

*Proposal for Development of New Document Titled:*

**Moisture in Insulating Systems of  
Gas Insulated & Liquid Immersed  
Transformers & Reactors, Revision 2**

*Proposed by  
Prof. Valery Davydov in private capacity*

Presented to SC Transformer Standards Meeting  
Wednesday 2 November 2011, 4:30-5:30 p.m.  
*F11 IEEE/PEC Transformers Committee Meeting, Boston MA*

# List of Sub-Committees (SC) of IEEE/PES Transformers Committee (TC)

1. Dielectric Tests SC
2. Distribution Transformers SC
3. Dry Type Transformers SC
4. Insulating Fluids SC
5. Insulation Life SC
6. Performance Characteristics SC (*e.g.: Effect of Moisture on FRA*)
7. Power Transformers SC
8. Bushings SC
9. Instrument Transformers SC
10. HVDC Converter Transformers & Smoothing Reactors SC
11. UG Transformers & Network Protectors SC
- 12. Transformer Standards SC**
13. Administrative SC
14. Meetings Planning SC

# State of the Art

- **The current approach is that *each* existing IEEE TC standard or guide contains *its own solution* to the moisture related phenomena it is dealing with**

# Statement of the Problem in Technical Terms

- **To fit into the existing organizational TC structure, the moisture subject is split into the two areas:**
  - “Moisture-In-Oil”
  - “Moisture-In-Paper”
- **In the author’s opinion, such division is the main reason for the lack of progress in resolving the moisture related issue during the last *few decades***
- **Moreover, there is no “official” space for a so-to-speak “*Moisture-in-Gas*” area in the IEEE TC documents, while the moisture equilibrium charts and other theoretical applications developed for the *Paper-Air Physical Complex* are widely used for liquid immersed transformers**

# Statement of the Problem in Technical Terms (Cont'd 1)

- The current approach does not allow to address properly the two (2) major types of *moisture dynamics* in the insulation system of a transformer or reactor:
  1. A relatively fast phenomenon of moisture exchange between the *surface* of solid insulation and the surrounding liquid or gaseous medium in response to a sudden temperature change. The response time is in order of hours or minutes:
    - **E.g. 1:** Let's consider moisture dynamics for a short-term emergency overload mode. In a wet unit, the water bubble emission may occur within the first *5-10 minutes* of the overload
    - **E.g. 2:** Let's consider a 2-Tx substation. Unit 1 was off for 12 hours, and now is switched back on. The load of Unit 2 drops *by step* back to normal. If the unit is wet, the oil Relative Saturation (RS) could reach the 100% level within *an hour* or even faster
  2. A slow phenomenon of moisture diffusion inside the *bulk* solid insulation. For lightly loaded units, the diffusion time is years

# Statement of the Problem in Technical Terms (Cont'd 2)

- It is preferred that a standard or guide does not contain too much scientific information
- On the other hand, no good standard or guide could be developed without a sound scientific basis

# What Is Proposed?

- It is proposed to consider a uniform solution to the issue of Moisture in Insulating Systems of Transformers and Reactors *as a whole*
- It is proposed to develop a new document that would serve as *a single knowledge base document* for all IEEE Transformers Committee standards and guides dealing with moisture
- The proposed title of the new document is:  
*Moisture in Insulating Systems of Gas Insulated & Liquid Immersed Transformers & Reactors*
- When needed, a certain standard or guide would refer to this document and/or develop its own higher level application based on this document

# What Is Proposed (Cont'd)?

- **It is proposed considering the *Insulation System* of a transformer or reactor as a *Physical Complex*:**
  - *Solid-Gas* (dry type, gas insulated & vacuum insulated units)
  - *Solid-Liquid* (liquid immersed units without headspace), or
  - *Solid-Liquid-Gas* (liquid immersed units with headspace)
- **It is proposed using the physical laws and mathematical equations for the *Solid-Gas Physical Complex* as the basis for all the three above listed physical complexes**
- **For the physical complexes containing the *liquid medium* it is proposed adding suitable knowledge and solutions**
- **It is proposed addressing different types of insulating solids, liquids and gases by providing appropriate coefficients and other parameters for the general mathematical equations derived for the *Solid-Gas Physical Complex***



# Statement of the Problem in Organizational Terms

- **The proposed approach is unprecedented in the C57 series of documents**
- **Right now the proposed approach does not fit in**
- **If accepted, the Transformers Committee will need to decide on:**
  - Where to put such document
  - What to call it
  - How to deal with a working group that will write it
  - How to deal with the later working groups to maintain it.

# What Will Happen Today?

- **Members of the Transformer Standards SC will vote for:**
  - Establishing or not a new Task Force (TF) under the Standards SC

# What Tasks are Proposed for New TF?

**If established, it is proposed that new TF will deliver a *report* stating:**

1. A conclusion on the merit of the proposed new document currently titled “Moisture in Insulating Systems of Gas Insulated & Liquid Immersed Transformers & Reactors”
2. Formulation of the Title and Scope of a body (TF? WG?) that would be developing the proposed new document
3. A recommendation on the document type to be developed:
  - a. **Standard, Guide, Interpretation Guide or Trail Use Guide?**
  - b. **Single or double logo?**
4. A list of existing IEEE (and IEC?) standards and guides on moisture
5. A recommendation on an action plan / timing

# Why Do We Need Another Task Force?

- **Currently, the existing Task Force “Moisture in Oil” (MIO) acts in accordance with its approved Scope**
- **The TF MIO is not authorized to act outside the area of the SC Insulating Fluids**
- **The issue of moisture is of high importance for *all* SCs and WGs of the Committee**
- **Subdivision of the issue into the limited areas of knowledge, such as “moisture-in-oil” and “moisture-in-paper”, is confusing, to say the least**
- **Significant improvements in moisture measurement techniques and understanding of moisture phenomena of the last decade are still to be incorporated into the IEEE TC standards and guides**

# Why Do We Need Another TF (Cont'd)?

- The proposed new document will consider the phenomena of moisture in Insulating Systems of Transformers and Reactors as a *WHOLE*
- In the author's opinion, now is the right time to replace the current practice of dealing with moisture and moisture-related temperature and ageing phenomena in each separate standard or guide by a new practice of dealing with the issue of moisture by means of a single comprehensive document
- For enabling the existing TF "Moisture in Oil" delivering the new document, it is proposed that the new body to be established reconsiders both the *Title* and *Scope* of the existing TF MIO

# Scope of TF Moisture in Oil as of 2009

The management of moisture in transformers and insulating fluids is one of the more challenging and often controversial dynamics with respect to transformer reliability. This task force is intended to improve the committee's understanding of moisture - by collecting data and providing any additional guidance this data demonstrates.

The main focus will be in gathering information with respect to the 35, 25 and 20 ppm levels of moisture in terms of temperature. What can be learned to qualify or quantify this statement to offer guidance to users? Percent saturation of moisture in oil is an important parameter to consider.

The ongoing collection and evaluation of transformer data will encompass many parameters due to the complexity of moisture in transformers. Data collection will include oil testing and on-line monitoring.

1. **Moisture Data providers (task force members, other)**
  - Owners, Laboratories, manufacturers, and repair facilities
  - On-line monitor providers
  - On-Line monitor users
2. **Information from existing studies – possible background info or data collection**
  - Cigre
  - IEC
  - Independents
3. **List of desired data parameters**

# Questions?