Georgia Tech NEETRAC
National Electric Energy Testing, Research and Applications Center

NEETRAC NEWS

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In This Issue...

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Baseline Projects Recently Launched

NEETRAC launched the following Baseline project proposals presented during the May 2020 Management Board Meeting. If you would like to serve as an advisor for any of these projects, please email suzanne.schmidle@neetrac.gatech.edu and indicate which project interests you.

Impact of Environment and Design on the Tracking of Covered Conductor

Baseline Project Number 20-107

Overhead medium voltage covered conductors (also known as aerial cables, spacer cables, or tree-wires) are used by many utilities. They address the potential issues that a bare wire system may have during major weather and climate events. The main goal is to provide a robust layer of insulation between the energized conductor and the surrounding air media. The layer reduces the risk of tracking, failures due to line contacts, and their unintentional consequences.

Therefore, the tracking resistance of overhead covered conductors is an important parameter within their performance. Currently, the tracking resistance of covered conductors is not assessed directly, i.e. only the tracking performance of the outer layer material is studied using polymer plaques. This approach does not correlate with the geometry, configuration, and electric stress distribution the covered conductors see in the field. Therefore, in this project, NEETRAC will further advance the tracking resistance testing of medium voltage overhead covered conductors by designing the principles of a prototype system that enables tracking performance under field conditions.

Baseline Projects Recently Launched - Cont'd

Field Diagnostics for Distribution Transformers

Baseline Project Number 20-108

Transformers are an important part of every utility distribution system. A distribution transformer connects every customer to the grid and so the required transformer fleet is both large and complex. As with most utility assets, the fleet is well-aged and requires investment to maintain. As of today, diagnostic techniques are deployed to assess the condition of large power transformers due to their cost and lead times to replace. Distribution transformers, on the other hand, are commodity items with a low capital cost, which only impact a handful of customers upon failure. As a result, they are not typically candidates for the same diagnostic testing that is used on large transformers. If efficient (low cost, easy to deploy) forms of diagnostic testing were available then utilities could have a means of addressing their distribution transformers.

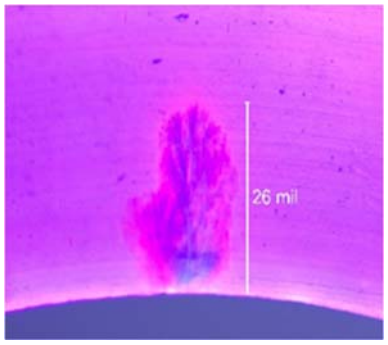
The purpose of this scoping study is to explore the applicability of traditional and non-traditional diagnosis methods for assessing the condition of the electrical components of padmount transformers. In addition to direct diagnosis, this project intends to explore the use of additional system measurement data from Smart Grid devices and other modern system edge approaches to enhance the diagnosis of distribution transformers.

Baseline Projects Recently Completed

The following Baseline project closeouts were presented at the May 2020 Management Board Meeting. The reports will be finalized and distributed to eligible Members in the coming months.

Enhancing the AWTT for Special Applications

Baseline Project Number 16-043



The current AWTT testing protocol for assuring baseline performance characteristics of extruded underground distribution cables insulated with EPR and TRXLPE insulations was developed over 30 years ago. Since that time, insulation compounds and manufacturing processes have improved to the point that the current testing protocol is not able to compare the performance differences between modern cable core designs. This project was designed to evaluate the ability of a newly developed, enhanced testing protocol to distinguish the difference between different core designs, allowing utilities to make distinctions that cannot be made with the existing protocol.

This test program differed from the test protocol in ICEA S-94-649 by having:

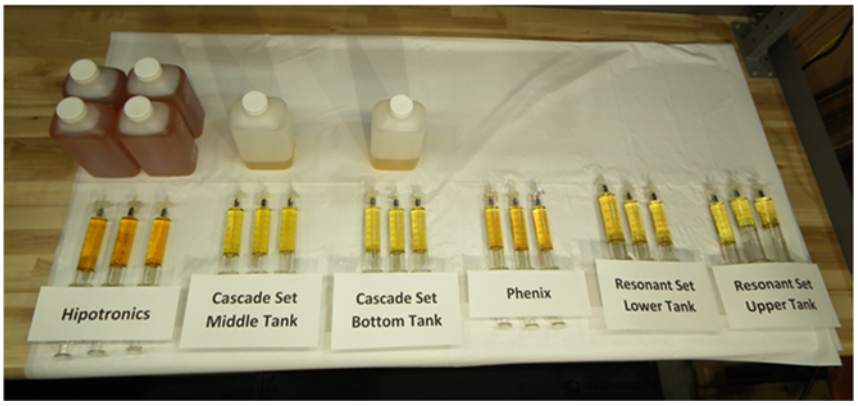
- Increased sample active test length from 21 feet to 42 feet
- Increasing the number of samples in each aging group from 3 to 9
- Removal of 180 day AWTT tests
- Addition of 360 day hot impulse tests
- Addition of tree counts for breakdown samples

Completion of the test program, on all cables and analysis of the resulting data, led to the following conclusions:

- The enhanced test procedure is practical to run in existing lab footprints
- There are enhancements in the test procedure from:
  - Increased lengths
  - Increased sample numbers
  - Improved tree count methods
- This test procedure provides a method to determine more clearly the improved value of material / design developments

Power Equipment Oil Analysis: Lab Performance / Sampling Techniques

Baseline Project Number 17-135



Oil Samples Collected from NEETRAC Equipment

Utilities regularly conduct diagnostic tests including Dissolved Gas Analysis (DGA), moisture content, ac breakdown, and others, on fluid containing equipment as part of their standard maintenance programs. This requires the utility to collect a sample of the dielectric fluid (typically oil) from the device and submit the sample for analysis in a suitably equipped laboratory. The tests performed are highly sensitive, often measuring in parts per million, and are impacted by many environmental factors in addition to the aging of device. The basis for this testing is the assumption that the sample represents the bulk oil and the test results are representative for the whole device. In most cases, the results indicate a healthy device but in cases where the results are unexpected (or indicate poor condition) users proceed question the sampling technique.

The results of the laboratory sampling study (samples in image) are summarized in the table and indicate that the degree of impact on the different DGA gases (9-gas tests were performed – impacted gases shown here) vary significantly even between repeated samples.

Summary of Effects Observed in DGA and Moisture Content Comparisons

Gas/Moisture	Experiment 1 Repeatability	Experiment 2 Flushing	Experiment 3 Bubble Ejection
Hydrogen	Some Impact	Some Impact	Unclear
Acetylene	Unclear	Some Impact	Some Impact
Carbon Dioxide	Some Impact	Some Impact	Most Impacted
Carbon Monoxide	Some Impact	Most Impacted	Unclear
Nitrogen	Some Impact	Unclear	Most Impacted
Oxygen	Most Impacted	Unclear	Unclear
Moisture	Most Impacted	Most Impacted	Not Applicable

Three of the major findings of the project were:

1) Oil sampling is complicated with few clear answers and many opportunities to impact the results.
2) Procedures for oil sampling exist but they differ in what appear to be result-altering ways.
3) Assessing DGA results is multi-faceted and continues to evolve; therefore, impact / influence of oil sampling methods will change (needs further investigation).

Voltage Withstand Requirements for Distributed Energy Resources Isolation Devices

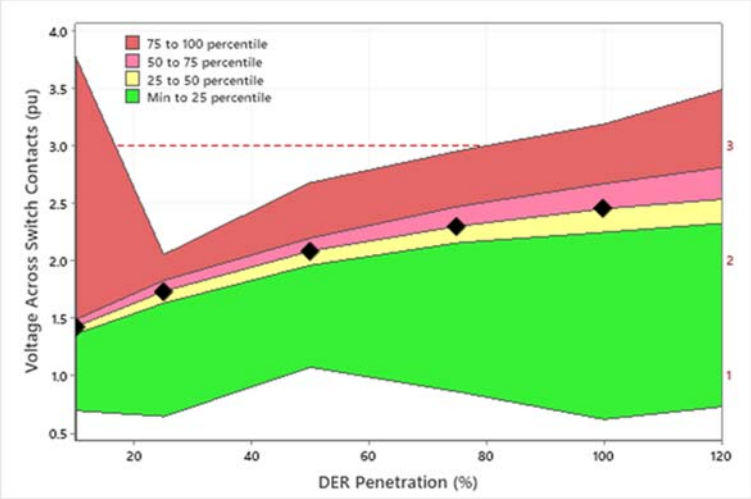
Baseline Project Number 18-177

Increased penetration of Distributed Energy Resources (DER) on distribution feeders can lead to reverse power flows when certain system and load conditions are met. This situation may lead to unintentional islanding. Under the likely scenario of a phase to ground fault, there could an over voltage condition across the contacts of the switch. Furthermore this voltage may be above the design withstand voltage. This problem is known as the Ground Fault Overvoltage (GFOV) issue. The magnitude of the GFOV issue is difficult to estimate as it depends upon many factors.

In this project, a general feeder model with variable factors was constructed (DER penetration, DER control mode, grounding configuration, load characteristics, and fault impedance levels). This model simulated the voltage across the contacts. More than 3,000 simulations were conducted, this provided on exhaustive simulation of all cases. The simulation results allowed for further understanding and quantification of the likelihood of the GFOV issue. The analysis also established the impact on the isolation device withstand voltage requirements.

The major findings of the project were:

1) Ground Fault Over-Voltage (GFOV) issue can be a real concern in many scenarios.
2) The issue is not simple and depends on several factors which can only be investigated with detailed models and analysis.
3) Penetration of the DER onto system has the biggest influence for the factors investigated with voltages up to approximately 3.5 U_0 occurring between the contacts of the isolation device.



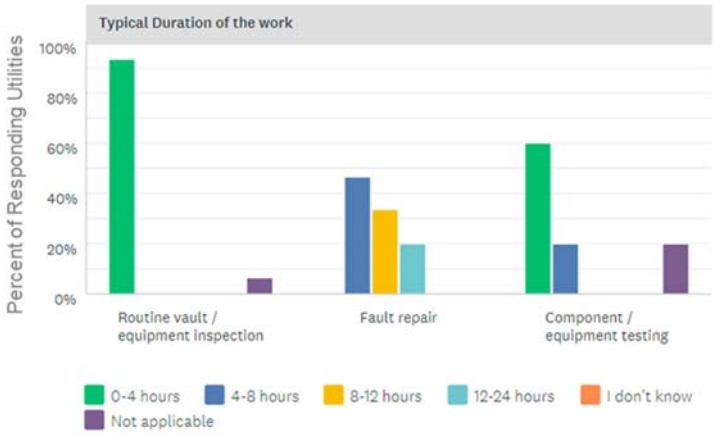
Detailed results are in the reports; however, this figure shows that as the DER Penetration increases more of the scenarios lead to > 2Uo appearing across the switch. Above 50% DER more than half of the scenarios lead to >2Uo between the contacts.

Baseline Projects Recently Completed - Cont'd

Maintaining Worker Safety in Energized Utility Vaults

Baseline Project Number 19-034

This project benchmarked utility practices to identify and mitigate worker safety risks when entering / working in utility manhole / vaults. Sixteen Members (15 U.S. Members & 1 Canadian Member) representing 31 operating companies that own more than 546,000 manholes / vaults participated in this study. The U.S. utility response accounts for approximately 27% of all electrical manholes / vaults in the U.S. The benchmarking topics include types of tests (atmospheric testing, thermal testing, and electrical testing), time of tests (entry and duration), technologies employed, and criteria used to identify atmospheric/thermal/electrical risks.



A few of the key takeaways from this project are:

Standards/Enforcement

- A list of standards / enforcements from the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (DOL), American National Standards Institute (ANSI), and ASTM International are reviewed in this work.

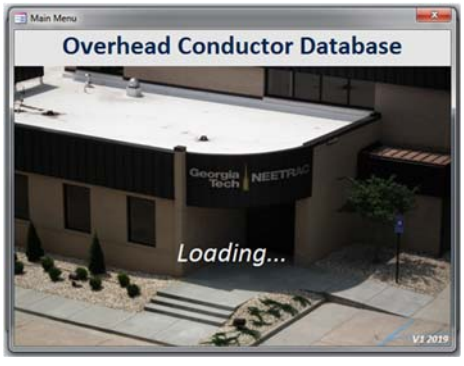
Knowledge Gap

- Atmospheric risks are well defined in the standards. Utilities identify and mitigate such risks before workers enter the manholes/vaults. Continuous monitoring of atmospheric conditions for the work duration in vaults is also performed to ensure worker safety.
- Thermal and electrical risks are not discussed as much as atmospheric risks in the standards. There is a lack of guidance on testing to identify these risks at the time of vault entry or for the work duration.

Overhead Conductor Testing Database

Baseline Project Number 16-124

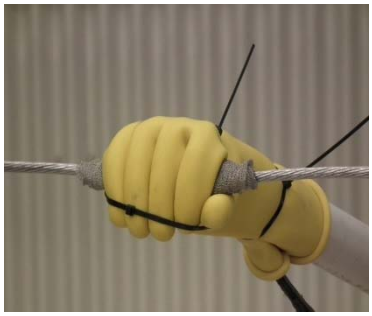
NEETRAC regularly performs tests to assess the condition of overhead conductors. These assessments often include overall conductor strength and elongation, as well as the strength and elongation of individual strands. This project developed a more comprehensive database (relational tables, etc.) that will provide for better processing of past and current conductor assessment data. This allows NEETRAC to develop new information to support asset management of overhead lines and provide context to Members when reporting conductor assessment results.



Baseline Projects Recently Completed - Cont'd

Dielectric Performance of PPE by Measuring Worker Exposure Currents in Wet and Dry Conditions

Baseline Project Number 17-205



ASTM D120 provides information on choosing the correct glove class for use with various system voltages, but does not provide information on PPE resistance values or resistance data for commercially available dielectric gloves. Testing has been carried out, in realistic scenarios, to determine the resistance values for PPE available on the market. Additionally, it has identified how the dielectric strength and worker exposure currents vary at different points of the lifetime of the PPE. This information has been used in simulations to more accurately calculate touch and step |potentials in a range of use scenarios.

Among the major findings of this work are:

1) Grounding procedures and conditions in which PPE are used really matters for the exposure current level.
2) Boots and gloves do show degrading performance with age. The major impacts of aging:
   a) 30 – 50 % reduction in resistance
   b) At least 10 – 20 % reduction in breakdown strength
3) Detailed models of cases needed to assess impact on worker exposure; simulations can now be completed.

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Management Board Meetings

The next three Management Board meetings have been scheduled for the following dates:

January 20 - 21, 2021

May 19 - 20, 2021

September 22 - 23, 2021

For details, please visit the Member Section of the NEETRAC website at www.neetrach.gatech.edu.

2020/2021 NEETRAC Member Management Board Representatives

1. 3M……. Mark Hoisington
2. Alumaform…….. Pete Landsgaard
3. Ameren……. James Huss
4. American Electric Power…….. Jim Salerno
5. BC Hydro……Fred Dennert
6. Borealis Compounds, Inc.……..Susan Song
7. Consolidated Edison……. Frank Doherty
8. Dominion Energy…….. Liz Sullivan
9. Dow Chemical Company……..Brent Richardson
10. DTE Energy……Naera Haghnazarian
11. Duke Energy……...Chris Fletcher
12. Eaton…….. Alan Yerges
13. Exelon……. Lisa Perrone
14. FirstEnergy……..Randy Coleman
15. Gresco Utility Supply……..Brad Schafer
16. Hubbell Power Systems……Charles Worthington
17. LS Cable & System……Tim West
18. Nova Scotia Power……Jim McFadgen
19. NRECA……...Reed Cooper
20. Pacific Gas & Electric…….. Marlon Viduya
21. PPL Corporation……..……Jean Blanc
22. Prolec GE…….. Carlos Gaytan
23. Prysmian Group……Bill Temple
24. Public Service Electric & Gas..…... Ed Gray
25. Rauckman Utility Products……..Jim Rauckman
26. S&C Electric…….. Marshall Mauney
27. San Diego Gas & Electric……..…. Christian Henderson
28. Smart Wires…….. Haroon Inam
29. Southern California Edison……Alan Kasanow
30. Southern Company……..Michael Pearman
31. Southern States, LLC…….. Joe Rostron
32. Southwire Company……... Sherif Kamel
33. Tacoma Power……..Joe Rempe
34. TE Connectivity……Brian Ayres
35. TVA…… Sam Delay
36. Viakable…….. Raul Garcia
37. WEC Energy Group…….. Michael Smalley