Testing Farms
Served at 480 GrY/277 Volts

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We Energies
Stray Voltage Testing

- The farm and utility ground systems connected together comprise a circuit, regardless of the voltage.

- Stray voltage testing is intended and designed to perform a circuit analysis on that circuit.
Circuit Analysis Techniques

• Simplify

• For multiple voltage and current sources, short the voltage sources and open the current sources, and apply one at a time.

• Apply Kirchoff’s Current and Voltage Laws.

• Apply Ohms Law.

• Thevenin and Norton Equivalent Circuits.

• Superposition.
Tests

Load Box Test
Voltage drop test
Signature test
Profile test
24 Hour recording
“How is the investigative procedure affected by the farm being served at 480 GrY/277 Volts”?
To Answer that question, let’s first examine how:

- the impact of load on the utility system is different for a 480 GrY/277 Volt three phase service……..

- and how distribution of power on the farm differs from that of a single phase service.
Four Wire Multi-Grounded System

- Grounded Wye Primary Transformer Bank
- Delta Primary Transformer Bank
Grounded Wye Transformer
Delta Connected Transformer
The secondary (low voltage) side of the three phase banks can be interconnected in a variety of manners, independently of the connection on the primary (high voltage) side.
Load Box Test

Intended to examine the condition of the distribution primary neutral and the farm grounding system by measuring the resistance of the farm and primary neutral.
Inject a current into the neutral system, measure the voltage rise, measure the current into the farm and the primary, and determine the resistance of each with the formula

$$ R = \frac{V}{I} $$
Important Considerations are:

• A balanced three phase load on any system using three transformers will NOT cause any neutral current in the primary.

• If the transformer bank has no primary winding connection to the primary neutral, the load (at the farm) CAN NOT cause a primary neutral current.

• The only way to move the primary neutral is to apply a load on the neutral from a transformer connected line to neutral (which may have to be at another location.)
Load Box Test: Load Box Operated From Single Phase Service on Farm

Farm service is a 240 Volt 3 phase ungrounded service. Farm House served from a single phase 120/240 Volt Transformer. Load box operated from house service. Measurements (graphs) from 3 phase service in barn.
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Load Box Test

Farm NOT Isolated

PRN-Ref  SCN - Ref  PRN-SCN  Cow Contact Voltage

Farm Isolated

Load Box 3  Load Boxes Off

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Farm served from three phase service. Load Box operated from single phase service 6 spans to the north.
What about the system calculations?
At the single phase transformer

- $\Delta I_{pri} = \Delta I \text{ load box} / \text{transformer ratio}$

- $R_t = \Delta V_p / \Delta I_{pri}$

- $R_p = \Delta V_p / \Delta I_{p\text{neutral}}$
OR

\[ Rp = \ \text{Parallel Combination of} \ \Delta Vp / \Delta Ip_{\text{neutral}} \]

In Each Direction
At the three phase transformer

- $\Delta I_{net} = \Delta I_{sec(farm)}$

- $R_f = \Delta V_s / \Delta I_{sec(farm)}$

- $K = V_{cc\ (hi)} / V_{s(hi)} \times 100$

- $\Delta CR = (I_{Primary\ Neutral} / I_{Phase}) \times 100$
Voltage Drop Test

Designed to assess the condition of the secondary distribution neutral system by measuring the resistances of the service drop neutral.
Single Phase Service

SECONDARY NEUTRAL VOLTAGE DROP TEST

REMOTE REFERENCE ROD

CENTRAL YARD POLE

Vs TO REFERENCE

REMOTE PANEL TO REFERENCE

CYP TO REMOTE PANEL

DISTANCE "C"

DISTANCE "A"

DISTANCE "B"

HAIR DRYER

REPEAT FOR EACH ADDITIONAL BUILDING

AMP METER

BARN
480 Gr Y/277 Volt Service
480 GrY/277 Volts

480 to 120
• There is no convenient test load for operation at 277 Volts.
• There is no convenient outlet to energize a test load at 277 Volts.
• Available fault currents and arc flash hazards make connecting a load directly in a panelboard hazardous.
• Little Farm load is operated at 277 Volts, making substitution of farm load uncertain.
Solution?

Operate a 120 Volt test load at subpanel outlets as part of your signature test.
Signature Test

Designed to look for on-farm equipment faults and problems with the farm wiring system.
• The test will still identify detectable faults.

• The system response to various loads are interpreted differently, depending upon the connection of the load.
Further Complications

• The farm may be milking on a virtually continuous basis, making it necessary to conduct tests on top of farm load.
• Be careful not to overload equipment, including transformer fuses when conducting testing simultaneously with farm load.
Primary Profile Test

Designed to assess the condition of the primary neutral system.
“24 Hour Test”

Done to monitor the normal operation of the farm over two milkings.
A Couple of Last Tests

• Spot checks at stock tanks. (There may be a lot of them.)

• Check for crowd gate caused transients in the cow contact areas, and for possible high frequency signals caused by the farm’s cow ID system.