

prolec®



Services



More than 50 years of experience in the power industry

We are dedicated to providing reliable solutions for every transformer application throughout the electrical grid.

We offer a variety of services related to the installation, assessment, and maintenance of transformers. From an external evaluation and all required field tests to a complete relocation project, **Prolec GE** is prepared to take care of your transformer needs.

Prolec GE can provide the following services:



Assembly

Power transformers are usually transported disassembled with all detachable accessories removed from the unit due to route restrictions. **Prolec GE's** assembly services consist of the prompt and complete field assembly of all components of the transformer. The process includes a thorough inspection of the interior of the main tank and accessories to check for any damage to the equipment that may have occurred during transportation.

The process ends with a pressure test to verify that the transformer is completely sealed following assembly.

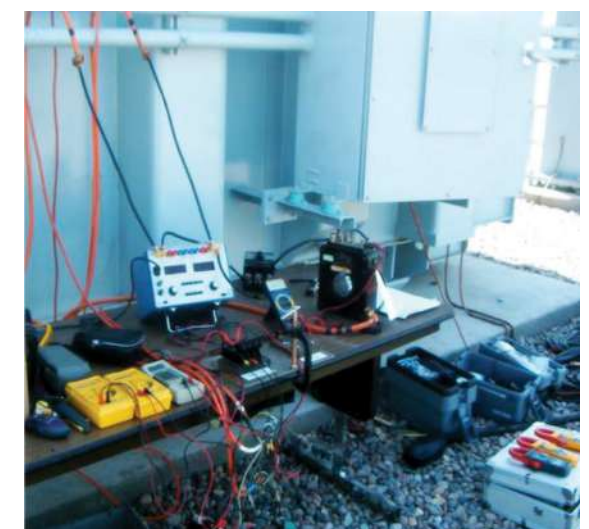
Oil filling process under vacuum

When transformers are shipped without oil, and once the assembly process has been completed, excess moisture must be extracted from the insulation. The process begins with the dew point measurement in order to obtain the insulations moisture content. If it is greater than 0.5%, a drying process is performed according to **Prolec GE's** Installation, Operation and Maintenance Manual. Then a vacuum oil fill process is performed at a controlled rate. The oil is tested prior to processing, and then oil filling can take place. Transformers shipped oil filled does not require this process.



Field testing

Electrical tests are performed to the transformer to verify its integrity after it has been transported, assembled, dried and oil filled. These are performed according to **Prolec GE's** Installation, Operation and Maintenance Manual plus any agreed customer request. Examples of these tests are: insulation resistance (windings, core, and frame), ratio, and power factor. The oil is also tested at the field (power factor, dielectric strength, etc) and once the transformer is oil filled, a sample is sent to obtain a detailed chemical analysis and DGA. These tests are performed and evaluated by experienced personnel comparing the results with the factory tests. Some optional tests that could be performed are frequency response, vibration, transients, etc.



Technical consulting service

If the processes of assembly, vacuum, oil filling and field tests are performed with company crews and you want to minimize the risk of non-compliance with the Installation, Operation and Maintenance Manual. **Prolec GE** field engineer can be contracted to provide technical knowledge and field expertise. This engineer will be able to answer questions and provide guidance on the proper receiving, installation, storage, operation and maintenance procedures. Historic data shows that many of the causes for taking a transformer out of operation during its early life are defects due to an inadequate field assembly. Many customers have benefited from taking advantage of **Prolec GE's** technical expertise through this optional service.

Spare parts

Like all equipment, many transformers parts and accessories will eventually need to be replaced during the transformer operating life. In order to meet our customer needs, **Prolec GE** has a wide range of spare parts in stock available for immediate delivery and with the confidence that the exact part required for your equipment is being delivered. If a part is not in stock, it can generally be obtained with very competitive delivery times. **Prolec GE** also offers the specialized installation of these parts.



Transportation

Moving a transformer that weighs several tons is not an easy task. This is why **Prolec GE** has developed specialized transportation across North America and around the world. This transportation team can deliver your transformer anywhere with the guarantee that it will be handled by expert whether by train, road, sea or air. In addition, **Prolec GE** has a continuous impact tracking system to verify the adequate handling of your equipment. As an option we can provide online GPS and impact monitor system.

Unloading

The unloading process is as important as the transportation process. Inexperienced handling can damage the transformer risking total loss of the equipment. **Prolec GE** crews have the knowledge and experience of handling the critical aspects of hoisting the transformer with slings, lift it with hydraulics jacks, haul it or pull it until it is placed in its base or final resting spot.



Receiving inspection

Once a transformer reaches its final destination, specialized personnel should perform an inspection to guarantee the conditions in which the transformer is delivered. This consists in reviewing the impact records, conducting a series of external inspections and performing necessary tests.

Relocation

Relocation consists of several services that must be perfectly coordinated. The typical scope of these services includes:

- Verifying the original condition of the transformer
- Draining and disassembling
- Packing and transporting to the new site
- Assembling, drying, oil filling and final testing

Prolec GE has the appropriate resources and experience to coordinate the full scope of this work.

Failure investigation

In the event a transformer fails during operation, the two most important tasks that need to be performed are:

1. Locate and install a replacement as soon as possible.
2. Perform a complete failure analysis to determine the root cause of the problem.

For the distribution transformers (industrial, commercial, residential) **Prolec GE** has developed a set of tests (electrical and oil analysis), which can be performed at site and are used to assess abnormalities, and define an action plan for the transformer repair or replacement.





Field repairs

In the event that your transformer requires a major repair, **Prolec GE** has the experienced personnel and the resources to work at site and correct the defects. Some repairs could be exterior, such as installation of spare parts (bushings, gauges, etc.), painting, correcting or revising the control system. The interior of the transformer can be inspected to locate and repair areas, which generate gases, partial discharges or excessive noise, re-tightening of winding packages, or replace the tap changer.

Service center

In the case a distribution transformer (industrial, commercial, residential) needs a major repair, Prolec GE has a service centers in the United States, staffed with qualified personnel to provide prompt service. Our Service Centers meet high- level quality and are technically supported by our design and technology departments at the **Prolec GE** factory as required.



Condition assessment

After several years in operation, it is important to evaluate the condition of the transformer to determine options to extend the life of the asset or to minimize the probability of a future failure. **Prolec GE** has the knowledge, experience, design information, and trained personnel capable to perform such studies. If needed, **Prolec GE** can incorporate analysis of networks, power systems, and transient events that may impact the integrity of the specific transformer application.

Prolec GE has a combination of factory and field experts at the Monterrey facility and in other countries. The evaluation is a complete study, which performs a diagnosis of key elements of the transformer and its use. This evaluation typically results in an estimate of the remaining productive life and the recommended maintenance or other actions relative to improving the reliability or increasing its useful life.

Service maintenance contract

In certain circumstances the transformers owners / users don't have the resources to fulfill maintenances requirements according to **Prolec GE's** Installation, Operation and Maintenance Manual by themselves, that is why **Prolec GE** offers the possibility to take full responsibility of the transformer maintenance during the life expectancy, ensuring the equipment will be in optimal working conditions.

Training

Maintenance of a power transformer is not simple. Therefore, **Prolec GE** offers courses taught by our experts and cover the most important aspects of the transformers and operation details of the equipment. Written material is provided to each participant and the courses contain a practical hand-on section where the participants consolidate their learning.

Prolec GE supports the planning and execution of all its services, not only in its extensive and proven experience with transformers handling, but also with solid technical references such as international norms, technical literature, industrial practices and our own research and developmental activities.



Customers recognize Prolec GE service quality at each and every point of interaction, since the first contact with customer along with out 24/7 service.

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Recommended Tests and Reference Values for Transformer Mineral Oil (*)

| Test and Method | New Transformers prior to energization | | | | Suggested limits for continued use of service-aged oil | | |
|--|--|------------------|------------------|------------------|--|--------------|------------------|
| | ≤ 69 kV | >69- <230 kV | ≥230- <345 kV | 345 kV and above | ≤ 69 kV | >69- <230 kV | 230 kV and above |
| Dielectric strength ASTM D1816-97, KV minimum | 1 mm gap 25 2 mm gap 45 | 30 52 | 32 55 | 35 60 | 23 40 | 28 47 | 30 50 |
| Neutralization number (acidity), ASTM D974-02, mg KOH/g maximum | 0.015 | 0.015 | 0.015 | 0.015 | 0.2 | 0.15 | 0.1 |
| Interfacial tension, ASTM D971-99a, mN/m minimum | 38 | 38 | 38 | 38 | 25 | 30 | 32 |
| Color ASTM D1500-98 ASTM units maximum | 1 | 1 | 1 | 0.5 | | | |
| Water content ASTM D1533-00 mg/kg maximum | 20 | 10 | 10 | 10 | Refer to "Suggested maximum water content" table. | | |
| Visual examination, ASTM D1524-94 (1999) | Bright and clear | Bright and clear | Bright and clear | Bright and clear | | | |
| Power factor, ASTM D924-99e1, % maximum | 25 °C 100 °C | 0.05 0.4 | 0.05 0.4 | 0.05 0.3 | 0.05 0.3 | 0.5 5 | 0.5 5 |

* For more information, please consult IEEE Std C57.106-2002

Suggested maximum water contents in mg/kg (or ppm) and percent saturation (*)

| Average oil temperature | 50 °C | | 60 °C | | 70 °C | |
|-------------------------|----------------|--------------|----------------|--------------|----------------|--------------|
| | mg/kg (or ppm) | % saturation | mg/kg (or ppm) | % saturation | mg/kg (or ppm) | % saturation |
| ≤ 69 kV | 27 | 15 | 35 | 15 | 55 | 15 |
| >69 - <230 kV | 12 | 8 | 20 | 8 | 30 | 8 |
| 230 kV and greater | 10 | 5 | 12 | 5 | 15 | 5 |

* For more information, please consult IEEE Std C57.106-2002

TRANSFORMER OIL CLASSIFICATIONS

| No. | To be considered | NN | IFT | OQUIN | Color |
|-----|------------------------------|-------------|-------------|------------|----------------|
| 1 | Good Oils | 0.00 - 0.10 | 30.0 - 45.0 | 300 - 1500 | Yellow Pale |
| 2 | Oils Type To | 0.05 - 0.10 | 27.1 - 29.9 | 271 - 600 | Yellow |
| 3 | Marginal Oils | 0.11 - 0.15 | 24.0 - 27.0 | 160 - 318 | Shining Yellow |
| 4 | Bad Oils | 0.16 - 0.40 | 18.0 - 23.9 | 45 - 159 | Amber |
| 5 | Very Bad Oils | 0.41 - 0.65 | 14.0 - 17.9 | 22 - 44 | Coffee |
| 6 | Very Bad Oils in End | 0.66 - 1.50 | 9.0 - 13.9 | 6 - 21 | Dark Coffee |
| 7 | Oil in Disastrous Conditions | 1.51 and up | ----- | ----- | Black |

Quick Reference of Useful Standards and Guides

| Number | Description |
|----------------------------|--|
| IEEE Std C57.12.00 - 2000 | IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers |
| IEEE Std C57.12.80™ - 2002 | IEEE Standard Terminology for Power and Distribution Transformers |
| IEEE Std C57.12.90 - 1999 | IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers |
| IEEE Std C57.91 - 1995 | IEEE Guide for Loading Mineral-Oil-Immersed Transformers |
| IEEE Std C57.93 - 1995 | IEEE Guide for Installation of Liquid-Immersed Power Transformers |
| IEEE Std C57.104 - 1991 | IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers |
| IEEE Std C57-106™ - 2002 | IEEE Guide for Acceptance and Maintenance of Insulating Oil in Equipment |
| IEEE Std C57.115 - 1991 | IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers Rated in Excess of 1000 MVA (65 °C Winding Rise) |
| IEEE Std C57.116 - 1989 | IEEE Guide for Transformers Directly Connected to Generators |
| IEEE Std 62 - 1995 | IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus - Part 1: Oil Filled Power Transformers, Regulators and Reactors |



LOCATIONS

MEXICO

APODACA

Blvd. Carlos Salinas de Gortari
Km. 9.25 Apodaca, NL
66600 MX
+52 81 8030 2000
+52 81 8030 2400

USA

SHREVEPORT

7000 W Bert Kouns Industrial Loop
Shreveport, LA 71129
+1 (318) 687-6600

WAUKESHA

400 S Prairie Ave.
Waukesha, WI 53186
+1 (262) 547-0121

DALLAS

9011 Governors Row
Dallas, TX 75247
+1 (800) 338-5526

GOLDSBORO

2701 US-117
Goldsboro, NC 27530
+1 (919) 734-8900

BRAZIL

CANOAS

Avenida Guilherme Schell, 11500
Bairro Industrial - Ciudad de Canoas
Esteio, RS 92.420-820
+55 (51) 3477-8700

For more information
contact your local GE sales representative

prolec.energy/prolecge

