

DISCUSSION MEETING SUMMARY

Study Committee D1

Materials and Emerging Test Techniques

27th August 2024

Chair: Simon Sutton (GB)

Secretary: Gordon Wilson (GB)

Special Reporters: Jérôme Castellon (FR), Qiang Liu (GB), Karsten Juhre (DE), Uwe Riechert (CH)

1. INTRODUCTION

The activities of SC D1 include evaluation of new developments and assessing performance within:

- New and existing materials for electrotechnology
- Diagnostic techniques and related knowledge rules
- Emerging test techniques which may be expected to have a significant impact on power systems in the medium to long-term

2. RUNNING OF THE MEETING

Papers may be accessed here: <https://sessionpapersdoc.cigre.org/> if you are registered for the Session. They will then be available on e-cigre.org.

The Special Report is accessible here: [D1_SPECIAL_REPORT_2024](#) where the papers submitted are briefly summarised and discussed by the SC D1 Special Reporters.

The chairman gave a brief introduction of the scope and activities of SC D1. The structure of the SC was described along with a short overview of the range of current WGs.

Each Special Reporter introduced their respective section of the GDM with remarks about the questions posed and the reason for raising some of the topics. The Special Reporters managed the ensuing discussion:

- PS1 – Uwe Riechert (CH)
- PS2 – Qiang Liu (GB) and Jérôme Castellon (FR)
- PS3 – Karsten Juhre (DE)

Each contributor had 5 mins to present, including two minutes of questions. Where several contributions discussed similar aspects of the same question, the discussion was grouped.

Two NGN showcase winners got to present their papers and were given 15 mins. The papers aligned with PS1 and PS3.

3. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 1

PS1 – Testing, monitoring and diagnostics

- Testing and condition monitoring for reliability in conventional high voltage systems and power electronics applications.
- Assessment of diagnostics for equipment in remote or inaccessible locations.
- PD measurement under DC, rectifier, and impulse stress.

23 submissions were received in advance of the session and 1 spontaneous contribution was made during the session.

A presentation was also given by an NGN paper award winner. Filip Stuchała (PL) presented on "Lightning Properties of selected insulating Liquids based on the Acceleration Voltage Parameter"

The questions in the Meeting were divided into 4 topics:

1. Machine Learning
2. DGA and Transformer diagnostics
3. Partial discharge (PD) measurement
 - a. new techniques
 - b. applications and experience
4. New test requirements and experience

Much discussion was generated by the submissions particular for Topics 2 and 3 which received the most contributions in advance.

On Topic 2: Questions and comments were received from participants from Germany, Italy, USA, Netherlands and UK about the uncertainties in DGA measurements (Q2). Emphasis was placed on the need to understand trends rather than absolute measurements. DGA will tell you that there is something to be concerned about but further work is required to understand the risk. A question was raised about reported values in DGA reports, for example that repeatability of +/- 15% is expected, but what is seen in reality. A response was received that labs taking due precautions to eliminate errors may achieve these repeatability levels but some labs may be further away in practice.

There were no prepared contributions for Q3 but it was commented that in the US fluid filled cables are being replaced. It was noted that even though there are limits for gases, when DGA results exceed them, the customer does not always take action in the way that they might for transformers

On Q4, it was suggested that alcohol (methanol and ethanol) is useful in the USA where transformers are typically sealed and contain thermally upgraded Kraft paper. But as they are relatively volatile the testing on bottled samples (rather than syringes) is not recommended.

Q5 generated significant debate around acids in mineral oil and esters with questions and comments from participants from UK, US, South Africa, Norway and Germany. There is no consistent breakdown of LMA (low molecular weight acid) and HMA (high molecular weight acid) as this depends on the fluid and partitioning varies according to the acid types so it is affected by temperature. A question was raised about whether HMAs in esters, typically considered benign for paper ageing, have other negative consequences as they change the permittivity.

On Topic 3: Q6 had many prepared contributions and generated much discussion about the assumptions that are made when taking PD measurements and the differences that might be observed when monitoring assets in service compared with laboratory studies. PD monitoring using optical techniques appear are becoming more popular but are complementary to, rather than superseding, UHF measurement techniques.

In response to a question to the contributor on Q7, it was explained that PD monitoring has been used for a few decades now and substantial amounts of data and case studies exist to support the development AI tools although these still have to be validated by experts.

A debate about the presence of noise and its significance formed the discussion in response to the prepared contribution for Q8.

4. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 2

PS2 - Materials for electrotechnical purposes and modelling

- Ageing of materials under electrical, mechanical or thermal stresses and ageing markers.
- Modelling materials and field simulations for AC and DC applications.
- Assessment of compatibility of aged and new materials resulting from refurbishment or life extending activities.

14 submissions were received in advance and presented at the session.

The questions related to PS2 cover liquids & liquid systems (Q1-4), gases (Q5) and solids (Q6-8). The prepared contributions on liquids generated much discussion, which became quite lively at times.

Q1 and Q2 both related to oil-paper insulation systems and participants raised questions about the relative merits of Tensile Strength (TS) and Degree of Polymerisation (DP) with participants from Germany, Poland, Brazil and Japan adding to the prepared contribution presenters. Even after much study the correlation of these is unclear or it at least it has been established that they cannot be correlated in every case. It was suggested that this may be because the DP considers only the cellulose component in paper and other factors such as additives play a part in the TS. The elongation component of TS could be assessed and used in assessing paper samples but it was suggested that the method is insufficiently sensitive to be relied upon.

Corrosive sulphur was a lively topic for the GDM (Q3) as it has been in previous years. Although it is less of a hot topic, it is clear that the matter is not settled and there is still confusion for some in the industry. Passivators are a popular mitigation in use but it provides only a monolayer of protection on copper and no protection of silver. A question was raised about the potential presence of sulphur in vapour phase liquids - ensuring this is not a problem is the responsibility of transformer OEMs. As it is produced from mineral oil there is a risk but one participant suggested it had been found but it was from handling not in the original material.

Q5 prompted a debate around the loss of CO₂ from C₄F₇N/CO₂ gas mixtures, whether it was solely due to ageing "O" rings. This seems to be the case and topping up with the nominal ratio gas mixture can result in an accumulation of C₄F₇N and the owner needs to take care of this.

5. CONTRIBUTIONS TO PREFERENTIAL SUBJECT 3

PS3 - Materials to enable the energy transition

- Alternative electrotechnical materials or manufacturing processes which reduce environmental footprint.
- Materials and systems for energy storage; batteries, charging devices, capacitors etc.
- Materials to enable a hydrogen economy

6 submissions were received in advance and presented at the session

Prepared contributions were presented to an interested and engaged audience on Q1-4. On the subject of liquid immersed fault current limiting devices, it was suggested that although commercial devices exist there is little experience and utilities have not started to use them much yet.

Other than the prepared contributions, there were few responses to suggestions for other materials that might be considered to reduce carbon footprint but this is likely to be a subject of interest going forward as utilities look for ways to meet net zero targets

A presentation was also given by an NGN paper award winner. Ismael Antolin Maestre (ES) presented on "Experimental evaluation of the dielectric properties of insulating paper impregnated with mineral and vegetable oil as function of moisture".

6. CONCLUSION

The General Discussion Meeting had 278 people attend throughout the day. Contributions were made by representatives from 14 countries and 53 questions or spontaneous contributions made by delegates from 17 countries.