IEEE PES Transformer Committee

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Review summary of IEEE 259

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Review summary of IEEE 259 - 1999

Title: IEEE Standard **Test Procedure for the <u>Evaluation of Systems of Insulation</u>** for Dry-type Specialty and General-Purpose Transformers

According to the "history" on the IEEE website:

- Original edition 259 – 1974
- Superseded by 259 – 1994
- Superseded by 259 – 1999
- Reaffirmed 259 – 2010
- Administratively withdrawn 2017

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The revision of IEEE 259 is to support the revision of IEEE C57.12.60 which references IEEE 259 for the low voltage EIS for transformers.

IEC 61857-1 and IEEE C57.12.60 cover the same basic test methodology. If IEEE C57.12.60 refers to IEEE 259, it could refer to an IEC standard without the need to duplicate test standards.

Moving forward: IEEE 259 needs revision. The following are only some of the more significant locations needing revision. All of IEEE 259 must be revised for harmony and flow. Once the more significant revisions are agreed to, the entire text can undergo the complete revision.

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Introduction, section/clause 1 Overview and Scope

According to the **Introduction** and **clause 1.1, Scope**
This standard was developed to provide a test procedure for evaluating the thermal endurance of insulation systems for use in the types of transformers described in NEMA ST 1-19881 and NEMA ST 20-1992.

The **Introduction** and **Scope** state that standard is for:

> In general, these dry-type transformers are used with the primary windings connected to secondary distribution circuits of 600 V nominal and below.

The Introduction and clause 1.1 of IEEE 259 give further limits that IEEE 259 is only for use if the transformers based on the EIS evaluated complies to NEMA requirements.

Should IEEE 259 remain restricted to only apply for NEMA compliant transformers?

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Clause 2: Normative references

The revision of the text resolves the revision of this clause.

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Clause 3: Insulation test specimens

The title is poorly worded. A more correct title would be: **Electrical** insulation system test specimens

Present text in the second paragraph of clause 3.

> In those cases where the actual transformer is too large to use as a test specimen, a representative-size specimen may be used. The lack of experience with large transformers prevents the establishment of a standard test model.

Referring to the test coils as representative-size specimens has been a problem of wording in all previous standards related, C57.122.60 and IEC 61857-41. Any coil is a coil. This is not a transformer evaluation. The wording going into IEEE 259 must be focused on that purpose of 259 – the EIS evaluation. Can't the smaller test coils be called small, easy to handle test coils? Smaller size clearly conveys that the coils are smaller and easier for handling.

All test coils are to be made using production procedures and materials, the test coils are production coils. It is the means of construction, not the size.

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Clause 3: Insulation test specimens

The word “model” comes into the text. Replace *model* with test coil throughout the standard.

Clause 3, subclauses

a) The materials that are used for the various components of the specimen shall be representative of those that ultimately will be used in actual transformers. Everything possible shall be done to assure that the individual components are uniform and representative of those used in actual service.
b) Insulation thickness and creepage distances shall be appropriate for the voltage class and industry or equipment standards or practices. The presence of partial discharge in an insulation system will have some effect on the system’s life, and its presence in the test sample may prejudice the temperature aging results.

There is no indication as to why PD should or should not be expected to be occurring. This reference just appears without purpose. The occurrence of PD should be expected to reduce the EIS performance and life. However, since the test coils are aging non-energized PD can only occur during the 60s dielectric test used for diagnostics. So, PD is not an aging factor within the scope of 259 – single factor which is thermal decomposition.

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Clause 3: Insulation test specimens

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c) The arrangement of the different components, such as conductors, insulations, supporting members, spacers, shields, and **ground**, should duplicate electrically, thermally, and mechanically the conditions existing in the actual transformer.

Q. Does this mean that all of the components including shield and ground metal are to undergo thermal exposure during aging?

d) The design and construction of the specimens **shall** be representative of the prevailing engineering practices and manufacturing procedures and processes.

*Q. If the test specimens "shall" be representative of the prevailing engineering practice and … HOW can you evaluate **new processes and designs**? All you can evaluate is the same existing everything.*

e) Provisions shall be made for making electrical test on the various insulation components.

Q. It seems like a good idea to actually test the specimens. Isn't this obvious?

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Clause 3: Insulation test specimens

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f) If self-heating is used, provisions shall be made for exciting and loading the specimen. This is cover in clause 4.2.1 and is not needed here.

End of comments of clause 3.

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Clause 4: Test Procedure

Start with the first sentence of clause 4.

All test specimens shall be subjected to initial screening tests followed by repeated test cycles, consisting of the parts as given in order in Table 1.

Rewrite

All test specimens shall be subjected to initial screening tests, refer to 4.1. Test specimens which are determined to be usable for the thermal aging evaluation shall then be placed under test, refer to 4.2.

The balance of clause 4 can be kept with relatively the same information. Rewording will be necessary.

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Clause 4: Test Procedure

Clause 4.1 subclause c)
The first appearance of "Thermal shock" we know from numerous attacks on 61857-41; **thermal shock is a test of an actual transformer**. This is an evaluation of **only the EIS**, not the transformer. The word "shock" needs to be changed to "exposure" = thermal exposure.

This change or words must be uniform throughout the revised standard.

More in clause 4.1
The title of 4.1 is Initial screening tests. The word "initial" screening implies there will be other screening tests; perhaps the title should be 4.1 Pre-thermal aging screening test.
And reword: … All test ~~samples~~ coils shall be subjected to dielectric screening prior to exposure to an elevated temperature …

Separate all of the Initial screening test from all aspects of the thermal aging. Clause 4.1 must have only one meaning; evaluation of the test coils prior to the start of thermal exposure.

Clause 4.1 needs much more revision than this but time to move on.

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Clause 4: Test Procedure

Clause 4.2, first paragraph, second sentence

> … The aging temperatures and the duration of exposures at each temperature **shall** be selected so as to require 6–10 test cycles …

Once again let's place a "shall" on a condition which is not controllable. No one knows the life at any selected aging temperature until AFTER the results are available. How can a requirement of the number of aging cycles by make? A complete lack of understanding that the purpose of the EIS evaluation is to find the life at any elevated aging temperature.

> The aging temperature and the duration of exposure at each elevated aging temperature shall be selected to result in an expected life evaluation completion in 6 to 10 full cycles. {*The information presently in the paragraph following Table 3 give the guidance on making adjustments to the length of the aging cycle. Move that text to merge with this paragraph*.}

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Clause 4: Test Procedure

Clause 4.2, second paragraph

Present wording: The highest aging temperature shall result in an average time to end-of-life of at least 100h.

Rewrite: To be used in the analysis, the highest temperature shall be one at which the log average life of the set of test specimens accumulated a minimum of 100-hours.

If I have a 24-hour aging cycle and the test coils are good during 3 cycles [72 hours] and fail on test cycle #4 [96 hours] , the average life is less than 100-hours but the life is known to be within less than 24-hour period. If the life cycle is 504 hours and all the test specimens fail the life is known only within 252 hours. Is the data only usable based on the number of test cycles or should it be on the confidence level of the data?

Clause 4.2 – Table 3

The usual need to clean up the information in the Table will be necessary.

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Clause 4: Test Procedure

4.2.1/ 4.2.2

Oven aging, which is considerably more controllable and cost effective is the alternate. Gees, need a LOT of money to cover the electrical usage. After all, the coils are designed to **not hold heat**.

Clause 4.2 needs much more revision than this but time to move on.

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Clause 4.3 Mechanical stress

If the test specimens are heated using electrical current, are the coils not being vibrated naturally at aging temperature. What then is the purpose of adding a one-hour vibration condition for coils heated by internal resistance heating? The vibration conditioning should be limited to test coils aged in ovens.

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Clause 4: Test Procedure

Clause 4.4 Thermal ~~shock~~ = Thermal **exposure**
Thermal shock is a test used to evaluate transformers.
Thermal exposure is one of the conditioning steps used to help locate breaks in the electrical insulation. This conditioning step is used to enhance condensation on the surface of the electrical insulation. The condensation is intended to fill any physical breaks in the electrical insulation to detect insulation failure during the diagnostic evaluation.

Not much in the present text of this subclause. It will need revision but no suggestions other than use the IEC text.

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Clause 4: Test Procedure

Clause 4.5

The entire clause may be usable as one option to achieve condensation. Any revision must include the option to use a **Condensation Chamber**; refer to IEC 61857-41 for text. Clause 4.5 needs work.

Once again, the purpose of surface condensation is for diagnostics, not to evaluate a fully assembled and operating transformer in humid or underwater applications. Diagnostics, not operating conditions.

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Clause 4: Test Procedure

Clause 4.6 and subclauses

Rewrite all of 4.6 to be consistent with IEC 61857-41 version 4 after the last rewrite. Not just rewriting all of that text here. {*I suggest Joe T. to be the main writer of this clause*.}

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Clause 5 – Interpretation of data

Here again, the text for this was developed in IEC 61857-1 and 61857-41. Also, the revised test in C5.12.60 is available. No need to redevelop the given. Refer to clause C57.12.60 clause 4.4 Data treatment.

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Overall summary

1. No clause or subclause can remain without significant revision.
2. All of the information in IEEE 259 – 1999 already exist in other published standards.
3. Revision of IEEE 259 will add nothing to the industry which is not already available.
4. IEEE 259 as written is actually a limited test standard intended to apply only to applications described in NEMA ST 1-19881 and NEMA ST 20-1992.

So, if we are going to revise IEEE 259, let's do it at the level to make IEEE 259 useful. It will take a lot of revision work.

Comments?
Input?

Thank you.