DAKOTA® ELECTRIC ASSOCIATION

Your Touchstone Energy® Cooperative

Electric Service Manual

Section 2 – Electric Services

Contents

Section 2 – Electric Services

2.1 New Service Installation Process

To ensure a smooth process, members wanting electrical service for new construction need to contact Dakota Electric to apply for service. The process for service extensions and connections will vary depending upon your needs. The typical process will include:

- Establishing an account with us
- Identifying the service location
- Conveying to Dakota Electric all required right-of-ways
- Paying any required line extension charges

During the process Dakota Electric will request the following information when applying for service:

- Member name
- Contractor name
- Address of new construction
- Type of service requested
- Size of service panel (amps)
- Size and number of service entrance conductors
- Request for electrical inspection permit

- For Multi Family & Commercial services, additionally:
  - Apartment, unit or suite numbers
  - A plot plan designating building or addition location
  - Completed Dakota Electric Commercial and Industrial Information Form

To coordinate your new service installation or for alterations to an existing service, remember to contact Dakota Electric as far in advance as possible to avoid delays:

- For new single-family homes, contact us at (651) 463-6247 and ask for the Utility Service Coordinator

- To coordinate Residential Developments contact us at (651) 463-6373 and ask the Residential Developments Coordinator
  - Please visit the Construction Design Website , for details.

- For Multi-family and all other Commercial Services contact us at (651) 463-6262 and ask for the Commercial Service Coordinator
  - For Commercial Services you will be requested to submit a Dakota Electric Commercial and Industrial Information Form, to provide key design information which is required for Dakota Electric to design your electrical supply.

Special Considerations:
Only approved voltage configurations are available for new or rebuilt electrical services. Please view our Available Electrical Services section for more information.

When the extension for a new service requires crossing public streets or roads or uses public right-of-way, Dakota Electric must comply with government regulations of occupancy and obtain special permits. To obtain permits, the process could require public hearings. The following are some items which may add time to the process for new service extensions:

- When an underground or overhead line will cross the property of others, easements must be obtained from those landowners.
- Trees that endanger the future reliability of a new overhead line must be trimmed or removed.
- All State, County and/or City permits and private easements, must be properly executed and obtained before Dakota Electric can install the service extension.

To transfer ownership of an existing service, either use the start-stop-service page on our web site or contact a Member Service Representative at (651) 463-6212.

2.1.1 Line Extension Policy – General Information

Below are general policies applicable to all extensions of service.

- It shall be the policy of Dakota Electric (DEA) to provide and extend electric service to any member within its service area in accordance with the rate schedules and policies established by the Association.

- Dakota Electric requires that, on overhead services, the member or developer provide all necessary tree clearing of the power line route which is outside the public right-of-way. Clearing includes removal of any debris as a result of tree cutting, as may be required. The typical required width of the right-of-way to be cleared is 10 feet on each side of the power line. Dakota Electric will provide all necessary tree trimming on new overhead service extensions within the public right-of-way. It is the goal of Dakota Electric to cooperate with the member to save as many trees as possible, without jeopardizing the reliable operation of the power line.

- The member shall pay the cost of any subsequent relocation or rearrangement of any portion of the Association's system made to accommodate their needs or to accommodate alterations in grade.

- Equipment, such as motors and generators that are interconnected with the Association, shall not cause objectionable voltage flicker on the distribution system. The member shall apply starters/controllers to the motors, as required,

to limit the starting currents to levels acceptable to the Association. For interconnected generation, the member shall design and operate the generation system and the load transfer to and from the generation system, so as not to cause objectionable voltage flicker on the distribution system. See Section 2.6.6 for voltage flicker information.

- Metering for all new installations shall meet the requirements of the Association's technical standards for metering, See Section 3.

- All members wiring must meet the applicable requirements of the National Electric Code (NEC), National Electric Safety Code (NESC) and other requirements of the State and local jurisdictions.

2.1.2 Residential Line Extension Policy

Below are requirements specific to new residential service extensions

- Costs
  - The member will be charged a flat fee for an extension of 75 feet or less.
  - For extensions longer than 75 feet, the member will be charged a fee for each additional foot beyond 75 feet.
  - The member will be assessed additional charges if above normal costs are incurred by Dakota Electric to accommodate member installation preferences or the member requests a nonstandard installation.
  - The member will be required to obtain and/or grant easements to the Cooperative for any portion of the extension that is outside a public right-of-way or easement, at no cost to Dakota Electric. The Cooperative will prepare the necessary easement documents and will be reimbursed by the member for costs incurred for property title search, surveying, and recording fees.
  - The member will pay any additional installation costs incurred by the Cooperative because of: Delays caused by the member due to installation of underground facilities after the ground is frozen; surface and subsurface conditions that impede the installation of underground facilities, such as rock formations; paving of streets, alleys or other areas prior to the installation of the underground electrical facilities.
  - The member will also be responsible for costs incurred for any relocation or rearrangement of any portion of the system made to accommodate the member after construction is underway or complete.

- Residential Overhead Service
  - Dakota Electric will furnish and install the overhead service wire between the overhead system and the member-owned service mast. The member will be charged the line extension costs as outlined above.

- Residential Underground Service

- Dakota Electric will install underground primary or secondary wire between the public right-of-way and a Dakota Electric defined Utility Connection Point located no closer than fifty (50) feet from the building. The 50 feet will be measured from the closest point of the building to the Dakota Electric existing or proposed facilities. The member will be charged the line extension costs as outlined above.

- The member is responsible for the installation of the underground secondary wire between the Utility Connection Point and the meter. Dakota Electric will make the connection required at the Utility Connection Point.

- For underground service, the member shall provide a right-of-way strip that is within four (4) inches, plus or minus, of the finished grade, free from obstructions and completely accessible to the Cooperative's equipment prior to installation of the underground extension.

- Application Notes
  - If a member requests an individual residential service extension to a location with no permanent residence, the member will pay the full cost of installation. If a permanent residence is constructed within five (5) years, the member will be refunded the amount less the normal line extension charge at the time the permanent residence is constructed.

  - Dakota Electric's policy is to not install a transformer within 50 feet of a single family residential home.

  - If the closest point of the member's house is within 150 feet of the distribution system in the public right-of-way, the member must install their own secondary wire from the Dakota Electric defined Utility Connection Point.

2.1.3 Commercial Line Extension Policy

Dakota Electric will provide overhead or underground, single-phase or three-phase electric service to commercial (including commercial developments) and industrial members and apartment complexes in accordance with established applicable rates and charges.

Dakota Electric will install, own, and maintain the underground primary service to a Utility Connection Point designated as either a single-phase or three-phase pad-mounted transformer.

An economic analysis will be made for any service that involves abnormally high investments, and/or those with low anticipated revenue. A contribution in the aid of

construction will be required if the estimated investment is not justified by the anticipated revenue.

When underground service is requested, the member shall provide a right-of-way strip that is within four (4) inches, plus or minus, of the finished grade, free from obstructions and completely accessible to the Association's equipment.

The member shall furnish the pad for the pad mounted transformer on underground systems in accordance with specifications provided by Dakota Electric. See Diagrams and Drawings for detailed transformer pad specifications.

The member will pay any additional installation costs incurred by Dakota Electric due to:

- Delays caused by member.
- Installation of underground facilities after the ground is frozen.
- Soil conditions that impair the installation of underground facilities, such as rock formations.
- Paving of streets, alleys or other areas prior to the installation of the underground facility.
- For new services the following are the maximum transformer sizes available:
  - For all single-phase services, a 75 kVA distribution transformer is the largest size available.
  - For 277/480V three-phase services, a 1500 kVA transformer is the largest size available.
  - For 120/208V three-phase services a 500 kVA distribution transformer is the largest size available.
  - Multiple transformers and service entrances will be required when service capacity requirements exceed the maximum available transformer size.
  - Please note: The member cannot parallel multiple transformer services without written Dakota Electric approval of the design and the installation of proper relaying and protection.

2.2 Residential Services

2.2.1 General

There are two methods that services are installed by Dakota Electric, Overhead and Underground. Each type has different installation requirements. In all cases Dakota Electric must be contacted to determine the Utility Connection Point location. Dakota Electric will determine the Utility Connection Point after reviewing the

existing electric facilities in the area and the needs of the new service. Contact the Utility Services Coordinator at (651) 463-6247 to coordinate the installation of any new residential service. It is important that you or your contractor coordinate the installation or modification of the electrical service before starting work with Dakota Electric.

2.2.2 Overhead Services

Overhead electrical service is only available in selected areas, due to municipal codes or clearance issues. All overhead electrical services are required to meet the National Electrical Safety Codes (NESC) requirements. The NESC requires service entrance conductors be connected to the building so that the required clearances from the service conductors to windows, doors, awnings, drain pipes and other parts of the building or other obstructions are maintained. Below are the general installation requirements for overhead residential services.

- The member shall provide safe and adequate anchorage attachment on the building or an approved mast or riser above the roof for Dakota Electric's service connection. Under no circumstances shall service midspan wires be supported by or attached to a roof or other building.

- Where the service wires are to be installed on masonry buildings or where there is no surface suitable for the attachment of the service wires, it will be the electrical contractor's responsibility to install secondary service attachment points.

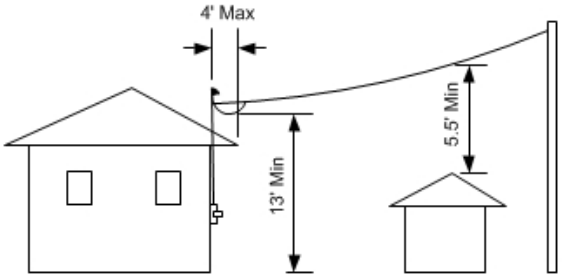
- Where screw-type service knobs can be used by Dakota Electric, the contractor shall indicate the exact location of the studding, joists or frame work suitable to withstand the strain of the service wires. The point must be within two feet of the service entrance head. If construction of the member's building is such that Dakota Electric cannot securely anchor its service drop, Dakota Electric will not connect the service. Dakota Electric is not responsible for damage caused by insecure fastenings or efforts to secure them.

- Where a pipe-type service mast designed for use as a service drop termination is used, Dakota Electric will furnish and install clamp type service wire holders.

- To prevent the entrance of moisture, service entrance conductors shall be connected to the service drop conductors at a point below the level of the service head. This is referred to as the drip loop.

- The clearances shown in section 2.6.1 must be maintained for overhead secondary wires (750 volts or less).

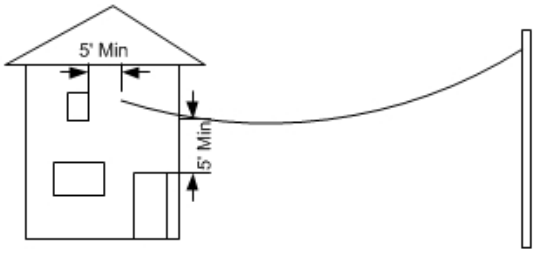
DEA Design Clearance Requirements for Secondary Wires - 750V or Less



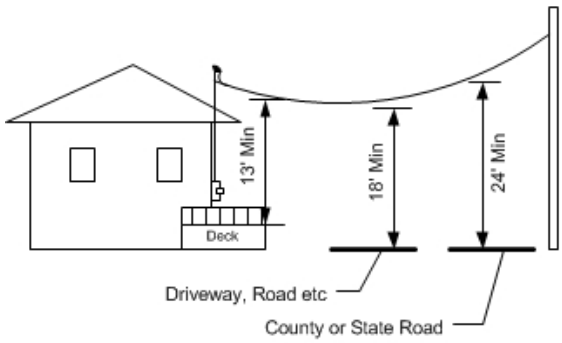
- At least 13ft clearance from any part of the secondary wire to ground where area is subject only to pedestrians. Including balcony or decks.

-At least 5.5ft above roof

- Connection point to the service mast must be no farther then 4 ft from the edge of the roof.
(NEC 230.24 Exceptions)



- Connection point to the structure must be greater than 5 ft from any window or door.
(NESC Table 234.1)



- At least 13 ft over the walking surface of any deck.

- At least 18 ft over any driveway, city roads or other drivable surface.

- At least 24ft over most County and State Roads. (Typical Roadway Permit Requirements)

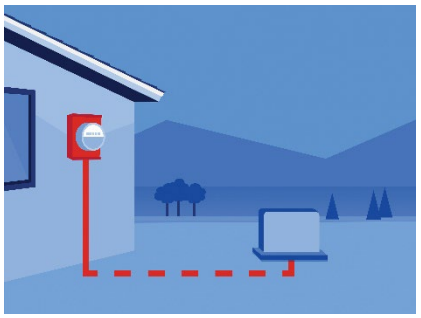
Clearances shown are based upon NESC Table 234. An additional clearance has been added to the required minimum values, to allow the NESC clearances to be maintained throughout the life of the installation, including adverse weather conditions.

- It is recommended that overhead service conductors be about 16-18 feet above ground at point of attachment on the building. Where structure or clearance does not permit this, a maximum of 28 feet or a minimum of 13 feet (including drip loop) shall be maintained.

- If the building is too low to obtain the above minimum clearance, as in the case of a ranch-type house, the member shall install a mast to provide the necessary mounting height. The mast shall be made of at least a 2 inch, galvanized rigid conduit, and shall be of adequate strength or be supported by braces or guys, to safely withstand the strain imposed by the service drop.

- NOTE: Required clearances for electrical wires or cables above or near swimming pools and grain elevators / storage silos, are significantly greater. See the Overhead Clearances Section 2.6.1

2.2.3 Underground Services



Dakota Electric can provide underground electrical service at most locations. Depending upon the existing facilities within the area, the installation can be quick and easy or may require additional installation to extend electrical supply. To avoid costly rework, contact Dakota Electric to review your proposed design and to coordinate location and placement before you move ahead with equipment purchases or installation work.

Underground electrical service could be extended from existing underground facilities or originate from an existing overhead line. Your Dakota Electric Utility Service Coordinator will be glad to talk with you about the different options and costs.

- It is the responsibility of the member or their contractor to install the meter socket and extend the secondary wires to the approved Utility Connection Point. The Utility Connection Point could be a transformer, secondary pedestal or utility pole. Contact the Utility Service Coordinator at Dakota Electric for wiring requirements and charges associated with the installation. The location of the meter socket must be approved by Dakota Electric.

- Underground Residential Service From existing utility poles - Dakota Electric can provide electrical service from most existing overhead facilities. Typically the member's contractor will install secondary wire from the meter socket to the utility pole. A Dakota Electric representative will work with the electrician on the specifics of the installation.

- Dakota Electric does not allow member owner equipment to be mounted on Dakota Electric equipment, including poles. This is due to the significant cost to Dakota Electric to pay for moving the member's equipment to a new pole in the event the existing pole is damaged or otherwise needs to be replaced. Mounting of meter sockets is not allowed on Dakota Electric poles.

- Underground Residential Service of existing underground facilities - Obtaining electric service for a residence from existing underground facilities is easily coordinated with Dakota Electric. If your new home is located within a development, there typically is already an established Utility Connection Point for your lot. Have your electrician contact Dakota Electric to learn how they need to

extend the secondary wire, before they decide where to mount the service and meter socket. The location for the meter socket must be approved by Dakota Electric. See section 3.1.1 for more information on meter locations. The member's electrician is required to run the secondary wire from the home or business to the Utility Connection Point.

- Please note: If your home is not within a platted development, additional coordination will be required. Contact Dakota Electric Utility Service Coordinator, to set up a time for yourself and/or your contractor to meet with Dakota Electric personal to review the options and associated costs.

2.3 Residential Developments

Dakota Electric's Residential Development Coordinator will provide coordination for all new residential developments. A residential development agreement will be required for each development. Contact the Residential Development Coordinator at (651)-463-6373

The developer is required to provide the following information to allow Dakota Electric to design the electrical facilities:

- Developer contact information
- Engineer contact information
- Development Preliminary Plat and Grading Plan
- Development Final Plat and Grading Plan (once available and approved)
- Project Schedule (including start dates and major milestones)

Given the above information, Dakota Electric will design the required electrical facilities and provide payment requirements.

Signed contract and payment must be received by Dakota Electric before electrical facility installation is scheduled for construction. It is important to note that the curb, blacktop and grading must be completed, along with lot corners installed before any electrical installation work can be started.

Key Developer Requirements;

- Provide all required easements for Dakota Electric facilities
- Remove any trees and/or stumps within right-of-way affecting the installation or maintenance of the electrical facilities.
- Establish grades in the easements and right-of-ways that are within four (4) inches of final grade.
- Install Dakota Electric provided conduit for crossings as designated by Dakota Electric.

- Provide required silt fencing and vegetation restoration (including sod).
- Coordinate with Dakota Electric's personnel as required to ensure access and construction efficiency.

2.4 Commercial Services

Contact Commercial Service Coordinator at (651) 463-6262 when installing or upgrading a commercial service.

2.4.1 Commercial Service Requirements

- **Service Size** - In general Dakota Electric will limit the maximum transformer size at any one service to 1500kVA. When the Member's actual load requires a service exceeding a 1500kVA transformer, Dakota Electric requires the service be split into two or more services. Dakota Electric will individually meter each service transformer to ensure proper transformer sizing. The member has the option of receiving a single bill for the multiple services. See Available Electrical Services for more information on available service sizes and voltages.

- **Service Installation Requirements -** Dakota Electric will install the electrical supply including the transformer. The Member is responsible for owning and installing the secondary wires from the secondary of the transformer to the Member's service. Dakota Electric will supply secondary connectors and terminate the Member's secondary cables within the Dakota Electric transformer. The contractor or Member must advise Dakota Electric of their planned service and secondary conductor sizing and quantity.

- **Service Location -** Dakota Electric must approve the location of all Meters and transformer installations. The location of the transformer and meter socket must be reviewed with the Commercial Service Coordinator. The Transformer Location Requirements are very important to be followed to ensure a safe and reliable installation.

- **Load Balance Requirement** - Wiring on three-phase installations shall be arranged so that the individual phase amperages are balances. Difference in amperage between any two-phase wires shall not normally be greater than 20 percent without written approval from Dakota Electric's Engineering Department. Significant load imbalance can result in damage to the service transformer and wires. Significant load imbalance will cause voltage imbalance and that can result in damage to your motors and other equipment.

- **Voltage Flicker and Motor Starting Requirements** - Members are not allowed to start any motors or apply any loads to the Dakota Electric system that produces objectionable voltage flicker for other members connected to the Dakota Electric

system. Dakota Electric has established guidelines to help the member. See Section 2.6.6 for more information.

- **Power Quality** - Dakota Electric will take corrective measures, when possible, to assure the electrical supply voltage is within ANSI standard guidelines. When objectionable disturbances are reported to Dakota Electric, Dakota Electric will strive to determine the source and when possible correct the cause. When the source of the objectionable disturbance is determined to be caused by another member's equipment, Dakota Electric will notify the member, and that member will be responsible for correcting the problem.

    - While Dakota Electric is very proud of its service reliability the following are typically outside the control of Dakota Electric and are not always possible to resolve.
        - Service Interruptions (Dakota Electric does not provide uninterruptible electric service)
        - Voltage & Current Sags / Swells due to;
        - Events on the system, including lightning, trees, animals, vehicles etc.
        - Operation of utility protective devices, including fuses, breakers, recloser etc.

2.5 Temporary Services

"Temporary Service" is any service for a construction project, carnival, temporary display, temporary lighting, etc… which is not expected to continue in use for a period long enough to justify a permanent service installation. For a basic temporary service connection, the member will be billed at the current flat rate. For a temporary installation when a primary extension is required, the member will pay in advance the estimated cost of installing and removing, less salvage.

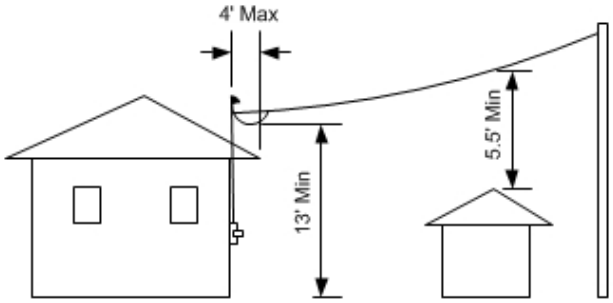
Guidelines for Temporary Services - The member shall provide a service structure which meets the requirements of a temporary installation with respect to service-drop clearances, metering, grounding and safety. Prior to installation, the member should contact Dakota Electric for relative information including location of connection point, size of load, cost, and regulations or requirements.

- For Residential Temporary Services contact Utility Service Coordinator at (651) 463-6247
- For Commercial Temporary Services contact Commercial Service Coordinator at (651) 463-6262

2.6 Technical Information

2.6.1 Overhead Clearances

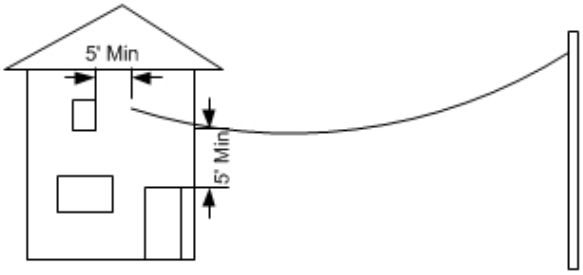
DEA Design Clearance Requirements for Secondary Wires - 750V or Less



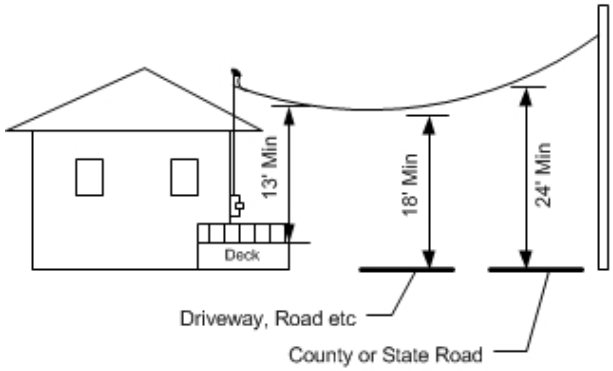
- At least 13ft clearance from any part of the secondary wire to ground where area is subject only to pedestrians. Including balcony or decks.

-At least 5.5ft above roof

- Connection point to the service mast must be no farther then 4 ft from the edge of the roof.
(NEC 230.24 Exceptions)



- Connection point to the structure must be greater than 5 ft from any window or door.
(NESC Table 234.1)



- At least 13 ft over the walking surface of any deck.

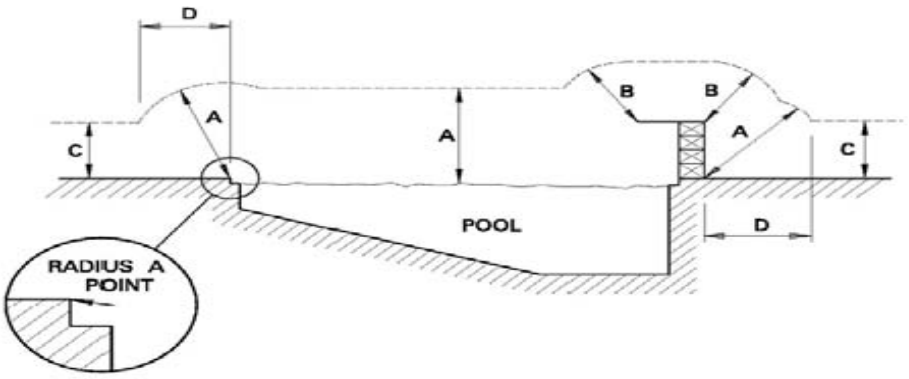
- At least 18 ft over any driveway, city roads or other drivable surface.

- At least 24ft over most County and State Roads. (Typical Roadway Permit Requirements)

Clearances shown are based upon NESC Table 234. An additional clearance has been added to the required minimum values, to allow the NESC clearances to be maintained throughout the life of the installation, including adverse weather conditions.

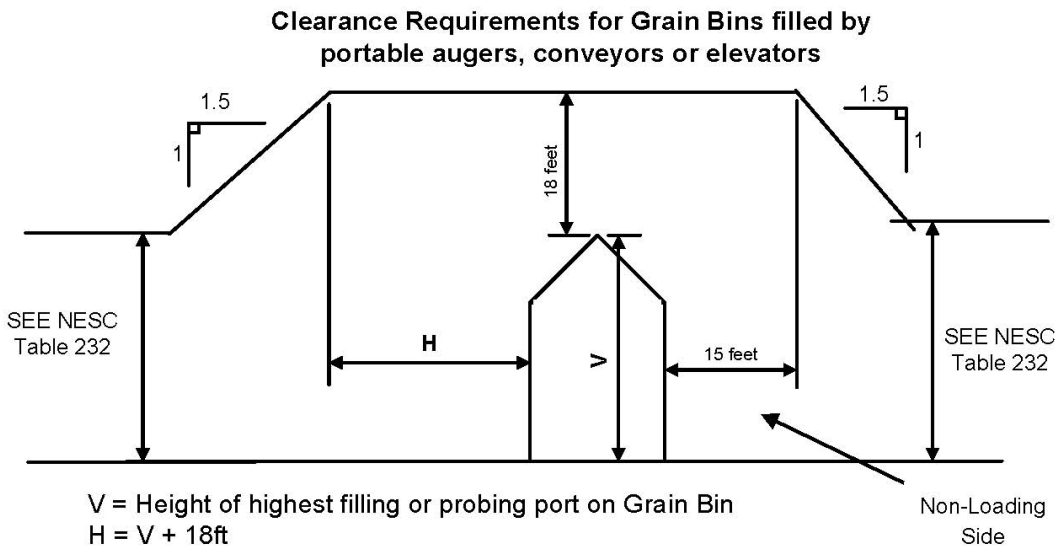
- Swimming Pools
  Required clearances for wires above or near swimming pools and are significantly greater.
  - Below are the NESC and NEC required minimum clearance distances for Swimming Pools.
  - It is Dakota Electric's policy to not install new secondary or primary lines above a swimming pool. We request that members do not install swimming pools under existing wires, even if the code clearances are maintained.

Clearance Requirements for Swimming Pools



	CASE	Wire or Cables operated at 0-750V	Wires or Cables operated at 751V to 50kV
A.	Minimum clearance in any direction from the water level, edge of pool, base of diving platform or anchored raft.	23 Feet	25 Feet
B.	Minimum clearance in any direction to the diving platform or tower.	15 Feet	17 Feet
C.	Vertical clearance over adjacent land	Overhead Service Requirements Section 2.6.1	See NESC table 232

- Grain or Other Storage Facilities
  The NESC has special clearance requirements for grain bins, or other storage facilities where permanent or portable augers, conveyors, or elevators are used.
  - It is important to contact Dakota Electric design personnel before the concrete pad for the bin is poured, to confirm the proper clearances are achieved.
  - Below is the NESC minimum required clearances for grain bins filled by portable loading systems. For other types of facilities contact Dakota Electric, Commercial Service Coordinator at (651) 463-6262.

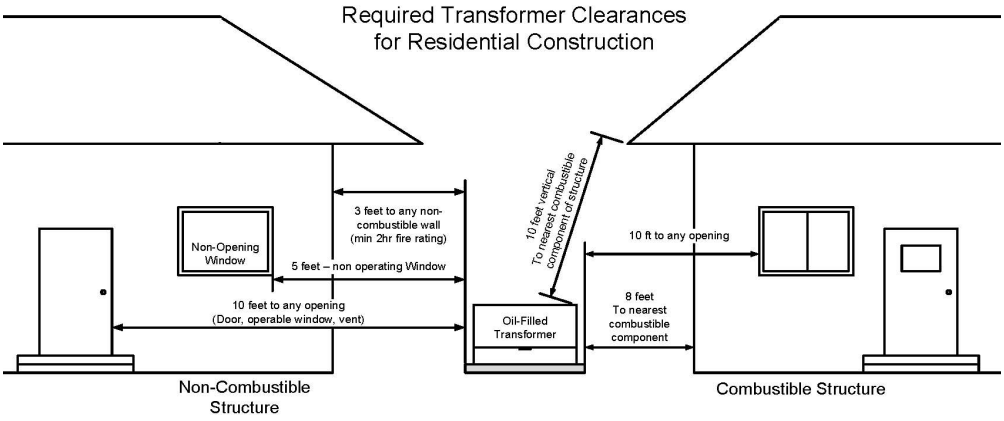


2.6.2 Transformer Location Requirements

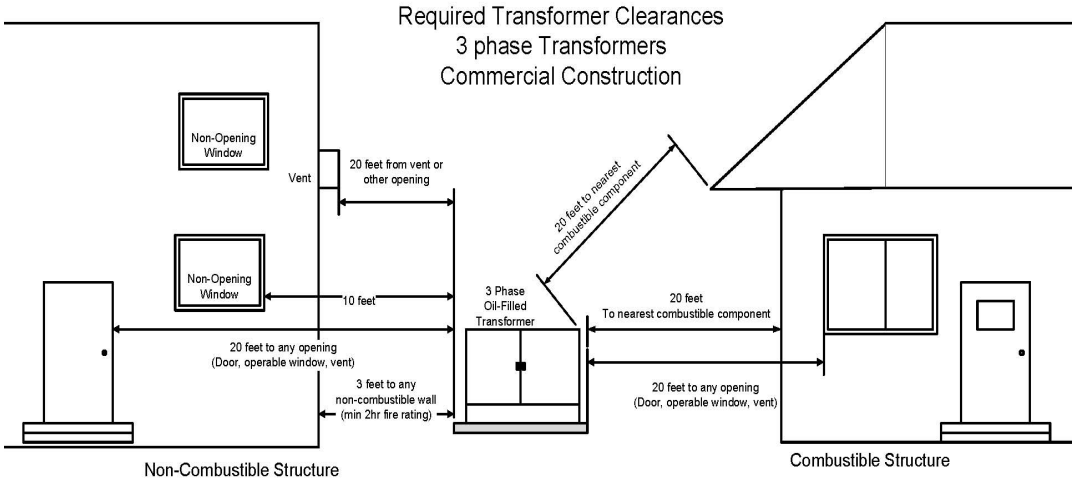
All Distribution transformers used by Dakota Electric contain Mineral Oil. The oil is flammable and thus the transformers need to be installed to reduce the potential for transformer fire to cause damage to a structure. The transformers are also heavy and need to be replaced using large vehicles with heavy lifting equipment. Adequate space needs to be provided to allow for quick removal and replacement of failed transformer to allow restoration of service. The following are Dakota Electric's required standards for new installation of distribution pad mounted transformers. These minimum distances are based upon several national codes and standards.

- For all single family residential homes, Dakota Electric policy is to not install a transformer any closer than 50 ft from the structure.

- **Single Phase Padmount Transformers** shall be installed no less than:
  - 3 ft from non-combustible walls (min 2hr fire rating)
  - 8 ft from any combustible wall or surface
  - 10 ft from permanent (non-opening) windows
  - 10 ft from building openings, such as louvers, windows and doors (Residential)
  - 10 ft from gas meters
  - 20 ft from storage containers for flammable liquids or gas



- **Three Phase Padmount Transformers** shall be installed no less than:
  - 3 ft from non-combustible walls (min 2hr fire rating)
  - 20 ft from combustible walls or components
  - 10 ft from permanent (non-opening) windows
  - 10 ft from gas meters
  - 20 ft from windows which open, doors, vents and other openings, such as louvers
  - 20 ft from any fire escape
  - 20 ft from storage containers of flammable liquids or gas



- Three phase transformers require greater clearances then single phase, due to their larger tank size and the greater quantity of mineral oil contained within.

- Note: Transformers which are exposed to traffic shall be protected by 8 inch steel posts, filled with concrete when located in traffic area and each corner of

the transformer exposed to traffic must be protected by a steel bollard. See Bollard Specification

- A minimum of 3 ft of working space must be maintained from each side of the transformer to allow for normal dissipation of the heat from the transformer and transformer replacement.

- A minimum of 10 ft of working space from the front (door side) of the transformer must be maintained to allow for field crew operation of the transformer. If a fence or solid wall is constructed around the transformer, at least one side (the side with the door) must remain open for cooling and access for the field crews for switching and transformer replacement.

- Due to the need for cooling and the flammability of the oil, distribution transformers shall not be installed in any enclosed structure with both walls and roof.

- All metal equipment (Cabinets, controls, pipes) located within 6 ft of a distribution transformer must be bonded to the transformer ground. This is required by the NESC and is designed to reduce the possibility of a person contacting both metal surfaces, when they are at different potential levels and resulting in the flow of current through the body.

- All three phase pad-mounted transformers are required to be installed on cement pads, meeting the requirements of Dakota Electric. The member / owner is responsible for providing the pad for the transformer.
    - Pad specification for transformers up to 300kVA
    - Pad specification for transformers 500kVA – 2000kVA

2.6.3 Distribution Transformer Mineral Oil Information

The oil used in transformers is called an insulating oil or mineral oil. The transformer oil has the following functions:

- Prevention of electrical discharges between the transformer coils: corona and arc (insulating)

- Removal of heat generated by the transformer (cooling). The transformer oil is forced by natural convection to circulate through the coils and carry the heat away from the coils. Larger transformers have cooling fins that enhance the cooling capability.

- The transformer oil is usually a highly-refined mineral oil that is stable at normal operating temperatures. ASTM standard D3487 "Standard Specification for Mineral Insulating Oil used in Electrical Apparatus" provides additional information about the mineral oil used in distribution transformers.

- The oil may burn, but will not ignite readily. The following are some typical properties for the mineral oil used in distribution transformers.

Mineral Oil Properties (Typical)	
Appearance	**Clear Brown**
Pour Point	**-40 Deg C / -40 Deg F**
Flash Point	**>145 Deg C / >290 Deg F**

2.6.4 Arc Flash & Fault Currents

Proper protection and coordination is important to the safety and reliability of the electrical system. When designing the electrical equipment for a facility, knowing the available fault current levels is important. The actual fault current available from the Dakota Electric system changes hourly and is dependent upon many factors. The actual available fault current changes as generation is added and subtracted from the system and as the distribution system is reconfigured for maintenance, construction or permanent load transfers. Also, over time, as the electrical system grows the actual available fault current levels are increasing.

Fault Current

For 120/240 residential, single-phase construction, Dakota Electric's design standard is to keep the maximum available fault current below 10,000 amps. Most single-phase meter sockets and service entrance equipment is designed to handle up to 10,000 amp of fault current.

For commercial installations the maximum fault current level is dependent upon the size (kVA) of the transformer supplying the facility. To provide the electrical designer available fault current numbers which will be usable for the expected life of the facility, Dakota Electric calculates the maximum fault current possible through a distribution transformer. All services need to be sized and designed to handle these fault current levels.

Transformer Max Fault Current Values are provided at the secondary of the distribution transformer. These values are calculated assuming minimum expected transformer impedance and zero source impedance for the primary electrical system.

Three Phase Underground Services			
(kVA)	**Minimum Impedance Percentage**	**120/208V 3Ø or Ø-G Fault (amps)**	**277/480V 3Ø or Ø-G Fault (amps)**
45	1.3	9,610	4,170

75	1.5	13,880	6,020
112.5	1.5	20,820	9,020
150	2	20,820	9,020
225	2.25	27,760	12,030
300	2.25	37,010	16,040
500	2.25	61,680	26,730
750	3.6	--	25,060
1000	4.25	--	28,300
1500	4.25	--	42,450
2000	5.25	--	45,800

Three Phase Overhead Services						
(kVA)	**Minimum Impedance Percentage**	**120/208V 3Ø or Ø-G Fault**	**277/480V 3Ø or Ø-G Fault**	**240/120V 4 Wire Delta 3Ø Fault**	**240/120V 4 Wire Delta Ø-G Fault**	**480V Delta 3Ø Fault**
45	1.5	8,330	3,610	7,220	8,080	3,610
75	1.5	13,880	6,020	12,030	13,470	6,020
112.5	1.5	20,820	9,020	18,040	20,210	9,020
150	1.5	27,760	12,030	24,060	26,950	12,030
225	1.7	36,740	15,920	31,840	35,660	15,920
300	1.7	48,990	21,230	42,450	47,550	21,230
500	1.7	81,640	35,380	70,760	79,250	35,380
750	2	104,090	45,110	90,210	101,040	45,110

Single Phase Underground and Overhead Services					
(kVA)	**Minimum Impedance Percentage**	**120/240V L-L Fault**	**120/240V L-G Fault**	**120V L-L Fault**	**480V L-L Fault**
10	1.5	2,780	4,360	5,560	1,390
15	1.5	4,170	6,540	8,330	2,080
25	1.5	6,950	10,900	13,890	3,470
37.5	1.5	10,420	16,350	20,830	5,210
50	1.5	13,890	21,810	27,780	6,940
75	1.7	18,380	28,860	36,770	9,190
100	1.7	24,510	38,480	49,020	12,260
167	1.7	40,930	64,260	81,860	20,470
250	2	52,080	81,770	104,170	26,040

Arc-Flash

NFPA and NEC are continuing to improve the safety of the electrical facilities. Proper labeling for Arc-Flash is one of those requirements. To support Arc-Flash studies, Dakota Electric's Engineering department can run a study to provide the maximum and minimum fault currents at a given location. It is very important that these actual fault current levels are not used to size the service equipment, as the actual fault current levels may increase over time. Any fault current values provided for Arc-flash studies are reflective of the present normal electrical configuration and are subject to change without notice.

Many times we receive requests for the X/R ratio of the distribution system supplying the Member's system. Dakota Electric does not provide X/R ratios as these values vary considerable by daily generation, transmission and distribution configuration changes. The good news is neither of the common methods used for calculating arc-flash energy require the X/R ratio.

Dakota Electric provides:

- The present system maximum expected fault current on the source (12.5kV) side of the distribution transformer
- The present system minimum expected fault current on the source (12.5kV) side of the distribution transformer
- The minimum impedance and typical impedance for the distribution transformer
- The transformer fuse protection

2.6.5 Transformer Fusing Standards

Fusing Chart for Transformers					
KVA	**1-phase Overhead**	**1-phase Pad-mount**	**Fuse Amps**	**3-phase Pad-mount**	**Fuse Amps**
1	1 ½ X				
1 ½	1 ½ X				
3	1 ½ X				
5	1 ½ X				
7.5	1 ½ X				
10	2 X	RTE-358C03	3		
15	2 ½ X	RTE-358C03	3		
25	5 ½ X	RTE-358C05	8		
37.5	7 X	RTE-358C08	15		
45				RTE-358C03	3
50	10 X	RTE-358C08	15		
75	15 T	RTE-358C10	25	RTE-358C05	8
100	20 T	RTE-358C10	25		
113				RTE-358C08	15
150				RTE-358C08	15
167	30 T	RTE-358C12	50		
225				RTE-358C10	25
300				RTE-358C10	25
500				RTE-358C12	50
750				RTE-353C14	65
1000				RTE-353C16	100
1500				RTE-353C17	140

Single phase Padmounted Transformer Protective Fusing		
Transformer kVA	**RTE Bay-o-net Fuse Catalog #**	**RTE Isolation Link Catalog #**
10	4000358C03	3001861A01M
15	4000358C03	3001861A01M
25	4000358C05	3001861A02M
37.5	4000358C08	3001861A03M

50	4000358C08	3001861A03M
75	4000358C10	3001861A05M
100	4000358C10	3001861A05M

Three Phase Padmounted Transfomer Protective Fusing		
Transformer kVA	**RTE Bay-O-Net Fuse Catalog #**	**RTE Isolation Link Catalog #**
45	4000358C03	3001861A01M
75	4000358C05	3001861A02M
112.5	4000358C08	3001861A03M
150	4000358C08	3001861A03M
225	4000358C10	3001861A05M
300	4000358C10	3001861A05M
500	4000358C12	3001861A06M
750	4000358C14 *	3001861A05M
1000	4000358C16 *	3001861A05M
1500	4000358C17	3001861A05M
2000	3038361C05CB **	3001861A05M

* Note change to 353 series RTE bay-o-net fuses

** High amp RTE bay-o-net fuse

2.6.6 Flicker & Motor Starting

Voltage Flicker is caused when there is a large step change in the electrical demand. Typically, voltage sags result from the starting of large motors or the connection of very large loads to the system. Other loads supplied by the same electrical system see the drop (or rise) in voltage and can be affected.

For example, the light output from an incandescent lamp is directly related to the voltage. A drop in the system voltage will result in a drop in the output of the lamp. The larger the reduction in the voltage the greater the reduction in the light levels. For a single motor starting, like with a home air-conditioner, this voltage reduction is small and may occur a couple of times per hour and is typically not objectionable. For equipment like arc-welders, which are turning on and off many times per hour and causing significant voltage flicker this can be more objectionable. If the voltage sag is large enough, some equipment may turn off or reset during the voltage sag. A good example of this is a personal computer (PC). While they are not generally affected by typical voltage changes; if the voltage sag is below 111-113 volts the computer may reset and if this occurs frequently, the computer could be damaged.

It is the responsibility of the person causing objectionable voltage flicker to correct the problem they are creating. Table 1, documents reasonable levels, below which voltage flicker should not be objectionable. Reasonable limits for other starting frequencies can be interpolated from the table or derived from the IEEE Standard 141-1993 flicker curve graph Figure 1.

Figure 1: Flicker Curve

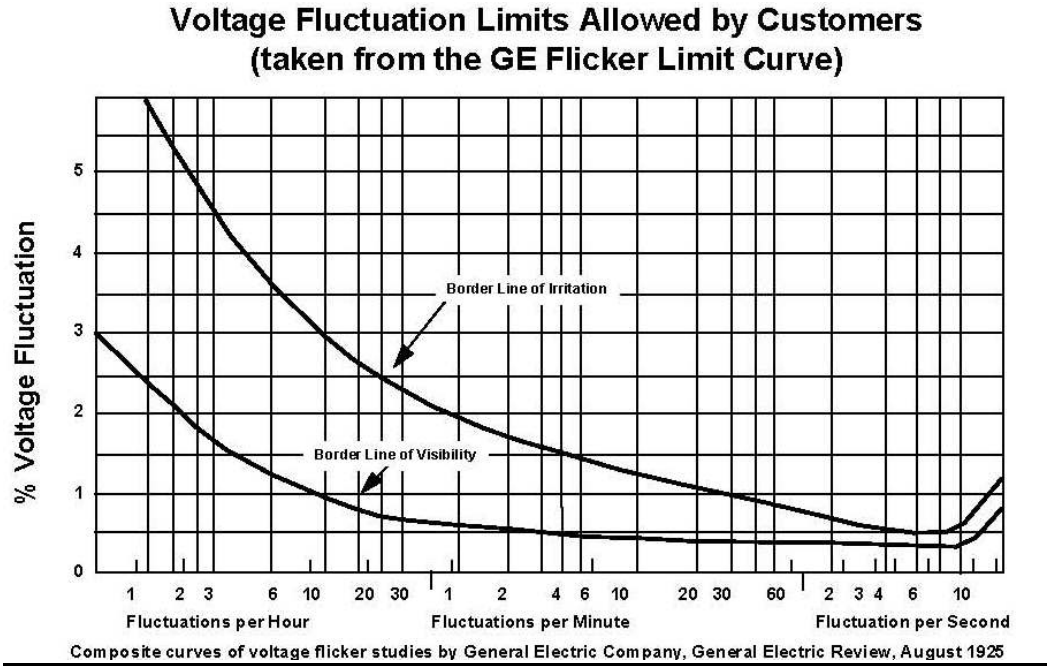


Table 1. Voltage Flicker Limits

Motor Starting Frequency	**On DEA Primary 12.47 kV System**	**At Customer's Connection to DEA Facilities**	**At Customer's Utilization Locations ***
1 per Hour or greater	3.0 %	4.0 %	6.0 %
5 per Hour	1.7 %	2.5 %	3.5 %
20 per Hour	1.0 %	1.5 %	2.5 %

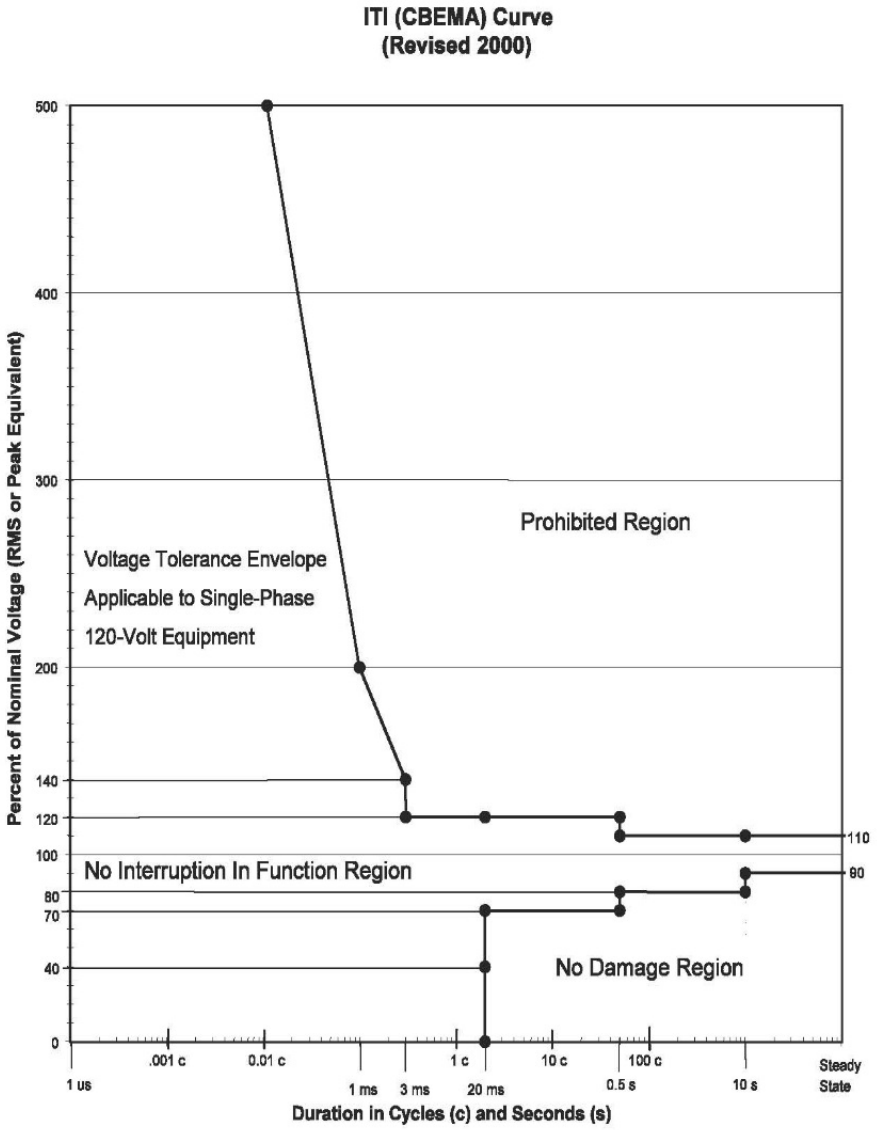
* This level is only shown for reference and is not a Dakota Electric limit.

The limits established for the three columns are based on the perception of flicker at different frequencies of occurrence from IEEE Standard 141-1993 and the relative number of customers that would be affected. Flicker imposed on the

Dakota Electric 12.47 kV primary lines must be limited to just above the borderline of visibility since it can affect many other customers on the feeder.
The flicker at the customer's connection to Dakota Electric facilities is pertinent when other customers are served from the same transformer. The other customers will be subjected to the flicker levels seen at this common connection point. Its location is typically at the secondary terminals of the transformer or a secondary pedestal. The limits for this situation are defined as midway between visibility and the borderline of irritation.

The last column in table 1 shows recommended flicker limits for other utilization locations on the motor owner's electrical system. A good electrical design will hold the maximum voltage flicker at the utilization points to the levels shown or better. The limits listed, are just below the borderline of irritation. It is the customer's choice what level of voltage flicker they will impart upon their facilities.

Voltage sag limitations are normally less of a constraint than voltage flicker. Dakota Electric uses the ITI Voltage Tolerance Envelope (CBEMA Curve) as a guideline to evaluate effects of voltage sags. Equipment should tolerate voltage sags to 80% of the nominal service voltage for up to ten seconds and to 90% continuously according to the voltage tolerance limits. Most motors should be up to speed within the ten second timeframe. If starting times exceed ten seconds, voltage sags need to be limited to 90% of the nominal service voltage.



NEMA Standards address voltage sag tolerance requirements for motors. The NEMA standards require motors to start with motor terminal voltages as low as 90% of their nameplate voltage rating. This corresponds to about 86% of the nominal service voltage.

Table 2, lists the minimum starting voltage at the motor terminals for the different service voltages. Voltage sags below these levels may cause motors to experience starting problems. The voltage sags limits in Table 3 are more restrictive than the ITI Voltage Tolerance Envelope. As such, if these voltage levels are maintained at the motor terminals during starting, there should not be any voltage sag problems with other equipment.

Table 2. Minimum Starting Voltage at Motor Terminals

Nominal Service Voltage	Motor Nameplate Voltage	Minimum Motor Terminal Voltage During Starting
120	115	103.5
208	200	180.0
240	230	207.0
480	460	414.0

Table 3, showing starting current limitations, has been developed to provide customers with guidance regarding the size of motors that can be started without violating voltage flicker and sag limitations on the DAKOTA ELECTRIC 12.47 kV primary system. Starting currents may need to be further constrained due to effects on the secondary side of the transformer, if there are other customers served from the same transformer. These limits allow single-phase motors up to 15 horse power and three-phase motors up to 60 hp to be started without reducing the starting current, provided the motor design is NEMA "G" or better.

Table 3. Maximum Starting Current Limits

Single-Phase 240 volt	400 Amps
Three-Phase 208 volt	1000 Amps
Three-Phase 240 volt	900 Amps
Three-Phase 480 volt	450 Amps

Starting currents may need to be further limited if they cause adverse effects for other customers or if starting frequency exceeds four starts per hour.
The starting current limitations are applied to the sum of motor starting currents if multiple motors are started simultaneously.
Dakota Electric Engineering should be consulted to evaluate flicker and voltage sags on the secondary of the specified transformer if a large motor is being supplied from a transformer serving multiple customers. It is the customer's responsibility to make certain that their own electrical system is capable of handling the permitted starting currents without excessive voltage drop or flicker.
Motor starting current is considered to be the same as the locked-rotor current when started at full voltage. Motors with higher locked-rotor currents than shown may be operated if used in conjunction with a device designed to limit starting currents to the specified values. Such devices include reduced voltage, autotransformer, and wye-delta starters, as well as variable speed drives. In addition, higher starting currents may be allowed in some areas of the Dakota Electric system if approved by Dakota Electric Engineering (based on the results of engineering design studies). In any case, a customer causing service interference to others will be responsible for the costs of any corrective actions.

2.6.7 Available Electrical Services

Dakota Electric provides service voltages which are the common service voltages utilized in the industry and provides the diversity necessary to meet the Member's needs. There are many ways possible to electrically wire a member's load with electricity.

Available Service Voltages for New Services				
		Max Transformer kVA	**Transformer Voltage**	**Max Service Size (1)**
Residential Single Phase - Overhead or Underground				
120 / 240 -3 wire		75 kVA	240 / 120	400 amp
Commercial Single Phase – Overhead or Underground				
120 / 240 - 3 wire		75 kVA	240 / 120	400 amp
240 / 480 - 3 wire		75 kVA	480 / 240	200 amp
Commercial Three Phase				
Overhead	208Y / 120 - 4 wire Wye	225 kVA (3-75 kVA)	120 V (3)	1000 amp
Underground	208Y / 120 - 4 wire Wye	500 kVA	208Y/120 3-PH	2000 amp
Overhead	480Y / 277 - 4 wire Wye	225 kVA (3-75 kVA)	277 V (3)	1000 amp
Underground	480Y / 277 - 4 wire Wye	2000 kVA	480Y/277 3-PH	3000 amp
Primary Metered Service – Overhead or Underground				
7.2 / 12.47kV 4 wire Grounded Wye		----	----	10 MVA

There are limited locations where Dakota Electric has chosen to install a two-phase primary line. It is possible to provide three-phase 120/240 or 240/480 volt services using an “open Delta” configuration. This type of service is limited to a maximum of 200 amp service (75 kVA of load) for new connections. These connections require special engineering and will only be made available for special temporary applications, where normal three-phase primary is not available. If three-phase primary is available then these “open Delta” configuration shall not be used for new or rebuilt services.

Special Service Voltages				
		Max Transformer kVA *	**Transformer Voltage**	**Max Service kVA ****
Commercial Three Phase Service supplied with Two Transformers				
Overhead or Underground	Open Delta Secondary 240 / 120 - 4 wire	2-50 kVA	240 / 120 (2)	200 amp 75 kVA
Underground	Open Delta Secondary 480 / 240 - 4 wire	2-50 kVA	480 / 240 (2)	200 amp 75 kVA

* Note: Transformers connected in an open delta configuration have only 86.6% of their combined nameplate rating. This is a relatively inefficient connection, where three-phase loads are predominate and should not be used if three primary phases are available.
** Note: Motor loads on Open Delta services are limited to 50 HP or less. Exceptions to the above rules may be made when clearly warranted, due to unusual engineering or economic circumstances.

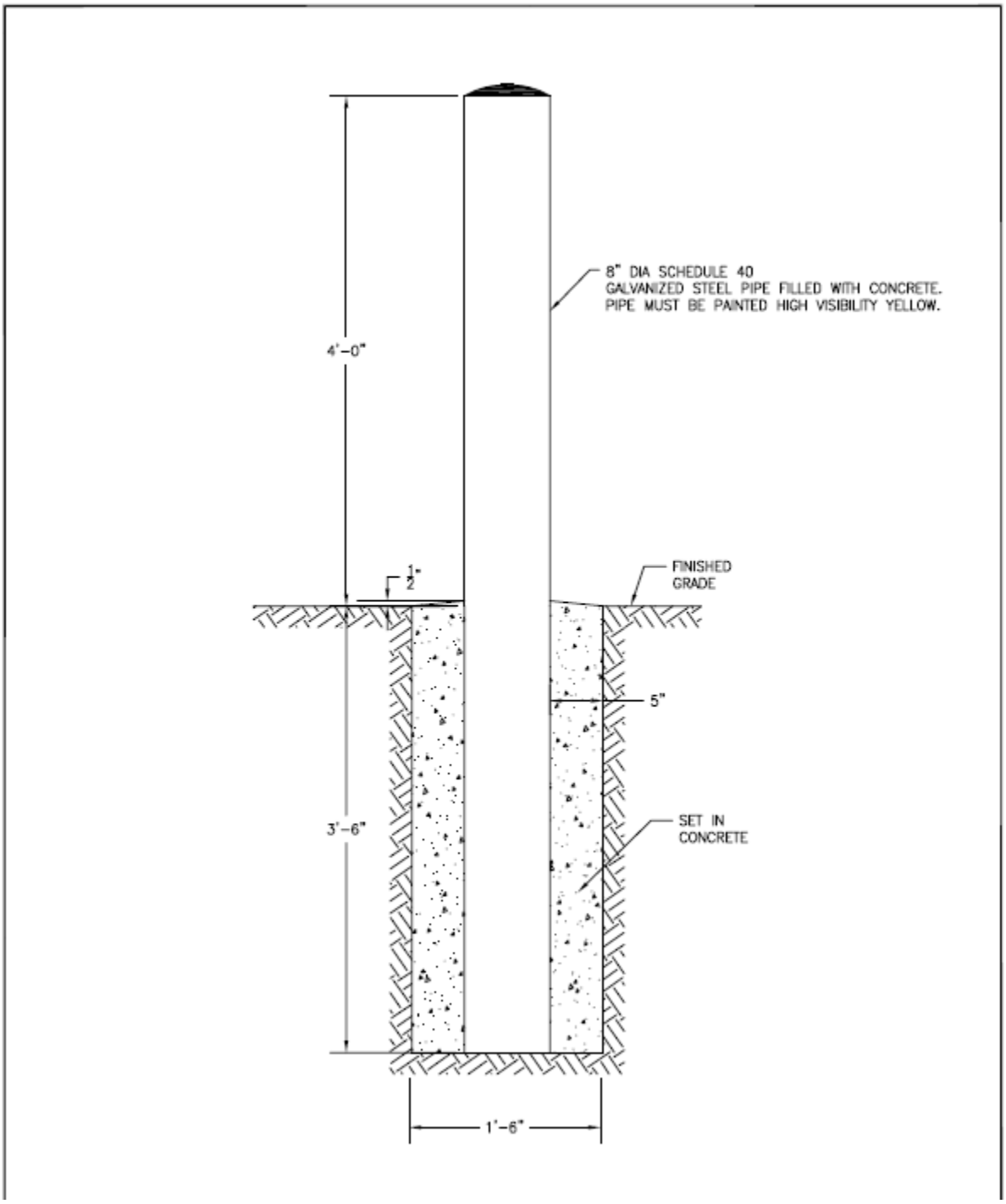
Unavailable Voltages:

The following voltages and services not available for new installations;

- Single Phase 120V
- Three-phase 120/240, four wire Delta. If required a 120/208 4-wire Wye service with the member utilizing a dry type transformer for all 240V loads shall be used.
- Three-phase 480V Delta
- Three-phase 240V Delta
- No Three-phase, three-wire services are available for new installations or rewires.

2.6.8 Bollard Specification

Each pad mount transformer pad that will be near vehicle traffic will need a steel bollard installed on each corner facing traffic. The diagram is below. For a full page print out, click here.



2.6.9 Glossary

- **Cold Sequence Metering** – Self-contained metering using a fully rated disconnect (Meter Switch) installed on the utility side of the metering to allow the metering to be de-energized to allow metering work to be safely completed.

- **Current Transformer** - A current transformer (CT) provides a current on its secondary terminals that is proportional to the current in the primary circuit. Current transformers are used in metering and protective circuits to step down the current to levels which can be easily utilized.

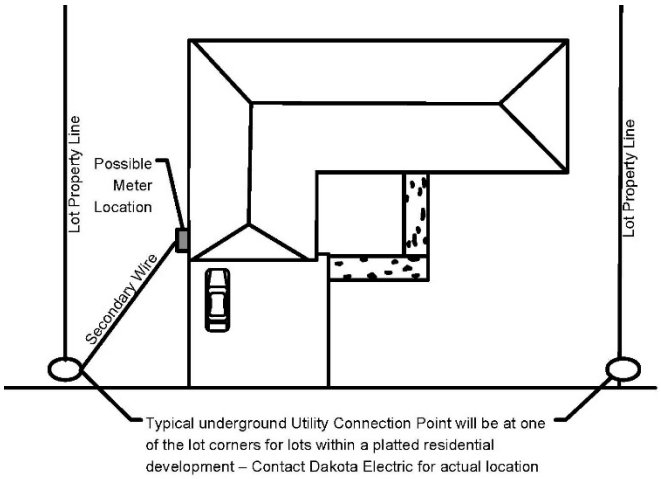
- **Meter Switch** - This switch is used to interrupt power to a meter and the load. This switch is also used to de-energize a meter to allow it to be safely removed or installed. This is referred to as cold sequencing a meter.

- **Member –** Dakota Electric Association "customer", as a not for profit cooperative everyone who received electric service from Dakota Electric is a member of the Dakota Electric Association.

- **Self-Contained Meter** - A self-contained meter is designed to carry the full rated current of the circuit being metered and being energized at the line voltage. It does not require auxiliary instrument transformers to step down line current or voltage.

- **Transformer Rated Meter** - When the electrical supply needs of the load exceed the rating of a self-contained meter, instrument transformers are used. Current and voltage transformers are used to step down the current and voltage of the circuit to levels which then can be measured by the meter.

- **Utility Connection Point** - This is the point where the Dakota Electric owned facilities are connected to the Member owned facilities. For residential this is typically in a transformer or pedestal; for underground commercial service this is typically in the Dakota Electric distribution transformer.



- **Voltage Transformer** - A voltage transformer (VT) also known as a potential transformer (PT), provides a voltage on its secondary terminals that is in proportion to the voltage of the circuit. Voltage transformers are used in metering

and protective circuits to step down the voltage to levels which can be easily utilized.

2.6.10 Codes and References

The following is a brief list of applicable codes and other references which are used in the electric service handbook. *Note - Many links on this page link to web sites that are external to Dakota Electric and thus Dakota Electric does not control the content of these sites.*

- EMF - Electric and Magnetic Fields - are invisible lines of force associated with the production, transmission and use of electric power. For more information on the health aspects of EMF we recommend you go the National Institute of Health web site.

- IEEE - Institute of Electrical and Electronics Engineers (IEEE), the world's largest professional association who's core purpose, is to foster technological innovation and excellence. IEEE hosts various standards committees and publishes and maintains those standards.

- National Electrical Code (NEC) - Published by the National Fire Protection Association (NFPA), the National Electrical Code covers the installation of electrical facilities in public and private structures, commercial and industrial facilities.

- National Electrical Safety Code (NESC) - Published by the IEEE, the National Electrical Safety Code sets the ground rules for practical safeguarding of persons during the installation, operation, or maintenance of electrical supply and communication lines and associated equipment.