Electrical Preventative Maintenance (EPM) Program

Nationwide Energy Partners offers a robust, well-documented EPM program at no cost to our customers.

Studies show that more than two-thirds of all electrical systems failures can be prevented by a routine preventative maintenance program. Failure rates are three times higher for components not included as part of a preventative approach. Nationwide Energy Partners' no-cost EPM program is a valuable benefit that reduces the likelihood of electrical equipment problems, saving property owners from the high-costs and headaches associated with untimely failures.

Frequency of EPM

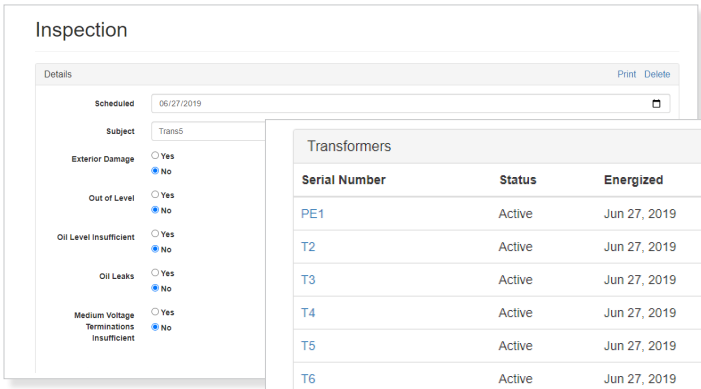
Routine work is completed every 12–24 months.

Major Inspections are conducted every 3–6 years.

Note: Frequency of major maintenance on cables may be increased based on conditions determined by routine inspections and maintenance.

Record Keeping

The electrical preventive maintenance program is well documented as to scope and frequency of maintenance. All routine maintenance activities and testing results are recorded for trending purposes. All repairs and/or replacement of electrical components are documented. When changes are made to the electrical distribution system, all applicable drawings and maintenance schedules are adjusted to accurately reflect the change. Spare parts inventories are updated with any new equipment added.



Left: ***Inspection Report***

Below: ***Transformers Report***

Transformers

Serial Number	Status	Energized	Location
PE1	Active	Jun 27, 2019	40.064751399999999, -83.129897600000007
T2	Active	Jun 27, 2019	40.064979000000001, -83.129310799999999
T3	Active	Jun 27, 2019	40.064777100000001, -83.129870499999996
T4	Active	Jun 27, 2019	40.064760800000002, -83.130544900000004
T5	Active	Jun 27, 2019	40.064303199999998, -83.131117200000006
T6	Active	Jun 27, 2019	40.0645971, -83.131069100000005
T7	Active	Jun 27, 2019	40.065319899999999, -83.130984499999997
T1	Active	Mar 4, 2021	40.065249399999999, -83.129680699999994

ROUTINE INSPECTIONS/MAINTENANCE CHECKLIST

1. Verify that accessible cable bends meet or exceed manufacturer's minimum allowable bending radius.
2. Inspect terminations, splices, and exposed sections of cable for physical damage and evidence of overheating and corona discharge.
3. Inspect cables, terminations, and splices for dirt, tracking, water streaks, shield ground connections where visible, and adequate clearance from grounded metal parts.
4. Measure and record load currents, where possible, and determine whether load currents are within cable ampacity ratings.
5. Perform infrared testing of cables, splices, terminations, and connections.
6. Verify that the transformer is bolted down.
7. Check cable identification tags and compare to drawings. Repair or replace damaged or missing tags.
8. Check to make sure that normal open is parked and marked (if applicable)
9. Verify level and on pad.
10. Verify lock is installed and working.
11. Verify NEP decals are installed and legible.
12. Check for correct Transformer number and phase.
13. Note all visual damage inside and out.
14. Inspect all infrastructures that are over five years old during first routine inspection and perform a required DC high-potential test and infrared test.

MAJOR INSPECTIONS, MAINTENANCE, AND TESTING CHECKLIST

1. Complete routine inspections and maintenance prior to performing major inspections, maintenance, and testing.
2. Observe general condition of cable, terminations, and splices. Inspect taped connections for deterioration or charring of tape. Inspect connectors for damage, overheating, corona discharge, discoloration, and oxidation. Correct sources of damage and repair or replace damaged components in accordance with manufacturer recommendations.

3. Inspect exposed compression-applied connectors for correct cable match and indention. Notify NEP of non-compliant connectors.
4. Inspect bottom of cable surface for wear or scraping due to movement at the point of entrance into conduits, ducts, and where cables rest on supports.
5. Inspect terminations and splices for soft spots and for surface tracking. Disassemble splices or terminations with soft spots to determine the extent of the damage. Repair or replace damaged terminations and splices in accordance with manufacturer recommendations.
6. Check all accessible bolted electrical connections for tightness using a calibrated torque wrench. Tighten connections in accordance with manufacturer recommendations.
7. Inspect Bellville washers for proper compression for aluminum conductors.
8. Inspect the cable grounding conductors, metallic sheath bonding, connections, and supports for corrosion and tightness. Ensure cable grounding continuity with main grounding system.

TESTING PROCEDURES

DC HIGH-POTENTIAL TESTING

Note: Humidity, wind, and surface conditions strongly affect the results of DC high-potential testing. Plan and coordinate testing in accordance with cable and test set manufacturer recommendations. Complete cable and shield tests for continuity, shorts, and grounds prior to high-potential testing. Record temperature and relative humidity at the time of testing.

1. Test new cables after all splices and terminations are made but before final connections to equipment. Perform testing after terminations and splices using hot dielectric compounds have fully cooled to ambient temperatures.
2. Do not exceed 80 percent of cable manufacturer's factory test value for acceptance test voltages, 60 percent for maintenance testing, or the maximum test voltages listed, whichever is less. Note: Do not exceed test voltage of 1.7 times the voltage rating of existing cable where new cable is connected to existing cable.
3. Test cable sections and conductors individually.
4. Disconnect cables from the attached switching equipment. **Note:** Lower test voltages are required when cables remain connected to equipment and accessories. Disconnect and ground surge arresters, potential transformers, and capacitors.
5. Ground all conductors and shields.
6. Check the DC high-potential test set for proper operation. Ensure that the input voltage to the test set is regulated.
7. Turn the test set off and attach the test lead to the conductor to be tested.

8. Remove the ground connection from the conductor being tested and use corona shields, guard rings, taping, glass jars, or plastic bags to prevent corona current from influencing readings. When taping, completely tape exposed conductor with standard electrical insulating tape. When using plastic bags, inflate plastic bags and seal with tape around exposed conductive parts so that no part of the bag touches the conductor. Ensure that exposed conductors are completely shielded.

9. Apply the test voltage slowly in a minimum of five equal increments until maximum test voltage is reached, with no increment exceeding the voltage rating of the cable, and with each voltage step being held for an equal interval of time long enough to allow the leakage current to reach stability, approximately 1 to 2 minutes.

10. Record leakage current in microamperes at the end of each interval before the voltage is raised to the next level. **Note:** A linear increase in leakage current is expected, and it should stabilize or decrease from the initial value at each step.

11. Plot test voltage versus leakage current on graph paper as test progresses. **Note:** Any excessive or nonlinear increase in leakage current can indicate imminent cable failure. Discontinue the test and consult the manufacturer for recommendations.

12. Calculate the resistance of the cable at each step. **Note:** At any step where the calculated leakage resistance decreases approximately 50 percent or more of that of the next lower voltage level, discontinue the test to prevent cable failure and to retain the cable in a serviceable condition until a replacement cable can be installed.

13. Raise the conductor to the specified maximum test voltage and hold for 15 minutes on shielded cable and for five minutes on non-shielded cable. Record readings of leakage current at 30 seconds and 1 minute intervals thereafter.

    Note: As Long as the leakage current decreases or remains steady after it has leveled off, the cable is considered satisfactory.

    Note: If the leakage current starts to increase, excluding momentary increases due to supply-circuit disturbances, extend the test to determine whether the rising trend continues. Increasing leakage current will result in the complete breakdown of the damaged insulation, evidence by an abrupt increase in leakage current accompanied by a sharp decrease in test voltage. This is a characteristic of approximately 80 percent of all DC high-potential test failures on cables with elastomeric insulation.

    Note: Sudden failure or flashover can occur if the insulation is already completely or nearly punctured. Voltage increases until it reaches the sparkover potential of the air gap length, then flashover occurs. Polyethylene cables exhibit this characteristic for all failure modes.

14. Calculate the polarization index for the cable. The polarization index is the ratio of leakage current after 1 minute to the leakage current after 5 minutes of maximum test voltage. Polarization index for satisfactory cable is between 1.25 and 2.

    Note: Polarization indices less than 1 are considered failures, and indices between 1 and 1.25 are considered marginal. Consult the cable manufacturer for recommendations.

15. After recording all measurements, rapidly turn the test equipment to zero volts and monitor cable voltage. Record the decaying voltage every 15 seconds for 90 seconds, and then every 60 seconds until the charge is down to 1000 volts, then ground the cable. Remove the test lead for connection to the next conductor.

    Note: Ground tested conductors for a minimum of 30 minutes.

16. Where one or more cables have not passed DC high-potential testing, isolate and locate the failed section of cable. Repair or replace the failed section of cable.

17. Upon satisfactory completion of the test, connect cables to equipment. Tighten connectors to manufacturer recommended torque levels.

HOW TO INTERPRET DC HIGH-POTENTIAL TEST RESULTS

1. Weakness in the insulation system is evidenced by leakage current that does not decrease, or that falls and then rises.

2. The plot of leakage current versus voltage should be a relatively straight line with no “knee” appearing in the curve.

3. The plot of leakage current versus time at full test voltage should indicate a continuous decrease in leakage current to a steady value.

4. The plot of voltage versus time should indicate a continuous decay in voltage until the test is interrupted.

INFRARED TESTING

Note: Provide supplemental barriers and safety precautions during infrared testing to prevent accidental contact with exposed energized components.

1. Perform infrared testing in accordance with cable and test equipment manufacturer recommendations.

2. De-energize cables. Remove accessible covers, plates, weathershields, etc., of equipment, transformer, primary enclosure, switchgear, etc., to reveal cables, terminations, splices, etc.

3. Energize cables and turn on all normal loads.
4. Perform infrared testing of all accessible electrical connections while cables are energized and operating under maximum load conditions.
5. Use an infrared testing device designed to measure actual operating temperatures, or designed to detect significant deviations from surrounding conditions. Provide documentation of device calibration.
6. Prepare a certified report identifying the cables tested and describing the results of the infrared test. Include notation of deficiencies detected, remedial action taken, and results from retesting after remedial action. Maintain a permanent record of all infrared test results to track electrical characteristics of cables, terminations, and splices over time.
7. Consult cable, termination, splice, accessories, and component manufacturers for repair or replacement recommendations, if infrared test results indicate overheating of components.

OIL SAMPLE TESTING (3RD PARTY)

1. All three phase transformers will have oil sample testing completed every 3–6 years.
2. Testing will be done by a reputable third party testing agency.
3. Records for testing will be kept in accordance to the section listed previously in this document.
4. Tests that have been reported to NEP as “poor” will be addressed immediately, and NEP will follow the testing agencies recommendations.