



**ABSTRACT**

All the readers of Transformers Magazine and attendees of Transformer Academy already realize that DGA is one of the most comprehensive tests for oil-filled electrical devices. Also, readers well understand the complexity of these tests. This aspect is emphasized by all DGA standards, guides, and ample literature and research on DGA methodology. DGA includes three major steps: sampling, measurements, and diagnosis. In this column, the focus will be on the measurement location.

Maintenance staff and even transformer-responsible officers and owners face the dilemma of where to perform the routine and crucial DGA tests on their precious transformer. The alternatives for performing such tests are multiple (at least 5), and each possesses its pros and cons and may even have significant financial impact. Usually, the financial staff chooses to send the oil analysis to the most convenient source, and maintenance engineers need to select the DGA provider by performance and timing. Those facts impose a very judicious compro-

mise between cost, quality, and react time.

This column describes the considerations and deliberations of using in-house or external outsourcing DGA supplier tests. Considerations of using online DGA versus offline will be described in a future column.

**KEYWORDS:**

DGA tests outsourcing, in-house oil laboratories, knowledge conservation, quality assurance

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# Where to perform the dissolved gas analysis?

## 1. Introduction

Up to now, we have covered the complexity of dissolved gas analysis and its vulnerability to so many factors. Even the transformer users collect the oil sample by an experienced team and perform the diagnoses by the best experts or software health index. It highly depends on the DGA test provider.

In the early days of DGA for the power transformer industry, most DGA tests were performed in laboratories owned and / or controlled by organizations correlated to manufacturing or operating electrical equipment. In our time (2022), most offline DGA tests are performed by organizations focused on oil tests and measurement devices. Transformer maintenance engineers and their financial administrators need to decide if it is worth having their DGA tests or using one of the multiple outsourcing alternatives. Sometimes this decision emerges from the overall politics of the organization – to prefer to outsource, for example – but it has a huge impact on the energy availability both in routine and emergency situations. This situation has been even more emphasized during the pandemic period when outsourcing has highlighted some implications of delivering DGA samples to an external organization.

The majority of technical and financial staff are aware of the quality standards ISO 17025 and ISO 90001, which are mostly compulsory for all transformer oil bids. Quality standards are indeed optimized for the quality control of each organization and, in this case, of oil laboratories. But the users should keep in mind that those quality standards are not an insurance of accurate and correct results. In case of an internal laboratory investing in official ISO, accreditation may be unnecessary if the laboratory itself preserves the most important principles of quality assurance. Quality standards ISO17025 are indeed, in most cases, a factor of distinction between quality laboratories and those of lower performances. Around the world, there are very good laboratories that do not even possess those standards and, nonetheless, provide quality results, even better than some with ISO17025 accreditation.

Another important issue that bidders should meticulously check is if the specific test they require is accredited by ISO17025. Some users erroneously consider that if a laboratory has one accredited oil test, it performs all oil tests with the same high quality. This situation mostly occurs with accredited PCB in oil, which is compulsory and needs accreditation, or



*Disclaimer: Because of the sensibility of commercial issues and in order to preserve neutrality, no specific company of actual DGA providers will be mentioned in this column. Therefore, this column will not recommend using internal or external DGA service providers. Each case should be customized according to its specific needs.*



Figure 1. Synchronizations of transformer specifications and oil test laboratories specifications

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even some “uncomplicated” accreditation oil test, such as water-in-oil by Karl Fisher, or oil acidity. Accreditation for those tests is not at all an indication of DGA performances. For a laboratory to provide high-quality results, the ISO17025 is only a primary action but not sufficient for adequate quality. There are many laboratories around the world that indeed provide very accurate DGA and other oil results at a higher level than medium-accredited laboratories. In the case of DGA tests, prices correlate less to quality outputs.

### 2. Motivation for testing DGA and other oil tests in an in-house laboratory as a substitute for an outsourced laboratory

Transformer oil tests have emerged and have been developed by organizations and companies that own or manufacture transformers. As with every major technological development, the main driver here is the economic motive. Oil tests in general, as well as DGA, have proven their efficiency in emergencies such as external

trips or situations that needed to be clarified and preventing transformer failure only in the last decades. In the early 60s of the last century, most of the oil and offline DGA tests were performed in laboratories in the vicinity and under the authority of transformer-related companies. In the last decades, more offline oil tests have been performed in organizations that provide mainly test services. This transfer is also caused by financial reasons, but it does affect the technological or even maintenance conditions of transformers.

Oil tests by the same organizations include many advantages, such as:

- Transformer maintenance staff and laboratory personnel have a common employer, a common goal and values (Fig. 1). Of course, the main target for an in-house laboratory is to fulfil as much as possible the organization and transformer’s needs. In contrast, the main target of the outsourced laboratory is to increase the revenue of the laboratory itself by reducing the overall prices for performing the DGA tests, for example.

- **Commercial and national security** (Fig. 2). As we are aware, in the period of publishing this column, hostilities actions among countries, nations, and commercial companies are unfortunately on the rise. Power transformers are part of the basic strategic assets of each country and organization and have become a target for physical or remote attacks. If one exports or outsources any crucial tests for one’s strategic asset, one may expose and uncover some critical conditions.
- Having a laboratory and transformer under the same roof allows free and unrestricted communication between the transformer owner and transformers diagnosis staff. As in medical care, the patient needs to renounce any secrecy for the sake of a better and more accurate diagnosis. The transformer owner also needs to feel free to reveal all identifying plans and actual maintenance secrets. This may have a very positive impact on the overall diagnosis. But if the personal health data exist on any digital platform, it may at some point in time be used for negative purposes with regards to the patient. Some situations related with power transformer oil tests may reveal vulnerability issues of that important asset for each organization. For external laboratories or a DGA diagnosis provider, it may be problematic to expose the number, size, and condition of such strategic asset for any utility or country.
- Transformers may attract unfriendly operations from economic competitors or national enemies.



- **Time and distance** (Fig. 3). Those two parameters are already described as critical parameters for DGA accuracy. Even DGA standards mention performing DGA tests within a certain time frame from sampling. Also, previous columns have described the effect of transporting oil samples by air or shaking during travelling. Keeping time and distance as short as possible improves DGA and overall health index accuracies. The in-house

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laboratory is usually in the vicinity of transformers. Normally, the in-house laboratory is the closest option for DGA. The time and distance are vital

not only in an emergency but also for routine measurement. DGA is more reliable and representative as the time elapsed from sampling to test is short-



Figure 2. Commercial and national security concerns

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er and less exposed to transport stresses.

- Time becomes especially crucial in emergencies when correct and rapid DGA tests are demanded to establish the implication of an energized transformer after a fatal situation such as Buchholz or external alarm. Without a reliable and trained DGA testing apparatus and team, the decision to energize the transformer or not may have negative impacts.
- **Adaptability and test procedure continuity.** With an in-house laboratory, the transformer owner has the privilege of being able to control and decide which DGA test method to apply according to its transformer's

design, importance, and age. A well-established in-house laboratory provides the chance for database continuity and assures correct trending. If any issue arises with the reliability of the results, transformer owners may directly and confidentially clarify them with the laboratory managers for the benefit of the equipment.

- **Adaptability sampling** (Table 1) – devices and DGA measurements units. As presented in previous columns, there are many alternatives for sampling and transporting the oil for DGA from transformers to the laboratory. There are also a few options to introduce the oil into the extraction system for dissolved gas measure-

ments. A syringe is not always the best option for those purposes, and different bottled materials are sometimes a better for both sampling and testing. An in-house laboratory has the benefit of being able to instruct the sample team accordingly to the best option for delivering the oil for DGA tests.

- If the transformer fleet introduces new transformers with new insulating materials, such as non-minerals oil, it is important to adapt the oil lab capabilities to those new materials. External laboratories may be adapted to only one or several types of insulating liquids but not specific to those existing in the transformers.
- **Financial stability.** In our unstable contemporary world, companies may disappear or be bought by others, and then discontinue oil tests. On the other hand, prices are subject to currency rates, employment market fluctuations, or even geopolitical impacts. Therefore, an in-house laboratory enjoys stable prices and controlled and stable promptness in performing those oil tests.

## The in-house laboratory offers a few significant benefits that probably will cause the industry to return to performing DGA tests mainly in an owned or controlled laboratory



Figure 3. Time and distance

Table 1. The adaptability of DGA sampling containers and DGA test devices

Sample container	Syringes	Flexible bottle	Bottle	Ampoule	Ampoule	Oil volume in ml
Material	glass	metal	glass	glass	metal	
Sealed transformer	+++	-	-	+	-	30
With membrane in conservator	+++	++	+	++	-	30-200
New transformer	+++	-	-	-	-	30-200
Free breathing transformer	+	++	+	+	+	30-100
Over-pressurized transformer	-	+++	+++	++	++	30-100
Headspace DGA	++	-	-	-	-	30
Partial vacuum extraction	+++	-	-	++	++	
Multi-stroke vacuum extraction	+++	+++ (non-mercury)	+++ (non-mercury)	-	-	100-200
Portable device	+++ (for MS special one)	-	-	-	-	50 or 110 (MS) or 100 (ES)

• **Preserving the knowledge of DGA testing and even DGA diagnosis.**

Despite the concept of many transformer owners and managers, the ability to perform a valuable diagnosis and health index assessment highly depends on understanding major test procedures. This is especially valid for DGA, which is one of the principal pathways to analyze transformer conditions. By renouncing DGA test capabilities, the company is also renouncing to be competent to provide a valuable health index based on DGA and, of course, the rest of the oil tests.

Nowadays, many companies around the world centralize oil tests and DGA into service centres, including the testing and diagnostic capabilities. For internal users, the advantages are literally for in-house laboratories if the distances are not too long. However, all other advantages are still actual.

### 3. Conclusion

In this column, the advantages of using in-house laboratories are presented. An in-house laboratory offers a few signifi-

cant benefits that probably will cause the industry to return to performing DGA tests mainly in an owned or controlled laboratory. Security and knowledge preservation is probably crucial in driving a company to use inner laboratories.

Despite the advantages of an in-house laboratory, most remote DGA tests are

conducted today in outsourced locations. There are proper and convincing reasons for doing this. The following column will debate the advantages of outsourcing DGA tests to a central laboratory and how to select those laboratories through an adequate bidding process. Also, a reference to aspects of using portable and online DGA devices will also be elaborated.

#### Author



**Marius Grisaru** has an MSc in Electro-Analytical Chemistry from the Israel Institute of Technology. He has almost 30 years of intense experience in almost all transformer oil test chains, from planning, sampling and diagnosis to recommendations and treatments, mainly in Israel but also in other parts of the world. He is responsible for establishing test strategies and procedures and creating acceptance criteria for insulating liquids and materials based on current standardization and field experience. In addition, he trains and educates electrical staff on insulating matrix issues from a chemical point of view. He is an active member of relevant Working Groups of IEC, CIGRE, and a former member of ASTM. He is also the author and co-author of many papers, CIGRE brochures, and presentations at prestigious international conferences on insulation oil tests, focusing on DGA, analytical chemistry of insulating oil, and advantageous maintenance policy for oil and new transformers.