

IDAPA 31 – IDAHO PUBLIC UTILITIES COMMISSION

31.61.01 – Rules for the Measurement of Stray Current or Voltage (Stray Voltage Rules)

Who does this rule apply to?

These rules are applicable to dairy producers, public utilities and all persons or entities involved in any way in the measurement or remediation of stray current or voltage within Idaho.

What is the purpose of this rule?

To provide for the continued, safe and efficient availability of electricity while addressing complaints regarding stray current or voltage.

What is the legal authority for the agency to promulgate this rule?

This rule implements the following statutes passed by the Idaho Legislature:

- These rules are promulgated pursuant to the authority of the Idaho Public Utilities Law, Sections [61-515](#) and [61-520](#), Idaho Code, and the Stray Current and Voltage Remediation Act, Section [61-803](#), Idaho Code.

Who do I contact for more information on this rule?

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**31.61.01 – RULES FOR THE MEASUREMENT OF STRAY CURRENT OR VOLTAGE
(STRAY VOLTAGE RULES)**

GENERAL PROVISIONS

Rules 0 through 20

000. LEGAL AUTHORITY (RULE 0).

Idaho Public Utilities Law, Sections 61-515 and 61-520, Idaho Code, and the Stray Current and Voltage Remediation Act, Section 61-803, Idaho Code. (4-6-23)

001. TITLE (RULE 1).

01. Title. The title of these rules is the IDAPA 31.61.01, “Rules for the Measurement of Stray Current or Voltage” (Stray Voltage Rules). (4-6-23)

002. -- 003. (RESERVED)

004. INCORPORATION BY REFERENCE – REFERENCE TO SAFETY CODES (RULE 4).

01. Safety Codes. (4-6-23)

a. The National Electrical Safety Code (NESC) is applicable to public utilities and is adopted by the Commission Order, “Safety and Accident Reporting Rules for Utilities Regulated by the Idaho Public Utilities Commission.” (4-6-23)

b. The National Electrical Code (NEC) is applicable to the installation of wires and facilities used to convey electric current and to apparatus to be operated by such electric current. Adoption of the National Electrical Code is found at Section 54-1001, Idaho Code, and IDAPA 07.01.06, “Rules Governing the Use of National Electrical Code,” Section 011. (4-6-23)

005. -- 009. (RESERVED)

010. DEFINITIONS (RULE 10).

01. Incorporation by Reference. These rules incorporate by reference definitions found in Idaho Code 61-802, the NEC and the NESC. (4-6-23)

02. Equipotential Plane (EPP). See NEC. (4-6-23)

03. Primary System. 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. (4-6-23)

04. Secondary System. Means the low-voltage utility electrical system on the secondary side of a distribution transformer. The dairy’s on-farm system begins on the dairy’s side of the metering points, except for dairies metered on the high voltage side of the transformer(s). In the case of dairies metered on the high voltage side, the on-farm system begins at the transformer’s low-voltage lugs. (4-6-23)

05. Service Provider. Any person, company or other legal entity providing stray voltage or current testing, consulting, measurements, analysis services, construction, or hardware. (4-6-23)

06. Shunt Resistor. A physical resistor or combination of resistors used to simulate a dairy cow’s body resistance, body-to-metal contact resistance, and hoof-to-earth contact resistance between the cow and contact points during the measurement of cow contact voltage. A shunt resistor shall be five hundred (500) ohm plus or minus two percent (+/- 2%). (4-6-23)

07. Source Resistance. That portion of resistance in the circuit, other than the resistance of the cow and its contact resistance, when the cow is completing a circuit between contact points. (4-6-23)

08. Stray Current or Voltage. (4-6-23)

a. Unless the context otherwise requires, the term “stray voltage” shall mean stray current or stray voltage. (4-6-23)

09. Tests, Measurements, Procedures and Analysis. Means any or all of the stray voltage testing, measurement, work and work product defined in these rules. (4-6-23)

10. Transient. Transient or transient deviation means a non-steady state increase or spike in voltage or current. For the purpose of identifying and reporting transients in cow contact voltage (Vcc) or current (Icc), a transient occurs when the recorded maximum Vcc or Icc in a recording interval exceeds two hundred percent (200%) of the steady state Vcc or Icc recorded during the same recording interval. (4-6-23)

11. Utility. Means a public electric utility as defined in Section 61-332A, Idaho Code. (4-6-23)

011. -- 020. (RESERVED)

APPLICABILITY AND ADMISSIBILITY **Rules 21 through 30**

021. UTILITY (RULE 21).

A utility measuring or testing for stray voltage or current at the request of a dairy producer, as directed by the Commission or on its own initiative, shall conduct such measurements in accordance with these rules. (4-6-23)

022. DAIRY PRODUCER (RULE 22).

01. Serving Notice on the Utility. A dairy producer providing written notice to a utility pursuant to Section 61-804, Idaho Code, may provide such notice with or without first having conducted tests or measurements of stray voltage. (4-6-23)

02. Cooperation. When a written notice is filed with the utility, the dairy is obligated to make any contact point(s), service panels, grounding 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 fourteen (14) days of the utility's receipt of such notice. (4-6-23)

023. SERVICE PROVIDERS (RULE 23).

All service providers shall follow these rules. (4-6-23)

024. -- 030. (RESERVED)

QUALIFICATIONS OF PERSONS PERFORMING AND ANALYZING **RESULTS OF STRAY VOLTAGE TESTS**

Rules 31 through 50

031. PERFORMANCE OF TESTS AND MEASUREMENTS (RULE 31).

Measuring and testing for stray voltage under these rules for consideration by the Commission shall be performed by a qualified testing professional as such: (4-6-23)

01. Professional Engineer. A professional engineer, licensed in any state, who has completed no fewer than forty-eight (48) hours of Commission-approved stray voltage training and who has been involved in no fewer than five (5) prior investigations involving the measurement or testing of stray voltage. (4-6-23)

02. Master Electrician. A master electrician, licensed in any state, who has completed no fewer than forty-eight (48) hours of Commission-approved stray voltage training and who has been involved in no fewer than five (5) prior investigations involving the measurement or testing of stray voltage. (4-6-23)

03. Technician. A technician who, under the supervision of a person presumed qualified under Subsections 031.01 and 031.02, has completed no fewer than eight (8) hours of Commission-approved stray voltage training and who has been involved in no fewer than five (5) prior investigations involving the measurement or

testing of stray voltage.

(4-6-23)

032. DATA ANALYSIS (RULE 32).

Analysis of data under these rules, for consideration by the Commission, shall be performed by a qualified analyst. A professional engineer, licensed in any state, who has completed no fewer than forty-eight (48) hours of stray voltage training and who has been involved in no fewer than five (5) prior investigations involving measurement or testing of stray voltage shall be presumed to be a qualified analyst.

(4-6-23)

033. PERSONS OTHERWISE QUALIFIED (RULE 33).

A person who does not satisfy the qualifications in Sections 031 and 032, 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.

(4-6-23)

034. -- 050. (RESERVED)

**CALIBRATION OF AND EQUIPMENT USED FOR MEASURING
AND RECORDING VOLTAGE, CURRENT, AND RESISTANCE**

Rules 51 through 70

051. GENERAL REQUIREMENTS FOR STRAY VOLTAGE MEASURING AND RECORDING EQUIPMENT (RULE 51).

Equipment used for the measurement or testing of stray voltage, current, and resistance shall meet the following criteria:

(4-6-23)

01. Resolution and Accuracy. The accuracy and resolution of any instrument used to measure or record cow contact voltage or current, shall limit the error to five percent (5%) or less at one volt (1 V) or two milliamperes (2 mA).

(4-6-23)

02. Voltage Measurement. Instruments used to measure cow contact voltage shall be capable of separating and independently measuring alternating current (AC) and direct current (DC) voltages. These instruments shall have a minimum internal impedance of ten thousand (10,000) ohm and shall be capable of measuring the true-rms voltage.

(4-6-23)

03. Current Measurement. A clamp-on ammeter, a digital multi-meter (DMM) with clamp-on device, or an in-line ammeter shall be used to measure current through a conductor or resistor connected between two (2) points. The meters shall be capable of separating and independently measuring alternating current (AC) and direct current (DC) and shall be capable of measuring the true-rms current. Care must be taken to assure that clamp-on ammeters used have the required resolution and accuracy.

(4-6-23)

04. Resistance Measurement. Resistance shall be measured using either a volt ohmmeter (VOM) or a DMM. Resolution shall be to the level of one (1) ohm or less when measuring a resistance of less than one thousand (1,000) ohm. Accuracy shall be within plus or minus five (+/-5) ohm for a five hundred (500) ohm resistance.

(4-6-23)

05. Resistance-to-Earth Measurement. Grounding electrode resistance-to-earth measurements shall be made with a three- (3) point fall-of-potential instrument or a clamp-on resistance-to-earth tester.

(4-6-23)

052. CALIBRATION REQUIREMENTS (RULE 52).

01. Measuring Equipment Calibration. All measuring equipment shall 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 shall not be used after its next "calibration due" date for measurements or tests conducted during a stray voltage investigation. Calibration shall be performed by either:

(4-6-23)

- a. The manufacturer of the equipment, who shall certify that the equipment meets the manufacturer's

specifications for accuracy and resolution; or (4-6-23)

b. A laboratory currently certified as meeting all applicable Institute of Electrical and Electronic Engineers (IEEE) and International Organization for Standards (ISO) standards. (4-6-23)

02. 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. (4-6-23)

03. Field Check. Before voltage or current measurement or testing is performed, the instrument shall be field-checked by comparing measurements to those of other instruments or against a known source. (4-6-23)

053. REQUIREMENTS FOR MONITORING AND RECORDING DEVICES (RULE 53).

Digital recording devices shall be used for the purpose of recording current and voltage for extended periods, such as the forty-eight (48) hour test. 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 Section 051. Recording devices and monitoring systems shall be capable of recording transient deviations of one-tenth (0.1) 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 Subsection 051.01 of these rules. All recording devices shall be able to log the time and date of all data recorded and shall have their internal clocks synchronized. (4-6-23)

054. REQUIREMENTS FOR LOAD BOXES (RULE 54).

01. Volts. A load box shall be a primarily non-inductive nominal two hundred forty (240) volt, resistance heating type load with a minimum nominal full load of eighteen (18) kilowatts (kW). (4-6-23)

02. Split-Load. A load box shall be capable of operating at two (2) or more load settings, including approximately fifty percent (50%) and one hundred percent (100%) of the load box's rated total load. (4-6-23)

055. -- 070. (RESERVED)

TESTING AND MEASUREMENT PROCEDURES

Rules 71 through 80

071. STRAY CURRENT OR VOLTAGE TESTS (RULE 71).

Subject to Subsection 071.02, there are six (6) tests used to detect and measure stray current or voltage. (4-6-23)

01. Scheduling of Stray Voltage Tests. Efforts shall be made to perform the tests under conditions substantially similar to those conditions existing at the time(s) the dairy producer believes stray voltage to be a problem. (4-6-23)

a. Test 1 - Cow Contact Test; (4-6-23)

b. Test 2 - Forty-Eight (48) Hour Test; (4-6-23)

c. Test 3 - Primary Profile Test; (4-6-23)

d. Test 4 - Secondary Neutral Voltage Drop Test; (4-6-23)

e. Test 5 - Load Box Test; and (4-6-23)

f. Test 6 - Signature Test. (4-6-23)

02. Testing Sequence. Test 1 shall be performed first. Tests 1 and 2 are used to determine the presence and level of stray voltage and shall be performed in all investigations, subject to the provisions of Subsection 071.03.

Tests 3, 4, 5, and 6 may be performed in any order and may be performed without first determining that these tests are required under Paragraph 071.02.b. Tests 3, 4, 5, and 6 may be performed prior to starting the recording for Test 2 or while Test 2 is in progress. Test 2 may be interrupted as necessary to conduct Tests 4, 5, and 6, or for review and analysis of the data recorded up to that point. (4-6-23)

a. If the results from Tests 1 and 2 indicate that stray voltage does not exceed the preventive action level (PAL), the utility has no further testing or remediation obligations under these rules during this test cycle. (4-6-23)

b. If the PAL is exceeded, the utility shall perform the remaining four (4) tests except as provided in Subsection 071.03. The utility shall also perform analysis to determine whether the portion of the stray current or voltage attributable to an off-farm source exceeds fifty percent (50%) of the PAL. (4-6-23)

c. If the PAL is exceeded, and the portion of the stray current or voltage attributable to an off-farm source does not exceed fifty percent (50%) of the PAL, the utility has no further testing or remediation obligations. (4-6-23)

d. If the PAL is exceeded, and the portion of the stray current or voltage attributable to an off-farm source exceeds fifty percent (50%) of the PAL, the utility shall conduct remediation pursuant to Section 091. Under this condition, the forty-eight (48) hour recording of Test 2 may be reduced to no fewer than twenty-four (24) hours. (4-6-23)

e. For all testing conducted under these rules, the utility shall have a qualified analyst prepare a report pursuant to Section 082. (4-6-23)

03. Suspended or Limited Testing. The utility may suspend a stray voltage investigation or conduct a limited evaluation, as agreed between the utility and the dairy producer. (4-6-23)

072. PREPARATION FOR TESTING (RULE 72).
The person performing the tests shall perform the following: (4-6-23)

01. Remote Reference Grounding Rod. (4-6-23)

a. Remote reference grounding rod(s) shall be installed and penetrate moist soil to a depth of thirty (30) inches. When practicable, remote reference rods shall be installed at least twenty-five (25) feet away from the nearest underground conductive electrical equipment of any type or at a distance equal to three (3) to four (4) times the buried depth of any metallic structure connected to the service entrance neutral. The reference ground rod shall be located not closer than twenty-five (25) feet from the centerline of a primary electrical conductor right-of-way. A reference rod shall be located not closer than one hundred (100) feet from the edge of a transmission line right-of-way. (4-6-23)

b. All remote reference grounding rods shall be checked for “remoteness” prior to their use for tests or measurements and if found to be insufficiently “remote,” a new location for that reference ground rod shall be found and retested for remoteness. Remoteness of the reference ground shall be determined by measuring the voltage from the transformer grounding electrode conductor to the remote reference ground. The resistance-to-earth of the transformer grounding electrode shall be measured. The grounding electrode current shall be measured. Remoteness is considered adequate if the measured voltage (transformer grounding conductor to reference ground, V_p) is within twenty percent (20%) of the voltage calculated by multiplying the grounding electrode current by the grounding electrode resistance-to-earth. (4-6-23)

c. If the transformer grounding electrode is within twenty-five (25) feet of other primary or secondary grounding electrodes, this remoteness test shall be conducted at the first primary system grounding electrode upstream of the transformer that is greater than twenty-five (25) feet from other primary or secondary system grounding electrodes. (4-6-23)

02. Inspecting the Transformer(s). Prior to testing, the utility transformer shall be inspected, grounding electrode resistance measured, and any repairs necessary for safety be 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 shall be made by the utility or other qualified personnel. (4-6-23)

03. In-Line Ammeters. If in-line or series ammeters are used, they shall be installed under safe conditions in accordance with the NESC and the NEC with the entire dairy system or the specific circuit to be tested de-energized. (4-6-23)

04. Pre-Test Documentation. (4-6-23)

- a.** All pre-test calibration requirements from Section 052 shall be completed and documented. (4-6-23)
- b.** A sketch or drawing of the dairy shall be prepared indicating: (4-6-23)
 - i.** The location of the buildings; (4-6-23)
 - ii.** Secondary electrical service panels and secondary feeder systems serving cow contact areas; (4-6-23)
 - iii.** Transformer(s) and central distribution point; (4-6-23)
 - iv.** Existing grounding electrodes (if known); (4-6-23)
 - v.** The location of all cow contact points to be tested; (4-6-23)
 - vi.** All remote reference grounding rods; and (4-6-23)
 - vii.** All primary and secondary neutral test points used in conjunction with the remote reference grounding rod(s). (4-6-23)
- c.** A listing of planned test points shall be prepared using the applicable form prior to beginning each test. Each test shall be listed separately and specific reference numbers shall be given to each planned test point. (4-6-23)

05. Safety. (4-6-23)

- a.** If the service provider reasonably concludes that a dairy's noncompliance with the NEC poses a significant and immediate safety hazard which prevents completion of any test or measurement required by these rules, then the service provider's obligations to proceed under these rules shall be suspended until the hazard is eliminated. (4-6-23)
- b.** At the discretion of the service provider conducting the test, livestock shall 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 shall be noted and de-energized where practical. (4-6-23)

073. TEST 1 -- COW CONTACT TEST (RULE 73).

01. Purpose. This test is to determine the location(s), if any, where stray current or voltage exceeds the PAL and to identify the location(s) at which the cow contact voltage will be recorded in the forty-eight (48) hour test. (4-6-23)

02. Selection of Cow Contact Points. 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. (4-6-23)

03. Conducting the Test. The voltage across the shunt resistor or current through the shunt resistor shall be measured between cow contact points as shown in Figure 1. The source resistance shall be calculated during analysis for all cow contact points. (4-6-23)

a. When using a voltmeter to measure voltage between contact points where one (1) of those points is the floor surface, the equipment shall be arranged as shown in Figures 1 and 2, using a metal plate, which shall make a high quality conductive contact with the ground or floor. If the service provider is unsure of having a high quality conductive contact with the floor or ground, then the procedure described in Paragraph 073.03.c. shall be followed. If necessary, corrosion shall be removed from the point(s) where test lead(s) make contact with metal equipment. (4-6-23)

b. When using an in-line milliammeter or a clamp-around milliammeter to measure current between contact points and one (1) of those points is the floor surface or earth, the equipment shall be arranged as shown in Figure 3, using a metal plate which shall make high quality conductive contact with the ground or floor. If the service provider is unsure of having a high quality conductive contact with the floor or ground, then the procedures described in Paragraph 073.03.c. shall be followed. If necessary, corrosion shall be removed from the point(s) where test lead(s) make contact with metal equipment. (4-6-23)

c. A metal plate used to make an electrical contact with the earth or floor shall be of regular shape (square, rectangular or round), and shall have a surface area equal to or greater than sixteen (16) square inches (4 inches x 4 inches or equivalent). Place a weight not less than twenty (20) pounds on the metal plate. This weight shall be applied evenly across the metal plate and not to the adjacent concrete or earth. Place the metal plate a minimum distance of twelve (12) inches from any metal equipment making contact with the floor or earth. (4-6-23)

i. Where the metal plate is to be placed on a concrete floor, the surface shall be flat. Clean the floor surface with a stiff brush to remove debris that may add excess resistance. Use water to clean the floor surface at the point where the metal plate will be placed. Place a paper towel or similar material soaked in saltwater between the metal plate and the concrete floor. (4-6-23)

ii. Where the metal plate is to be placed on the ground or earth surface, the surface shall be flat. Remove any debris and add water to the area, if necessary, to dampen the soil. The surface of the metal plate that will make contact with the earth shall be clean and free of corrosion before use. Remove any corrosion, if necessary. (4-6-23)

04. Recording the Data. The person conducting this test shall record the location of, and measured values at, each test point. At each cow contact location, an open circuit voltage reading (V_{oc}) and a voltage with five hundred (500) ohm nominal shunt resistor placed across the input to the meter (V_{shunt}) shall be taken. These readings shall be taken with ten (10) seconds or less time between each reading. Alternatively, a current measurement (I_{shunt}) may be taken in place of the voltage reading (V_{shunt}). Data for these test points shall be recorded on the form in Appendix 1. (4-6-23)

05. Source Resistance Calculation. The source resistance (R_{source}) shall be calculated for each cow contact location measured and the value recorded in Appendix 1. The following formulas shall be used to calculate source resistance.

$$R_{source} = \frac{V_{oc} - V_{shunt}}{V_{shunt}} \times R_{shunt}$$

$$R_{source} = \frac{V_{oc}}{I_{shunt}} - R_{shunt}$$

(4-6-23)

074. TEST 2 -- FORTY-EIGHT HOUR TEST (RULE 74).

01. Purpose. This test is to determine whether stray current or voltage exceeds the PAL at selected location(s) over a forty-eight (48) hour period, subject to Subsection 074.06 and Paragraph 071.02.d. 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. (4-6-23)

02. Setup. A digitizing data recorder with averaging capability and capable of detecting and recording transient deviations of one-tenth (0.1) second or less in duration shall be used to record the following: (4-6-23)

- a.** Voltage from primary neutral at the transformer to remote reference ground, V_p . (4-6-23)
- b.** Voltage from secondary neutral in the service panel serving the area of the cow contact to remote reference ground, V_s . (4-6-23)
- c.** Voltage drops (V_p s) from primary neutral at the location of connection for V_p to secondary neutral at the location of the connection for V_s . (4-6-23)
- d.** Cow contact current through (I_{cc}) or voltage across a five hundred (500) ohm resistor at the high voltage point(s) found in Test 1, V_{cc} . (4-6-23)

03. Measurement Interval. The results of the forty-eight (48) hour test may be highly indicative of the presence of stray voltage. A recording interval as high as ten (10) seconds may be used provided that transient deviations of voltage or current of one-tenth (0.1) second or less in duration of voltage or current are recorded to the maximum ability of the instrument. (4-6-23)

04. Measurement at the Cow Contact Point(s). Measurements to the earth or concrete surface shall be to a metal plate as described in Paragraph 073.03.c. When making measurements to metal objects, corrosion shall be removed to obtain a low resistance connection. (4-6-23)

05. Recording the Data. Data gathered by the recording equipment during the forty-eight (48) hour test including transients shall be downloaded and retained with the records of the investigation. In addition, the steady-state data shall be summarized in the investigation report. The recorded data shall be made available to the dairy producer or utility upon request. The person conducting this test shall record the location of, and measured values at, each test point. The identification of the cow contact point shall be recorded on the form in Appendix 2. Transient deviations shall be recorded on the supplemental data form, page 3 of 3 in Appendix 2. A plot of the voltage versus time may be substituted for the recording of measured values in Appendix 2. (4-6-23)

06. Reduced Recording Period. If a qualified analyst concludes that remediation by the utility is required under Paragraph 071.02.d. prior to the completion of a forty-eight (48) hour recording period, the recording period may be reduced to no fewer than twenty-four (24) hours. (4-6-23)

075. TEST 3 -- PRIMARY PROFILE TEST (RULE 75).

01. Purpose. This test is to measure or calculate neutral-to-earth voltage (NEV) for a multi-grounded distribution system. (4-6-23)

02. Conducting the Test. The primary profile test requires concurrent measurement of the ground electrode resistance and current at all primary system ground points within three quarters (3/4) 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 (3/4) of a mile. Alternatively, the voltage between a remote grounding rod and the primary ground point being tested may be measured. (4-6-23)

a. This test shall be conducted starting at one (1) end of the distribution system and working toward the other end along the main primary distribution system. Figure 4 below illustrates the procedure. (4-6-23)

i. Where the dairy is served by a dedicated tap of less than one-half (1/2) mile in length from a distribution line, the neutral-to-earth voltage shall be measured at each primary ground along the tap and along the distribution line to a distance of three-quarters (3/4) of a mile in each direction from the point of the tap; or (4-6-23)

ii. Where a dairy is served by a dedicated tap that extends more than one-half (1/2) mile from the

distribution line, the neutral-to-earth voltage shall be measured at each primary grounding electrode along the tap and along the distribution line to a distance of one-half (1/2) mile in each direction from the point of the tap. (4-6-23)

03. Recording the Data. The person conducting this test shall record the location of, and measured values at, each test point. Data and calculation results for these test points shall be recorded on the form in Appendix 3. (4-6-23)

076. TEST 4 -- SECONDARY NEUTRAL VOLTAGE DROP TEST (RULE 76).

01. Purpose. This test is used to determine the impact of each secondary service on the neutral-to-earth (NEV) and cow contact voltages on the dairy under controlled conditions. (4-6-23)

02. Conducting the Test. This test shall be performed for all service entrances. A proxy load of known characteristics (such as a resistive load like a one hundred twenty (120) volt, fifteen hundred (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 that being tested shall be turned "off" to perform this test. A diagram showing the connections and measurement points for this test is shown in Figure 5. (4-6-23)

03. Data Collection. The following data shall be collected for each secondary neutral tested: (4-6-23)

- a. Gauge and type of neutral wire. (4-6-23)
- b. Length of neutral wire. (4-6-23)
- c. Neutral current, I_{sn} . (4-6-23)
- d. Voltage drop (V_{DropM}) between both ends of the secondary neutral being tested. (4-6-23)
- e. Cow contact voltage (V_{cc}) or current (I_{cc}) at the same points used in the forty-eight (48) hour test. (4-6-23)
- f. Primary neutral at the transformer to reference ground voltage, V_p . (4-6-23)
- g. Secondary neutral to reference ground voltage, V_s . (4-6-23)

04. Measurements. The three (3) voltages (V_{cc} , V_p and V_s) shall be measured with the proxy load "off" and "on." Calculated expected voltage drops (V_{DropC}) (see Appendix 4) shall be compared with measured voltage drops (V_{DropM}). If the measured and calculated voltage drops differ significantly, further investigation shall be undertaken to determine the source of additional voltage drop within the circuit. Neutral current shall be measured and recorded with the proxy load on (I_{sn}). (4-6-23)

05. Recording the Data. Any person conducting this test shall record the location of, and measured values at, each test point. Data and calculation results for these test points shall be recorded on the form in Appendix 4. (4-6-23)

077. TEST 5 -- THE LOAD BOX TEST (RULE 77).

01. Purpose. To determine the extent to which the primary system contributes to stray current or voltage at cow contact points. For dairies with three (3) phase balanced primary service, the service provider shall perform Steps One and Two in Paragraph 077.02.b. below. (4-6-23)

02. Conducting the Load Box Test. This test shall be performed at the same time of day as the time(s) of highest cow contact voltage found in the forty-eight (48) hour test. During this test, voltage and current shall be measured and recorded at the points indicated in Figure 6. (4-6-23)

- a. The load box test requires the recording of eight (8) data points during each of the five (5) test

steps. The eight (8) data points that shall be measured or calculated and recorded for each step are: (4-6-23)

- i. Primary line to neutral voltage, V_{pri} . (4-6-23)
- ii. Load Box Current, I_{lb} . (4-6-23)
- iii. Voltage at load box connection to secondary system, V_{lb} . (4-6-23)
- iv. Calculate transformer current I_p using $I_p = \frac{I_{lb} \times V_{lb}}{V_{pri}}$. (4-6-23)
- v. Voltage from primary neutral at the transformer to remote reference ground rod, V_p . (4-6-23)
- vi. Voltage from secondary neutral in the service panel serving the area of the cow contact to remote reference ground rod, V_s . (4-6-23)
- vii. Voltage from primary neutral at the transformer to secondary neutral at the service panel serving the area of cow contact, V_{ps} . (4-6-23)
- viii. Cow contact voltage (V_{cc}) or current (I_{cc}) at the same point(s) used in the forty-eight (48) hour test. (4-6-23)

b. Except for dairies with three (3) phase balanced primary service, the following five (5) test steps shall each be conducted for at least two (2) minutes: (4-6-23)

- i. Step One: The load box shall be de-energized, the dairy shall remain “on,”. (4-6-23)
- ii. Step Two: The load box shall be de-energized, the dairy shut “off,”. (4-6-23)
- iii. Step Three: The load box shall be set to half load, the dairy shut “off,”. (4-6-23)
- iv. Step Four: The load box shall be set to full load, the dairy shut “off,”. (4-6-23)
- v. Step Five: The load box shall be set to full load, the dairy shall be turned “on,”. (4-6-23)

03. Calculating the K Factor. The K factor is a calculated ratio (V_{cc}/V_s). The K factor should be less than one (1) because V_{cc} (cow contact voltage) should be less than V_s (the dairy ground to reference ground voltage). If the K factor is greater than one (1), then there is contribution to V_{cc} from sources other than V_s . (4-6-23)

04. Recording the Data. The person conducting this test shall record the location of, and measured values at, each test point. Data and calculation results for these test points shall be recorded on the form in Appendix 5. (4-6-23)

078. TEST 6 -- SIGNATURE TEST (RULE 78).

01. Purpose. This 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. (4-6-23)

02. Conducting the Signature Test. During this test, individual pieces of major current drawing equipment shall be started and stopped. The effects of starting, operating, and stopping each piece of equipment shall be measured and recorded for a period of operation of at least fifteen (15) seconds. The person conducting the test shall identify and record the equipment being tested and record the specific times that the equipment was started and stopped. A digitizing data recorder with averaging capability shall be used to measure and record the required electrical data. These measurements shall be taken at the same locations at the dairy where measurements were taken for the purpose of the load box test and forty-eight (48) hour test. (4-6-23)

- a. Voltage from primary neutral at the transformer to remote reference ground rod, V_p . (4-6-23)
- b. Secondary neutral at the service panel serving the area of cow contact to remote reference ground voltage, V_s . (4-6-23)
- c. Primary neutral voltage drop (V_{ps}) from the location of connection for V_p to secondary neutral voltage at the location of the connection for V_s . (4-6-23)
- d. Cow contact voltage (V_{cc}) or current (I_{cc}) at the preselected point. (4-6-23)

03. Recording the Data. All of the data gathered by the recording equipment during the signature test, including transients shall be downloaded and retained with the records of the investigation. In addition, the steady state data shall be summarized in the investigation report. The recorded data shall be made available to the dairy producer or utility upon request. The location of all test point(s) shall be recorded on the form in Appendix 6. A plot of the voltage versus time may be substituted for the recording of measured values on Appendix 6. (4-6-23)

079. -- 080. (RESERVED)

ANALYSIS AND REPORTING THE DATA
Rules 81 through 90

081. ANALYZING THE COLLECTED DATA (RULE 81).

01. Cow Contact Points. Examine the data recorded for the forty-eight (48) hour test in Appendix 2 and determine the highest steady state value of cow contact voltage (V_{cc}) or current (I_{cc}). Determine the value of primary neutral to reference voltage (V_p) that was present for the highest cow contact value. Record these values on the data sheet of Appendix 7. These values shall be identified as “test cow contact voltage or current” (V_{cc} 48hr or I_{cc} 48hr) and “primary neutral to reference voltage at time of maximum cow contact voltage or current” (V_p 48hr). The three (3) data sets created from the values are: (4-6-23)

a. The primary to reference ground voltage and the cow contact voltage or current measured during the load box test (Appendix 5) with the farm power “off” and the load box “off” shall be recorded on the data sheet of Appendix 7 as V_p OFF and either V_{cc} OFF or I_{cc} OFF. (4-6-23)

b. The primary to reference ground voltage and the cow contact voltage or current measured with the load box set at one-half (1/2) load shall be recorded on the data sheet of Appendix 7 as V_p HALF LOAD and either V_{cc} HALF LOAD or I_{cc} HALF LOAD. (4-6-23)

c. The primary to reference ground voltage and the cow contact voltage or current measured with the load box at maximum shall be recorded on the data sheet of Appendix 7 as V_p FULL LOAD and either V_{cc} FULL LOAD or I_{cc} FULL LOAD. (4-6-23)

02. Contributions to Stray Voltage or Current for Single Phase Dairies. The utility contribution to cow contact voltage or current shall be determined using the following formula. Compare the values determined to the preventive action level (PAL).

$$\begin{aligned} &\text{Utility contribution to} \\ &\text{cow contact voltage} = \frac{V_{p48} - V_{pHALF}}{V_{pFULL} - V_{pHALF}} \times (V_{ccFULL} - V_{ccHALF}) + V_{ccHALF} \end{aligned}$$

or

$$\begin{aligned} &\text{Utility contribution to} \\ &\text{cow contact current} = \frac{V_{p48} - V_{pHALF}}{V_{pFULL} - V_{pHALF}} \times (I_{ccFULL} - I_{ccHALF}) + I_{ccHALF} \end{aligned} \quad (4-6-23)$$

03. Contributions to Stray Voltage or Current for Three Phase Dairies. The utility contribution to cow contact voltage or current for dairies with three (3) phase balanced load service, shall be determined by directly using the results of the load box test results for Step 1 and Step 2 as specified in Paragraph 077.02.b. (4-6-23)

a. The Vcc measured during Step 1 of the load box with the load box “off” and the dairy “on” will be the total Vcc. (4-6-23)

b. The Vcc measured during Step 2 of the load box test with the load box “off” and the dairy “off” is the contribution to Vcc from the utility, Vccutility. (4-6-23)

c. The contribution to Vcc by the dairy is the difference between Vcc and Vccutility, Vccdairy = Vcc - Vccutility. (4-6-23)

082. REPORTING (RULE 82).

Within a reasonable period of time after completion of any tests required to be performed by the utility under these rules, a qualified analyst shall prepare a written report. The report shall include a summary of the tests performed, a copy of the sketch or drawing of the dairy prepared pursuant to Section 072, all of the data or results obtained from the tests, and an analysis of the data or results obtained from the tests. If remediation was required under these rules, 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. (4-6-23)

083. -- 090. (RESERVED)

REMEDIAL ACTIONS AND COMMISSION PROCEEDINGS

Rules 91 through 999

091. REMEDIATION (RULE 91).

01. Utility System. If the utility is required to conduct remediation, it shall commence such remediation within five (5) business days. The utility shall diligently pursue to completion remedial procedures which shall reduce, and are reasonably likely to sustain, that portion of the stray current or voltage attributable to the utility’s distribution system to a level equal to or less than fifty percent (50%) of the PAL. This may include addressing other off-dairy sources. (4-6-23)

02. Other Dairies, Farms and Industrial Sites. If a utility’s contribution to stray voltage exceeds fifty percent (50%) of the PAL 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. (4-6-23)

092. COMMISSION PROCEEDINGS (RULE 92).

01. Filing with the Commission. All petitions seeking relief under Section 61-805, Idaho Code, shall be filed with the Commission Secretary pursuant to Section 005. Petitions shall conform to IDAPA 31.01.01, Section 053. The petitioner shall file an original and five (5) copies of the petition. (4-6-23)

093. FIGURES AND APPENDICES (RULE 93)

All figures and appendices to these rules can be found on the Commission website at www.puc.idaho.gov. (4-6-23)

094. -- 999. (RESERVED)