MEMORANDUM OF EX PARTE COMMUNICATION WITH THE DEPARTMENT OF ENERGY

Date: December 9, 2019

Docket No. EERE-2017-BT-TP-0055

This letter is in follow up to our letter of November 12, 2019 which memorialized a teleconference of November 7, 2019. This letter provides additional clarification of some points raised by NEMA in public comments to subject Docket, filed July 9, 2019.

Department staff asked for clarification about common test practices, typical field installation practices, test procedure setup and also asked if more data pertaining to NEMA comments regarding "as-shipped" versus "worst case" testing results could be provided. NEMA undertook to answer these questions and consulted with NEMA Members who manufacture affected transformers to evaluate what additional information might be available.

In response to those questions, we offer the following.

1) Question: Regarding the "worst-case" versus "as-shipped" configuration, is the "highest-voltage" configuration the same as the "as-shipped" configuration? How often is that true?

   Answer: For liquid-immersed distribution transformers, the comments about worst-case versus as-shipped configurations are isolated to single-phase pole mount transformers by nature of the "E/2E" secondary voltage rating (reference IEEE C57.12.00-2015, Table 7) that is most often utilized (aka "series-multiple"). The E/2E rating indicates that the sections of the winding can be connected in parallel at E volts or series for operation at 2E volts, both at full rated kVA, or in series with a center terminal for three-wire operation at 2E volts between the extreme terminals and E volts between the center terminal and each of the extreme terminals.

   With respect to series-multiple secondaries, out of all single-phase, liquid-immersed, pole mount distribution transformers tested in calendar year 2018, the highest voltage (secondary) configuration was the as-shipped configuration for 943 out of every 1000 units.

   Single-phase pad mounts and three-phase pad mounts do not typically have series-multiple secondaries.

   For liquid-filled transformers having multiple primary configurations, the process of reconfiguring the primary voltage rating is almost always done via a switch. This can be done in a matter of seconds and does not present any undue burden. Per section 10 of IEEE C57.12.00-2015, single-phase and three-phase transformers designed for series-

multiple operation are to be shipped in the series (higher voltage) configuration. The voltage configuration with the highest losses does not always coincide with either the higher or lower voltage rating but depends on the rated current and the physical winding arrangement in each configuration.

Dry-type transformers are not made with switches and must be reconfigured manually. How long this reconfiguration takes depends on design and construction, but NEMA estimates one half hour is needed to reconfigure and test, and then another half hour to restore initial configuration.

The breakdown of which configuration (the higher-voltage or the lower-voltage) has higher losses is as follows for one NEMA Member's liquid-filled inventory: [Note that these do not add up to 100%, by a substantial margin, because in most cases these designs are not manufactured in dual-voltage configuration.]

	Single-Phase Poles	Single-Phase Pads	Three-Phase Pads
Losses higher in higher-voltage configuration	96 / 1000	10 / 1000	20 / 1000
Losses higher in lower-voltage configuration	22 / 1000	4 / 1000	31 / 1000

The results are similar for dry-type products, as they too are rarely sold in reconfigurable wiring designs.

2) Question: Pertaining to the "worst-case" versus "as-shipped" configuration, for testing, how often is it necessary to re-wire a recently completed transformer to test it in the "worst-case" configuration and then re-wire it back to the standard "as-shipped" configuration for shipping?

   Answer: Some manufacturers test all units and all configurations, while others use an AEDM to determine efficiency. Those who opt to test all units must undergo rewiring and retesting described in item 1.

3) Question: How long does it take to re-wire and then restore the original wiring configuration, as described in the preceding item?

   Answer:
   a) For a single-phase liquid-filled pole mount unit, it takes around 15 minutes to internally reconfigure the secondary for testing by:
      i. Removing the cover
      ii. Unfastening the nuts from the low-voltage bushings (these are at least partially under oil, so the job is apt to be messy)
      iii. Reconfiguring the low-voltage connections

iv. Reinstalling and tightening the bushing nuts
v. Reinstalling and tightening the cover band

b) For a dry-type three-phase transformer, it takes approximately 30 minutes to reconfigure because of the need to unbolt and reconnect multiple cable connections to reconfigure the windings. For a three-phase transformer, each winding must be disconnected and reconfigured. Single-phase dry-type designs will take about 15 minutes (similar to item A), but they represent a small percentage of shipments.

For some NEMA Members, transformers that are reconfigured in this fashion have to be tested on a more *manually* operated test system. Testing such a unit would likely take 20 minutes versus around 5 minutes on the more highly automated test system. Reconfiguring the low-voltage connections back to their original configuration would take an additional 15 minutes following the same procedure outlined above.

4) Question: If much of transformer efficiency testing is done by AEDM, why is re-wiring a burden? How often is physical testing required? What percentage of tests performed physically require re-wiring?

Answer: NEMA agrees rewiring is not a burden when utilizing an AEDM. The benefit of aligning DOE efficiency requirements with the as-shipped configuration is that it allows manufacturers the ability to continually gauge their actual (measured) efficiency performance against the rating derived via AEDM. This is especially attractive for higher-volume, single-phase pole mount units because in the event a test of compliance is conducted and a basic model is found to be non-compliant, the exposure could reach into the tens of thousands of units. Since manufacturers typically test 100% of their transformers anyway, it seems like an unfortunate opportunity to miss.

5) Question: In supplemental comments, NEMA provided a mathematical explanation of the "as-shipped" versus "worst-case" scenario and provided some actual numbers. Is there a larger body of data NEMA can share with DOE to perform their own review and analysis?

Answer: Refer to response to question #1, above.

6) Question: Does NEMA have any other supporting data regarding our argument that most customers install products in the "as-shipped" configuration that would bolster our argument that testing in the "worst-case" configuration is not the most accurate representation of actual field-use conditions?

Answer: Refer to response to question #1, above.

Sincerely,

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