

**Subsurface Transformers and Network Protectors Subcommittee
Task force / Working Group Report**

Document #: _____ n/a

Document Title: Corrosion Effects on Subsurface Transformers

Chair: Will Elliott Vice-Chair Justin Minikel

Secretary Audrey Siebert-Timmer Per Cent Complete 0

Current Draft Being Worked On: _____ n/a Dated: _____ n/a

Meeting Date: April 27, 2021 Time: 2:20 PM CST

Attendance:	Members	<u>28</u>
	Guests	<u>50</u>
	Total*	<u>78</u>

* For details of attendance, please refer to AMS system of the Transformers Committee

Attending Members:

- | | |
|--|---|
| Martin Bachand, Cloverdale Paint Inc. | Daniel Mulkey, Mulkey Engineering Inc. |
| Thomas Dauzat, Prolec GE | Dwight Parkinson, EATON Corporation |
| William Elliott, Prolec GE | George Payerle, Carte International Inc. |
| Benjamin Garcia, Southern California Edison | James Ratty, Electronic Technology Inc. |
| Zoran Goncin, Partner Technologies Inc. | Pedro Salgado, Electronic Technology Inc. |
| Chris Guertin, Cloverdale Paint Inc. | Adam Sewell, Quality Switch, Inc. |
| Said Hachichi, Hydro-Quebec | Avijit Shingari, Pepco Holdings Inc. |
| Jane Hall, Cloverdale Paint Inc. | Audrey Siebert-Timmer, IFD Corporation |
| Ramadan Issack, American Electric Power | Igor Simonov, Toronto Hydro |
| Robert Kinner, FirstPower Group LLC | Jonathan Sinclair, PPL Electric Utilities |
| Brad Kittrell, Consolidated Edison Co. of NY | Edward Smith, H-J Family of Companies |
| Brian Klaponski, Carte International Inc. | Michael Thibault, Pacific Gas & Electric |
| Justin Minikel, EATON Corporation | Alan Traut, Howard Industries |
| Tyler Morgan, Duke Energy | John Vartanian, National Grid |

Attending Guests

- | | |
|--|---------------------------------------|
| Scott Abbott, PPG | Darren Brown, Howard Industries |
| *Nabi Almeida, Prolec GE | Erich Buchgeher, Siemens Energy |
| Greg Ante, Southern California Edison | *Paul Chisholm, IFD Corporation |
| Edmundo Arevalo, Bonneville Power Administration | Rhett Chrysler, ERMCO |
| Elise Arnold, SGB-SMIT Group | Michael Dahlke, Central Moloney, Inc. |
| Ryan Bishop, Minnesota Power | Paul Florida, Howard Industries |

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James Gardner, SPX Transformer Solutions	*Dan Schwartz, Quality Switch, Inc.
Carlos Gaytan, Prolec GE	Jeremy Sewell, Quality Switch, Inc.
Ken Hampton, Baltimore Gas & Electric	Jaber Shalabi, Virginia Transformer
George Jalhoum, PPL Electric Utilities	Dave Sheehan, HICO America
Kristin James, EATON Corporation	Stephen Shull, BBC Electrical Services, Inc.
Anna Johnson, Arkema	James Spaulding, City of Fort Collins
Krzysztof Kulasek, Hitachi ABB Power Grids	Neil Strongosky, Memphis Light, Gas & Water
Michelle Kutzleb, TJH2B	Marc Taylor, Cogent Power Inc.
Andrew Larison, Hitachi ABB Power Grids	Eric Theisen, Metglas
Christopher Lianides, Southern California Edison	Timothy Tillery, Howard Industries
Tiffany Lucas, SPX Transformer Solutions, Inc.	Jeremy Van Horn, IFD Corporation
*Alejandro Macias, Centerpoint Energy	Duy Vo, Central Maine Power
Nitesh Patel, Hyundai Power Transformers USA	*Mike Waldrop, Memphis Light, Gas & Water
Vinay Patel, Consolidated Edison Co. of NY	Shelby Walters, Howard Industries
Chris Pitts, Howard Industries	Daniel Weyer, Nebraska Public Power District
Jarrold Prince, ERMCO	Leon White, H2 Scan
Jonathan Reimer, Fortis BC	Alan Wilks, Independent Consultant
Mahesh Sampat, Independent Consultant	*Michael Zarnowski, Carte International Inc.
Anil Sawant, Virginia Transformer	Kyle Zemanovic, EATON Corporation
Jeff Schneider, Spire Power Solutions	
<i>(*Attendee requested membership)</i>	

Meeting Minutes:

1. Will Elliott called the meeting to order at 2:20 PM CST.
2. Opening remarks and announcements.
3. Will Elliott reviewed IEEE Essential Patent Claims and SA Copyright Policy. No issues were raised.
4. Membership changes were noted:
 - i. Added: Juan Carlos Cruz Valdes, Zoran Goncin, Said Hachichi, Jane Hall, Micheal Morgan, Aniruddha Narawane, James Ratty, Pedro Salgado, Jonathan Sinclair, Edward Smith
5. Quorum was verified. The working group consisted of 36 members, requiring **19** for quorum. **26** members were confirmed through the WebEx poll. **28** members were confirmed afterwards through the attendance records.
6. Will Elliott requested approval of the minutes. George Payerle made a motion, seconded by Tom Dautat for approval of the minutes. **Minutes were unanimously approved.**

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7. Will Elliott requested approval of the agenda. Martin Bachand made a motion, seconded by Brian Klaponski for the approval of the agenda. **Agenda was unanimously approved.**

8. New Business:
 - i. Historical Corrosion Reports
 - a. Will Elliott review historical corrosion reports that are available including:
 1. 1968 GE corrosion report by Gary Nonken which is likely the origin of AISI 409 for 1-ph submersibles.
 2. 1968 IEEE transaction article “Fundamentals of Corrosion and Corrosion Control for Residential Subsurface Transformers” also by Gary Nonken from GE.
 3. 1972 IEEE transaction article “Corrosion Experience with Subway Transformers” by John Donnelly from Boston Edison.
 4. 1991 GE / ConEd corrosion report. Will Elliott has a request in process to release the this to the taskforce.

 - ii. Material Compatibility Testing: Pitting Corrosion 3D CT-Scan Results
 - a. Will Elliott reviewed 3D CT-scan test method and results performed on samples from the material compatibility tests. This test was performed in attempt to provide a more accurate measurement for pitting depth (vs the caliper method used in the Fall 2020 report). Reviewed report will be posted in the website. Key findings / observations were:
 1. Corrosion Rate was highest with Silicon-Bronze materials (results were comparable to previous findings in the Fall 2020 report). It was noted that measured corrosion rates do not reflect actual service environments, but rather indicate relative performance.
 2. Silicon-Bronze materials had a large percent pitted surface area.
 3. Coating bare Copper cathode reduced corrosion rate.
 4. Easier machinability of stainless-steel alloys come at the cost of corrosion resistance.
 - b. Tiffany Lucas asked samples were weight to calculate mass loss. Will Elliott confirmed this measurement was taken; results are included in the Fall 2020 report.
 - c. Tom Dauzat commented that the bare copper cathode is simulating exposed copper in the vault.
 - d. Zoran Goncin asked if pitting corrosion was observed on the threads. Will Elliott responded that none was observed. Tom Dauzat commented that this may be due to the test set up (bolts torqued together) which likely did not allow the electrolyte solution to go between the threads.
 - e. Zoran Goncin asked why 316 stainless-steel was not included. Will Elliott commented that one of the early questions for the task force was hardware compatibility and the materials tested are explicitly permitted for hardware in the current STNP equipment standards (so materials selected were readily available on hand).
 - f. Zoran Goncin commented that they do not use 304 stainless steels because of galling. instead, they used 316 stainless steels. In these cases, they also recommend all components are 316 stainless steel rather than carbon steel.

 - iii. Taskforce Discission: Next Steps
 - a. Will Elliott reviewed the proposed draft which was compiled as an informative guide for the equipment user. Proposed draft was emailed to taskforce members and included the following sections:
 1. Guide Purpose

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2. Methods to Defining the Environment
 3. Vault Design Considerations
 4. Design Considerations for Equipment Enclosures with Superior Corrosion Resistance
 5. Cathodic Protection Guide
 6. Proposed Simulated Vault Corrosion Test Method
- b. Tom Dauzat asked about annealing for stress relaxation and SCC (stress corrosion cracking). Will Elliott commented there is a lot to the welding process.
 - c. Tiffany Lucas commented that austenitic stainless steels can be susceptible to SCC and a stress relief heat treatment will help to prevent that. Tiffany commented that this is related to welding guidelines and we may not want to include this.
 - d. Tom Dauzat commented that for paint touch-ups it is best to paint the entire affected area as it provides a coating that will limit crevices for corrosion.
 - e. Dan Mulkey commented that the vast majority of subsurface transformers are installed in enclosures / chambers / spaces that are very small. Dan Mulkey recommended we distinguish the difference between a vault installation (e.g. where there is additional room around the transformer for crews to walk around) vs “surface operable” (e.g. where there is no additional room around the transformer). He stated the available space likely will define what you can or cannot do.
 - f. Tom Dauzat commented that for 300 stainless-steel transformers it is difficult for crews to see a pin hole leak versus cooper bearing and/or 409 stainless-steel has a uniform rust/corrosion making it easier for crews to identify when to service the transformer.
 - g. Dan Mulkey commented that standard installation processes have a bare copper ground rod however the vast majority installation will have the rod above water. Will Elliott agreed that keeping the copper out of the electrolyte will make a big difference, but cautioned what certainty we know where the water level is..
 - h. Dan Mulkey commented that soil likely will change over time. Something to consider when testing water.
 - i. Brad Kittrell commented that ConEd replaces anodes all the time (crews have spare parts in the truck). They use a “passive” (galvanic “sacrificial” anode) system.
 - j. Tom Dauzat commented that painting the bare copper in the vault would extend the life of the anodes.
 - k. Tom Dauzat made a motion for developing a PAR for a guide on corrosion (similar to what is available for Tap Changers). **There was no second, motion did not pass.**
 - l. Edmundo Arevalo commented he would like the information to be included in the transformer specification.
 - m. Brain Klaponski commented that it may be too early for a PAR. We need to continue gathering data to focus the scope (there is a lot in the proposed draft).
 - n. Dan Mulkey commented the best time to submit a PAR in December as you get an extra year.
 - o. Discussion was tabled as we ran out of time. **Will Elliott to call a meeting in two months to discuss further and assign out actions.**
9. Next meeting: is planned for October 18, 2021 in Milwaukee, Wisconsin USA
- i. The following seven attendees requested membership, and five will be added to membership for the Fall 2021 meeting:
 - a. Attendees requesting membership which were approved based on attendance:
 1. Nabi Almeida, Prolec GE
 2. Paul Chisholm, IFD Corporation

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3. Alejandro Macias, Centerpoint Energy
 4. Dan Schwartz, Quality Switch, Inc.
 5. Mike Waldrop, Memphis Light, Gas & Water
- b. Attendees requesting membership which did not meet attendance criteria:
1. Michael Zarnowski, Carte International Inc.
 2. Ashmita Niroulaa, Ergon

10. The meeting was adjourned at 3:35 PM CST.

Submitted by: Audrey Siebert-Timmer

Date: 04/26/2021