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:	**TUESDAY, October 20, 2020**	**Time:**	**2:20 PM CST**

Attendance:	**Members**	**15**
	Guests	**60**
	Total*	**75**

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

Meeting Minutes / Significant Issues / Comments:

1. Will Elliott called the meeting to order at 2:22 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:
    a. Added: 26 attendees requested membership after the taskforce first meeting in Fall of 2019.

5. Quorum was verified. The working group consisted of 26 members, requiring **13** for quorum. 15 members were confirmed through the WebEx poll. 15 members were confirmed afterwards through the roster.

6. Will Elliott requested approval of the agenda. Hearing no requests for changes, the agenda were approved as written.
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7. Will Elliott requested approval of the Fall 2019 minutes. Hearing no requests for changes, the agenda were approved as written.

8. New Business:
    a. Will Elliott reviewed field corrosion measurement procedure that was followed during testing. No comments were received from the group.

    b. Will Elliott reviewed 1500 and 3000 hrs results from Salt-Spray testing
        i. Test procedure was based on the new 1500 salt-spray test for BARE enclosure material (substrate) in C57.12.32-2019 with a few modifications. Details on test method is included in report that will be posted on the website.
        ii. Test were performed on the bare and coated test panels with and without weld beads. Details on test samples are included in the report that will be posted on the website.
        iii. Summary of test results are as follows:

1. Bare Cu-bearing steel failed evaluation criteria of 2.5% as it had a 5.08% mass loss after 1500 hrs.
2. Bare Cu- bearing steel with weld % mass loss increased to 8.04% after 1500 hrs.

iv. Will commented that there are concerns with the test method and potential with flawed measurements with the tests specified in the standard. These tests were performed as a preliminary experiment to give the group some data to decide where we should go next.

c. Will Elliott reviewed results from material compatibility testing
   i. Test procedure involved creating galvanic cells using various hardware materials and copper cathode combinations.
      1. Hardware components included bolts, washers and weld-nuts with the following materials: 304 Stainless Steel, Carbon-Steel, 303Se Stainless Steel, Silicon-Bronze and Galvanized Steel as a bonus.
      2. Cathode configurations: bare copper, coated copper, no copper
      3. Used silicone chalk to insulate electrical connections in order to measure galvanic potentials. Assemblies were suspended in an electrolyte solution in glass jars with nylon zip ties and various cathodes wrapped around the inside surface of the jar.
      4. Further details on test procedure can be found in the report which will be posted on the website.
   ii. Test measurements involved measuring the % mass loss / year, as well as measuring depth of pit which was used to calculate pitting corrosion rate mm / year, and surface corrosion depth resulting in a similar mm / year rate. Details on measurement methods can be found in the report.
   iii. Test results: surface corrosion
      1. Worst surface corrosion was found on Silicon Bronze hardware with copper cathode
      2. In general surface corrosion was the worst with a bare copper cathode, better with coated copper cathode and best with no copper cathode.
   iv. Test results: pitting corrosion
      1. Worst pitting corrosion occurred on the stainless steel samples.
      2. In general pitting corrosion was the worst with a bare copper cathode, better with a coated copper cathode and best with no copper cathode.
      3. Using a coated copper cathode resulted 50% reduction in corrosion-rate at minimum
   v. Will Elliott noted that cu-bearing steel was not tested.
   vi. Will commented that galvanized steel samples were also tested and showed minimum corrosion but as this material is not used commonly in the industry we did not review the results in the meeting.
   vii. Will commented that there are limitations in making conclusions based on the testing, and there are opportunities to improve and expand the test method. These tests were performed as a preliminary experiment to give the group some data to decide where we should go next. Of particular concern is the significant pitting corrosion observed on the stainless steel samples.

d. The group discussed the results
   i. Zoran Goncin asked if the presented mass loss and corrosion rate were linked
      1. Will Elliott commented that mass loss was measured because that method is defined in the current C57.12.32-2019, and corrosion rate was not based on that measurement. He stated that corrosion rate was an independent and separate

measurement based on physical measurement of final dimensions of the samples, and was not based on the mass loss measured.

2. Tom Dauzat requested to add the term pit to the corrosion rate title to clarify. Will Elliott clarified that that column represented corrosion depth rate and included both pitting and uniform surface corrosion. The table was updated to reflect "corrosion depth rate".

ii. Comment from Tom Dauzat: Fastenal recommend not mixing materials to limit corrosion (e.g. Stainless with Stainless). Did you see that in your results?

3. Will Elliott same hardware is preferred but regardless material selection you will have crevices which could be a corrosion point.

iii. Comment from Tom Dauzat: 303se is supposed to be better for threads and galling, though you could add lubricant to mitigate this

4. Steve Shull noted that if you add lubricant you will have apply higher torque.

iv. Christopher Sullivan asked if thread coatings / treatment would impact corrosion rates (e.g. Loctite, Teflon tape).

5. Will Elliott not sure as we didn't test this. That being said, no corrosion was observed on the threads themselves

v. Zoran Goncin commented that it is best practice to have multiple test samples. Will Elliott agreed.

vi. It was noted that the silicone bronze and bare copper had 15.05 mm pit which is close to 0.5 inches!

1. Will Elliott commented this is probably related to the amount of copper surface area in the cell.

vii. Jane Hall suggested testing samples as per ASTM standards and generate Tafel curves to compare corrosion performance. These methods are a bit more repeatable. Suggested we could also do a long-term corrosion test for 6 months.

e. Will Elliott requested group input on the next steps / next test procedure:
   i. Tom Dauzat volunteered to build boxes with pipe flanges for further testing
   ii. Jane Hall volunteered to contribute in developing the test plan.
   iii. Zoran Goncin mentioned he would provide comments to Will Elliott.
   iv. Bob Kinner volunteered to contribute.

f. Will requested vault information from users including size, volume, how much cooper is in the vault etc.
   i. Brad Kittrell from ConEd volunteered to provide some information.

9. Next meeting: April 27; Toronto, Ontario, Canada
   a. The 7 attendees requested membership and will be added to membership for the Spring 2021 meeting.

10. The meeting was adjourned at 1:35 PM CST.

Submitted by: Audrey Siebert-Timmer

Date: 20/10/2020