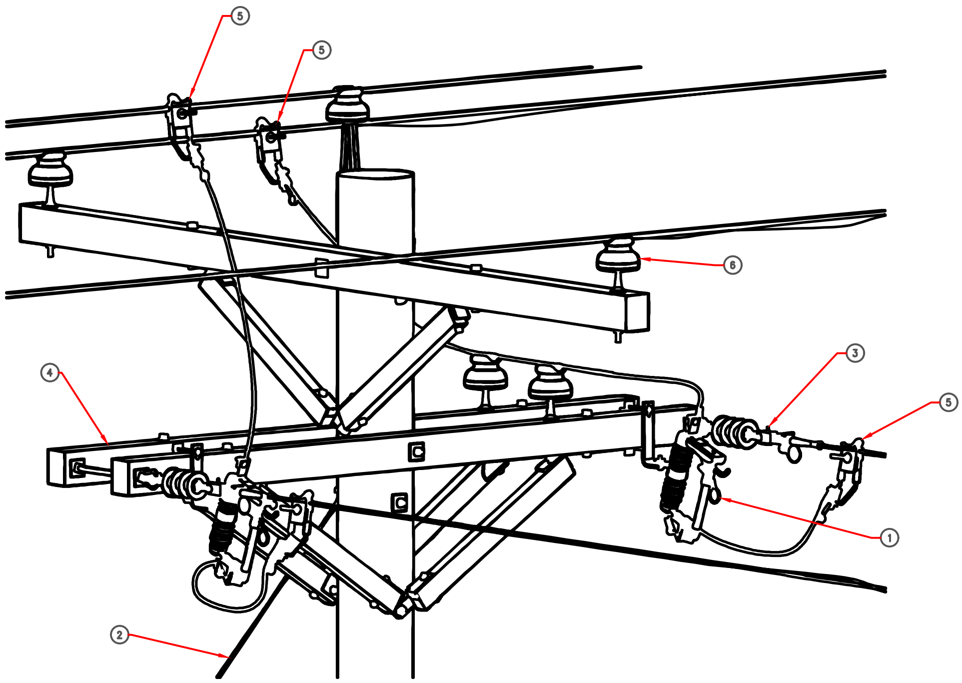
SC6.7.2	3-PHASE TRANSFORMER BANK CONNECTION DIAGRAM (D-Y, 277/480V SERVICE)	APPROVED AS OF 5/31/2019

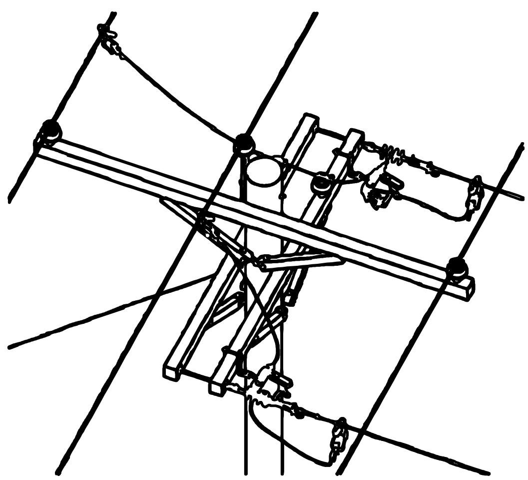
BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	Xfmrs OH 1Ø All kVA, 3Ø Voltages		3
2	100A Cutout, 1Ø, 15kV, Arm–mount		3
3	Clamp, Ground, Transformer		3
4	Bolt, Machine, 3/4" x FC w/nut		2
5	Mount, Cluster		1
6	Cap, wildlife guard,15 kV bushing		6
7	7–Spool Rack Assembly, 3Ø		1
8	Crossarm, Sgl		1
9	Wire, #4 Solid SD Cu Bare		28
10	Wire, #4 Solid SD Cu Covered		18
11	Clamp, Hot Line		3
12	Clamp, Stirrup		3
13	Pin, Insul., Steel, Std Shank (5/8"x 6–1/2")		1
14	Insulator, 138 kV, Pin, Grey ANSI 55–4		1
15	Bracket, extension, secondary, 6"x3"x4"		1
16	Bracket, clevis, secondary		1
17	Bolt, Doublearm, 5/8" x FC w/nuts		1
18	Washer, Curved, 3/4"		1



SC6.7.3	3-PHASE TRANSFORMER BANK CONSTRUCTION	APPROVED AS OF 5/31/2019

BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	FUSED CUTOUT		2
2	DOWN GUY		1
3	DEAD END INSULATOR		2
4	DOUBLE CROSS ARM		2
5	HOT LINE CLAMP		2
5	HOT LINE STIRRUP		2
6	ARM MOUNTED PIN		2



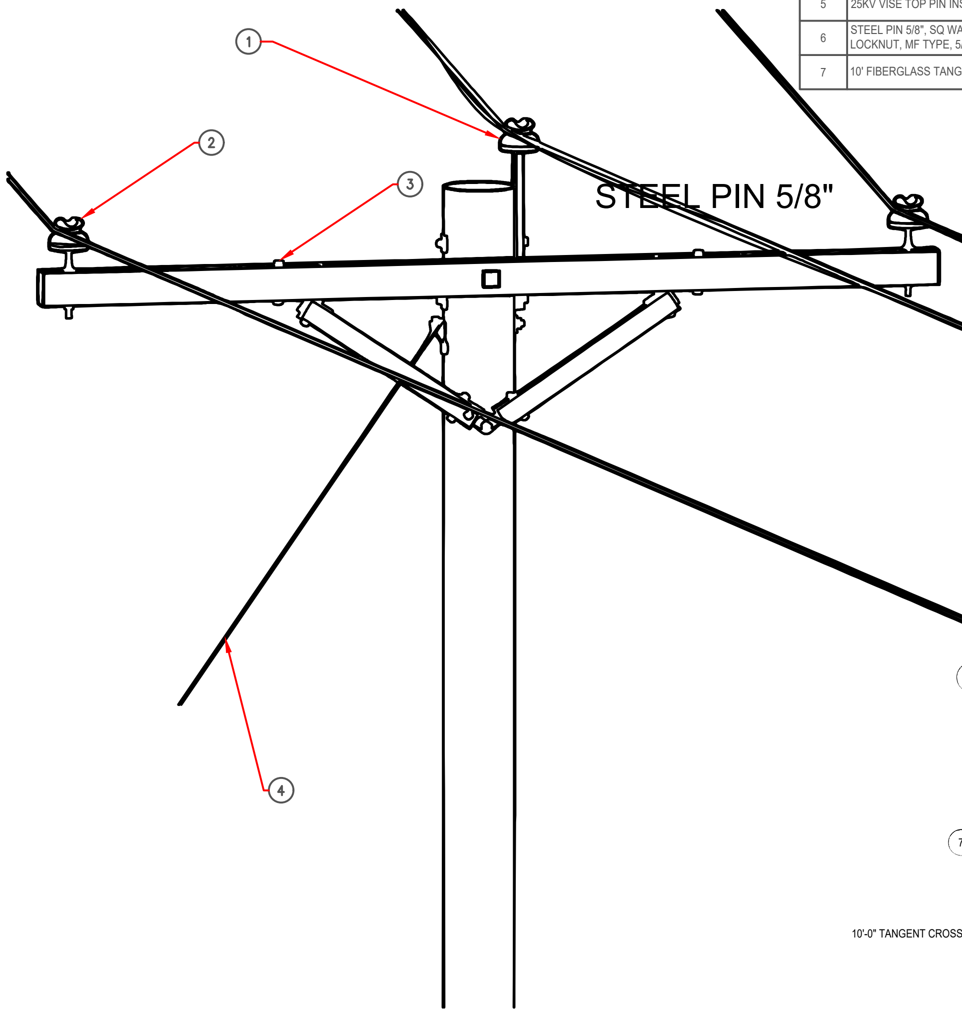


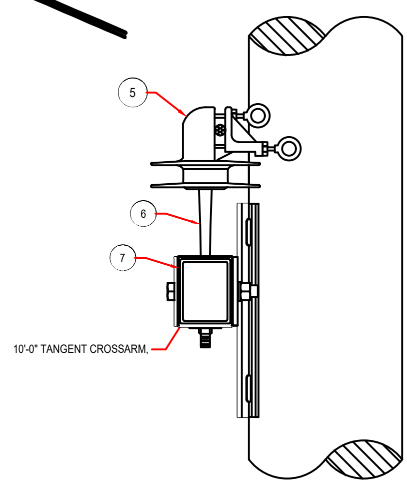
NOTES:

1. Contact CLP field representative or engineering for corssarm dimensions and applications.
2. Vertical spacing of crossarms centerline to centerline is 36-in for #4/0 and smaller conductor and 48-in if larger than #4/0.
3. Provide 6-in minimum separation from guy hardware to primiary phase and neutral hardware.
4. For slack spans keep spans as short as possible (100-ft max), do not use automatic deadends or splices, and rake and key the pole when possible.

SC6.8	TYPICAL 1-PHASE TAP	APPROVED AS OF 5/31/2019

BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	POLE-TOP PIN, 15KV	TBD	1
2	ARM-MOUNTED PIN, 15KV	TBD	2
3	CROSSARM, SINGLE	TBD	1
4	DOWNGUY	TBD	1
4	ANCHOR	TBD	1
5	25KV VISE TOP PIN INSULATOR	HENDRIX, HPI-25VTU-01	4
6	STEEL PIN 5/8", SQ WASHER, 5/8" BOLT SIZE LOCKNUT, MF TYPE, 5/8" BOLT SIZE	MACLEAN	A/R
7	10' FIBERGLASS TANGENT CROSSARM, ASSEMBLY	PUPI	1





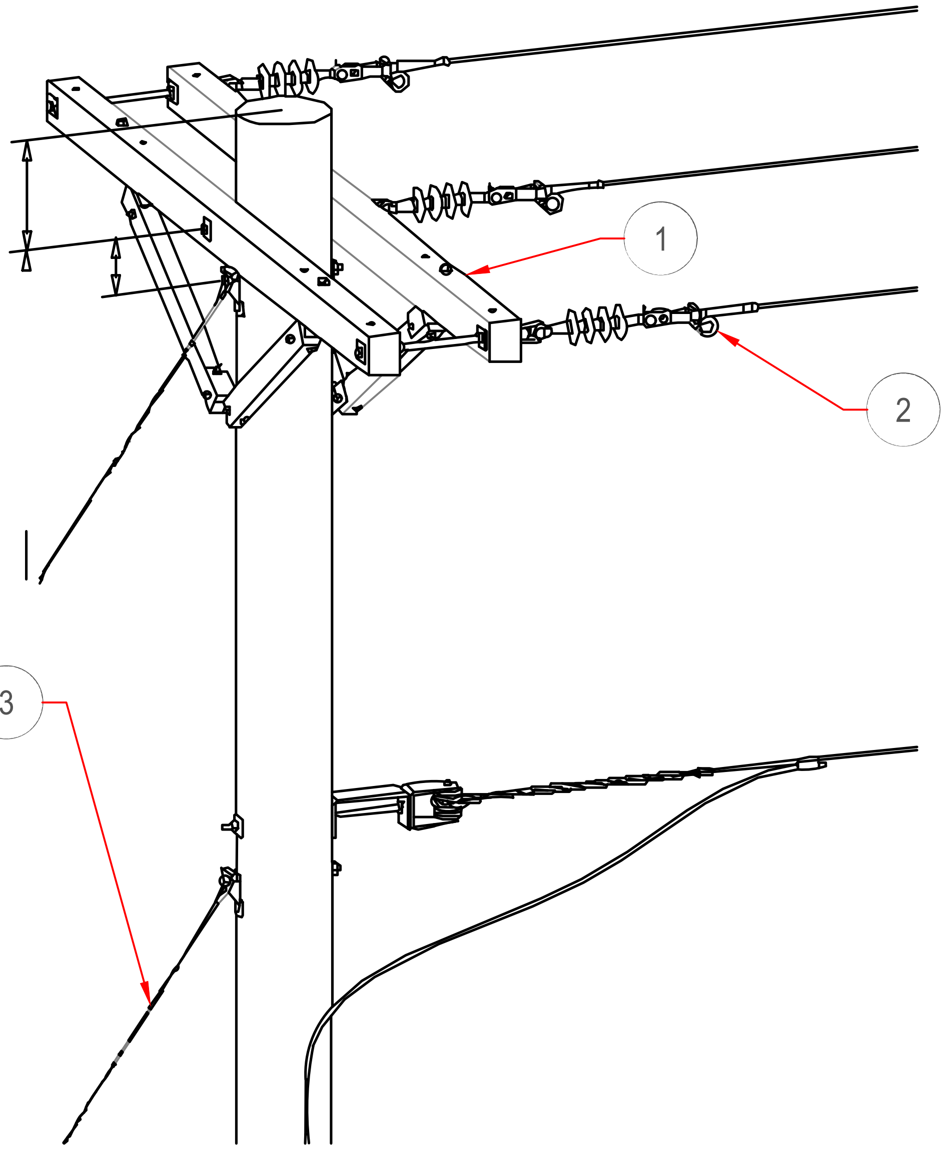
25kV VISE TOP PIN INSULATOR ON FIBERGLASS CROSSARM.

NOTES:

1. Contact CLP field representative or engineering for corssarm dimensions and applications.
2. Provide 6-in minimum separation from guy hardware to primiary phase and neutral hardware.

SC6.9	TYPICAL 3PHASE TANGENT	APPROVED AS OF 5/31/2019

BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	CROSSARM, DOUBLE	TBD	1
2	DEADEND ASSEMBLY, ARM	TBD	3
3	DOWNGUY WITH ANCHOR	TBD	2



NOTES:

1. Contact CLP field representative or engineering for corssarm dimensions and applications.
2. Provide 6-in minimum separation from guy hardware to primiary phase and neutral hardware.

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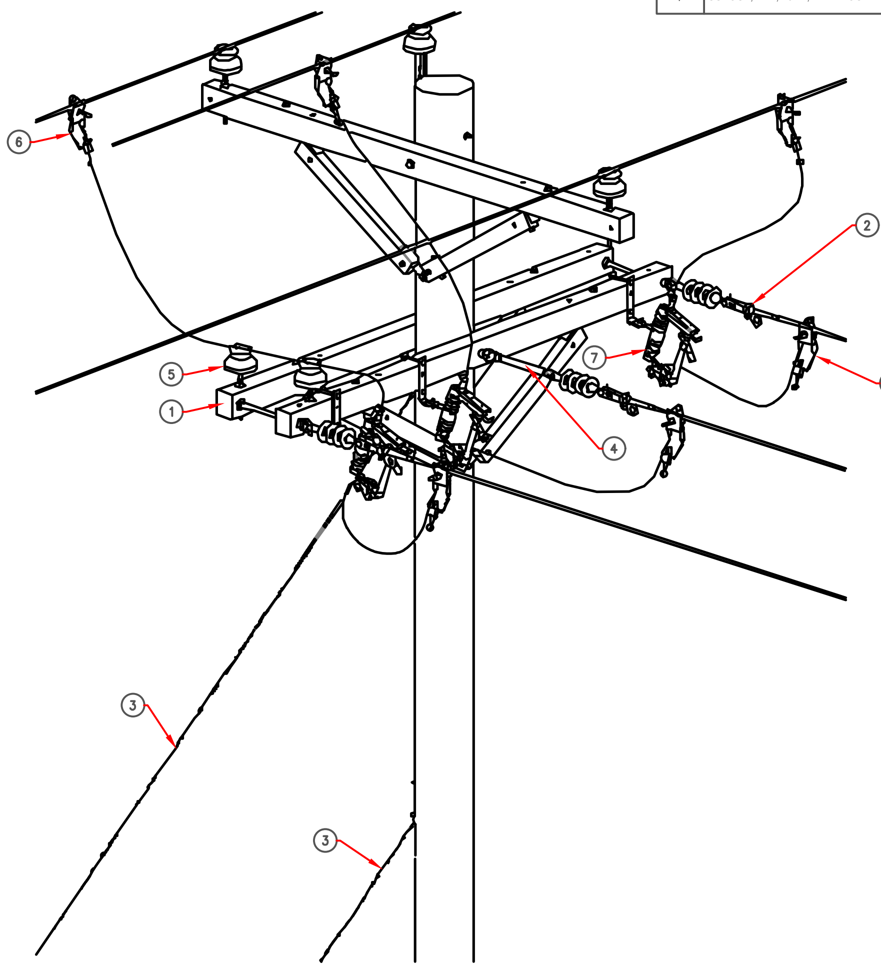
SC6.10	TYPICAL 3-PHASE DEADEND	APPROVED AS OF 5/31/2019

BILL OF MATERIALS			
ITEM	MATERIAL	MANUFACTURER ID	QTY
1	CROSSARM, DOUBLE		1
2	DEADEND, ARM		3
3	DOWNGUY		1
3	ANCHOR		1
4	EXTENSION LINK, LIGHT, 14"		1
5	ARM-MOUNTED PIN, 15KV		2
6	CLAMP, STIRRUP (FOR SMALLER THAN 4/0)		6
6	CLAMP, HOT LINE (FOR SMALLER THAN 4/0)		6
6	*CONNECTOR, WEDGE (FOR 4/0 AND LARGER)		6
7	CUTOUT, 1PH, 15KV, ARM-MOUNT		3



NOTES:

1. Contact CLP field representative or engineering for corssarm dimensions and applications.
2. Vertical spacing of crossarms centerline to centerline is 36-in for #4/0 and smaller conductor and 48-in if larger than #4/0.
3. Provide 6-in minimum separation from guy hardware to primiary phase and neutral hardware.

SC6.11	TYPICAL 3-PHASE TAP	APPROVED AS OF 5/31/2019

150 FOOT RULING SPAN

		SPAN LENGTH (FEET) / SAG (INCHES)											
WIRE SIZE	**TEMP °F**	**50**	**70**	**90**	**110**	**130**	**150**	**170**	**190**	**210**	**230**	**250**	**I.T.**
#2 ACSR 6/1 SPARROW RBS 2850	30	1	2	4	5	7	10	13	16	19	23	27	311
	40	1	3	4	6	9	12	15	19	23	27	32	264
	50	2	3	5	7	10	14	18	22	27	32	38	225
	60	2	3	6	9	12	16	21	26	31	38	44	192
	70	2	4	7	10	14	18	24	29	36	43	51	167
	80	2	5	7	11	16	21	27	33	41	49	58	148
	90	3	5	8	12	17	23	30	37	45	54	64	133
	167	4	7	12	18	26	34	44	55	67	80	95	90
	ML	3	6	10	15	21	28	35	44	54	65	77	712
1/0 ACSR 6/1 RAVEN RBS 4380	30	1	1	2	4	5	7	9	11	13	16	19	723
	40	1	2	3	4	6	8	10	12	15	18	21	645
	50	1	2	3	5	6	9	11	14	17	20	24	568
	60	1	2	4	5	7	10	13	16	19	23	27	495
	70	1	2	4	6	9	11	15	18	22	27	32	428
	80	1	3	5	7	10	13	17	21	26	31	37	368
	90	2	3	6	8	12	15	20	25	30	36	43	318
	167	3	6	10	16	22	29	37	46	57	68	80	169
	ML	2	4	7	11	15	20	26	33	40	48	56	1095
4/0 ACSR 6/1 PENGUIN RBS 8350	30	1	1	2	3	5	6	8	10	12	14	17	1635
	40	1	1	2	4	5	7	9	11	13	16	18	1476
	50	1	2	3	4	6	7	10	12	15	18	21	1318
	60	1	2	3	5	6	8	11	14	17	20	23	1163
	70	1	2	3	5	7	10	12	16	19	23	27	1014
	80	1	2	4	6	8	11	14	18	22	26	31	877
	90	1	3	5	7	10	13	17	21	26	31	36	755
	167	3	6	10	15	20	27	35	43	53	64	75	363
	ML	2	3	5	8	11	14	18	23	28	34	40	2104
477 AAC 19 STRAND COSMOS RBS 8360	30	1	3	4	6	9	12	15	19	24	28	33	1256
	40	2	3	5	8	11	14	18	23	28	34	40	1052
	50	2	4	6	9	13	17	22	27	33	40	47	890
	60	2	4	7	11	15	20	25	32	39	46	55	767
	70	2	5	8	12	17	22	29	36	44	53	62	675
	80	3	5	9	13	19	25	32	40	49	59	70	604
	90	3	6	10	15	21	28	35	44	54	65	76	550
	167	5	9	16	23	32	43	56	69	85	102	120	350
	ML	2	4	7	10	15	19	25	31	38	46	54	2090

I.T. = Initial Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

200 FOOT RULING SPAN

		SPAN LENGTH (FEET) / SAG (INCHES)											
WIRE SIZE	**TEMP °F**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**I.T.**
#2 ACSR 6/1 SPARROW RBS 2850	30	7	10	14	18	23	28	34	41	48	56	64	192
	40	8	11	15	20	25	31	38	45	53	61	71	174
	50	9	12	17	22	28	34	41	49	58	67	77	160
	60	9	13	18	24	30	37	45	53	62	72	83	148
	70	10	14	19	25	32	39	48	57	67	77	89	138
	80	10	15	21	27	34	42	51	60	71	82	95	130
	90	11	16	22	28	36	44	54	64	75	87	100	123
	167	14	20	28	36	46	57	68	81	96	111	127	97
	ML	12	18	24	31	40	49	59	71	83	96	110	713
1/0 ACSR 6/1 RAVEN RBS 4380	30	4	6	8	10	13	16	19	22	26	31	35	559
	40	4	6	9	11	14	18	21	25	30	34	39	496
	50	5	7	10	13	16	20	24	29	33	39	45	440
	60	6	8	11	14	18	22	27	32	38	44	50	391
	70	6	9	12	16	20	25	30	36	42	49	56	350
	80	7	10	14	18	22	28	33	40	47	54	62	315
	90	8	11	15	19	25	30	37	44	51	59	68	287
	167	12	17	23	30	38	46	56	67	79	91	105	187
	ML	9	13	18	23	29	36	44	52	61	71	81	1095
4/0 ACSR 6/1 PENGUIN RBS 8350	30	3	4	6	8	10	12	14	17	20	23	26	1488
	40	3	5	6	8	11	13	16	19	22	26	29	1340
	50	4	5	7	9	12	15	18	21	25	29	33	1198
	60	4	6	8	10	13	16	20	24	28	32	37	1065
	70	5	7	9	12	15	19	22	27	31	36	42	943
	80	5	8	10	13	17	21	25	30	35	41	47	836
	90	6	8	11	15	19	23	28	34	40	46	53	744
	167	10	15	20	27	34	42	50	60	70	81	94	420
	ML	6	9	12	16	20	25	30	36	42	49	57	2087
477 AAC 19 STRAND COSMOS RBS 8360	30	6	9	12	15	19	24	29	34	40	47	54	1122
	40	7	10	13	17	22	27	33	39	46	53	61	988
	50	8	11	15	20	25	31	37	44	52	60	69	881
	60	8	12	17	22	27	34	41	49	57	66	76	797
	70	9	13	18	24	30	37	45	53	62	72	83	729
	80	10	14	20	26	32	40	48	57	67	78	90	674
	90	11	15	21	27	35	43	52	62	72	84	96	628
	167	15	22	30	40	50	62	75	89	104	121	139	436
	ML	9	12	17	22	28	34	42	50	58	68	78	2090

I.T. = Initial Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

250 FOOT RULING SPAN

		SPAN LENGTH (FEET) / SAG (INCHES)											
WIRE SIZE	**TEMP °F**	**150**	**170**	**190**	**210**	**230**	**250**	**270**	**290**	**310**	**330**	**350**	**I.T.**
#2 ACSR 6/1 SPARROW RBS 2850	30	20	26	33	40	48	56	66	76	87	98	110	152
	40	21	27	34	42	50	59	69	80	91	103	116	144
	50	22	29	36	44	52	62	72	83	95	108	121	138
	60	23	30	37	46	55	65	75	87	99	112	127	132
	70	24	31	39	47	57	67	78	90	103	117	132	127
	80	25	32	40	49	59	70	81	94	107	121	136	123
	90	26	33	42	51	61	72	84	97	111	126	141	119
	167	30	39	49	60	72	85	99	114	130	148	166	101
	ML	28	35	44	54	65	77	89	103	118	134	150	712
1/0 ACSR 6/1 RAVEN RBS 4380	30	12	15	18	23	27	32	37	43	49	56	63	426
	40	13	16	20	25	30	35	41	47	54	61	69	388
	50	14	18	22	27	32	38	44	51	59	66	75	357
	60	15	19	24	29	35	41	48	55	63	72	81	330
	70	16	20	26	31	37	44	52	60	68	77	87	307
	80	17	22	27	33	40	47	55	64	73	82	93	288
	90	18	23	29	35	43	50	59	68	77	88	98	271
	167	24	31	39	48	58	68	79	92	105	119	134	200
	ML	20	26	33	40	48	56	66	76	87	98	111	1095
4/0 ACSR 6/1 PENGUIN RBS 8350	30	7	10	12	15	17	21	24	28	32	36	40	1326
	40	8	11	13	16	19	23	27	31	35	40	45	1199
	50	9	12	15	18	21	25	29	34	39	44	49	1082
	60	10	13	16	20	24	28	33	38	43	49	55	977
	70	11	14	18	22	26	31	36	42	47	54	60	884
	80	12	16	20	24	29	34	40	46	52	59	66	805
	90	13	17	21	26	31	37	43	50	57	65	73	737
	167	21	27	34	41	50	59	68	79	90	102	115	466
	ML	14	18	22	27	33	39	45	52	60	68	76	2088
477 AAC 19 STRAND COSMOS RBS 8360	30	15	19	23	29	34	41	47	55	62	71	79	1037
	40	16	20	26	31	37	44	52	60	68	77	87	948
	50	17	22	28	34	41	48	56	65	74	84	94	876
	60	19	24	30	36	44	52	60	69	79	90	101	815
	70	20	25	32	39	47	55	64	74	85	96	108	764
	80	21	27	34	41	49	58	68	79	90	102	114	720
	90	22	28	36	43	52	62	72	83	95	107	121	683
	167	30	38	48	59	70	83	97	112	128	145	163	506
	ML	19	25	31	38	45	53	62	72	82	93	104	1912

I.T. = Initial Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

CITY LIGHT & POWER

300 FOOT RULING SPAN

SPAN LENGTH (FEET) / SAG (INCHES)													
WIRE SIZE	**TEMP °F**	**200**	**220**	**240**	**260**	**280**	**300**	**320**	**340**	**360**	**380**	**400**	**I.T.**
#2 ACSR 6/1 SPARROW RBS 2850	30	40	49	58	68	79	91	103	116	130	145	161	136
	40	41	50	60	70	81	93	106	120	134	150	166	132
	50	43	52	61	72	83	96	109	123	138	15	171	128
	60	44	53	63	74	86	98	112	126	142	158	175	125
	70	45	54	65	76	88	101	115	130	145	162	180	122
	80	46	56	66	78	90	103	118	133	149	166	184	119
	90	47	57	68	79	92	106	120	136	152	170	188	116
	167	53	64	76	89	104	119	135	153	171	191	212	103
	ML	49	59	71	83	96	111	126	142	159	177	197	712
1/0 ACSR 6/1 RAVEN RBS 4380	30	25	30	36	42	48	56	63	71	80	89	99	352
	40	26	32	38	44	51	59	67	76	85	95	105	332
	50	28	34	40	47	54	62	71	80	90	100	111	314
	60	29	35	42	49	57	66	75	84	94	105	117	298
	70	31	37	44	52	60	69	78	88	99	110	122	285
	80	32	39	46	54	63	72	82	92	104	115	128	272
	90	33	40	48	56	65	75	85	96	108	120	133	262
	167	42	50	60	71	82	94	107	121	135	151	167	209
	ML	36	44	52	61	71	81	92	104	117	130	145	1095
4/0 ACSR 6/1 PENGUIN RBS 8350	30	15	18	21	25	29	33	38	43	48	54	59	1176
	40	16	20	23	27	32	36	42	47	53	59	65	1077
	50	18	21	25	30	35	40	45	51	57	64	71	988
	60	19	23	28	32	38	43	19	55	62	69	77	909
	70	21	25	30	35	41	47	53	60	67	75	83	842
	80	22	27	32	38	44	50	57	64	72	81	89	783
	90	24	29	34	40	47	54	61	69	77	86	96	732
	167	35	42	50	59	68	78	89	100	113	125	139	503
	ML	25	30	36	42	49	56	63	72	80	89	99	2088
477 AAC 19 STRAND COSMOS RBS 8360	30	27	33	39	46	54	61	70	79	89	99	109	985
	40	29	35	42	49	57	65	75	84	94	105	116	924
	50	31	37	44	52	60	69	79	89	100	111	123	872
	60	33	39	47	55	64	73	83	94	105	117	130	827
	70	34	41	49	58	67	77	87	99	111	123	137	787
	80	36	43	51	60	70	80	92	103	116	129	143	752
	90	37	45	54	63	73	84	95	108	121	135	149	722
	167	48	58	69	81	94	107	122	138	155	173	191	563
	ML	34	41	48	57	66	76	86	97	109	121	135	2090

I.T. = Initial Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

150 FOOT RULING SPAN

		SPAN LENGTH (FEET) / SAG (INCHES)											
WIRE SIZE	TEMP °F	50	70	90	110	130	150	170	190	210	230	250	I.T.
#2 ACSR 6/1 SPARROW RBS 2850	30	1	3	4	7	9	12	16	20	24	29	34	249
	40	2	3	5	8	11	15	19	23	29	34	41	211
	50	2	4	6	9	13	17	22	27	33	40	47	181
	60	2	4	7	10	15	19	25	31	38	46	54	158
	70	2	5	8	12	16	22	28	35	43	51	61	141
	80	3	5	9	13	18	24	31	39	47	57	67	127
	90	3	6	9	14	20	26	34	42	52	62	73	117
	167	4	8	13	19	26	35	45	56	68	82	97	88
	ML	3	6	10	15	21	28	35	44	54	65	77	712
1/0 ACSR 6/1 RAVEN RBS 4380	30	1	2	3	4	6	8	10	13	16	19	22	607
	40	1	2	3	5	7	10	12	15	19	22	26	515
	50	1	2	4	6	8	11	15	18	22	27	31	433
	60	1	3	5	7	10	13	17	22	26	32	37	365
	70	2	3	6	8	12	16	20	25	31	37	44	311
	80	2	4	7	10	14	18	23	29	36	43	51	269
	90	2	4	7	11	15	21	26	33	40	48	57	238
	167	3	6	11	16	22	30	38	48	58	70	82	165
	ML	2	4	7	11	15	20	26	33	40	48	56	1094
4/0 ACSR 6/1 PENGUIN RBS 8350	30	1	2	3	4	5	7	9	11	14	17	20	1377
	40	1	2	3	4	6	8	11	13	16	20	23	1179
	50	1	2	4	5	7	10	13	16	19	23	27	997
	60	1	3	4	6	9	12	15	19	23	28	33	838
	70	2	3	5	7	10	14	18	22	27	33	39	707
	80	2	4	6	9	12	16	21	26	32	38	45	604
	90	2	4	7	10	14	19	24	30	37	44	52	526
	167	3	6	10	15	21	28	36	45	55	66	77	353
	ML	2	3	5	8	11	14	18	23	28	34	40	2003
477 AAC 19 STRAND COSMOS RBS 8360	30	2	4	6	9	12	16	21	26	32	38	45	931
	40	2	4	7	10	14	19	25	31	38	45	53	789
	50	2	5	8	12	17	22	28	35	43	52	61	686
	60	3	5	9	13	19	25	32	40	49	58	69	610
	70	3	6	10	15	21	27	35	44	54	64	76	553
	80	3	6	11	16	22	30	38	48	58	70	83	508
	90	4	7	12	17	24	32	41	52	63	76	89	471
	167	5	10	17	25	35	47	60	75	92	110	130	324
	ML	2	4	7	10	15	19	25	31	38	46	54	1883

F.T. = Final Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

200 FOOT RULING SPAN

SPAN LENGTH (FEET) / SAG (INCHES)													
WIRE SIZE	**TEMP °F**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**	**I.T.**
#2 ACSR 6/1 SPARROW	30	8	12	16	21	26	33	40	47	55	64	74	167
	40	9	13	17	23	29	35	43	51	60	70	80	154
	50	10	14	19	24	31	38	46	55	64	75	86	143
	60	10	15	20	26	33	41	49	59	69	80	92	134
	70	11	16	21	28	35	43	52	62	73	84	97	127
	80	11	16	22	29	37	45	55	65	77	89	102	120
RBS 2850	90	12	17	23	31	39	48	58	69	81	94	107	115
	167	14	21	28	37	46	57	69	83	97	112	129	95
	ML	12	18	24	31	40	49	59	71	83	96	110	712
1/0 ACSR 6/1 RAVEN	30	5	7	9	12	16	19	23	28	33	38	44	450
	40	6	8	11	14	18	22	27	32	37	43	50	393
	50	6	9	12	16	20	25	30	36	42	49	56	347
	60	7	10	14	18	23	28	34	40	47	55	63	311
	70	8	11	15	20	25	31	37	44	52	61	70	282
	80	8	12	17	22	27	34	41	49	57	66	76	258
RBS 4380	90	9	13	18	23	29	36	44	52	62	71	82	239
	167	12	17	23	30	38	47	57	68	79	92	106	185
	ML	9	13	18	23	29	36	44	52	61	71	81	1094
4/0 ACSR 6/1 PENGUIN	30	4	5	7	9	11	14	17	20	24	28	32	1239
	40	4	6	8	10	13	16	20	23	27	32	37	1074
	50	5	7	9	12	15	19	23	27	32	37	42	931
	60	5	8	11	14	17	22	26	31	36	42	48	812
	70	6	9	12	16	20	24	30	35	41	48	55	716
	80	7	10	13	17	22	27	33	39	46	54	62	639
RBS 8350	90	8	11	15	19	24	30	37	44	51	59	68	578
	167	11	15	21	27	34	42	51	61	72	83	96	412
	ML	6	9	12	16	20	25	30	36	42	49	57	2027
477 AAC 19 STRAND COSMOS	30	8	11	15	20	25	31	37	44	52	60	69	875
	40	9	12	17	22	28	34	41	49	58	67	77	788
	50	9	13	18	24	30	37	45	54	63	73	84	720
	60	10	15	20	26	33	40	49	58	68	79	91	665
	70	11	16	21	28	35	43	53	63	73	85	98	619
	80	12	17	23	30	37	46	56	67	78	91	104	582
RBS 8360	90	12	18	24	31	40	49	59	70	83	96	110	550
	167	17	24	33	43	54	67	81	96	113	131	150	404
	ML	9	12	17	22	28	34	42	50	58	68	78	1889

F.T. = Final Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

CITY LIGHT & POWER

250 FOOT RULING SPAN

WIRE SIZE	TEMP °F	150	170	190	210	230	250	270	290	310	330	350	I.T.
		SPAN LENGTH (FEET) / SAG (INCHES)											
#2 ACSR 6/1 SPARROW RBS 2850	30	22	28	35	43	51	61	71	82	93	106	119	141
	40	23	29	36	45	53	63	74	85	97	110	124	135
	50	24	30	38	46	56	66	77	89	101	115	129	130
	60	25	32	39	48	58	68	80	92	105	119	134	125
	70	25	33	41	50	60	71	82	95	109	123	139	121
	80	26	34	42	52	62	73	85	98	112	127	143	117
	90	27	35	43	53	64	75	88	101	116	131	148	113
	167	31	40	49	60	72	86	100	115	132	149	168	100
	ML	28	35	44	54	65	77	89	103	118	134	150	711
1/0 ACSR 6/1 RAVEN RBS 4380	30	14	18	22	27	32	38	44	51	59	66	75	357
	40	15	19	24	29	35	41	48	56	64	72	81	328
	50	16	21	26	32	38	45	52	60	69	78	88	304
	60	17	22	28	34	40	48	56	64	74	83	94	284
	70	18	24	29	36	43	51	59	69	78	89	100	267
	80	19	25	31	38	46	54	63	73	83	94	106	252
	90	20	26	33	40	48	57	66	76	87	99	111	240
	167	25	32	40	48	58	69	80	92	106	120	135	198
	ML	20	26	33	40	48	56	66	76	87	98	111	1094
4/0 ACSR 6/1 PENGUIN RBS 8350	30	9	11	14	17	21	25	29	33	38	43	48	1106
	40	10	13	16	20	24	28	32	37	43	48	54	981
	50	11	14	18	22	26	31	36	42	48	54	61	877
	60	12	16	20	24	29	35	40	46	53	60	68	791
	70	14	18	22	27	32	38	44	51	58	66	74	720
	80	15	19	24	29	35	41	48	56	63	72	81	661
	90	16	21	26	31	38	45	52	60	69	78	87	613
	167	21	27	34	42	50	59	69	80	91	104	117	459
	ML	14	18	22	27	33	39	45	52	60	68	76	2044
477 AAC 19 STRAND COSMOS RBS 8360	30	18	23	28	35	42	49	57	66	75	85	96	856
	40	19	24	30	37	45	53	61	71	81	92	103	797
	50	20	26	32	40	48	56	66	76	86	98	110	747
	60	21	28	34	42	50	60	70	80	92	104	117	705
	70	23	29	36	44	53	63	73	85	97	110	123	669
	80	24	30	38	47	56	66	77	89	101	115	129	637
	90	25	32	40	49	58	69	80	93	106	120	135	610
	167	32	41	51	63	75	89	104	120	137	155	175	472
	ML	19	25	31	38	45	53	62	72	82	93	104	1912

F.T. = Final Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

300 FOOT RULING SPAN

WIRE SIZE	TEMP °F	SPAN LENGTH (FEET) / SAG (INCHES) 200	220	240	260	280	300	320	340	360	380	400	I.T.
#2 ACSR 6/1 SPARROW RBS 2850	30	42	51	61	71	82	95	108	122	136	152	168	130
	40	43	52	62	73	85	97	111	125	140	156	173	127
	50	44	54	64	75	87	100	113	128	144	160	177	123
	60	45	55	65	77	89	102	116	131	147	164	182	120
	70	46	56	67	78	91	105	119	134	151	168	186	118
	80	47	57	68	80	93	107	122	137	154	172	190	115
	90	48	59	70	82	95	109	124	140	157	175	194	113
	167	53	64	77	90	104	120	136	154	173	192	213	103
	ML	49	59	71	83	96	111	126	142	159	177	197	712
1/0 ACSR 6/1 RAVEN RBS 4380	30	28	34	40	47	54	63	71	80	90	100	111	313
	40	29	35	42	50	57	66	75	85	95	106	117	297
	50	31	37	44	52	60	69	79	89	100	111	123	283
	60	32	39	46	54	63	73	83	93	104	116	129	270
	70	34	41	48	57	66	76	86	97	109	121	135	259
	80	35	42	50	59	69	79	90	101	113	126	140	249
	90	36	44	52	61	71	82	93	105	118	131	145	240
	167	42	51	60	71	82	94	107	121	136	152	168	207
	ML	36	44	52	61	71	81	92	104	117	130	145	1094
4/0 ACSR 6/1 PENGUIN RBS 8350	30	17	21	25	29	34	39	45	50	57	63	70	1000
	40	19	23	28	32	38	43	49	55	62	69	77	912
	50	21	25	30	35	41	47	53	60	68	75	83	837
	60	23	27	32	38	44	51	58	65	73	81	90	774
	70	24	29	35	41	47	55	62	70	79	87	97	721
	80	26	31	37	44	51	58	66	75	84	93	103	675
	90	27	33	40	46	54	62	70	79	89	99	110	637
	167	35	35	51	59	69	79	90	102	114	127	141	497
	ML	25	30	36	42	49	56	63	72	80	89	99	2056
477 AAC 19 STRAND COSMOS RBS 8360	30	32	38	46	53	62	71	81	91	103	114	127	850
	40	33	40	48	56	65	75	85	96	108	120	133	807
	50	35	42	50	59	69	79	90	101	113	126	140	769
	60	37	44	53	62	72	82	94	106	118	132	146	736
	70	38	46	55	64	75	86	98	110	123	138	152	706
	80	40	48	57	67	78	89	101	114	128	143	158	680
	90	41	50	59	69	80	92	105	119	133	148	164	656
	167	51	62	73	86	100	115	130	147	165	184	204	528
	ML	34	41	48	57	66	76	86	97	109	121	135	1937

F.T. = Final Tension (lbs)

ML = Maximum Loading (1/4 inch ice with 4 lb/ft2 (40 mph) wind at 15°F)

RBS = Rated Breaking Strength (lbs)

CITY LIGHT & POWER

Appendix D: SERVICE CONNECTION TYPICAL EQUIPMENT SPECIFICATIONS

Table of Contents

Contact CLP Installation Manager for electrical equipment not listed.

* Note: Spec datasheet available – Request from base Installation Manager

** Note: Specification awaiting approval.

Appendix E: ABBREVIATIONS

When practicable, the following standard abbreviations and symbols shall be used on all electric distribution line construction and one-line drawings. Whenever these abbreviations or symbols do not clearly define the work to bedone, additional notes of explanation will be necessary for accurate understanding of the work order.

A, AMPS	Amperes
AAAC	All Aluminum Alloy Conductor
ACSR	Aluminum Conductor Steel Reinforced
AL	Aluminum
ALLEY	Alley Arm (sidearm)
AR	Cross-arm
ARR	Arrester (Surge, Lightning)
ASB	Anti-Splitting Bolt
ATO	Automatic Throw-Over
BAR	Buck-arm
BCU	Bare Copper
BP	Box Pad
BR	Brace
BRKT	Bracket
BRL	Barrel Configuration
C	Capacitor
CA	Concrete Anchor
CATV	Cable TV
CCS	Copper Clad Steel
CLF	Current Limiting Fuse
CNR	Corner (or Shoulder) Type Pins
CP	Concrete Pad
CSP	Completely Self-Protected Transformer
CT	Current Transformer
CU	Copper
CW	Copper weld
DA	Double Arming
DBL	Double (Pins/ INS &/ or Arms)
DB	Direct Bury
DDE	Double Deadend
DE	Deadend
DHA	Double Helix Anchor
DUP	Duplex
E	Electronic Recloser
ENC	Encased in Concrete
EX, EXIST	Existing
EXT	Extension
F	Fuse
FCI	Faulted Circuit Indicator

FE	Fused
FG	Fiberglass
FIMS	Facilities Information Management
FO	Fiber Optic
FS	Fused Switch
G	Gas Line
GO	Gang Operated
GRD	Ground
H, HVY	Heavy, High Strength
HPS	High Pressure Sodium
IN	Install
INS, INSUL	Insulator, Insulated, Insulate
IS	Interrupter Switch (Fault)
J, JBOX	Junction Box
KCMIL	Thousands Circular Mils
KV	Kilovolts
KVA	Kilovolt-Amperes
KW	Kilowatts
LA	Line Angle
LBS	Pounds
LBU	Load Break Unit
LF	Loop Feed
M	Meter, Meter Location
MH	Mounting Height
MO	Motor Operated
MV	Mercury Vapor, Medium Voltage
MVI	Molded Vacuum Interrupter
#	Number
N, NEUT	Neutral
NC	Normally Closed
NO	Normally Open
NR	Non Reclose
NT	Network Transformer
OD	Open Delta Connection
OH	Overhead
P, PRI	Primary
PB	Push Brace
PD	Pad-mount
PE	Photoelectric

PED	Pedestal
PH or Ø	Phase
PT	Potential Transformer
QUAD	Quadraplex
R	Recloser
RA	Rock Anchor
RBS	Rated Breaking Strength
REG	Regulator
RF	Radial Feed
RM	Remove, Removable
ROW	Right-of-Way
RP	Replace
RS	Ruling Span (for Sag/Tension)
SCADA	Supervisory Control & Data Acquisition System
S, SEC	Secondary
SECT	Sectionalizer
SER	Service
SG, SGH	Span Guy, Span Guy Heavy
SGL	Single (Pins, Arms, INS)
SHA	Single Helix Anchor
SL	Street Light
SOL	Solid
SS	Sanitary Sewer, Storm Sewer
ST	Static (Shield Wire/ Neutral Level)

STR	Strand, Stranded
SW	Switch
SWG	Sidewalk Guy
T-OP	Tee-Op 600 Amp Separable Connectors
TEL	Telephone
TEMP	Temporary
TERM	Terminate, Cable Terminator
TPA	Tipping Plate Anchor
TRANS	Transmission
TRI	Triplex
TS	Traffic Signal
TSFR	Transformer
TYP	Typical
U, UBLT	Underbuilt
UG	Underground
V	Volts
VERT	Vertical Construction
VLT	Vault
VT	Voltage Transformer
W	Watts, Waterline
WO	Without
WP	Wood Pole
X	Crossing, Cross
XA	Expanding Anchor