**SCHEDULE "S"**

Town of Cardston

# Underground Residential: Design and Installation Requirements

## Requirements for Design and Installation of Electrical Distribution Systems in Underground Residential Developments

Electrical Distribution System Operational Documents

Version 1.023

# Contents

# 1. General Provisions

**Regulations:**

- All underground electrical distribution facilities to be installed within the Town of Cardston and connected to the Town's electric distribution system operated by Cardston Electric Utility, must be designed and installed in accordance with the requirements of the Alberta Electrical and Utility Code (AEUC) or its replacement document, CSA Standards, as a minimum standard. In some cases, Cardston Electric Utility may request drawings and designs that exceed those minimum standards.

**Fortis Alberta:**

- Throughout this document, references are made to "Fortis Alberta" structure numbers and material item numbers. These references are used to simplify the purchasing of equipment since most suppliers in Southern Alberta use these numbers in their part numbering system. Although Cardston Electric Utility has its own set of standards and material item numbers, this documentation is designed to provide a common utility standard for designers and contractors to use. Structure drawings must be reviewed closely to ensure the structure dimensions and materials are followed accurately.

**Loop Feeds**:

- The norm for all URD designs within the Town of Cardston is to incorporate loop feed systems where possible; however, the construction of the loop may be delayed until future land developments take place. Construction drawings that do not incorporate loop feed systems in the initial stage of a subdivision must be accompanied with future development plans that show how the loop will ultimately be obtained and a timeline for the future development. It will be at the discretion of Cardston Electric Utility whether the radial feed will be an acceptable risk till the loop is established.

**Phase Loading:**

- For subdivisions where the loading per phase will exceed 100 kVA, a second or third phase may be required to maintain load balance on the system as a whole. If the overall plan of the subdivision requires that 3 phases be installed, an alternative to a loop feed may be the use of additional cables as a temporary loop feed. In this case, careful regard to phase labeling must occur when the system is returned to a normal state. All single line drawings must then show initial stage drawings (to be used by field staff for present day switching) and finished state drawings for final approvals.

**Primary Splices:**

- Primary splicing of cables should be avoided during initial installation; however, if a primary splice is required it must be completed by competent staff using standard materials as shown in the attached drawings. It will be at the discretion of Cardston Electric Utility operating staff to allow such splicing, determine where they are placed and how they will be marked for future location. All splices must be marked on the "as built" drawings and highlighted in such a way as to be easily detected.

**Temporary Cable Loops:**

- Temporary cable loops may be required for future expansion of the proposed subdivision. These loops shall be protected by a cement structure (transformer base) that is totally enclosed so that no access is available to the general public. The transformer hole must be covered with a steel plate of adequate strength and properly secured to the base so that it is not easily removed.

**Bare land Developments:**

- Distribution systems in "Bare land Developments" differ from regular subdivision and do not fall into the scope of the URD "turnkey" process described in this document. Contact Cardston Electric Utility for specifications and design requirements for Bare land Development.

**Commercial Services:**

- This document does not address standards for the development of commercial subdivisions. All commercial lots and subdivisions must be dealt with on an individual basis and not as part of this "turnkey" process.

**Facility Maps:**

- The facility maps provided to Cardston Electric Utility for review must indicate alignments of all power cables and/or trenches in relation to property lines and must be of a scale to provide the information in a legible and readable format. Congested areas and detail information must be provided as a blow up to assist in the legibility of the print. Individual primary and secondary cable runs must be shown on the plan, including all secondary service drop boxes, in a diagrammatic fashion, identifying in symbol form the type and quantity of each power cable used. The location of all primary and secondary road crossings must be shown in relation to property lines and/or FIP (Found Iron Pin) on both sides of the roadway.
- The facility maps must also show locations of all padmounted transformers, switching cubicles, street lights, ducts, caps and proposed primary splices. All other shallow utilities must be noted on the facility maps. Utility Right-of-Way (URW) cross-sections and road crossing cross-sections must all be displayed in detail.
- All driveway locations must also to be shown and the relationship between any transformer, stand-alone pedestal or street light standard, including dimensions showing separation between the facilities and driveways.

**Single Line diagrams:**

- Single line diagrams (SLD) typically depict the primary circuitry and its connection to devices within the electrical system. Normally, exact locating of the devices within the system is not required, but should be shown in general relationship to lots and areas for ease of reading. Normally the scale should 1:1500 metric or greater.
- Single phase primary circuits of a common phase in the same trench must be separated on the SLD. Three phase primary circuits in the same trench must clearly indicate the phase feeding single phase transformers.

- All padmount transformers must be shown on the SLD and must include the kVA ratings, secondary voltages and phase indication. Any "parked" or "parked and grounded" bushings must be shown.

**Sand Backfill:**

- Should there be any sharp rocks in the trench or in the backfill material; a minimum of 200mm of sand will be required both below and above the cables. Trench depth should be adjusted to cater to the additional depth of sand. Conductor depth must remain at 1M.
- All sand required must be provided by the Developer and must be free of clay, rocks, and organic materials. All sand must meet the following requirements:
- 100% must pass through the 25mm sieve.
- 95% must pass through the 5mm sieve.
- Maximum of 10% must pass through the 80- micrometer sieve.
- No more than 25% moisture content
- Plasticity index cannot exceed 6%.

**Backfill requirements for Frozen Ground Conditions:**

- To prevent spring time "slough-in", frozen material particularly large lumps must not be used for back fill purposes. Additional sand back fill and only smaller or unfrozen back fill material should be utilized. All additional materials must be hauled away from the job site after confirming with Cardston Electric Utility inspector if materials can be used and where to haul excess. Any slumping of the trench line will ultimately be the responsibility of the developer and therefore should be handled properly from the outset.

**Road Crossings:**

- Road crossings must be a maximum of 2.5M below finished grade with the highest duct at a minimum of 1.2M below final grade. Road crossing ducts must extend a minimum of 300mm behind curb or sidewalk in the case of monolithic curb and sidewalk.
- Road crossings alignments are to be off-set by a minimum of 1.5M from secondary pedestals and a minimum of 2.0M from the center line of padmount transformer bases. Since in most cases transformer bases and secondary pedestals are placed on lot lines an off-set of 2.0M is required to lot lines.
- If road crossing ducts are installed prior to completion of road then the material above should be maintained at required compaction levels. If however ducts are installed after the road is complete all fill must be compacted to 100% of that of the road material.

**Outside Approvals:**

- All crossings, including crossing of other utilities must meet appropriate AEUC or CSA criteria and approvals must be obtained from the appropriate utilities or pipeline companies. These approvals must accompany the final "To Construction" prints submitted to Cardston Electric Utility prior to on-site meeting.
- Approval from the other utilities included in the trench must also accompany these drawings, as well as their drawing proposals for the proposed subdivision.

**Excavation:**

- The Developer or his contractor will be responsible for all locates within the proposed subdivision prior to beginning excavation.

- Excavation outside of surveyed alignments or changes to grade elevations will not be allowed without written approval of the Developer's Engineer and Cardston Electric Utility inspector.
- No excavation shall occur within 3M of any energized or possibly energized equipment, stub outs or loops left for future taps without Cardston Electric Utility inspector being on site and supervising digging. Exposure of energized cable must utilize safe dig methods, proper hand exposure, hydrovac or other methods approved by Cardston Electric Utility inspector. Construction clearances and safe work clearances cannot be compromised at any time.
- Existing ducts and other utility facilities must be supported and/or moved according to the facility owner's standard of practices.

# 2. Cable Standards

**Cable Standards (Primary):**

The standard primary cable for circuits within a subdivision shall be single-phase, 14.4kV (nominal) primary, or three-phase, 25kV (nominal) primary, looped circuits through a development area. 25kV TRXLPE insulated cable, with bare copper concentric neutral and LLDPE neutral encapsulated jacket suitable for direct burial.

  - #1 AWG Aluminum cable (1/c) ( Fortis # 534-4103)

- Feeders can be loaded to a maximum of 1,771kVA single phase. Or 5,313kVA three phase (limited by cable ratings. However due to de-rating of elbows and cables in conduit, it is suggested that no more than 500 kVA be designed on each conductor. System balance must be a consideration at all times and any loading unbalance of more than 100kVA/phase should not be considered.
- No more than ten (10) single-phase transformers should be connected in series on a single- phase looped circuit.
- Should loading exceed the limits described above, contact Cardston Electric Utility for further information on larger wire sizes and standards to be used.

**Cable Standards (Secondary):**

- Cable used for secondary distribution systems within subdivisions shall be 2 conductor, compact stranded aluminum, 600V XLPE insulated cable, type USEB90, with jacketed bare copper concentric neutral.
  - 1/c - #4 AWG, 1000V, RW90 Cable ( for Street lighting)
  - 2/c – 1/0 AWG, 600V USEB90 (Fortis # 534-0104)
  - 2/c – 4/0 AWG, 600V USEB90 (Fortis # 534-0108)
  - 2/c – 300kcmil, 600V USEB90 (Fortis # 534-0109)
- #1/0 AWG is the norm for 100amp services. Should the load be larger than that (i.e. 200 amp) or if voltage drop cannot be maintained, #4/0 or larger may be used. The maximum voltage drop permitted is 5% (3% being cable losses and the remaining 2% allowed for customer system losses). #4/0 and

300kcmil is also used between the transformer and the pedestal depending on number and size of services fed from each pedestal.

**Single Power Pedestal:**

- Due to size limitations, the average number of services that may be fed from a single compartment or middle ( power ) section of licensed occupant pedestals is:
  - 8 runs of 1/0 AWG
  - 6 runs of 4/0 AWG
  - 4 runs of 300 kcmil

**Three Compartment Power Pedestal:**

- Three compartment power pedestals, where all three compartments are used for power distribution, allow for greater numbers of connections. The above number of runs applies to the center compartment but typically only 6 runs per side compartment are allowed.
  - Twenty (20) runs of #1/0 AWG cable (i.e., maximum of six (6) runs in each side compartment, and a maximum of eight (8) runs in the center compartment)
  - Fourteen (14) runs of 4/0 cable (i.e., a maximum of four (4) runs in each side compartment, and a maximum of six (6) runs in the center compartment, or
  - Ten (10) runs of 300 kcmil cable (i.e., a maximum of three (3) runs in each side compartment, and a maximum of four (4) runs in the center compartment. NOTE: The dimension of the middle compartment is bigger than the side compartments.
- The maximum allowable total count of secondary cables in a single compartment secondary pedestal is nine (9).
- Pedestals should be used whenever 2 or more services must be fed from a transformer.
- Streetlight circuits may be connected in the pedestal in addition to the specified limits above
- Two methods are used for service connections within Cardston Electric Utility. Secondary splices should be avoided.
  - Where the lots are small and customer service leads are short enough to be rolled up and contained within the standard wooden service box, they shall be designed using this method. All services that are to be contained within the service box shall be of sufficient length to be able to reach the customer's meter without splice. Generally 75% of the length of the lot is considered sufficient.
  - Where the lots are too large for the above method to be used, or determination of the load on each of the lots requires large conductors that cannot be practically rolled up and contained within the standard service box, a pedestal shall be provided for every 2 lots and the customer will be required to bring their service leads to the pedestal with sufficient length to be brought directly to the terminations contained within the pedestal.

**Residential Service Entrance Cable Sizes:**

- For new underground 240/120V residential service installations, the following minimum cable sizes (or larger) shall be used for utility-owned portions of cable.
- If the voltage drop does not allow for the use of the specified minimum cable size the next larger standard cable size shall be used.

**Table 1 – Minimum Cable Sizes for New Residential Services**

| Service Panel Size | Minimum Cable Size in Conduit | Minimum Cable Size Direct Buried |
|---|---|---|
| ≤ 125 Amp | 1/0 Aluminum USEB (137 Amps) | 1/0 Aluminum USEB (208 Amps) |
| 200 Amp | 4/0 Aluminum USEB (209 Amps) | 4/0 Aluminum USEB (314 Amps) |
| 225 Amp<br>300 Amp | 300 kcmil AL USEB (260 Amps) or<br>2×4/0 AL USEB (314 Amps) | 4/0 Aluminum USEB (314 Amps) |
| 400 Amp | 2×4/0 AL USEB (314 Amps) | 2×4/0 AL USEB (440 Amps) |

**Diversity Factors:**

- If multiple residences are served by the same transformer or secondary cable, the following diversity factors shall be used to adjust the expected peak loading. This accounts for the probability of residential loads using load simultaneously.

Example: Four houses, each 1700 sq. foot and 200 amp panels. Total load on cable segment is 12 kVA × 4 units ÷ 1.5 (Diversity Factor) = 32 kVA.

**Table 2 – Diversity Factors**

| # of Services | Diversity | # of Services | Diversity |
|---|---|---|---|
| 1 | 1 | 11 | 2.2 |
| 2 | 1.2 | 12 | 2.2 |
| 3 | 1.3 | 13 | 2.3 |
| 4 | 1.5 | 14 | 2.4 |
| 5 | 1.7 | 15 | 2.5 |
| 6 | 1.8 | 16 | 2.5 |
| 7 | 1.9 | 17-20 | 2.6 |
| 8 | 2.0 | 21-23 | 2.7 |
| 9 | 2.1 | 24-29 | 2.8 |
| 10 | 2.1 | 30 + | 2.85 |

**Standard Cable Alignments and Burial Depths:**

- All utility cables are to be installed in 3 party licensed occupant trenches as shown in the attached drawings. All primary, secondary and street light power cables are to be installed in the alignment closest to the property, with the primary cable closest to the property, telephone in the center and cable TV furthest from the property.
- Future subdivisions may include a 4 party trench and should 4 party trench alignments be required contact CNP for the appropriate trench and layout drawing. Gas requires a minimum of 1M horizontal

clearance to primary, except in the case of a 4 party trench, which has separation maintained through horizontal and vertical separation.

- Standard burial depths within Cardston shall be 1.0M as a minimum and 1.2M as the maximum. If soil conditions require sand backfill below and above the primary cable, depths of the trench should be adjusted to maintain 1.2M burial depth of the cable.
- Road crossing depths should be maintained at 1.5M for additional protection of facilities. All earthwork within the URW should be completed prior to installation of shallow services to maintain proper burial depths.
- In front street construction, the centerline of the main trench will typically be located 1.2m on road or 1.2m on URW for 3-Party construction, and 2.0m on URW for 4-Party construction.
- Although not normally used, rear lane distribution alignment shall be 1.2M on lane. Distribution installed within a laneway may require that all utilities be installed in duct. Confirm with Cardston Electric Utility as to requirements for any rear lane installations.
- All primary and secondary cables in the lane are to be installed in duct when crossing lanes or where the lane is to be paved.
- Although the crossing of utilities may not be totally avoidable, crossing points can create undue pressures upon insulation, increase the difficulty of repair and should be avoided whenever possible.
- To prevent damage to other utilities such as water and sewer systems, a minimum of 1.0M should be maintained from any valves, hydrants, catch basins, manholes, vaults, and sanitary and storm sewer lines. If this minimum cannot be maintained pre-approval must be obtained from Cardston Electric Utility.

Street lighting cables must maintain the minimum separations as listed in Table 3

**Table 3: Minimum separations from streetlight cables**

| Minimum separation from street light cable alignment | |
|---|---|
| Streetlight base | 0.5M |
| Curbs and sidewalks | 0.5M |
| Fire hydrants | 1.0M |
| TELUS pedestal | 1.0M |
| Other above ground facilities | 1.0M |
| Property pin | 1.2M |

Streetlight bases must maintain the minimum separations as listed in Table 4

**Table 4: Minimum separations from streetlight base**

| Minimum separation from street light base | |
|---|---|
| Cable alignment | 0.5M |
| Curbs and sidewalks | 0.5M |
| Fire hydrants | 1.0M |
| TELUS pedestal | 1.0M |
| Other above ground facilities | 1.0M |
| Property pin | 1.2M |
| Roadway without curbs or sidewalks | 3.0M |
| Underground high voltage line | 0.5M |
| Driveways | 1.0M |

# 3. Padmount transformers

**Padmount Transformers and Pedestals:**

- Padmount transformers for the purposes of this document will generally be single-phase, 14.4kV – 120/240V (nominal) rated primary and secondary, loop-feed transformers, and three-phase, 25kV – 120/208V (nominal) rated primary and secondary, radial-feed and loop-feed transformers.
- Secondary junction boxes or secondary pedestals are required whenever two (2) or more services are fed from a padmount transformer.

**NOTE:** the circuit and equipment identification and tagging requirements both on the engineering drawings and on the cables and equipment installed must match, be accurate, and be in accordance with the installation requirements Padmount Transformers and Secondary Junction Boxes and Pedestals.

**Transformer and Pedestal Locations:**

- Padmount transformers are to be mounted on pre-cast concrete bases, located at intersecting lot lines, and coordinated with other facilities and/or utilities located on the street, as per the typical front street and rear lane layouts and locations outlined in the 1200 Drawing Series.
- Changes or deviations to the typical alignments and location of padmount transformers and/or any of their associated equipment must be identified by the Developer's Consultant and Accepted by Cardston Electric Utility prior to finalizing the design.
- Padmount transformers are not to be set closer to a corner lesser than six (6) m to maintain a clear sightline at the intersection.
- Padmount transformers must have a minimum side and rear clearance of 1.5 m to fences, walls and buildings.
- A pressure treated 2" x 8" planking shall be installed in the gravel bed and shall be used for leveling the padmount transformer pre-cast concrete base.

- Guard posts are not intended for use along residential driveways where traffic is light. Consequently, transformers and pedestals shall have a 1.0 m minimum separation from driveways. Generally, transformers and pedestals should be designed and installed on the non-driveway side of the property.
- Utility right of ways required for padmount transformers and secondary pedestals shall be in accordance with the Utility Right of Way Guidelines.
- Padmount transformers are not to be placed in pie-shaped lots with frontages less than 8m to avoid driveway conflicts.
- The padmount transformer shall have a 4m operating clearance in front and 1m working clearance along its sides and back.
- The slope or grade on which the transformer base sits and the 4.0 m operating area in front of the padmount transformer's access lid must be less than 9.5° or less than a six (6) to one (1) slope (i.e., 1 m rise in 6 m run).
- The doors of underground equipment (i.e. transformers and switching cubicles) should always be oriented in the direction which provides four (4) meters of clear working area from the door for equipment operation.
- Joint-use pedestals (structure numbers 1231-2, 1231-5) are to be attached to the back of padmount transformers. Stand-alone pedestals (structure numbers 1231-1, 1231-3, 1231-8 and 1231-9) and other utility pedestals must be installed parallel to the road at a minimum distance of 1 m from the padmount transformer. A rear mounted pedestal and side mounted secondary junction boxes on the same padmount transformer is allowed. The proposed design detail must indicate the direction as to where the side boxes will face.

**NOTE:** bonding must be provided between all above ground metallic power and communication equipment (pedestals, padmount transformer and switching cubicle cases, etc.) that are separated by 3.0 m or less.

**NOTE:** the Developer is responsible for all costs of relocating padmount transformers and/or any of their associated equipment if conflicts with other facilities arise (i.e., due to driveway changes, lot changes) after installation until the end of the Warranty period.

**Guard posts (Bollards):**

- Guard posts must be installed on all sides of a transformer or cubicle if it is located in an area exposed to vehicle or maintenance traffic (i.e., snowplows or loaders) and is at risk of incurring damage.
- To avoid possible damage to the ground grid the guard posts should be installed before or at the same time as the ground grid.
- Guard posts must be bonded to the ground grid using #4 Cu for single phase or switching cubicles, and #2/0 Cu for three phase installations.
- If there is a secondary pedestal attached to the equipment/transformer pad, the guard post and ground grid should be extended in such a way as to protect the peripheral equipment also.
- Guard post encasement is to be compacted all around with suitable back fill or gravel.
- The guard posts are to be located 0.25 m diagonally from the outside corner edges of the facility, and refer to the An alternative to guard posts may include curbs, retaining walls, blocks, pocket easements, etc. as approved by Town of Cardston.
- Excavation for transformer or switching cubicle bases must be large enough to fit the pad and associated grounding system external to the pad. The soil below the pad must compacted and leveled sufficiently

to maintain the transformer base level and top of base 100mm (notches on corners of base normally indicate ground level) above finished grade. Sand and 2" X 8"planking will be required to assist in the leveling and maintenance of proper base levels.

- Normal cable laying procedures require that 2 loops of primary cable be left within the base, this is to accommodate possible burn offs and assist in the proper alignment of the cable and elbow with the insert busing.
- Primary cable loops are laid in a clockwise direction. At least one loop of secondary cable should be left with the base, secondary cable loops are laid in a counter-clockwise direction.
- Secondary cable should be on the bottom and the primary coils laid on top. (Likelihood of a primary burn off is much greater than a secondary.)
- Once the transformer has been set on the base and properly secured to the base, all ground, primary and secondary connections may be completed. Be sure that load-break elbows and inserts are used in the primary connections.
- All high-voltage terminations within the transformer must be connected to the grounding buss with #12 copper ground wire from the ground tab of each load-break elbow and insert. The primary cable must have fault indicators installed on the H1 cable at each location. Appropriate identification tags must be installed on the primary, secondary and the transformer itself (Switch numbers etc.)

**NOTE:** Until the takeover of the system by Cardston Electric Utility the contractor will be required to install padlocks at each transformer and switching cubicle location to prevent unauthorized entry. All pad mounted transformers and switching cubicles used within the subdivision must meet Cardston Electric Utility standards as well as all AEUC requirements.

**Residential Customer Loading Guidelines:**

- Design criteria that shall be used for the design of the secondary services shall be based on the following estimated load factors.
- Residential loading can vary substantially between customers. Use Table 5 to determine the expected loading for new residential services.
- The residence types listed in Table 5 are generalized, and do not account for certain types of large-draw electrical loads.
- Table 5 is categorized into house size which is the best indicator to understand the expected electrical load for each residence type.
- Where square footage is referenced, this generally refers to developed living space (i.e., a second floor is included but typically not garages nor basements).
- If the residence type is unknown (often because it is a bare lot), Annex A shall be used as a guide to help approximate the expected residential type on a lot.
- Table 5 has blanks where either 100 or 200 amp panels are very unlikely to be used for specific residence types. Contact your Cardston Electric Utility Inspector if this rare case occurs for loading values.
- Loads used when performing secondary voltage drop calculations are larger than when sizing individual transformers. The load increase helps account for the statistical probability that high load users may live the farthest away from the transformer, so that voltage drop remains within limits. Since upgrading secondary cable or redesigning pedestal locations can be expensive and disruptive to customers after initial construction, this is done to help reduce the risk of this occurring.

- Regarding residences built with 300 or 400 amp panels, trends on electrical usage are not as well established as with 100 and 200 amp services. For 300 amp and 400 amp panels, the loads are more specialized and require consultation with the home owner electrician.

**Table 5 – Residential Loads for New Design**

| **Residence Type** (heated by natural gas) (0.9 PF Used) | 100 Amp Panel** | | 200 Amp Panel | |
|---|---|---|---|---|
| | Minimum for Transformer Sizing | Secondary Cable Sizing, Voltage Drop | Minimum for Transformer Sizing | Secondary Cable Sizing, Voltage Drop |
| Apartment, Small Condo(typically 60 - 80 amp panel) | 4.5 kVA | 5.5 kVA | - | - |
| Townhouse, Row Housing One Part of Multi-Unit Dwelling (e.g., fourplex) | 5.5 kVA | 7.0 kVA | 8.0 kVA | 10.0 kVA |
| House (< 1500 sq. ft) (gas-heated) | 6.5 kVA | 8.0 kVA | 9.0 kVA | 11.0 kVA |
| House (1500-1999 sq. ft) or Half of a Duplex | 7.5 kVA | 8.5 kVA | 10.0 kVA | 12.0 kVA |

**Table 6**

**Residential Load Adjustment Factors**

| **Residence Type** (heated by natural gas) (0.9 PF Used) | 100 Amp Panel** | | 200 Amp Panel | |
|---|---|---|---|---|
| | Minimum for Transformer Sizing | Secondary Cable Sizing, Voltage Drop | Minimum for Transformer Sizing | Secondary Cable Sizing, Voltage Drop |
| House (2000-2499 sq.ft) | (8.0 kVA)* | (9.0 kVA)* | 10.5 kVA | 12.5 kVA |
| House(2500-2999 sq.ft) | (9.0 kVA)* | (9.5 kVA)* | 11.5 kVA | 13.5 kVA |
| House (3000-3999 sq.ft) | - | - | 13.0 kVA | 15.0 kVA |
| House (4000-4999 sq.ft) | - | - | 14.5 kVA | 17.5 kVA |
| * For residences with a square footage above 2000 square feet, the likelihood of a 100 amp panel being used for new construction diminishes rapidly. Cardston Electric Utility will not accept these in new designs unless a load calculation sheet for the planned home is provided to prove a 100 amp panel will be adequate | | | | |

| |
|---|
| * If the service is fed by 4/0 USEB cable, this column can still be used with a larger panel size as long as the main breaker size does not exceed 125 amps. |

| Type of Load Addition to Residence | New Residence – Additions Over Base Assumption Values |
|---|---|
| Central Air Conditioning (*Summer Only)* | Averaged in base assumptions |
| Electrical Vehicle(s)<br>** 7 kVA is the typical expected load addition if unknown* | Charger dependent:<br>Level 1 (120V): +2 kVA<br>Level 2 (240V), 32-amp: +5 kVA<br>Level 2 (240V, 40-amp: +7 kVA<br>Level 2 (240V), 50-amp: +10 kVA<br>Level 2 (240V), 80-amp: +17 kVA |
| Hot Tub | Averaged in base assumptions |
| Separate In-Law / Basement Suite | + 1.5 kVA per 1000 square feet |
| Electric Tankless Hot Water Heater (240V) | + 15 kVA or as specified by electrician |

Table 5 and Table 6 shall be used to determine load requirements for lots which will be used to size transformers and calculate volt drop. The Developer or Consultant shall choose which values are applicable to the development based on anticipated square footage of homes, lot size, or homes in previous stages

Example: 2300 sq. ft house, 200-amp panel, with planned Level 2 32-amp EV charger

- Transformer sizing: 10.5 kVA + 5 kVA (EV) = 15.5 kVA
- Secondary Cable / Voltage Drop: 12.5 kVA + 5 kVA (EV) = 17.5 kVA

**Transformer Sizing Guidelines:**

- Transformer size and number of services off a transformer shall be determined by using the "Residential Loading" tab of the Voltage Drop tool.
- The design size of new transformers serving multiple residential transformers are limited to approximately 70% of the rated load. This is done to promote efficiency as this allows for creepage in load growth over the decades of a transformer's lifecycle (i.e., 30-50+ years).
- The maximum size of transformer allowed for new design is 100 kVA. 167 kVA transformers are not recommended for new design. If a 100 kVA transformer is overloaded in the future it can be changed out for a 167 kVA unit (no sizes larger than this).
- The number of services allowed on a Transformer depends on these factors:
  - Transformer size

- Mix of 100 Amp and 200 Amp panels
- Mix of residence types (i.e., square footage)
- Mix of load additions from Table 6 for specific houses
- Diversity Factor

**Transformer Grounding:**

- The Developer's Consultant and Contractors are responsible, as part of the overall installation of the underground electrical distribution system, to complete the design, installation and interconnection of ground facilities at each padmount transformer location, appropriate for the transformer being installed, as per the standards drawings on Grounding.
- All conductive aboveground facilities (i.e., metal guard posts or bollards, stand-alone CATV & TELUS pedestals, Third Party facilities, metering pedestals) within 3.0 m of a padmount transformer must be tied into the transformer's ground grid.
- Prior to completion of any Work at each padmount transformer base, the grounding installation must be inspected and accepted by Cardston Electric Utility staff. The entire installation must comply with all governing standards for each structure. The ground grid's impedance must also be tested and recorded as meeting AEUC [A1] code requirements.

**Switching Cubicles:**

- Switching cubicles for the purposes of this document will generally be single-phase, 25kV (nominal), dead-front, and three-phase, 25kV (nominal), live-front and dead-front switching cubicles.
- The Developer and Consulting Engineer are responsible, as part of the overall installation of the underground electrical distribution system, to complete the design and installation of switching cubicles, where required, to accommodate any permanent and/or temporary distribution system requirements for primary feeder sectionalizing, looping, alternate feeds, supplying three-phase loads, provide for staged developments, etc. at the initial design stage, and provide any required switching cubicles, or system provisions for future developments (i.e., additional feeders, ducts) as deemed necessary by Cardston Electric Utility for the safe and efficient operation of the entire underground distribution system. The switching cubicles provided must be of the appropriate configuration system ratings.

**NOTE: T**he circuit and equipment identification and tagging requirements both on the engineering drawings and on the cables and equipment installed must match, be accurate.

**Switching Cubicle Locations:**

- Switching cubicles are to be mounted on pre-cast bases, because of their size. However special attention must be taken with the location and placement thereof to ensure that sufficient space exists (i.e., within URW's, Municipal reserves, utility right of ways, and to roads, driveways, buildings) to accommodate the installation and operation, and coordination with other facilities and/or utilities located on the street.
- For maintenance and operating reasons and personnel safety, switching cubicles must be located such that, a clear area of four (4) meters in front of the cubicle doors and a clear area of 1.5m at the side of the cubicle, are provided. Some equipment has operating handles, metering or other control devices. In such cases, a bigger clear area is required to accommodate the needed working space.
- Along major roadways, the cubicle's doors must be positioned ninety degrees (90°) away from the roadway.

**NOTE:** A larger URW is required for switching cubicle with a gradient control for an earth return system and should be confirmed with the Town of Cardston Electric Utility Department.

- A pressure treated 2" x 8" planking shall be installed in the gravel bed and shall be used for leveling the switching cubicle pre-cast concrete base.
- The slope or grade on which the cubicle base sits and the four (4) meters operating area in front of the cubicle's doors must be less than 9.5° or less than a six (6) to one (1) slope (i.e., 1 m rise in 6 m run). Refer to the details in drawing "Placement of Equipment – Drawing #1303
- Changes or deviations to the typical alignments and location of switching cubicles and/or any of their associated equipment must be identified by the Developer's Consultant and accepted by Town of Cardston Electrical Department prior to finalizing the design.
- Switching cubicle bases must not be set in sidewalks and are to maintain a minimum 3.0 m side clearance to bus stop pads, curb cuts, and all other street furniture.
- Single-phase switching cubicles are not to be placed in an alley where vehicular traffic is present. Instead, switching cubicles are to be placed on property in a pocket utility rights of way with a minimum setback of 0.6 m from the lane (i.e., from the front edge of the equipment to property line).
- Switching cubicles on utility rights of way must not straddle or be centered on lot lines.
- Three Phase switching cubicles are not to be placed in lanes as all equipment must also be designed and installed to open into the lane.

**NOTE:** To qualify as a lane, the roadway area must be permanently open to vehicle traffic. Where possible, switching cubicles should not be placed within the vicinity of school grounds or playgrounds.

**Cubicle Grounding:**

- The Developer's Consultant and Contractor are responsible to complete the design, installation and interconnection of ground facilities at each switching cubicle location, appropriate for the cubicle being installed.
- All conductive aboveground facilities (i.e., metal guard posts or bollards, stand-alone CATV & TELUS pedestals, Third Party facilities, metering pedestals, etc.) within 3.0 m of a switching cubicle must be tied into the cubicle's ground grid.
- Prior to completion of any Work at each switching cubicle base, the grounding installation must be inspected and Accepted by Cardston Electric utility. The entire installation must comply with all governing standards for each structure. The ground grid's impedance must also be tested and recorded as meeting AEUC [A1] code requirements.

**Primary Fusing:**

- The Cardston Electric Utility will complete the primary fuse coordination and will supply the required on-site fuse units at the Developer's cost.

**Metering and Secondary Demarcation:**

- All customer secondary connections and metering installations must be designed and constructed in accordance with the Canadian Electrical Code (CEC) – Part 1 [A2], and Town of Cardston Service and Metering Guide.

- Normally, in UEDS subdivisions the secondary ownership demarcation point for single family or duplex family lots and dwellings will be the line side of the meter base.
- For commercial services or multi-unit lots where the secondary cables are installed on private property or common property, the demarcation point will be at the secondary bushings of the padmount transformer for dedicated transformers. Secondary cables on the load side of the meter are always customer owned.
- There may be loads throughout the subdivision other than the residential and commercial lots and building being serviced that require metering (i.e., customer owned streetlights, Municipal reserves, irrigation services, etc.). The Developer's Consultant is responsible to identify all such loads, proposed servicing, and metering, prior to finalizing the design. Cardston Electric Utility will review the loads, the specifics of the situation, and specify the metering requirements that the Developer's Consultant will have to adhere to.
- Where metering pedestals or stand-alone enclosures are required, the metering point will typically be located as follows:
  - within 1.5 meters at or adjacent to the padmount transformer locations for individual services for customer owned secondary cables and/or systems; and
  - at or nearest the location where the secondary power cables cross from the URW into the lots or areas being served for Cardston Electric Utility owned secondary cables.
- As each metering situation above may differ, the final decision as to the metering requirements and location is at Cardston Electric Utility discretion.
- The metering pedestals or enclosures must be equipped with a disconnect switch and meet the requirements of the appropriate CSA Standards [A2] [A3].

# 4. Developer Installation Responsibilities

- All work performed by a contractor for the Developer must remain current on Cardston Electric Utility, AECU and CSA Standards.
- Proper excavation and backfill of materials from trench as per directives above.
- Proper installation of primary high voltage cables.
- Proper installation of secondary cables, service stub-offs and street light cables.
- Termination of primary cables within equipment installed within subdivision, such as transformers, Switching Cubicles.
- Termination of all secondary cables between transformer and pedestal.
- Proper marking and labeling of all service lead cables terminated in pedestal including the service address for each cable and installed in such a way that they cannot be easily removed.
- Proper care and handling of all primary and secondary cables must be adhered to at all times, bending radius of primary and secondary cables must be exceeded. Dragging of cables in such a way that the outside jacket is damaged or exceedingly scuffed will be permitted. Cables that are excessively scuffed may have to be replaced at the discretion of Cardston Electric Utility inspector.
- Care must be used in stripping insulation off primary cable, if solid core is scored it could break off during installation of terminations.
- Care must be used when creating coil loops with primary cables. Excessive twisting of cable will cause a breakdown of the insulation. The stripe on the cable must not turn more than ¼ of turn from a straight line.

- Contractors will not be allowed to work on any energized cable, any splices or work inside of energized equipment or riser structures.

**Site Preparation:**

Generally, the sequence of activities for preparation of the site for construction will be as follows:

- Rough grading along all required alignments and URW's.
- Location staking for all bases for padmount transformers and switching cubicles, secondary pedestals and street lights.
- Grade staking for all bases for padmount transformers and cubicles, secondary pedestals and street lights.
- Alignment staking for all power cable trenching, as well as grade levels.
- Staking of all secondary service lead drop boxes.
- All property corners are to be staked.

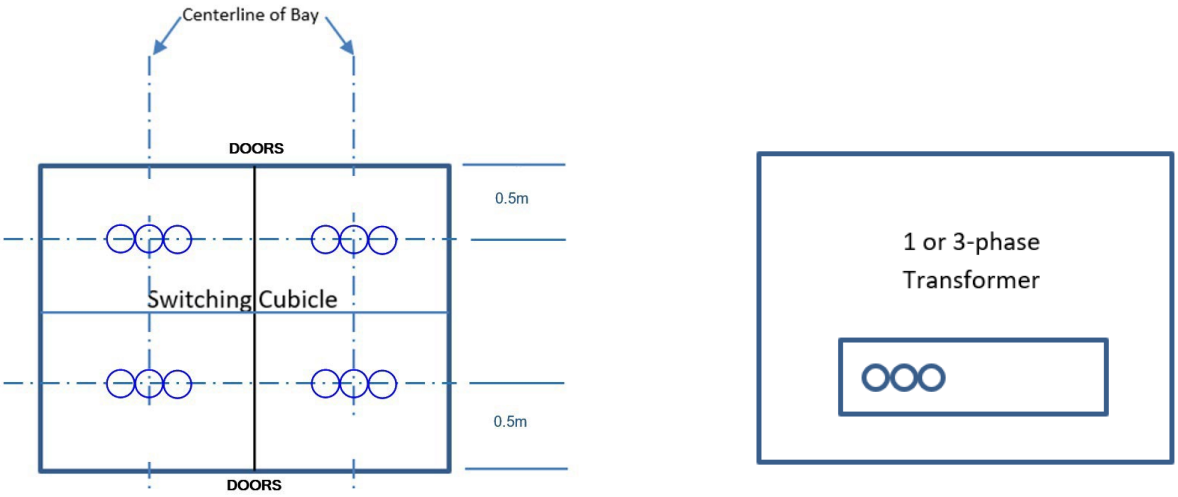
**Ducts:**

- Primary, secondary, service and streetlight cables are to be installed in ducts for the following installations:
  - Road crossings, Lanes
  - Parking lots or paved vehicle access areas
  - Commercial driveways; and
  - Side lots, where facilities are on easement
- Primary, secondary, service, and street lighting cables or systems are each to be installed in separate ducts. For further clarity, there shall be one primary system (i.e. 3-phase or 1-phase) per duct; one secondary cable per duct; one service cable per duct; or one street lighting cable per duct.
- Where primary, secondary, service or street lighting cables are to be installed in ducts, the following requirements shall be followed:
  - Pull calculations are to be completed and shall pass the cable pulling requirements for each section of cable installation.
- 3-phase (XYZ) lateral distribution feeders (i.e. #1 Al) are to be installed in a single duct (i.e. 1 – 4-inch).
- 3-phase (XYZ) main distribution feeders are to be installed in a single duct (i.e. 1 - 6-inch) or individual separate ducts (3 – 4-inch), as required.
- The "in" (1X) and "out" (2X) feed of a single-phase transformer are each to be installed in separate ducts when placed in the same trench.
- Where 3-phase (XYZ) and 1-phase (X) systems are placed in the same trench, each system is to be installed in separate ducts.
- The minimum duct size for use in primary cable installations shall be 102 mm (4 inches).
- The minimum duct size for use in secondary, service, or street lighting cable installations shall be 2 inches.
- For open-trench road crossings, one (1) additional future duct, of size that is the same as the size of the biggest duct in the trench, shall be installed along the same alignment, capped, and with a 7mm pulling line installed.

**NOTE:** Future ducts are to be identified with the quantity and construction text (i.e. "1-Future

Duct") on the facility maps.

- The pulling line should have the necessary tensile strength while not stretching or rotating, and it must not burn the duct. Use a synthetic rope. **Do not use** twine, nylon, or polypropylene pulling lines – these will burn the duct.
- The Developer's Consultant, Cardston Electric Utility may determine and specify the need for additional future duct installation in consideration of future extensions, future servicing and future developments. Where any of such requirements are identified during the design and construction stage, one future duct of size that is the same as the size of the biggest duct in the trench are to be installed accordingly Duct installations should include a 7mm pull rope.
- The integrity of the duct installation (i.e. Rigid PVC, DB2 PVC, HDPE) shall be checked by using an appropriately sized test mandrel or slug. The test mandrel or slug shall also be used to remove any debris in the conduit that may have settled inside during the installation and to spread lubricant into the duct system.
- Where cable pull tensions exceeds 750lbs, all horizontal sweeps (or horizontal bends) and all elbows (whether installed horizontally or vertically), shall be concrete encased with a minimum of 76mm throughout the bending radius of the duct. Ducts encased in concrete shall be separated from each other by at least 25 mm of concrete. The concrete mixture shall have a compressive strength of 17.2 MPa (2500 psi).
- 90-degree elbow ducts are to be installed under the equipment (i.e. transformers, pull box, switching cubicle), straight up, cut-off at 100mm (4") above the bottom of the base, and install a bell at the end of
  the duct, where practical. Provisions should be provided to protect the duct upon the installation of the cable when entering/exiting the duct system.
- For switching cubicles, ducts are to be installed 500 mm from the front wall and within the center of the bay.




For 1-phase and 3-phase transformers, ducts are to be installed within the half-left side of the base.

**Excavation:**

- The Developer's Contractor is responsible to arrange and ensure that all necessary locates and marking of all underground facilities has been completed prior to commencement of any excavation of the proposed Work within the development area.
- No deviation will be allowed during construction from the surveyed alignments or grade levels except with the written approval of the Developer's Consulting Engineer, and where significant alignment or grade changes are necessary.

**NOTE:** No trenching is to occur within 3.0 m of an existing energized padmount transformer, switching cubicle, or stub out, without an authorization from the local FortisAlberta Area Coordinator. The Developer's Contractor and the FortisAlberta Area Coordinator will determine or verify during the start-up meeting the distance the Contractor must maintain from the energized facility, coordination and method of excavation that will be required (i.e., hydrovac, hand) to complete the installation, coiling of the underground power cables, barricading of open trench, etc., to ensure that the required construction clearances are not jeopardized.

- The Developer's Contractor is responsible to ensure the temporary support, adequate protection, and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered during the progress of the Work, including all costs associated with this Work, or the costs of others.
- Where the grade or alignment of the trench is obstructed by existing utility structures such as conduits, ducts, pipes, or branch connections to main sewers or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed, by the Developer in cooperation with the owners of such utility structures.

**Cable Requirements:**

- The Developer's Consultant and Contractor must ensure that the top of all underground distribution power cables (i.e., all primary, secondary, and streetlight cables and feeders)

**NOTE:** all underground power cables must be within the burial depth ranges before and after energization (i.e., Cardston Electric Utility may not be able to energize, operate or accept the installation if the cables are not at the proper depths, thus, the importance of all cable alignments being within +/- 150 mm (6 inches) of final grade prior to construction).

- Where required, all burial depths should be planned and installed to avoid future conflict with other utilities, especially secondary service leads which should be at a sufficient depth to accommodate future gas installations.
- Standard trench widths for all underground power cable installation alignments will typically vary from a minimum of 300 mm up to 760 mm as per the following trench details on the UEDS Contractor Portal:
- Standard trench depths and placement of all underground power cable installations are 1.0m to 1.2m for standard trenching (direct buried cable installation) and 1.2m to 1.5m for road crossings (cables installed in ducts).
- Where power cables cross existing third party (i.e. Pipeline, Water, Sewer, etc.) facilities, the placement of cables and ducts may vary based on the existing depths of other facilities.

- The trench bottom must be free of stones and sharp objects. The trench bottom must also be kept level to facilitate laying-in of the underground power cables, and, where there is a change in the contour of the surface, that additional grade stakes are provided for reference, as required.
- For rocky areas, sand bedding of not less than 200 mm may be required below the underground power cables at the Cardston Electric Utility's discretion.

**Padmount Transformers:**

- The Developer's Contractor must excavate a hole large enough to accommodate each padmount transformer base or switching cubicle base and ground grid before the trenching is completed or any underground power cable or ground wire is installed.
- The Contractor must also properly compact the fill to support the base and to ensure proper leveling at each transformer and switching cubicle base location.
- The top of the base must be 150 mm above finished grade.
- After the Developer's Contractor has installed the underground power cables at the base, and the secondary service cables, where applicable, are extended away from the base, the Contractor will install sand over the cables, with a minimum cover of 200 mm and to extend 900 mm away from the base, before backfilling the main trench.
- After the Developer's Contractor has installed the padmount transformer bases or switching cubicle bases, the excavation must be backfilled, and surrounding fill compacted up to 400 mm below final grade.
- The required ground grid must then be installed.
- Grounding and the remaining excavation backfilled and compacted to within +/- 150 mm of final grade.
- No backfill will be allowed inside the padmount transformer bases.
- Proper compacting is required along all sides of all padmount transformer bases and switching cubicle bases.

**Primary Risers:**

- Sufficient lengths of primary cables must be left coiled at the riser structure to be able to reach to the primary overhead lines and losses due to terminations and curving of cables to fit structure requirements.

## 5. Inspection Guidelines and Requirements:

- Cardston Electric Utility inspector will advise the Developer in writing of any errors or deficiencies in the work when the error or deficiency is discovered.

**Trench and Backfill:**

- No backfilling is to be performed until Cardston Electric Utility Inspector has accepted the phase of the project to be backfilled.
- The Developer's Contractor is responsible to maintain the backfilled excavation, dispose of any spoil, and/or replace unacceptable backfill with sand or another acceptable backfill material, throughout the construction period.
- The Contractor is also responsible to compact all ditches, trenches, or other excavations as required to avoid future settlement problems.

- The backfill material will normally be the soil excavated from the ditch or trench, except where poor existing soil conditions are present, and sand or another acceptable backfill material must be substituted when backfilling. Poor existing soils are defined as having large stones, clay that has hardened, ice, snow, frozen lumps, high thermal resistivity (i.e., organic soils, peat, black loam, sod, straw) At no time will backfill containing the poor soils identified be used. All backfill material will be subject to the Acceptance of the Cardston Electric Utility Inspector.
- Backfill must be placed in uniform lifts not exceeding 300 mm of compacted depth per lift. Where clay is used as the backfill material, the moisture content of such clay must not exceed the plastic limit, or more than fifteen percent (15%), when being placed in the trench.
- For rocky areas or where poor soil conditions exist, sand bedding of no less than 200 mm may be required below the underground power cables at the Cardston Electric Utility Inspector.
- The Developer's Contractor must remove all excess earth and backfill material from the top of the concrete bases after backfilling.
- The Developer's Contractor will be fully responsible for any damage or accident to persons and/or property resulting from the condition of the backfilled trench. The Developer's Contractor is also responsible for maintaining the backfilled excavation until all settlement has ceased (i.e. typically one construction season).

**Backfilling Requirements in Frozen Ground Conditions:**

- Due to some potentially very serious incidents and numerous other complaints from various Authorities over the past few years, The Cardston Electric Utility has changed our construction requirements regarding the backfilling of trenches when digging in frozen ground conditions, or when the backfill freezes after excavation and prior to being put back in the trench. The concern is that past backfilling practices when dealing with frozen material have not been diligent enough or stringent enough and have allowed trenches to "slough-in" more than should be, particularly in the spring, creating problems for anyone in the area.
- The main problem is not related just to digging frozen material out of the ground, but also includes the material that was not frozen when excavated, but which has frozen by the time the trench is backfilled. If the soils taken out of the ground have any moisture content, the backfill heaps will freeze quickly. Trying to backfill with frozen lumps back in such a way that there is minimal sloughing in the spring is the problem. Therefore, when trenching is necessary in frozen ground, or if the backfill freezes after excavation, special precautions must be as follows:
  - If the backfill is frozen, the Developer's Contractor must notify the Cardston Electric Utility as to the proposed method of backfill.
  - Cardston Electric Utility will have the final call on the backfill regarding what is required and what is acceptable.
- The Developer's Contractor must supply and place a minimum of 200 mm of stone- free sand fill above and below the underground power cables.
- The Developer's Contractor should arrange spoil piles to maintain the soil in the center of the pile in a non-frozen state.
- All backfill immediately above the top layer of sand must be extracted from below the frozen surface of the backfill heaps. If the Cardston Electric Utility Inspector determines that the native frozen lumps will be utilized on top of the sand, then the frozen lumps must be power compacted. The native backfill must be compacted to within 150 mm of the top of the trench.
- Where possible "berm" the trench line to minimize the void if sloughing does occur.

- If the Cardston Electric Utility Inspector determines that the best solution is to haul away the native soil and bring in other backfill material, the Developer's Contractor will be responsible for the supply of all new backfill material and the disposal of all spoil. This requirement will be subject to the availability of an alternative material, disposal options of the native soil, moisture levels of trench area, monitoring of the site in the spring, etc.
- Where frozen backfill material has been used and subsequently settles in the trench, the Developer's Contractor will be responsible for any and all additional backfill and compaction required.
- Any trenches that create a hazard due to sloughing must be dealt with immediately. Both the Developer's Contractor and the Cardston Electric Utility Inspector have an obligation to track all Work done in the winter (frozen conditions) and monitor those sites in the spring (immediately after the frost comes out of the ground).

**Sand Backfill:**

- As Cardston Electric Utility Inspector does not inspect or see all backfill activity or practices, the Developer's Contractor must install spec sand with a minimum cover of 200 mm above all cables and ducts, extending in either direction as far as the trench exists, to ensure that no rocks or sharp edges are pushed on the cables during backfill. A minimum of 200 mm of sand may also be required below the cables at the Cardston Electric Utility Inspector discretion.
- All sand required must be provided by the Developer and must be free of clay, rocks, and organic materials, and meet the following grading requirements:
  - One hundred percent (100%) passing the 25-mm sieve.
  - Ninety five percent (95%) passing the 5-mm sieve
  - Maximum of ten percent (10%) passing the 80-micrometer sieve.
  - Liquid limit not to exceed twenty five percent (25%). Plasticity index not to exceed six percent (6%).

**Road Crossings:**

- Road crossings must be at a minimum depth of 1.2m to a maximum depth of 1.5 m below finished grade and excavated at right angles to the road.
- The end of road crossing ducts shall extend 600 mm beyond back of curb, or 600 mm back of sidewalk on both sides of the street, whichever is greater. It should end in locations where it is most accessible (i.e. not under driveways or pavements) and should be marked with a marker ball.
- The end of road crossing ducts shall maintain a separation of 2.0m away from the base of any equipment (i.e. switching cubicle, transformer, secondary pedestal, streetlight) and from property pins.

**NOTE:** This will allow enough space for digging a pit at the end of the duct and not disturb the foundation and grounding facilities of an equipment, and property pins.

**Primary Cables and Terminations:**

- All underground primary power cables must have continuity and phasing checks completed by the Developer prior to commissioning. This includes the installation of all fault indicators and phase identification tags. All permanent power cable identification tags must be installed prior to testing and verification of the cables.
- The following Work is to be completed by the Developer's Contractor as part of the overall installation of the underground electric distribution system:
  - Installation of all three-phase 25kV and single-phase 14.4kV primary power cables.

- Installation of all secondary and streetlight power cables and service stubs.
- Termination of all primary power cables at all padmount transformers and switching cubicles.
- Termination of all secondary and streetlight power cables at all padmount transformers and secondary junction boxes and pedestals.
- All primary and secondary underground distribution power cables must be supplied and installed as per the Cardston Electric Utility accepted IFC drawings for the development area, and in accordance with requirements of this publication, the AEUC, as well as the standard practices of the cable manufacturer's recommendations and limitations.

- The Developer's Contractor must exercise extreme care always when handling underground power cables to ensure that the cables will not be damaged due to any negligence or rough handling. The underground power cables must not be unduly dragged over abrasive surfaces, crimped or cut where the exterior jacket or insulating properties of the individual cables are jeopardized.
- The Developer's Contractor must supply and utilize vehicles and equipment suitable for the handling of reels of underground power cable. The vehicle shall be so constructed that it will allow safe handling and paving out of the power cable in a straight line, tangentially from the reel, without undue tension.
- All underground power cables must be placed in the trench with great care to avoid kinking, damage to the sheath, or placing on rocks or other unacceptable material.
- The power cables must be laid and pulled out in the trench at random separation with primary cables generally trained to the street side of the trench, secondary and streetlight cables to the center of the trench, and communication cables to the property side of the trench.
- Care must be taken when laying the underground power cables to avoid excessive snaking and/or crossing of the cables over each other which can create pressure points on the cables when backfilled and cause insulation damage.
- All underground power cables crossing roadways must be placed in a minimum four (4) inches PVC Type DBII duct. Primary and secondary power cables must be installed in separate ducts. The ducts should be sized so the power cables do not exceed forty percent (40%) of the cross-sectional area of the duct. The ducts must only be used for underground power cables. After installing the power cables, all road crossing duct ends must be covered by 200 mm of sand.
- When pulling underground power cables in duct, care must be taken not to use pulling distances that could result in damage to the cables or duct walls. The parameters that must be considered when determining safe pulling distances through the duct should include coefficients of friction, cable lubricants, and tension and sidewall bearing pressure levels. Accepted power cable lubricants must be used, where lubricant is required.
- The underground power cables at entrances into ducts, bases, etc., must not be positioned beyond the allowable minimum-bending radius of each cable (i.e., eight (8) times the cable diameter, or as otherwise noted by the manufacturer).

**Primary Cables:**

- All primary power cables and/or terminations required at, or entering, existing padmount transformers, switching cubicles, splice boxes, riser poles, etc., must be installed and completed by Cardston Electric Utility personnel only.
- No entrance to an existing plant or facilities that are energized will be allowed to the Developer's Contractor at any time.

**NOTE:** The Developer's Contractor must coordinate the excavation and installation of all primary power cables within 3.0 m of an existing energized padmount transformer, switching cubicle, poles/risers, or stub out, with the Cardston Electric Utility Inspector at the start-up meeting, as per the requirement of Section Excavation.

- All primary power cable terminations are to be completed by or under the direct supervision of a qualified journeyman power lineman.
- All primary power cable ends must be sealed by an appropriate cap, "phased-out", and identified by permanent engraved tags which identify each cable as phase X, Y or Z.
- All primary power cables that are left buried must be left coiled and placed horizontally in the splice pit and with a minimum of 200 mm of sand cover above cable ends.
- Marker tape must be placed 200 mm above the top of all primary power cables for the entire length of the cable trench.
- Marker Balls shall be installed as required
- The Developer's Contractor will not be allowed to use primary power cable splices during construction or installation of the underground distribution system without prior Acceptance of the Cardston Electric Utility Inspector
- Splices should be avoided for #1 AWG solid aluminum TRXLPE primary power cables but may be allowed on reel ends only where unavoidable.
- Where required, splices must be installed on the primary power cables as indicated on the drawings and in strict accordance to the manufacturer's instructions. All splice locations must be marked in the field with a marker ball, identified and dimensioned on the "red-line" as-built drawings and on the final "record drawings".
- Any damage to the primary power cables must be reported immediately to the Cardston Electric Utility Inspector, who will decide whether the cable can be repaired or whether the cable must be replaced. All repairs or replacement of any damaged primary power cable must be made to the satisfaction of the Cardston Electric Utility Inspector.
- The three (3) categories of primary power cable damage, together with the corrective procedures, are as follows:
    - Minor Cable Damage – Minor scratches, marks, and indentations to outer jacket (e.g. after pulling cable through a duct).

Corrective Action – The Cardston Electric Utility Inspector will determine whether corrective action needs to be taken.

- Moderate Cables Damage – Damage such as gouge or break, through to the concentric neutral strands will be inspected by the Cardston Electric Utility Inspector. The Cardston Electric Utility Inspector will ensure that the semiconductor insulation shield has not been penetrated.

Corrective Action – The cable jacket must be thoroughly cleaned and buffed with sandpaper in the area to be taped. Two (2) wraps of self-amalgamating tape and two (2) wraps of nylon tape will be applied to 50 cm on either side of the damaged area. Cables will not have more than one (1) such repair per terminal length.

- Severe Cable Damage – Damaged cable as determined by the Cardston Electric Utility Inspector to be too extensive to be repaired (i.e. a gouge or break where the semiconductor insulation shield has been penetrated and the neutral strands have been broken).

Corrective Action – The damaged cable must be removed and replaced with new cable.

**NOTE:** The Developer is responsible for the site and the underground distribution system throughout construction. Should any primary power cable be damaged before Cardston Electric Utility energizes the system and accepts the CCC, even though no fault of the Developer or the Developer's Contractor, the Developer's Contractor will be required to repair the cable in accordance with the requirements and category of damage identified above prior to Cardston Electric Utility accepting the CCC.

**Secondary Cables and Terminations:**

- All secondary power cables and/or terminations required at, or entering existing padmount transformers, switching cubicles, splice boxes, riser poles, etc., must be installed and completed by Cardston Electric Utility personnel only. No entrance to an existing plant or facilities that are energized will be allowed to the Developer's Contractor at any time.

**NOTE:** The Developer's Contractor must coordinate the excavation and installation of all secondary power cables within 3.0 m of an existing energized padmount transformer, switching cubicle, or stub out, with the Cardston Electric Utility Inspector at the start-up meeting.

- All secondary power cable terminations are to be completed by or under the direct supervision of a qualified journeyman power lineman or electrician, or by fourth year apprentice linemen or electricians.
- In urban subdivisions, the Developer's Contractor must install a 1/0, 4/0, or 300 kcmil secondary service lead. The length of secondary service cable required to serve the customer's meter base without requiring a splice shall be that according to the development plan of the property or if this is not available, the minimum length of secondary service cable shall be equivalent to three-quarters (¾) of the length (i.e. longest side) of the lot.
- The secondary service cable shall be coiled, laid in a secondary service box inside the property line of each lot, marked with a marker ball. The cable end properly capped and sealed, and the cable labeled
- The UED Consultant shall specify the size and length of the secondary service cable on the IFR and IFC prints (i.e. Notes or Legend Section). Cardston Electric Utility Inspector may perform inspections and measure the length of secondary service cable installed to ensure that the appropriate length of service cable is provided in accordance with the IFC prints.
- In rural subdivision, acreage lots or in large lot urban subdivision, the secondary service lead provision may be waived where the building location may vary and sizes of lots maybe considerably long. In this situation, if the required length of service cable exceeds forty (40) meters, which has been determined either through the required development plan of the house or by calculating three-quarters (¾) of the length (i.e. longest side) of the lot, the Developer's Contractor shall provide and install a secondary service cable up to the drop box inside the property line of each lot, stubbed, marked with a marker ball, the cable end properly capped and sealed, and the cable labeled.
- The top of the drop box must be a minimum of 300 mm below final grade. The location of the drop box must also be marked with a marker stake, a marker tape extending a minimum of 200 mm above final grade level and a marker ball on the property side of the box. To avoid future secondary cable damage when the electrician is excavating and installing the secondary service to the home or building, marker tape, or another suitable electrical marker, should also be installed 500 mm beyond the drop box into the property as a signal or indication to the electrician that they are close to the drop box and that extra care must be taken to ensure that the drop box and secondary service lead within are not damaged by the backhoe or ditcher hitting the drop box.

- Marker tape must be placed 200 mm above the top of all secondary power cables for the entire length of the cable trench.

**Secondary Cable Splices and Repairs:**

- The Developer's Contractor will not be allowed to use secondary power cable splices during construction or installation of the underground distribution system.

**NOTE:** The Developer is responsible for the site and the underground distribution system throughout construction. Should any secondary power cable be damaged before Cardston Electric Utility energizes the system and accepts the CCC, even though no fault of the Developer or the Developer's Contractor, the Developer's Contractor will be required to repair the cable in accordance with the requirements and category of damage identified in the "Primary Cable Splices and Repairs" segment of this section, prior to Cardston Electric Utility accepting the CCC.

- All lugs must be installed at the padmount transformer and all secondary pedestals must be secured, all doors installed and all terminal blocks installed and connected to the transformer.

**Padmount Transformers:**

- Padmount transformers must be tested in accordance with CSA Dielectric Tests. The Developer must supply the padmount transformer test reports and drawings from the transformer manufacturers. Certification of the test reports by an electrical engineer is required. The Oil Filled Equipment Sheet must also be filled in for each padmount transformer installed and returned with the "Red-Line" as-built drawings.
- All single-phase and three-phase padmount transformers must be supplied and installed as per the Cardston Electric Utility accepted IFC drawings for the development area, and in accordance with requirements of this publication, the AEUC, as well as the standard practices of the transformer manufacturer's recommendations and limitations.
- The Developer's Contractor will install the pre-cast concrete bases at each padmount transformer location after the installation of all power and communication cables that bypass the transformer base (i.e., primary power cables of different phase conductors, secondary service stubs, and communication cables).
- Proper rigging methods must be used (i.e., use of spreader bars) when installing or moving pre-cast bases. Two (2) wraps of each primary power cable and one (1) to two (2) wraps of each secondary power cable inside the base will be coiled and trained to allow for reasonable access to any termination without disturbing adjacent connections. The secondary power cables should be installed on the bottom and the primary power cables on the top. Once the pre-cast concrete base has been installed (i.e., leveled, ground grid installed, and all lifts of backfill and compaction completed) and the primary and secondary power cable ends are coiled up and capped, the Developer's Contractor will install the padmount transformer on the base and complete all cable terminations and miscellaneous Work. Once installed, all lifting bolts are to be removed. Each padmount transformer must be cleaned such that no dirt or oil is visible. The bus bar must also be cleaned such that all corrosion is removed. Once the padmount transformer is securely fastened to the base, the grounding connection to the ground grid and the ground bus must be completed.

**NOTE:** No cable terminations are to be completed until the padmount transformer is properly secured to the pre-cast inserts.

- The Developer's Contractor must install all required pre-formed primary and secondary power cable terminators, complete the cable terminations and grounding bonds, connect the concentric neutrals of each cable to the ground bus, and install all required fault indicators and cable tags and labels, within the padmount transformer enclosure.

**NOTE:** all primary and secondary power cable terminations are to be completed as per the manufacturer's recommendations, and Cardston Electric Utility specifications.

- The Developer's Contractor must also ensure that all the transformer-bushing inserts are installed as per the manufacturer's specifications, and that the all high-voltage bushings are grounded to the padmount transformer grounding bus using a #12 copper ground wire from the ground tab of each load-break bushing insert to the ground bar on the transformer housing
- The Developer's Contractor must install all switch numbers and phase indicators as per the Cardston Electric Utility accepted IFC single line diagram.
- Fault indicators must be installed on the source side of the primary power cables entering the padmount transformer, and must be securely clamped to the cable.
- Appropriate identification tags must also be securely attached to each cable terminated.
- Padmount Transformers and Pedestals, secondary junction boxes or secondary pedestals are required whenever two (2) or more services are fed from a padmount transformer.
- Upon completion of all Work within the padmount transformer, the Developer's Contractor must supply and install their padlock at each transformer to prevent unauthorized entry. Upon Cardston Electric Utility's energization of the system and Acceptance of the CCC, the Developer's Contractor's padlocks will be replaced with Cardston Electric Utility standard locks, and the construction padlocks returned to the Contractor.

**Bushing Designations:**

- Padmount transformer primary bushings are designated H1 to indicate that the bushing is connected to the H1 end of the primary winding. When the other end of the primary winding is grounded, it is designated as H2 on single-phase transformers and the terminal in the primary compartment of the padmount transformer is marked H2 directly on the tank. When the padmount transformer is installed, the transformer-grounding conductor must be run directly to this point. For padmount transformers with a secondary neutral connected to a system requiring a grounded neutral, a jumper is run from X2 to H2 but preferably to an adjacent point to keep H2 reserved for primary grounding.
- Padmount transformers designed for feed through operation have two (2) sets of primary bushings which are designated H1A - H1B, H2A - H2B, H3A - H3B, where A and B represent different connection points for the same phase. Single-phase mini-padmount transformers are loop-feed transformers with the primary bushings designated as H1A - H1B, with the H1A bushing on the lower left-hand side of the transformer. Past practices of connecting the underground primary power cables to these bushings have been inconsistent, creating potential crossovers between primary cables To avoid future confusion in all new installations, the underground primary power cables feeding from the left side of the padmount transformer must be connected to the H1A bushing (H2A and H3A bushings for three-phase), and the primary cables feeding from the right must be connected to the H1B bushing (H2B and H3B bushings for three-phase), regardless of the number of phases or where the system is fed from. This will avoid potential crossovers between the underground primary power cables during switching.

**Transformer Compartment Tagging:**

- To avoid possible switching errors, it is extremely important that each primary power cable, as well as the padmount transformer compartment is tagged appropriately. The locations and requirements for tagging padmount transformers are as follows:
  - Each primary power cable connection inside the padmount transformer must be tagged with the appropriate phase marker (i.e., 1X, 1Y, 1Z).
  - The same phase marker must be installed directly above the primary bushing on the padmount transformer tank wall. The primary power cable phase marker must match the phase marker on the tank wall.
  - The three-phase switches on loop-feed padmount transformers must be marked with the appropriate cable number, directly above the switch handle on the tank wall using the printed self-adhesive decals item numbers 494-2041 to 494-2045 (i.e., 1XYZ, 3XYZ, etc.).
  - The switch number must be attached to the inside of the padmount transformer at the front tank wall using one-inch high impact polyethylene tags (i.e., S304U).
  - The switch number should also be attached externally on the padmount transformer door close to the top using one-inch high impact polyethylene tags (i.e., S304U).

**Street Lights:**

- All street light poles or standards must have a uniform 0 degree tilt. Inspection of the vertical tilt and light pattern of each street light assembly will be made prior to final acceptance.
- All streetlights must be supplied and installed as per the Cardston Electric Utility accepted IFC drawings for the development area, and in accordance with requirements of this publication, the AEUC, as well as the standard practices of the manufacturer's recommendations and limitations.
- The Developer's Contractor will install the pre-cast bases at each streetlight location. Once the pre-cast base has been installed (i.e., leveled, ground installed, and all lifts of backfill and compaction completed) and the streetlight cable ends are looped in and capped, the Developer's Contractor will install the appropriate davit and luminaire, and complete all cable terminations, wiring and miscellaneous Work.
- Proper rigging methods must be used when installing or moving streetlight davits. All davit standards must be securely fastened to the anchor bolts on the base. All davit standards must also be leveled utilizing the appropriate shims, such that the pole shaft is perpendicular to the roadway cross-section, and all streetlight standards shall be installed such that there is 0 tilt (luminaires are to be installed parallel and level to the driving surface).
- The wiring between the luminaire, the insulated connector and the direct buried cable are to be completed by the Developer's Contractor as part of the installation. A sufficient length of wiring must be maintained to allow for a 460-mm length out of the hand hole.
- The luminaire and lamp must be installed securely on each standard, with care being exercised to level each luminaire accurately to provide a symmetrical light pattern on the adjacent roadway.

**NOTE:** LED luminaires shall have the following recorded upon installation; date, make, model no., and name plate wattage.

- All streetlight circuits are to be fed from secondary junction boxes and pedestals. Individual streetlight davits will be controlled by a photoelectric cell mounted on each davit. The aperture of the photoelectric cell shall face the northern skyline. Each light shall be tested at time of installation by covering the photoelectric cell to make it operate the light.
- Each streetlight davit must be grounded.

- All galvanized steel streetlight poles **MUST NOT** be over-painted or coated with another finish. Decorative poles should be ordered with the final paint finish specified at the time of ordering from the manufacturer.
- Where streetlights are required to be placed in front of corner lots with cut corners and potential conflict with driveways, the streetlight should be placed as close to the side lot lines, as possible, and away from the cut corner.

**Grounding:**

- All grounding must meet the requirements of the AEUC. All ground grids must be tested before connection of the concentric neutrals using the "Three Point Method" to below 6 ohms, to ensure that the grounds meet the code requirements. If the ground grid does not meet the code requirements, remedial action must be taken by the Developer to ensure compliance with the code requirements. Deep driven ground rods provide the best grounding and are recommended.
- All underground electrical distribution system equipment and apparatus must be grounded.
- The Developer's Contractor must install the ground grid at each padmount equipment (transformer, switching cubicle, etc.) base location prior to backfilling and compaction of the excavation.
- All primary and secondary concentric neutrals must be terminated to the appropriate ground bus and a #4 copper ground wire connected from the ground rods to the ground bus.
- In secondary and joint-use pedestals, the concentric neutrals must be terminated to the neutral block and a separate #8 copper white TWH wire connected from the neutral block to the apparatus ground lug.
- The metal sheath or shield of communication cables must also be interconnected with available primary and secondary system neutrals at each padmount transformer location as per the latest edition of AEUC and CSA Standard C22.3 No. 7.
- Bonding must also be provided between all above ground metallic power and communication equipment (i.e., secondary and joint-use pedestals, padmount transformer and switching cubicle cases, other equipment cases) that are separated by 3 m or less as per the latest editions of AEUC and CSA Standard C22.3 No. 7.
- The communication sheath or shield must be bonded to the effectively grounded neutral conductor at an interval not less than 300 m, and there must be a minimum of five (5) connections of grounding electrodes per km as per the latest editions of AEUC and CSA Standard C22.3 No. 7.
- Extra lengths of #4 bare copper conductors can be used to interconnect the communication sheath with the system neutral where required.

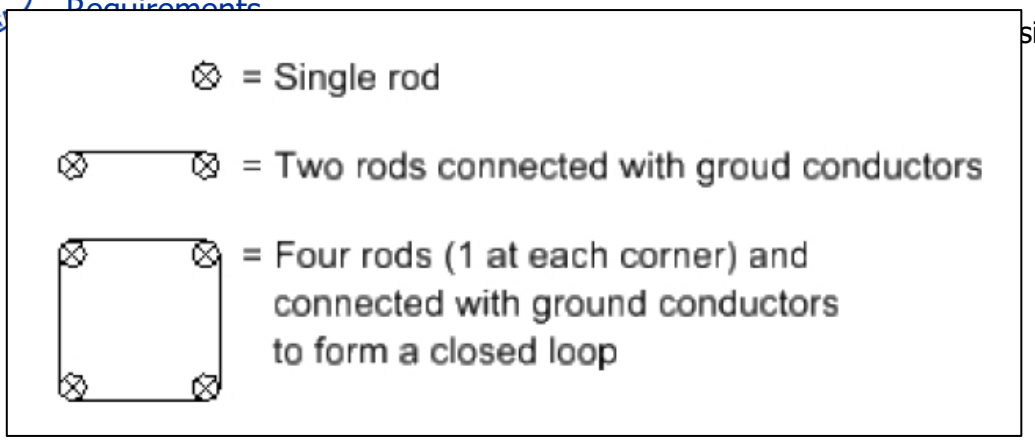



**Figure 1**

**Grounding Electrode:**

- A grounding electrode could be a single ground rod or a combination of ground rods connected with buried ground conductors as shown in Figure 1.

**NOTE:** The four ground rods interconnected with ground conductors is considered as one electrode.
All grounding must meet the requirements of the AEUC.

- All ground electrodes must be tested before connecting the concentric neutrals using the "Three-Point Method" or "Fall of Potential" to meet the maximum resistance per grounding electrode values as listed in Table 7 for each pad mount equipment (transformer, switching cubicle, MVIs, etc.) location.

**Table 7 – Resistance Requirements for Individual Electrodes**

| System Type | Number of Grounding Electrodes Tied Together with a Neutral | Maximum Resistance per Grounding Electrode |
|---|---|---|
| Considered an Earth Return Neutral | 2 | 6 Ω Winter (4.5 Ω Summer) |
| | 3 | 12 Ω Winter (9 Ω Summer) |
| | 4 | 18 Ω Winter (11 Ω Summer) |
| | 5 | 24 Ω Winter (14 Ω Summer) |
| Considered a Multi- Grounded Neutral | 6 or More | 25 Ω Winter (15 Ω Summer) |

**NOTE:** The values of the 'Maximum Resistance per Grounding Electrode' found in Table 7 was arrived at by assuming that one of the grounding electrodes does not function as designed.

- The maximum overall resistance of a neutral system (MGN or ERN) shall not exceed 6 Ω (4.5 Ω summer). To meet this requirement, the maximum resistances detailed in Table 7 shall be adhered to.
- Test results, showing the date of test, type of equipment and identification used, and measured ground resistances, must be documented.
- If the earth has very high resistance (rocky, sandy) and 25 Ω (15 Ω summer) cannot practically be attained for individual electrodes, the overall neutral system is still required to be 6 Ω (4.5 Ω summer) or less. Thus, additional electrodes will be required to meet this requirement. The overall resistance for the interconnected neutral system must be calculated using the following formula. Each Rn value is the meggered resistance of the individual grounding electrodes in ohms (Ω).
- Test results, showing the date of test, type of equipment and identification used, and measured ground resistances must be documented as shown below. The Developer must provide a report outlining the ground test results prior to final inspection. The results of these tests must also be added to the "Red-Line" as-built drawings beside the ground grid test report. All test reports must be signed by the testing authority, specify the following information.
    - Date of test
    - Equipment Identification
    - Ground resistance measured

**Padmount Equipment:**

- If a padmount equipment in an underground circuit is not tied into a Multi-Grounded Neutral system (considered as 6 or more electrodes as per Table 7) then a three-ring gradient control shall be used where applicable (switching cubicles, transformers, etc.).
- If the equipment is tied into 6 or more electrodes as per Table 7 then a single-ring gradient control can be used.

**Cable Terminations:**

- The Developer's Contractor must provide, when requested, the names of all qualified personnel (including copies of their certification) who may be completing terminations prior to the start of construction.

**Lengths of Cable Termination:**

- The following lengths of primary and secondary power cables must be provided for termination purposes in all padmount transformer and switching cubicle bases:
    - All primary power cable coils must have a minimum of one (1) full wrap or rotation of the bottom of the base (padmount transformers will typically accommodate two (2) full wraps whereas switching cubicles may only have space for one (1) full wrap).
    - All secondary power cable coils must have between one (1) and two (2) full wraps of the bottom of the base.
    - Secondary power cables are to be installed on the bottom with the primary cables on top.
- At no time will any primary or secondary power cable ends be left without the appropriate cap or be left exposed overnight without caps.

**Terminating Primary Cables:**

- All primary power cable terminations are to be completed by or under the direct supervision of a qualified journeyman power lineman. If an apprentice lineman (apprentices must be indentured in the

power lineman apprenticeship program) is working on primary terminations, direct supervision from the Developer's qualified journeyman power lineman is required.

- At each padmount transformer where the #1 AWG primary power cable is to be terminated, the Developer's Contractor must install the required separable load-break bushings and fault indicators, and make all phase conductor connections, as well as grounding bonds, within the padmount transformer enclosure.
- For all installations, underground primary power cables feeding from the left side of the padmount transformer must be connected to the H1A bushing (H2A and H3A bushings for three-phase), and the primary cables feeding from the right must be connected to the H1B bushing (H2B and H3B bushings for three-phase), regardless of the number of phases or where the system is fed from.
- All primary power cables must be properly dressed prior to termination according to the instruction provided by the terminator manufacturer, and appropriate identification tags securely attached to each cable so terminated.

**Load-Break Elbow:**

- Instructions provided by the manufacturer and supplied with each elbow are to be followed, including the proper installation of each load-break bushing insert.

**Terminating Secondary Cables:**

- All secondary power cable terminations are to be completed by or under the direct supervision of a qualified journeyman power lineman or electrician, or by fourth year apprentice linemen or electricians. If second or third year apprentices are working on secondary terminations, direct supervision of a qualified journeyman power lineman or electrician, or a fourth-year apprentice lineman or electrician is required.
- At each padmount transformer where the two-conductor secondary power cables are to be terminated, the Developer's Contractor must install the required crimp-style space lugs and terminate all secondary cables (including grounding bonds) in an accepted manner. The secondary power cables must be installed into the base and carefully trained up to the secondary junction boxes or secondary pedestals to prevent unnecessary crossing of cables and to allow for reasonable access to any termination without disturbing adjacent connections.
- Once the outer jacket has been removed from the secondary power cables, the concentric neutral strands are to be wound together for a minimum of 200 mm and the concentric neutral for each cable is to be installed to the neutral terminal. The phase conductors are to be neatly trained and placed in the secondary terminal blocks. Any excess lengths are to be cut off. All terminal bolts must be tightened such that secondary power cables cannot be moved by normal force on the ground bar.

**Warning Signs:**

- To conform to the AEUC, the Developer's Contractor must supply and install stick-on decals on all doors of secondary service pedestals, padmount transformers, and switching cubicles.
- Warning signs must also be posted on all riser structures, and warning marker tape for identifying underground power cables must be placed in all trenches with primary or secondary cables.

**Primary Cable Phase Tags:**

- All primary power cables are phased-out and identified by permanent tags which identify a cable as phase X, Y, or Z. The same phase is identified as entering or leaving a cable compartment by a prefix to the letter (i.e., 1X, 2X, or 3X). In normal application, the identities would be: 1X – source, 2X – loop, 3X – tap. Because subsequent switching to relocate the open point might reverse the sense of 1X and 2X as from source and to loop, the significance of the numbers can only be determined by reference to an up-to-date single line diagram, or by proof testing.
- For each primary power cable terminated at a padmount transformer or switching cubicle, the Developer's Contractor must supply and install tags to identify the phase. The correct phase color and label must be installed as per the Cardston Electric Utility accepted IFC single line diagram. Color-coding for the phase tags is as follows:
  - Red background with white letters for X phases (X1 to X5).
  - Yellow background with black letters for Y phases (Y1 to Y5).
  - Blue background with white letters for Z phases (Z1 to Z5).
- The primary power cable phase tag must be installed below the load-break elbow or terminator on the jacket of the cable inside the padmount transformer or switching cubicle.
- A similar or an extra phase tag must also be installed near the point where the elbow or terminator is attached. For padmount transformers, this phase tag must be attached to the transformer tank wall directly above the bushing well and for switching cubicles, this phase tag must be attached to the cubicle wall directly above the fuse holder. The phase number on the tank wall or compartment wall must match the phase number on the primary power cable. The surface of the padmount transformer tank wall or switching cubicle compartment wall must be cleaned before attaching the tag.

**NOTE:** tags installed in the winter may need to be replaced in the summer, since they do not stick very well in cold temperatures.

- On riser poles where the underground primary power cable is exposed to sunlight and weathering, the phase tag should be in the form of a high impact polyethylene tag on a polyethylene holder tied to the underground cable with a cable tie.
- Each package of phase tags contains five (5) cards for each phase (X, Y or Z phase). (material items 494-2011 to 494-2031).

**NOTE:** for U tags, the background is red with white letters, and the numbers and letters are the inverse to what is shown above.

- There are two (2) tags per card for cable tags and four (4) tags per card for the padmount transformer tank wall or switching cubicle compartment wall.

**NOTE:** Please also refer to the primary power cable phase tagging requirements and additional information in the padmount transformer tagging and switch compartment identification segments of Sections 6.9, Primary and Secondary Cables and Section 6.10, Padmount Transformers.

**Secondary Cable Labeling:**

- All secondary power service cables will be left unconnected for future connection upon completion of each lot service.

- Upon completion of construction, all secondary power service cables are to be removed from the terminal blocks at the padmount transformer, secondary junction boxes and pedestals, being careful to ensure that they do not tangle.
- Both ends of each secondary power service cable must be properly identified with both the legal description of the lot, as well as the Municipal address, by installing a 75-mm x 25 mm plastic write-on cable marking tape wrapped around the cable, with the address lot and block numbers, printed upon, using a Lumicolor #317, black permanent pen. The marking tape has a 19-mm x 25 mm space for noting the required information, and a 57-mm x 25 mm clear tape for protecting the written information. Each package of underground secondary power cable markers contains sixty (60) of these markers.

**Padmount Transformer and Switching Cubicle Switch Numbers:**

- For each padmount transformer and switching cubicle installed, the Developer's Contractor must supply and install switch numbers matching the Cardston Electric Utility accepted IFC single line diagram.
- High impact 1" Poly tags are to be used for all underground switch numbers at padmount transformers and switching cubicles. The tags are inserted in a tag holder and mounted with double-sided tape on the inside and outside of the padmount transformer or switching cubicle opposite the door (it should be located right above the switch operating handle if it exists and can be riveted on the cubicle door). Installation should be performed on a clean surface and on a warm day.

**Primary Risers**:

- Sufficient lengths of primary power cables must be left coiled at the primary riser location as identified by the Cardston Electric Utility Inspector. Cardston Electric Utility will complete all terminations and connection of the underground primary power cables to the overhead electric system

**Facility Map and Single Line Diagram Accuracy:**

- Throughout construction and inspection the Developer must maintain accurate "Red-Line" information and records of all construction and all changes to all engineering drawings and concealed services, as Work progresses.

# 6. Acceptance of Work and Energization:

- Cardston Electric Utility will accept, conditionally, the "total" installation when completed by the Developer. "Total" will mean the entire area bounded by the Developer's plans, as initially covered in the service agreement with Cardston Electric Utility. Note, Cardston Electric Utility will not energize portions of the planned area in a piecemeal manner, unless specific arrangements are made, and the Developer agrees to all additional costs, including temporary services, in advance.
- The Developer is responsible for the entire underground installation and all Works (both exposed and not exposed) until energization and final acceptance of the Construction Completion Certificate (CCC) by Cardston Electric Utility. Following construction, and on final construction inspection and satisfactory completion of the Works, Cardston Electric Utility will complete the off-site construction and the underground electrical distribution system will be commissioned and energized, and immediately becomes the sole property of Cardston Electric Utility, along with full responsibility for all future operation and maintenance. The Developer's CCC will be accepted and signed upon successful energization of the Works.

- In the event (upon attempt to energize the Works) Cardston Electric Utility determines that certain underground primary or secondary power cables have been damaged (and are not considered serviceable), the Developer must expedite the retesting of all such cables.
- The additional power cable testing requirements are as follows:
  - The Developer must arrange with an independent testing company for special tests of any damaged power cables or installation identified for testing. Tests must be carried out in accordance with the requirements and standards set down by Cardston Electric Utility and the cable manufacturer. The developer will be responsible for the costs of all tests.
- Damaged primary or secondary power cables, or portions thereof, must be located, excavated, and repaired or replaced by the Developer at the Developer's cost.
- All areas containing underground electrical distribution system facilities (i.e. URW's, easements, roadways, etc.) must be brought to full grade or within +/- 150mm of final grade before final installation will be energized, accepted and signed-off by Cardston Electric Utility.

## Drawings:

**Figure 1 - Typical 3 Party Trench**

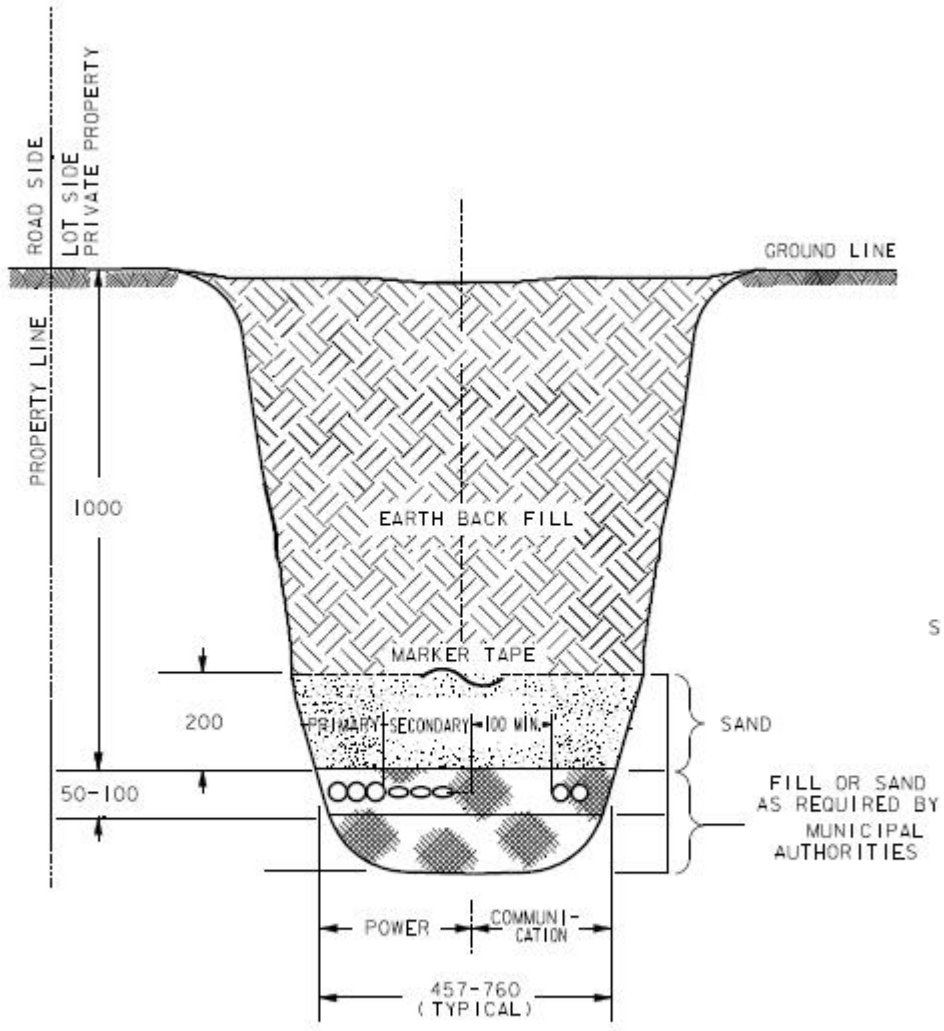
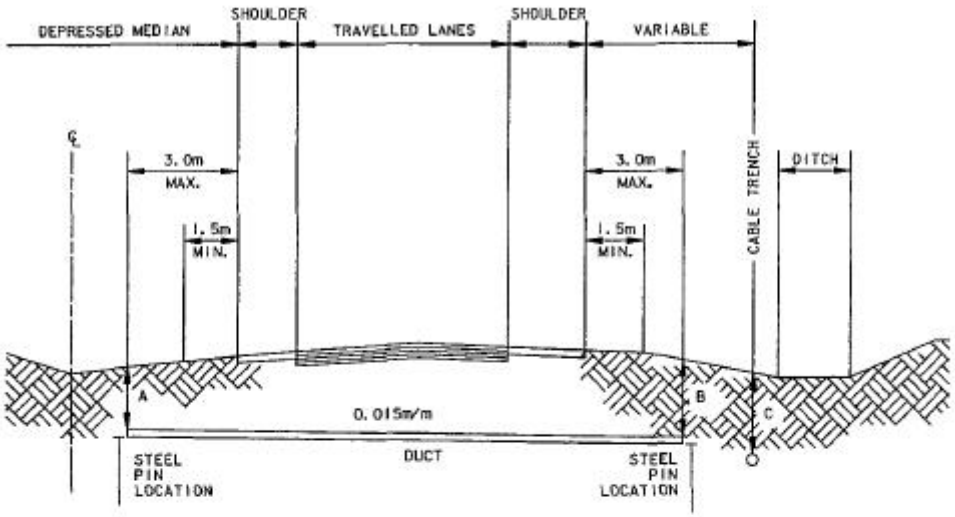


**Figure 2 - Rural Road Crossing**




NOMINAL HALF SECTION
RURAL HIGHWAY

NOTES:

1 - DUCT TO BE 3 INCH DIAMETER P.V.C. TYPE DB2 TO CSA STANDARD B196-1, LATEST REVISION (UNC ITEM 632-3030) OR AS PERMITTED UNDER CLAUSE 446 OF THE ELECTRICAL UTILITY REGULATIONS.

2 - DUCT TO EXTEND NOT LESS THAN 1.5m AND NOT MORE THAN 3.0m FROM THE OUTSIDE EDGE OF THE SHOULDER.

3 - AT THE MEDIAN TERMINATION OF THE DUCT, THE BURIAL DEPTH BELOW FINISHED GRADE (DIMENSION 'A') SHALL BE 850±100mm TO THE TOP OF THE DUCT.

4 - DUCT TO BE GRADED AS SHOWN.

5 - GALVANIZED FISH WIRE TO BE LEFT THROUGH DUCT AND WOUND AROUND LOCATION PINS.

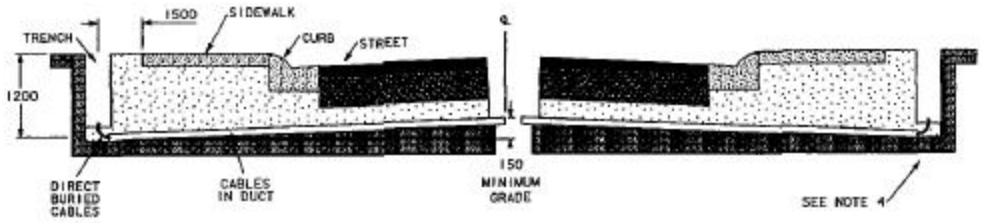
6 - TYPICAL COVER AT OUTSIDE DUCT TERMINATION (DIMENSION 'B') WILL BE 1180±100mm PROVIDED ROAD IS BALANCED.

7 - MINIMUM ACCEPTABLE BURIAL DEPTH FOR LIGHTING CABLE IS 1100mm (DIMENSION 'C').

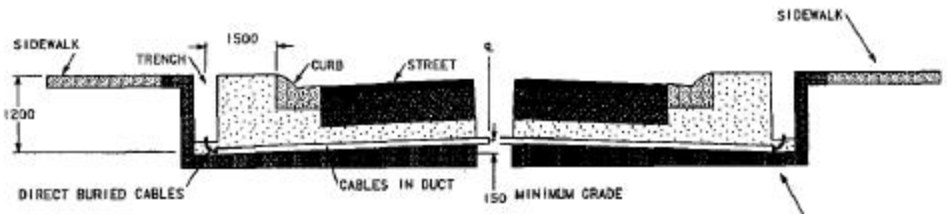
8 - REFER TO CONSUMER SERVICES MANUAL BULLETINS #C20-02, #028-01, & D18-01 FOR FURTHER INFORMATION.

9 - UNLESS OTHERWISE INDICATED, ALL DIMENSIONS ARE IN MILLIMETRES

**Figure 3 - Typical Street Crossing**




STREET CROSSING DESIGN
MONOLITHIC CURB & SIDEWALK




STREET CROSSING DESIGN
SEPARATE CURB & SIDEWALK

NOTES

1. DUCT SHALL BE GRADED FROM STREET CENTRELINE DOWN TOWARDS BOTH SIDES A MINIMUM OF 150mm
2. DUCT SHALL EXTEND 600mm BEYOND CURB OR SIDEWALK ON BOTH SIDES OF THE STREET
3. BACKFILL UNDER THE ROADWAY SHALL CONSIST OF COMPACTED SAND FILL, OR AS REQUIRED BY THE MUNICIPAL AUTHORITY OR DEVELOPER
4. COMPACTED SAND OR SELECT FILL TO BE PLACED AT THE ENDS OF THE DUCTS TO PREVENT DAMAGE TO CABLES DUE TO SETTLEMENT OF DUCTS OR CABLES
5. NOMINAL BURIAL DEPTH IS 1.2m

**Figure 4 - Typical Front Street Distribution**

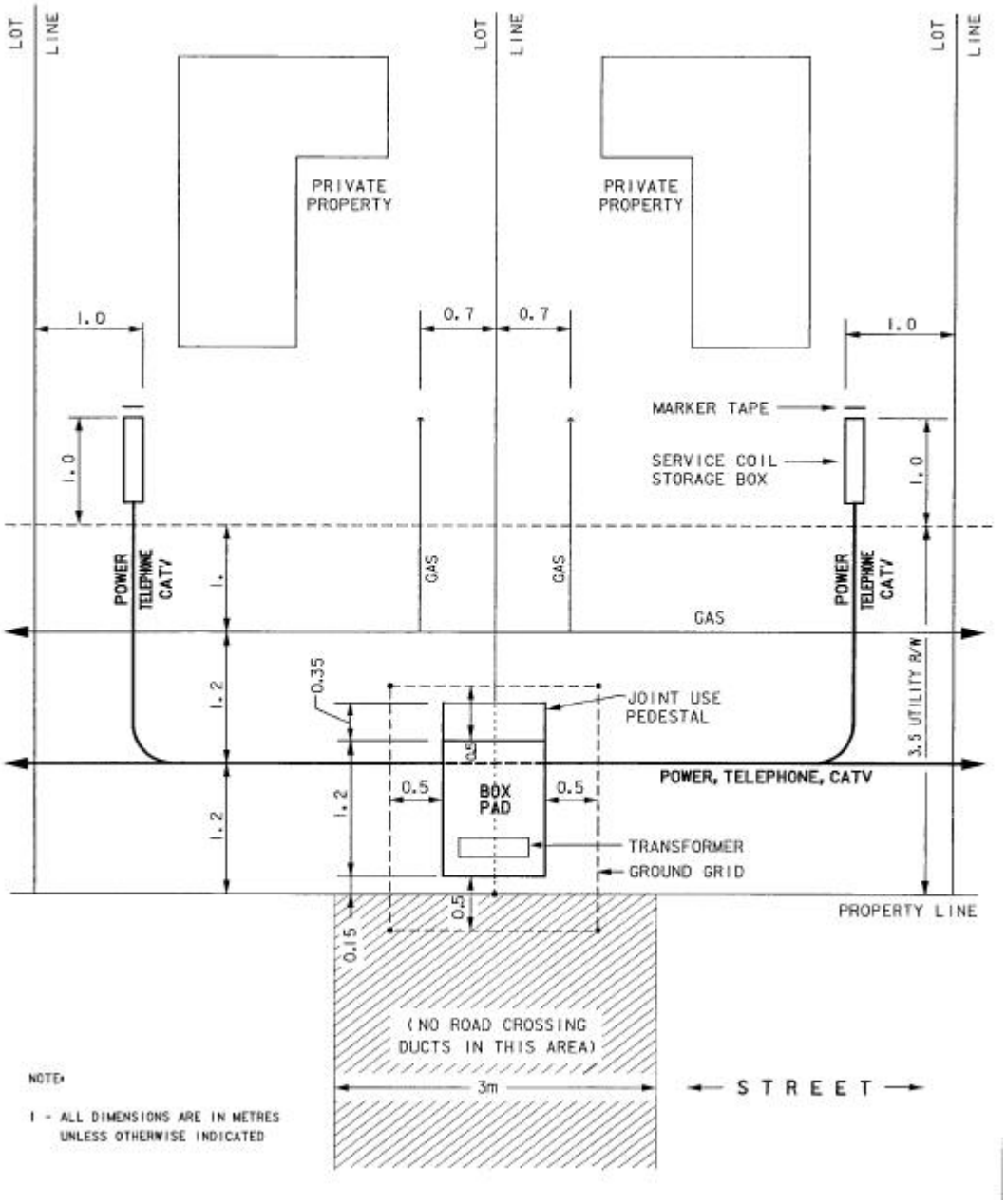
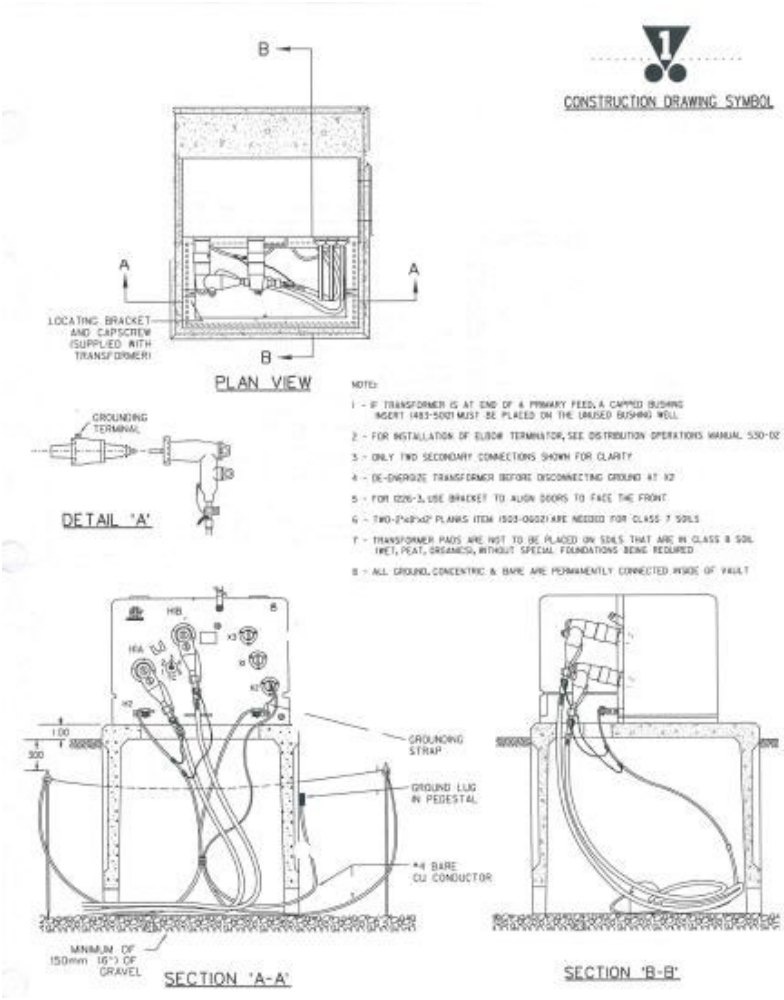


**Figure 5 - 1 PH Transformer Arrangement**

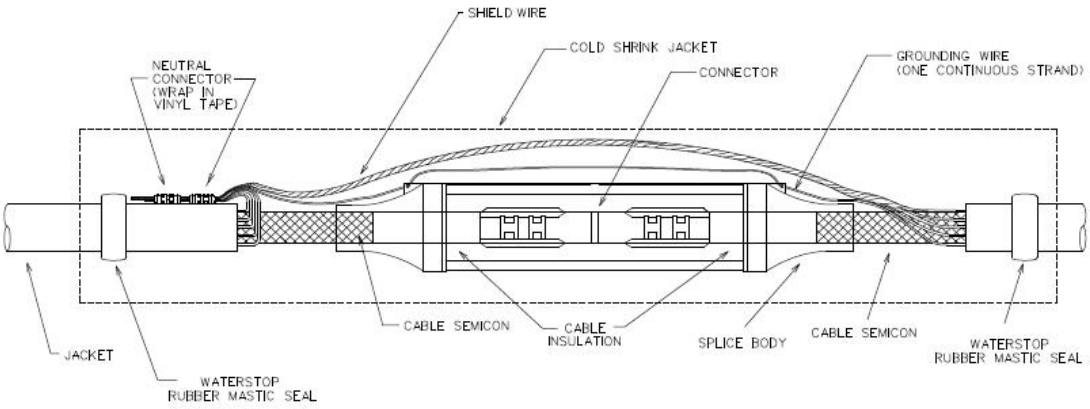


| Structure # 1227 | | | | | 15 kV 1-Phase Padmount Xmer | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item # | UI | - | -1 | -2 | -3 | -4 | -5 | -6 | Description |
| 4835010 | | | | | | | | 1 | FEEDTHROUGH, U/G, 25KV LOADBREAK |
| 4835012 | | | | | | 1 | | | INSULATING CAP, U/G, 25KV |
| 4835013 | | | 1 | | | | | | INSULATING CAP, U/G, 15KV |
| 4835031 | | | | | 1 | | | | INSERT, FEED-THRU, 15kV LOADBREAK |
| 4947051 | | | 1 | 2 | 3 | 1 | 2 | 3 | TAG HOLDER U/G FOR CABLE IDENTIFICATION |
| 5139491 | | | 10 | 10 | 10 | 10 | 10 | 10 | BOLT,STEEL,HEX,1/2-13 X 1-1/2,HDG,GRADE5 |
| 5142102 | | | 10 | 10 | 10 | 10 | 10 | 10 | WASHER, ROUND, 1:3/8 , 9/16 HOLE |
| 5142502 | | | 10 | 10 | 10 | 10 | 10 | 10 | WASHER, SPRING LOCK, SINGLE 1/2" |
| 5191131 | | | 1 | 1 | 1 | 1 | 1 | 1 | PADLOCK, RESTRICTED, 27.5mm,B |
| 5311013 | M | | 2 | 1 | 1 | 2 | 1 | 1 | WIRE, GREEN, 14AWG, SOLID, 600 V, TW |
| 5390602 | M | | 1 | 2 | 3 | 1 | 2 | 3 | CABLE, #4, MULTI STR. BOND. |
| 5530155 | | | 1 | 2 | 3 | 1 | 2 | 3 | CONNECTOR,COPPER C-TAP #2 TO #2SOL/STR. |
| 5532526 | | | 10 | 10 | 10 | 10 | 10 | 10 | CONNECTOR,TERMINAL LUG #4, 350 MCM 2 CA |
| 5590502 | | | 2 | 4 | 6 | 2 | 4 | 6 | TIE, CABLE WRAP, BLACK |
| 5740137 | | | | | | 1 | 2 | 3 | TERMINATOR,ELBOW,25KV 200A FOR #1 SOL AL |
| 5740202 | | | 1 | 2 | 3 | | | | ELBOW, LOADBREAK, 15KV, 200AMP, #2 |
| 5740330 | | | 2 | 2 | 2 | | | | BUSHING INSERT, LOADBREAK 15 KV 200 A |
| 5740335 | | | | | | 2 | 2 | 2 | BUSHING INSERT, LOADBREAK 25KV 200A |
| 5780305 | | | 1 | 1 | 1 | 1 | 1 | 1 | TAPE, VINYL, 3/4" x 66' CSA APPROVED |
| 5780311 | | | 1 | 1 | 1 | 1 | 1 | 1 | TAPE, LINERLESS SPLICING, 1 X 30 |

Remarks:
1. 1227-1 is for 15kV radial feed mini-padmount transformers.
2. 1227-2 is for 15kV loop-feed mini-padmout transformers.
3. 1227-3 is for 15kV Feed-Thru mini-padmount transformers.
4. 1227-4 is for 25kV radial feed mini-padmount transformers.
5. 1227-5 is for 25kV Loop-Feed mini-padmount transformers.
6. 1227-6 is for 25kV Feed-Thru mini-padmount transformers.
7. For Pad and grounding material see structure 1290.

Order item 579-0516 silicone grease for bushing inserts and elbows where required.

**Figure 6 - Primary Splice**



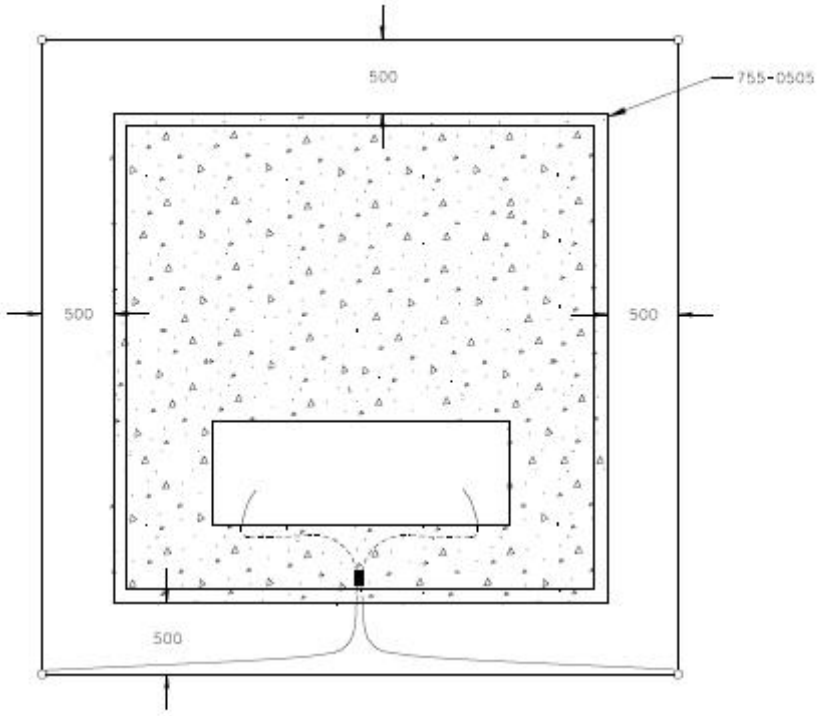

NOTE:

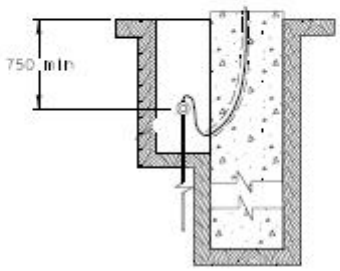
1 - 1329-1 FOR 25 kV, #1 SOLID AL TO #1 SOLID AL

PREMOLDED SPLICE - DIRECT BURIAL APPLICATION
25kV CONCENTRIC NEUTRAL
XLPE URD CABLE

| Item # | UI | | Description |
|---|---|---|---|
| 5514006 | | | SLEEVE, SERV SPLICE, #2 ACSR:SB:100 |
| 5530150 | | 2 | CONNECTOR, COMP. PG, COPPER, 1/0 TO 1/0 |
| 5530152 | | 2 | CONNECTOR, COMP PG, CU, U/G NEUT |
| 5530157 | | | CONNECTOR,COPPER C-TAP,#1/0-2/0 TO #1/0- |
| 5780212 | | | KIT, REPAIR JOINT,FOR DAMAGED CABLE |
| 5780214 | | 1 | KIT,CABLE SPLICE,25 KV,#1 SOL TO #1 SOL |
| 5780215 | | | KIT,CABLE SPLICE, 25KV 500 CMPT-500 CMPT |
| 5780220 | | | KIT, 2 WAY SPLICE, C/S FOR 750MCM |
| 5780230 | | 1 | KIT, SPLICE, COLD SHRINK FOLDBACK JACKET |
| 5780306 | | 1 | TAPE, INSULATING SELF AMALGAMATING 2"WD |
| 5780307 | | 1 | TAPE, VINYL, 2" WIDE X 30 YD. (MIN.) |
| 5780401 | | 1 | KIT, UNDERGROUND PREPARATION |

**Figure 7 - Grounding Methods for Transformer and Street Light**

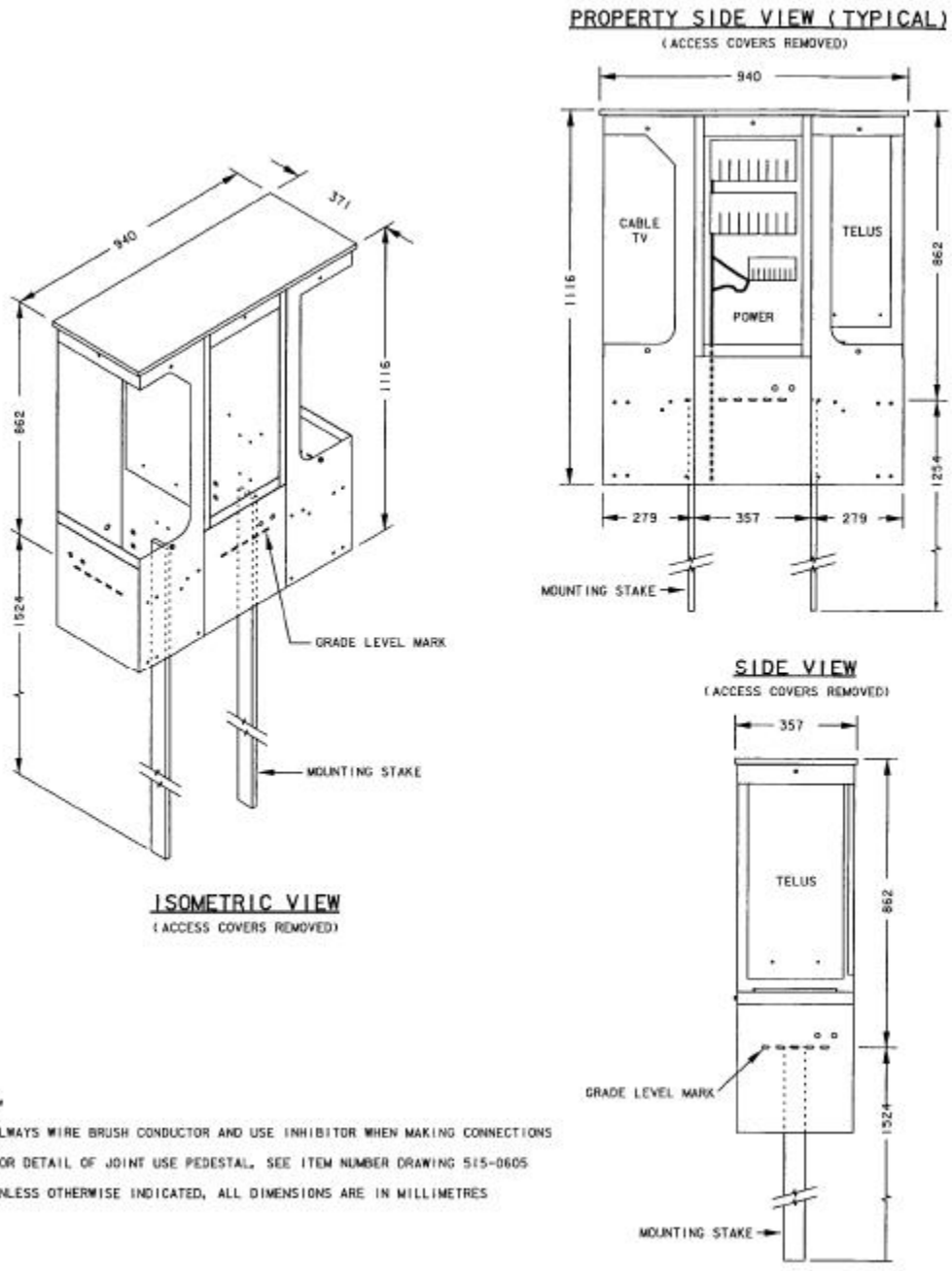



STREET LIGHT GROUND 1300-1

| Structure # 1300 | | | | | GRDING METHOD FOR 1-PH X'MER & STR. LITE | | | |
|---|---|---|---|---|---|---|---|---|
| Item # | UI | - | -1 | - | -3 | - | - | Description |
| 5310220 | M | | 2 | | 25 | | | CONDUCTOR, STR, #4, CU. |
| 5530645 | | | | | 4 | | | CONNECTOR, GRD ROD, MAX 3/4"ROD |
| 5571302 | | | 1 | | | | | ROD, GROUND, 5/8" X 8', STEEL |
| 5571320 | | | | | 4 | | | ROD, GRD, SECTIONAL, 3/4 X 6' TAPERED |

**Figure 8 - Three Way Pedestal**



| Item # | UI | -1 | -3 | -5 | -7 | Description |
|---|---|---|---|---|---|---|
| 4910305 | | 1 | 1 | 1 | 1 | SIGN, "DANGER BURIED CABLE" 1/EA |
| 5132401 | | | | 4 | 4 | BOLT, MACHINE, 1/2" X 1 1/2", H.D.GALV |
| 5132501 | | | | 2 | 4 | BOLT, MACHINE, HEX HEAD, 5/8" X 1 3/4" |
| 5132502 | | | | | 3 | BOLT, MACHINE, HEX HEAD, 5/8" X 2 1/2" |
| 5142102 | | | | 4 | 4 | WASHER, RD, 1:3/8 , 9/16 HOLE |
| 5142502 | | | | 4 | 4 | WASHER, SPRING LOCK, SINGLE 1/2" |
| 5142503 | | | | 4 | 14 | WASHER, SPRING LOCK, SINGLE HELIX,5/8" |
| 5150602 | | 1 | | | | PEDESTAL, JOINT POWER/TELEPHONE SERVICE |
| 5150604 | | 2 | 2 | | | STAKE, FOR JOINT USE PEDESTAL |
| 5150605 | | | 1 | 1 | 1 | PEDESTAL, 3 WAY, TRANSFORMER MOUNT |
| 5310220 | M | 2 | 2 | 2 | 2 | CONDUCTOR, STR, #4, CU. |
| 5340108 | M | | | 10 | 10 | CABLE, SEC. 2/c - 4/0 AL, JKT CONC NEUT |
| 5532238 | | | | 3 | 3 | CONNECTOR,TERMINAL FOR 4/0 AL 1HOLE 1/2" |
| 5532508 | | | | 2 | 2 | CONNECTOR, TERMINAL, 1/0:4/0 Cu,9/16" HO |
| 5551904 | | 2 | 2 | 2 | 2 | CONNECTOR, NEUTRAL FOR SUB SEC VAULT |
| 5551912 | | 2 | 2 | 2 | 2 | CONNECTOR, PHASE, 600V 9-TERMINAL |
| 5571302 | | 1 | 1 | | | ROD, GROUND, 5/8" X 8', STEEL |

Remarks:

1. All 1231 structures are for a maximum of 8 services.
2. 1231-1 is for 2 Party joint-use pedestal mounted on stakes.
3. 1231-3 is for 3 Party joint-use pedestal mounted on stakes.
4. 1231-5 is for 3 Party joint-use pedestal mounted on transformer.
5. 1231-7 is for 3 Party joint-use pedestal mounted on fibreglass pad with transformer.

**Figure 9 - Secondary Splice**

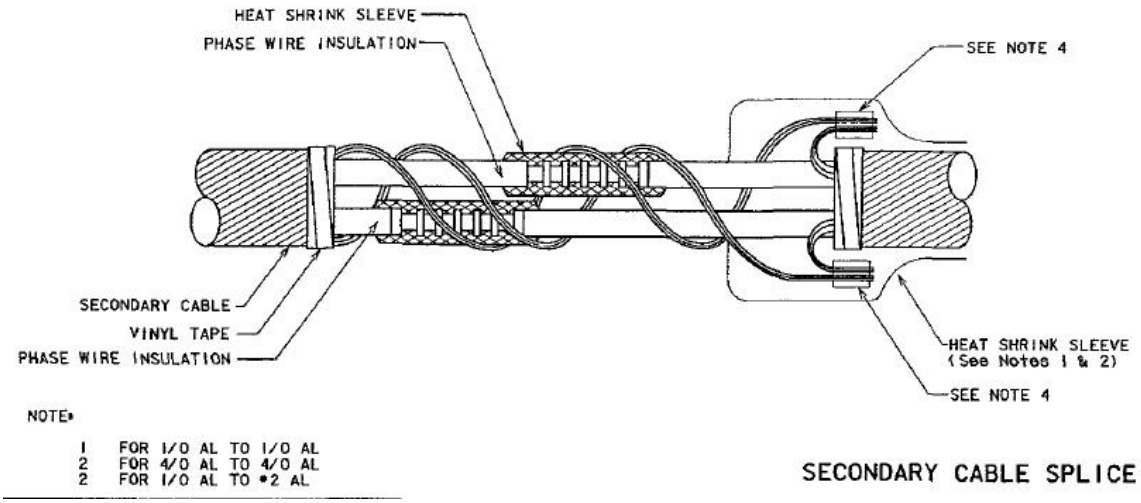
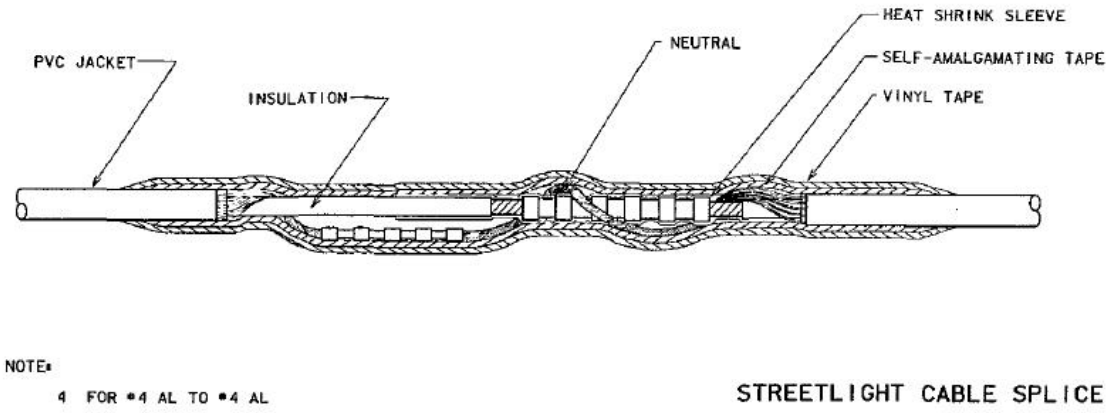
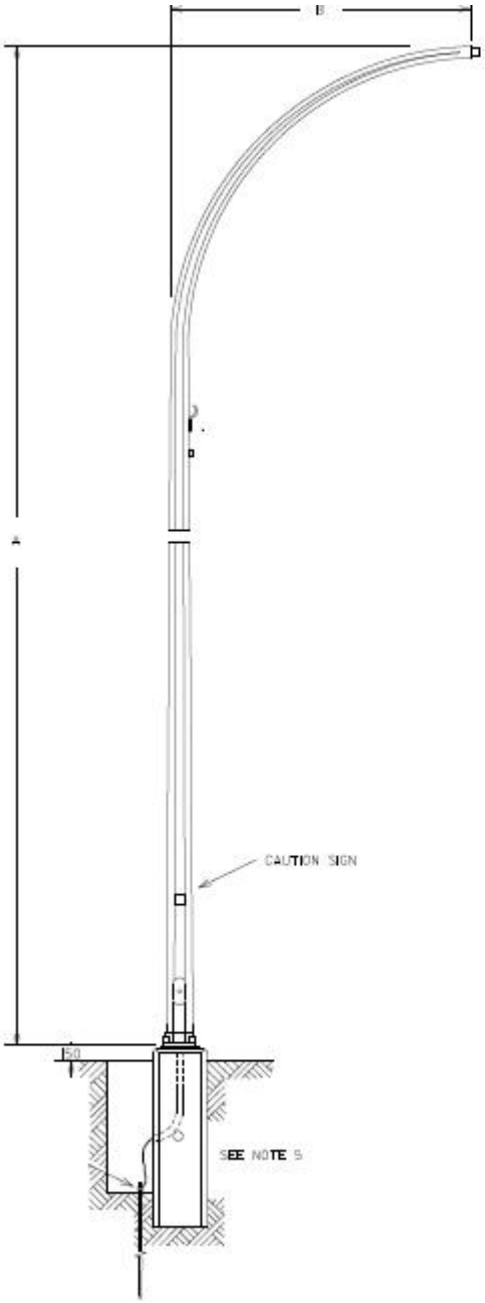


**Figure 10 - Street Light Splice**

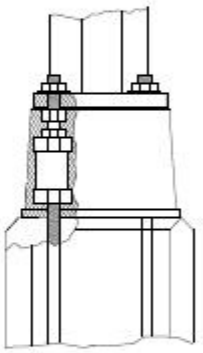



| Item # | UI | -1 | -2 | -3 | -4 | -5 | Description |
|---|---|---|---|---|---|---|---|
| 5511102 | | | | | 1 | | SLEEVE, TENS SPLICE, #4 ASC:SB & #4ASC |
| 5511254 | | | | | 1 | | SLEEVE, TENS SPLICE, #6 CU 7 STR |
| 5512110 | | | 2 | | | | SLEEVE, JUMPER, 4/0 ASC AND ASC:SB |
| 5512112 | | | | | | 2 | SLEEVE, JUMPER, 266.8MCM ASC:SB REDWOOD |
| 5512302 | | | | 2 | | | SLEEVE, JUMPER, 1/0 AL TO #2 CU |
| 5530150 | | | | | | 2 | CONNECTOR, COMP. PG, COPPER, 1/0 TO 1/0 |
| 5530152 | | 2 | 3 | 2 | | | CONNECTOR, COMP PG, CU, U/G NEUT |
| 5551201 | | | | | 2 | | SLEEVE, HEAT:SHRINK EXP ID .75" 12" LONG |
| 5551203 | | 2 | | 2 | | | SLEEVE, HEAT:SHRINK EXP ID 1.5 12" LONG |
| 5551205 | | 1 | 2 | 1 | | 2 | SLEEVE, HEAT:SHRINK EXP ID 2.0" 12" LONG |
| 5553010 | | 2 | | | | | SLEEVE, TENSION SPLICE FOR 1/0 AL |
| 5780306 | | | | | 1 | | TAPE, INSULATING SELF AMALGAMATING 2"WD |
| 5780307 | | 1 | 1 | 1 | 1 | 1 | TAPE, VINYL, 2" WIDE X 30 YD. (MIN.) |
| 5780401 | | 1 | 1 | 1 | 1 | 1 | KIT, UNDERGROUND PREPARATION |

**Figure 11 - Street Light Standard**

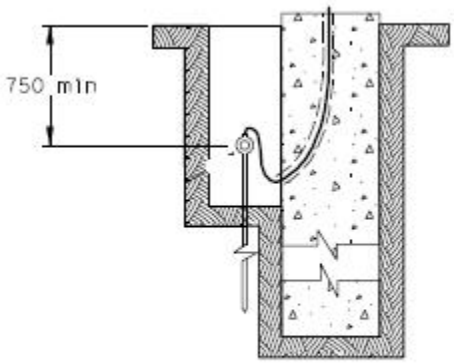



| A | B |
|---|---|
| 30' (9143) | 8' (2440) |



1421
(WITH FRANGIBLE)

| Item # | UI | -1 | -3 | -5 | -6 | -7 | -8 | Description |
|---|---|---|---|---|---|---|---|---|
| 4910305 | | 1 | 1 | 1 | 1 | 1 | 1 | SIGN, "DANGER BURIED CABLE" 1/EA |
| 5310220 | M | | | 2 | 2 | 2 | 2 | CONDUCTOR, STR, #4, CU. |
| 5390901 | M | 12 | 10 | 13 | 17 | 17 | 17 | WIRE, COPPER, 2 #14 SOLID, 600 VOLT, |
| 5571302 | | | | 1 | 1 | 1 | 1 | ROD, GROUND, 5/8" X 8', STEEL |
| 6450160 | | | | | | | | POLE, STEEL,60'X12',S/DAVIT |
| 6450315 | | | | 1 | | | | POLE, STEEL,GALV,30'X 8',S/DAVIT,W/FR |
| 6450321 | | | | | 1 | | | POLE, STEEL,GALV,35'X 8',S/DAVIT |
| 6450351 | | | | | | | 1 | POLE,STEEL,GALV,43'X8',S/DAVIT, W/FR |
| 6450353 | | | | | | 1 | | Pole,steel,galv,43'X12',s/davit,w/fr |
| 6450360 | | | | | | | | POLE, STEEL,GALV,50'X12',S/DAVIT |
| 6450404 | | | 1 | | | | | POLE, STEEL, 22' L, 6' SINGLE DAVIT |
| 6450406 | | 1 | | | | | | POLE, STEEL, 30' L, 8' SINGLE DAVIT |
| 7550205 | | | | 1 | 1 | | | BASE, PRECAST CONCRETE 11" BCD, 5' LONG |
| 7550208 | | | | | | 1 | 1 | BASE, PRECAST CONCRETE, 13" BCD, 7' LONG |
| 7550209 | | | | | | | | BASE, PRECAST HIGH STRENGTH,13" BCD 7' |
| 7550218 | | | | | | | | BASE, PRECAST CONCRETE, 18"BCD, 6.5'LONG |




STREET LIGHT GROUND