ARTICLE 20:10

PUBLIC UTILITIES COMMISSION

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CHAPTER 20:10:39

STRAY ELECTRICAL CURRENT AND VOLTAGE REMEDIATION RULES

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20:10:39:01. Definitions. Words and phrases defined in SDCL chapter 49-47 have the same meaning when used in this chapter. Terms used in this chapter mean:

(1) "Ampere," a unit of measure of electrical current;

(2) "Cow contact current" or "Icc," the alternating current, 60 Hertz, root mean square, steady-state current measured through the shunt resistor;

(3) "Cow contact voltage" or "Vcc," the alternating current, 60 Hertz, root mean square, steady-state voltage measured across the shunt resistor;

(4) "Current," an electrical parameter that is the flow or amount of electricity past any single point in a conductor or conductive element per unit of time;

(5) "Ground," a term used in electrical science meaning the point of lowest potential for an electrical system;

(6) "Ishunt," the measurement of current across the shunt resistor;

(7) "Milliampere" or "mA," one one-thousandth of an ampere;

(8) "Ohm," the standard unit of electrical resistance;

(9) "Open circuit voltage" or "Voc," the difference of electrical potential between two terminals when disconnected from any circuit;

(10) "Primary neutral to reference voltage" or "Vp," the voltage that exists between the primary grounding conductor point of an electrical system's utility transformer and a remote reference electrode;

(11) "Primary system," a term that describes the high voltage utility electrical system, including the generation, transmission, and distribution systems. It also refers to the high voltage side of a distribution transformer;

(12) "Remote reference electrode," a temporary point of measurement established by correctly installing a ground rod;

(13) "Resistance," an electrical quantity that quantifies a physical material's ability to conduct or not conduct electricity;

(14) "Root mean square," a mathematical conversion used to equate alternating and direct currents and voltages on similar terms;

(15) "Secondary neutral to reference voltage" or "Vs," the voltage that exists between the secondary grounding electrode/grounding conductor point of an electrical system's service entrance panel and a remote reference electrode;

(16) "Secondary system," the part of the electrical system on the customer's side of both the meter and transformer;

(17) "Service provider," any person, company, or other legal entity providing stray current or voltage testing, consulting, measurements, analysis services, construction, or hardware;

(18) "Shunt resistor" or "Rshunt," a physical resistor or combination of resistors used to simulate a dairy cow during the measurement of cow contact voltage or current. A shunt resistor must be 500 Ohms, plus or minus two percent;

(19) "Source resistance" or "Rsource," the portion of resistance in the circuit, other than the resistance of the shunt resistor;

(20) "Transient deviation," a non-steady-state increase or spike in voltage or current. For the purpose of identifying and reporting transient deviations in cow contact voltage or cow contact current, a transient deviation occurs when the recorded maximum Vcc or Icc in a recording interval exceeds 200 percent of the steady-state Vcc or Icc recorded during the same recording interval;

(21) "Voltage," the electrical quantity that describes the push or potential that electrical energy needs to flow in a circuit;

(22) "Voltage drop," the difference in voltages when a current passes through a resistance or impedance in a closed loop circuit and a voltage drop is produced across that resistance or impedance; and

(23) "Vshunt," the measurement of voltage across the shunt resistor.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:02. Purpose of rules – Conformance to electrical codes. This chapter standardizes the measurement and testing procedures used to measure stray current or voltage in dairies. This chapter does not replace existing safety standards embodied in electrical codes. Under this chapter, testing is intended to determine:

(1) The presence and amount of any stray current or voltage within the dairy;
(2) The sources of any stray current or voltage detected; and
(3) The percent contribution from the utility side and the dairy side of the dairy service entrance

to the total stray voltage or current measured on the dairy.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:03. Measurement and testing by utility. A utility measuring or testing for stray current or voltage at the request of a dairy producer, as directed by the commission, or on its own initiative, shall conduct the measurements in accordance with this chapter.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:04. Notice to utility. A dairy producer may provide notice to the utility pursuant to SDCL 49-47-3 with or without first having conducted tests or measurements of stray voltage.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:05. Cooperation between the dairy and utility. When a written notice is filed with the utility, the dairy is obligated to make any contact points, service panels, ground rods, or other electrical equipment at the dairy available to the utility for measuring and testing. The utility shall provide reasonable notice and cooperate with the dairy producer to establish an appropriate time to conduct the tests and measurements. The dairy shall cooperate with the utility so that all tests and measurements necessary to identify the existence and magnitude of stray current or voltage, if any, are completed within 14 business days of the utility's receipt of such notice.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:06. Service provider. A service provider is required to follow the rules in this chapter.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:07. Qualified testing professional. Measuring and testing for stray voltage must be performed by a qualified testing professional. The following persons are presumed to be qualified testing professionals:

(1) A professional engineer, licensed in any state, who has completed no fewer than 48 hours of commission-approved stray voltage training and who has been involved in no fewer than 5 prior investigations involving the measurement or testing of stray voltage;
(2) A master electrician, licensed in any state, who has completed no fewer than 48 hours of commission-approved stray voltage training and who has been involved in no fewer than 5 prior investigations involving the measurement or testing of stray voltage; and

(3) A technician who, under the supervision of a person presumed qualified under subdivision 20:10:39:07 (1) or (2), has completed no fewer than 8 hours of commission-approved stray voltage training and has been involved in no fewer than 5 prior investigations involving the measurement or testing of stray voltage.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:08. Qualified testing analyst. Analysis of data under this chapter must be performed by a qualified analyst. A professional engineer, licensed in any state, who has completed no fewer than 48 hours of stray voltage training and who has been involved in no fewer than 5 prior investigations involving measurement or testing of stray voltage is presumed to be a qualified analyst.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:09. Additional qualified testing professional or analyst. A person who does not satisfy the qualifications in § 20:10:39:07 or 20:10:39:08 may nonetheless be determined by the commission to be a qualified testing professional or a qualified analyst if, on motion of any party, the commission finds that person otherwise possesses the knowledge, skill, experience, training, or education that qualifies that person to offer expert testimony before the commission.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:10. General requirements for stray voltage measuring and recording. Equipment used for the measurement or testing of stray voltage, current, and resistance shall meet the following criteria:

(1) The accuracy and resolution of any instrument used to measure or record cow contact voltage or current shall limit the error to five percent or less at one volt or two milliampere;

(2) Instruments used to measure cow contact voltage must be capable of separating and independently measuring alternating current and direct current voltages. These instruments shall have a minimum internal impedance of 10,000 ohms and must be capable of measuring the true-root mean square voltage;

(3) A clamp-on ammeter, a digital multi-meter with clamp-on device, or an in-line ammeter is used to measure current between two points. The meters must be capable of separating and independently measuring alternating current and direct current and capable of measuring the true-root mean square current. A clamp-on ammeter must have the required resolution and accuracy;

(4) Resistance is measured using either a volt ohmmeter or a digital multi-meter. Resolution must be to the level of one ohm or less when measuring a resistance of less than 1,000 ohms. Accuracy must be within plus or minus 5 ohms for a 500 ohm resistance; and

(5) Grounding electrode resistance-to-earth measurements are made with a three-point fall-of-potential instrument or a clamp-on resistance-to-earth tester.

Source:

General Authority: SDCL 49-47-2.

Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:11. Calibration of measuring equipment. All measuring equipment must be calibrated according to the manufacturer's recommended calibration schedule, but no less than annually, to meet the manufacturer's specifications for the accuracy and resolution of the equipment. Measuring equipment may not be used after its next "calibration due" date for measurements or tests conducted during a stray voltage investigation. Calibration is performed by either:

(1) The manufacturer of the equipment, who shall certify that the equipment meets the manufacturer's specifications for accuracy and resolution; or
(2) A laboratory currently certified as meeting all applicable standards of the Institute of Electrical and Electronic Engineers and the International Organization for Standards.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:12. Calibration certificates. The service provider performing the tests and measurements shall maintain certificates from the manufacturer or the calibration laboratory demonstrating compliance with calibration requirements.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:13. Field check of measuring equipment. Before voltage or current measurement or testing is performed, the instrument is field-checked by comparing measurements to those of other instruments or against a known source.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:14. Requirements for monitoring and recording devices. Digital recording devices are used for the purpose of recording current and voltage for extended periods. The recording devices shall have the same level of resolution and accuracy as the meters being used for the measurements. Monitoring systems, which combine measuring and recording functions in a single instrument, shall have the same level of resolution and accuracy as specified in § 20:10:39:10. Recording devices and monitoring systems must be capable of recording transient deviations of one-tenth second or less in duration from the steady state. Digital recording devices, which have deviation settings, shall permit the deviation setting to be set low enough to meet the resolution and accuracy requirements in subdivision 20:10:39:10(1). All recording devices must be able to log the time and date of all data recorded and have their internal clocks synchronized.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:15. Requirements for load boxes. A load box is a primarily non-inductive nominal 240 volt, resistance heating type load with a minimum nominal full load of 18 kilowatts. A load box must be capable of operating at two or more load settings, including approximately 50 percent and 100 percent of the load box's rated total load.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:16. Stray current or voltage test. Subject to § 20:10:39:17, there are six tests used to detect and measure stray current or voltage: cow contact test; 48 hour test; primary profile test; secondary neutral voltage drop test; load box test; and signature test. Efforts must be made to perform the tests under conditions substantially similar to those conditions existing at the times the dairy producer believes stray voltage to be a problem.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:17. Testing sequence. The cow contact test and 48 hour test are used to determine the presence and level of stray voltage and are performed in all investigations, subject to the provisions of § 20:10:39:21. The cow contact test is performed first. The primary profile test, secondary neutral voltage drop test, load box test, and signature test may be performed in any order and may be performed without first determining that these tests are required under § 20:10:39:19. The primary profile test, secondary neutral voltage drop test, load box test, and signature test may be performed prior to starting the recording for the 48 hour test or while the 48 hour test is in progress. The 48 hour test may be interrupted as necessary to conduct the secondary neutral voltage drop test, load box test, and signature test, or for review and analysis of the data recorded up to that point.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:18. Preventive action level not exceeded. If the results from the cow contact test and 48 hour test indicate that stray voltage does not exceed the preventive action level as defined in SDCL 49-47-1(5), the utility has no further testing or remediation obligations under these rules during this test cycle.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:19. Preventive action level exceeded. If the preventive action level is exceeded, the utility shall perform the remaining four tests, except as provided in § 20:10:39:21. The utility shall also perform an analysis to determine whether the portion of the stray current or voltage attributable to an off-farm source exceeds 50 percent of the preventive action level.

If the preventive action level is exceeded and the portion of the stray current or voltage attributable to an off-farm source does not exceed 50 percent of the preventive action level, the utility has no further testing or remediation obligations.

If the preventive action level is exceeded, and the portion of the stray current or voltage attributable to an off-farm source exceeds 50 percent of the preventive action level, the utility shall conduct remediation pursuant to SDCL 49-47-3. Under this condition, the 48 hour recording of the 48 hour test may be reduced to no fewer than 24 hours.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:20. Report prepared by qualified analyst. For all testing conducted under this chapter, the utility shall have a qualified analyst prepare a report pursuant to § 20:10:39:59.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:21. Suspended or limited testing. With the written agreement of both the utility and the dairy producer, a stray voltage investigation may be suspended at any point in the investigation. With the written agreement of both the utility and the dairy producer, the utility may employ a limited set of tests or measurements on a dairy as part of an intentionally limited evaluation. If the utility proposes to suspend a stray voltage investigation or to conduct a limited evaluation, its reasons for doing so must be set forth in the written agreement between the utility and the dairy producer.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:22. Use of remote reference grounding electrodes. Remote reference electrodes are established by installing ground rods. In preparation for testing, each ground rod must be installed and penetrate moist soil to a depth of approximately 30 inches. When practicable, each remote reference electrode is installed at least 25 feet away from the nearest underground conductive electrical equipment of any type or at a distance equal to three to four times the buried depth of any metallic structure connected to the service entrance neutral. Each remote reference electrode must be located no closer than 25 feet from the centerline of a primary electrical conductor right-of-way and no closer than 100 feet from the edge of a transmission line right-of-way.

Each remote reference electrode must be checked for remoteness prior to its use for tests or measurements, and, if found to be insufficiently remote, a new location for that remote reference electrode must be found and retested for remoteness. Remoteness of the remote reference electrode is determined by measuring the voltage from the transformer grounding electrode to the remote reference electrode. The ground electrode resistance and current at the transformer are also measured. Remoteness is considered adequate if the measured voltage between the transformer grounding electrode and the remote reference electrode is within 20 percent of the voltage calculated by multiplying the transformer grounding electrode current by the transformer grounding electrode resistance.

If the transformer grounding electrode is within 25 feet of other primary or secondary grounding electrodes, this remoteness test is conducted at the first primary system grounding electrode upstream of the transformer that is greater than 25 feet from other primary or secondary system grounding electrodes.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:23. Inspection, repair, and measurement requirements. Prior to testing, the utility transformer is inspected, grounding electrode resistance measured, and any repairs necessary for safety are made and recorded. In the case of a customer-owned transformer, qualified personnel shall inspect the installation, measure grounding electrode resistance, and make and record any repairs necessary for safety. Measurements that require contact with utility or customer-owned primary wires or equipment are made by the utility or other qualified personnel.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:24. Use of ammeters. If in-line or series ammeters are used, they must be installed under safe conditions in accordance with the National Electrical Safety Code and the National Electrical Code with the entire dairy system or the specific circuit to be tested de-energized.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:25. Pre-test documentation. All pre-test calibration requirements required by §§ 20:10:39:11, 20:10:39:12, and 20:10:39:13 must be completed and documented. A drawing of the dairy is prepared indicating:

(1) The location of the buildings;
(2) Secondary electrical service panels and secondary feeder systems serving cow contact areas;
(3) Transformers and central distribution point;
(4) Existing grounding electrodes, if known;
(5) The location of all cow contact points to be tested;
(6) All remote reference electrodes; and
(7) All primary and secondary neutral test points used in conjunction with the remote reference electrodes.

A list of planned test points is prepared using the applicable form prior to beginning each test. Each test is listed separately and specific reference numbers are given to each planned test point.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:26. Suspension of testing due to presence of a safety hazard. If the service provider reasonably concludes that a dairy's noncompliance with the National Electrical Code or the National Electrical Safety Code poses a significant and immediate safety hazard that prevents completion of any test or measurement required by this chapter, the service provider's obligation to proceed under this chapter is

suspended until the hazard is eliminated.

At the discretion of the service provider conducting the test, livestock must be removed from any area where electrical equipment or wiring is examined or electrical measurements are taken. Testing may be suspended if the presence of cows or other animals creates a potential hazard to testing personnel. The locations of electric fences and other electrified cow control devices must be noted and de-energized where practical.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:27. Purpose of the cow contact test. The purpose of the cow contact test is to determine the locations, if any, where stray current or voltage exceeds the preventive action level and to identify the locations at which the cow contact voltage will be recorded in the 48 hour test.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:28. Conducting the cow contact test. The selection of cow contact points to be tested shall include a sufficient number of locations reasonably likely to demonstrate the presence of stray voltage or current, if any. The voltage across the shunt resistor or current through the shunt resistor is measured between cow contact points. The source resistance is calculated during analysis for all cow contact points.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:29. Use of a voltmeter to conduct the cow contact test. When using a voltmeter to measure voltage between contact points where one of those points is the floor surface or earth, the metal plate must make a high-quality conductive contact with the floor surface or earth, using the procedures described in § 20:10:39:31.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:30. Use of a milliammeter to conduct the cow contact test. When using an in-line milliammeter or a clamp-around milliammeter to measure current between contact points and one of those points is the floor surface or earth, the metal plate must make a high-quality conductive contact with the floor surface or earth, using the procedures described in § 20:10:39:31.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:31. Metal plate requirements. A metal plate used to make an electrical contact with the floor surface or earth must be square, rectangular, or round, and have a surface area equal to or

greater than 16 square inches. A weight of not less than 20 pounds is placed on the metal plate. This weight is applied evenly across the metal plate and not to the adjacent floor surface or earth. The metal plate is placed a minimum distance of 12 inches from any metal equipment making contact with the floor surface or earth. The surface of the metal plate that will make contact with the floor surface or earth must be clean and free of corrosion before use.

When the metal plate is placed on a floor surface, the surface must be flat. The floor surface is cleaned with a wire brush to remove debris that may add excess resistance, and then cleaned with water. A paper towel or similar material soaked in saltwater is placed between the metal plate and the floor surface.

When the metal plate is placed on the earth, the surface must be flat. Any debris must be removed and water added to the area, if necessary, to dampen the soil.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:32. Recording the cow contact test data. The person conducting the cow contact test shall record the location of, and measured values at, each test point. At each cow contact location, an open circuit voltage reading and a voltage reading with the shunt resistor placed across the input to the meter are taken. These readings are taken with ten seconds or less time between each reading. Alternatively, a current measurement may be taken in place of the voltage measurement. Data for these test points are recorded on the cow contact test form on file with the commission.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:33. Source resistance calculation. The source resistance is calculated for each cow contact location measured and the value recorded on the cow contact test form on file with the commission. The following formulas are used to calculate source resistance:

(1) Rsource = Rshunt x ((Voc – Vshunt) / Vshunt;

(2) Rsource = Voc/Ishunt – Rshunt.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:34. Purpose of the 48 hour test. The purpose of the 48 hour test is to determine whether stray current or voltage exceeds the preventive action level at selected locations over a 48 hour period, subject to §§ 20:10:39:19 and 20:10:39:38. The test also demonstrates whether the primary or secondary sides of the system have a specific impact on the recorded current or voltage at specific times of day. The results of the 48 hour test may be highly indicative of the presence of stray voltage.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:35. Data collection for the 48 hour test. A digitizing data recorder with averaging capability and capable of detecting and recording transient deviations of one-tenth of a second or less in duration is

used to record the following:

(1) Voltage from primary neutral at the transformer to remote reference electrode;
(2) Voltage from secondary neutral in the service panel serving the area of the cow contact to remote reference electrode;
(3) Voltage from primary neutral at the transformer to secondary neutral at the service panel serving the area of cow contact; and
(4) Cow contact current through or voltage across a shunt resistor at each high voltage point found in the cow contact test.

A recording interval as high as ten seconds may be used provided that transient deviations of voltage or current of one-tenth second or less in duration of voltage or current are recorded to the maximum ability of the instrument.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:36. Measurement requirements for the 48 hour test. When conducting the 48 hour test, measurements to the earth or concrete surface must be to a metal plate as described in § 20:10:32:31. When making measurements to metal objects, corrosion is removed to obtain a low resistance connection.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:37. Recording the 48 hour test data. All of the data gathered by the recording equipment during the 48 hour test, including transient deviations, is downloaded and retained with the records of the investigation. The steady-state data is summarized in the investigation report. The recorded data is made available to the dairy producer or utility upon request. The person conducting this test records the location of, and measured values at, each test point. The identification of the cow contact point and transient deviations are recorded on the 48 hour test forms on file with the commission. A plot of the voltage versus time may be substituted for the recording of measured values.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:38. Reduced recording period for the 48 hour test. If a qualified analyst concludes that remediation by the utility is required because the preventive action level is exceeded and the portion of the stray current or voltage attributable to an off-farm source exceeds 50 percent of the preventive action level, the recording period may be reduced to no fewer than 24 hours.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:39. Purpose of the primary profile test. The purpose of the primary profile test is to measure or calculate neutral-to-earth voltage for a multi-grounded distribution system.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:40. Data collection for the primary profile test. The primary profile test requires concurrent measurement of the ground electrode resistance and current at all primary system ground points within three quarters of a mile on either side of all primary service points serving the dairy, or to the end of the line if less than three quarters of a mile. Alternatively, the voltage between a remote reference electrode and the primary ground point being tested may be measured.

The primary profile test is conducted starting at one end of the distribution system and working toward the other along the main primary distribution system.

If the dairy is served by a dedicated tap of less than one-half mile in length from a distribution line, the neutral-to-earth voltage is measured at each primary ground along the tap and along the distribution line to a distance of three quarters of a mile in each direction from the point of the tap. If the dairy is served by a dedicated tap that extends more than one-half mile from the distribution line, the neutral-to-earth voltage is measured at each primary grounding electrode along the tap and along the distribution line to a distance of one-half mile in each direction from the point of the tap.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:41. Recording the primary profile test data. The person conducting the primary profile test shall record the location of, and measured values at, each test point. Data and calculation results for these test points are recorded on the primary profile test form on file with the commission.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:42. Purpose of the secondary neutral voltage drop test. The secondary neutral voltage drop test is used to determine the impact of each secondary service on the neutral-to-earth and cow contact voltages on the dairy under controlled conditions.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:43. Conducting the secondary neutral voltage drop test. The secondary neutral voltage drop test is performed for all service entrances. A proxy load of known characteristics (such as a resistive load like a 120 volt, 1,500 watt hairdryer) is required for this test. The proxy load must create a known and stable current and subsequent voltage drop for each neutral serving a main panel, sub-panel, or end-of-service area. All service entrances other than the service entrance being tested are turned off to perform this test.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:44. Data collection for the secondary neutral voltage drop test. The following data is collected for each secondary neutral tested:

(1) Gauge and type of neutral wire;
(2) Length of neutral wire;
(3) Neutral current;
(4) Voltage drop between both ends of the secondary neutral being tested;
(5) Cow contact voltage or cow contact current at the same points used in the 48 hour test;
(6) Voltage from the primary neutral at the transformer to remote reference electrode; and
(7) Voltage from secondary neutral in the service panel serving the area of the cow contact to remote reference electrode.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:45. Measurements used for the secondary neutral voltage drop test. For the secondary neutral voltage drop test, the three voltages (cow contact voltage, primary neutral to reference voltage, and secondary neutral to reference voltage) are measured with the proxy load "off" and "on." Calculated expected voltage drops are compared with measured voltage drops. If the measured and calculated voltage drops differ significantly, further investigation must be undertaken to determine the source of additional voltage drop within the circuit. Neutral current is measured and recorded with the proxy load "on."

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:46. Recording the secondary neutral voltage drop test data. Any person conducting the secondary neutral voltage drop test shall record the location of, and measured values at, each test point. Data and calculation results for these test points are recorded on the secondary neutral voltage drop test form on file with the commission.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:47. Purpose of the load box test. The load box test is used to determine the extent to which the primary system contributes to stray current or voltage at cow contact points.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:48. Timing of the load box test. The load box test is performed at the same time of day as the times of highest cow contact voltage found in the 48 hour test.

Source:

General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:49. Data collection for the load box test. The load box test requires the recording of eight data points during each of the five test steps. The eight data points that are measured or calculated and recorded for each step are:

(1) Primary line to neutral voltage;
(2) Load box current;
(3) Voltage at load box connection to secondary system;
(4) Transformer current as calculated by multiplying load box current by voltage at load box and dividing by primary line to neutral voltage;
(5) Voltage from primary neutral at the transformer to remote reference electrode;
(6) Voltage from secondary neutral in the service panel serving the area of the cow contact to remote reference electrode;
(7) Voltage from primary neutral at the transformer to secondary neutral at the service panel serving the area of cow contact; and
(8) Cow contact voltage or cow contact current at the same points used in the 48 hour test.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:50. Conducting the load box test. Except for dairies with three-phase balanced primary service, each of the following five steps for the load box test is conducted for at least two minutes:

(1) Step One: The load box is de-energized, the dairy remains "on," and the data is recorded;
(2) Step Two: The load box is de-energized, the dairy shut "off," and the data is recorded;
(3) Step Three: The load box is set to half load, the dairy shut "off," and the data is recorded;
(4) Step Four: The load box is set to full load, the dairy shut "off," and the data is recorded; and
(5) Step Five: The load box is set to full load, the dairy is turned "on," and the data is recorded.

For dairies with three-phase balanced primary service, the service provider performs steps one and two.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:51. Calculating the K factor for the load box test. The K factor is a calculated ratio of cow contact voltage/secondary neutral to reference voltage. The K factor should be less than one because cow contact voltage should be less than secondary neutral to reference voltage. If the K factor is greater than one, then there is contribution to cow contact voltage from sources other than secondary neutral to reference voltage.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:52. Recording the load box test data. The person conducting the load box test shall record the location of, and measured values at, each test point. Data and calculation results for these test points are recorded on the load box test form on file with the commission.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:53. Purpose of the signature test. The signature test is used to determine the contribution to stray current or voltage of individual pieces of equipment operating on the dairy. The test is best performed when there is minimal farm electrical activity.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:54. Data collection for the signature test. During the signature test, individual pieces of major current drawing equipment are started and stopped. The effects of starting, operating, and stopping each piece of equipment are measured and recorded for a period of operation of at least 15 seconds. The person conducting the test identifies and records the equipment being tested and records the specific times that the equipment was started and stopped. A digitizing data recorder with averaging capability is used to measure and record the required electrical data. These measurements are taken at the same locations at the dairy where measurements were taken for the purpose of the load box test and 48 hour test. The following measurements are taken:

(1) Voltage from primary neutral at the transformer to remote reference electrode;
(2) Voltage from secondary neutral in the service panel serving the area of the cow contact to remote reference electrode;
(3) Voltage from primary neutral at the transformer to secondary neutral at the service panel serving the area of cow contact; and
(4) Cow contact voltage or cow contact current at the preselected point.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:55. Recording the signature test data. All of the data gathered by the recording equipment during the signature test, including transient deviations, are downloaded and retained with the records of the investigation. The steady-state data is summarized in the investigation report. The recorded data is made available to the dairy producer or utility upon request. The location of all test points are recorded on the signature test form on file with the commission. A plot of the voltage versus time may be substituted for the recording of measured values.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:56. Analysis of the data collected during the tests. The person analyzing the data collected examines the data recorded for the 48 hour test and determines the highest steady-state value of cow contact voltage or cow contact current. The person determines the value of primary neutral to reference voltage that was present for the highest cow contact value. These values are identified as cow contact voltage or cow contact current and primary neutral to reference voltage at time of maximum cow contact voltage or current. These values are recorded as Vcc48 hr, Icc48 hr, or Vp48 hr. The three data sets created from the values are:

(1) The primary to reference ground voltage and the cow contact voltage or cow contact current measured during the load box test with the farm power "off" and the load box "off" are recorded as Vp OFF and either Vcc OFF or Icc OFF;
(2) The primary to reference ground voltage and the cow contact voltage or cow contact current measured with the load box set at one-half load are recorded as Vp HALF LOAD and either Vcc HALF LOAD or Icc HALF LOAD; and
(3) The primary to reference ground voltage and the cow contact voltage or current measured with the load box at maximum are recorded as Vp FULL LOAD and either Vcc FULL LOAD or Icc FULL LOAD.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:57. Determination of any contributions to stray current or voltage for single phase dairies. The utility contribution to cow contact voltage or cow contact current is determined using the following formulas:

(1) Utility contribution to cow contact voltage = ((Vp48 – Vp Half) / (Vp Full – Vp Half)) x (Vcc Full – Vcc Half) + Vcc HALF; or
(2) Utility contribution to cow contact current = ((Vp48 – Vp HALF) / (Vp FULL – Vp HALF)) x (Icc FULL – Icc Half) + Icc HALF.

The values determined are compared to the preventive action level.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:58. Determination of any contributions to stray current or voltage for three-phase dairies. The utility contribution to cow contact voltage or cow contact current for dairies with three-phase balanced load service is determined by directly using the results of the load box test results for step 1 and step 2 as specified in § 20:10:39:50.

The cow contact voltage measured during step 1 of the load box with the load box "off" and the dairy "on" will be the total cow contact voltage. The cow contact voltage measured during step 2 of the load box test with the load box "off" and the dairy "off" is the contribution to cow contact voltage from the utility or Vccutility. The contribution to cow contact voltage by the dairy is the difference between cow contact voltage and cow contact voltage from the utility. The formula is: Vccdairy = Vcc - Vccutility.

Source:

General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:59. Written report required – Copy to the dairy producer. Within a reasonable period of time after completion of any tests required to be performed by the utility under this chapter, a qualified analyst shall prepare a written report. The report shall include a summary of the tests performed, a copy of the drawing of the dairy prepared pursuant to § 20:10:39:25, all of the data or results obtained from the tests, and an analysis of the data or results obtained from the tests. If remediation is required by SDCL 49-47-3, the report shall specify the actions taken or to be taken. The utility shall provide a copy of the written report to the dairy producer.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.

20:10:39:60. Remediation. If the utility is required to conduct remediation, it shall commence such remediation in accordance with SDCL 49-47-3. Remediation efforts may include addressing other off-dairy sources. If a utility's contribution to stray voltage exceeds 50 percent of the preventive action level and the utility determines that another customer is a significant contributing source of stray voltage, the utility shall notify both the dairy and the other customer in writing.

Source:
General Authority: SDCL 49-47-2.
Law Implemented: SDCL 49-47-2, 49-47-3.