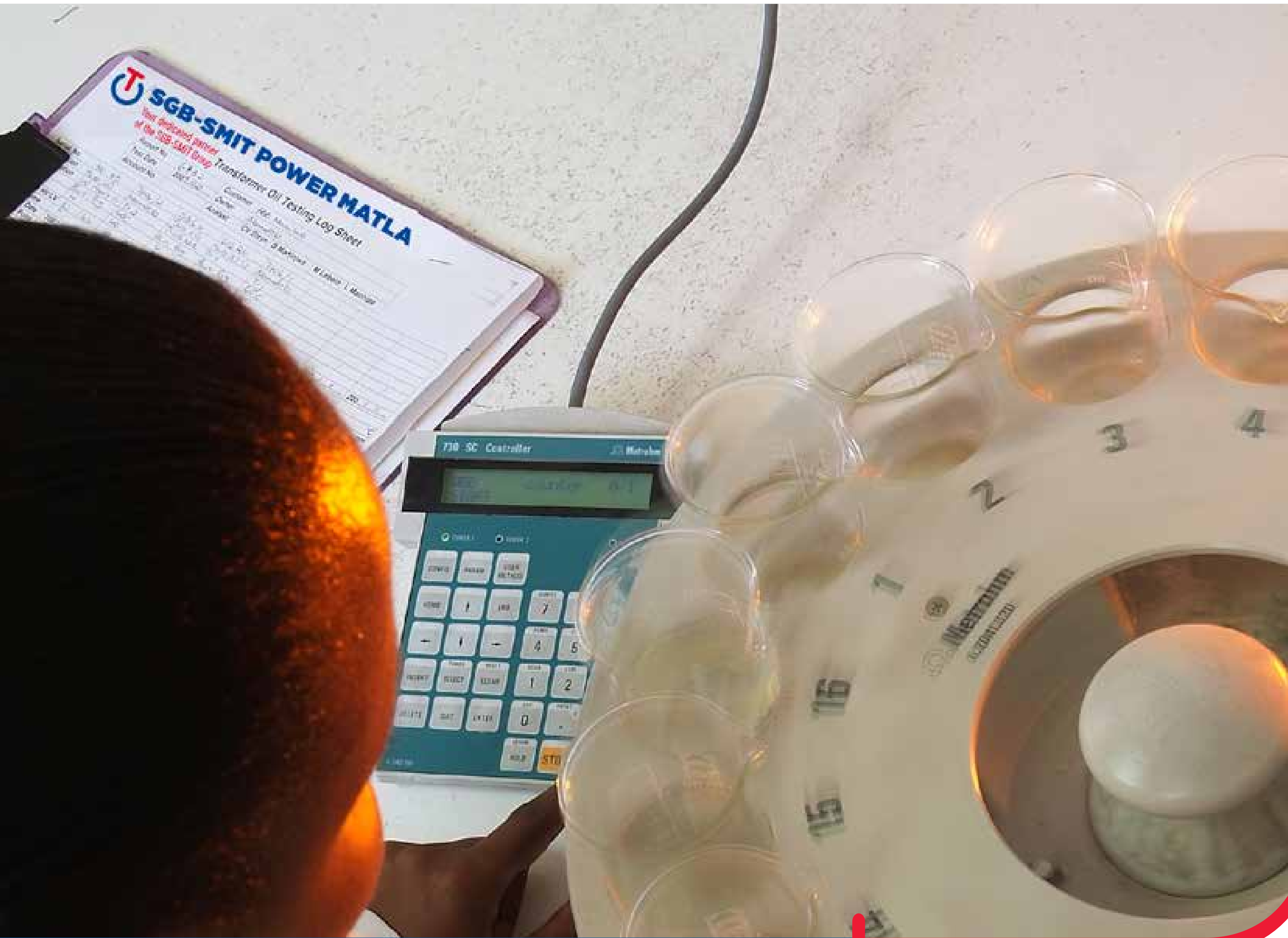
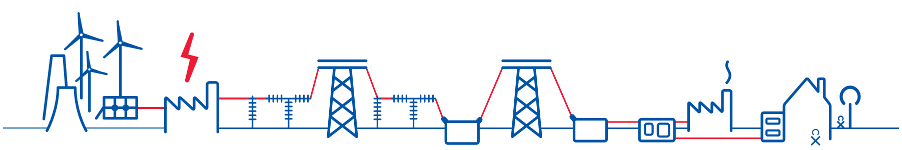
SGB-SMIT POWER MATLA

Your dedicated partner
of the SGB-SMIT Group

LABORATORY PROFILE





SGB-SMIT AT A GLANCE

Combined, more than

450

YEARS OF EXPERIENCE

Basis for know-how and for know-why

More than

3,500

EMPLOYEES

take care of your project

In more than

80

COUNTRIES

satisfied customers

READY FOR YOUR MARKET

The SGB-SMIT Group manufactures transformers for applications worldwide. Sales and service centers on all continents ensure optimum processes.

Our products meet the requirements in accordance with the applicable national standards.

PRODUCTS

- large power transformers
- medium power transformers
- large liquid-cooled distribution transformers
- liquid-cooled distribution transformers
- cast resin transformers
- shunt reactors
- series reactors
- phase shifters
- Lahmeyer-Compactstationen®

Transformers from 50 kVA up to incl. 1,200 MVA in the voltage range up to 765 kV.

QUALITY MANAGEMENT

The SGB-SMIT Group is certified in accordance with:

- DIN ISO 9001
- DIN ISO 14001
- DIN ISO 50001
- OHSAS 18001

TECHNOLOGIES

Technologies for conventional and renewable energy.

Status: December 2019

SGB SMIT POWER MATLA A MEMBER OF THE SGB-SMIT GROUP

SGB-SMIT POWER MATLA has over 70 years experience in successful design, manufacturing, testing, installation and commissioning of a full range of power and distribution transformers which include large power transformers of voltages up to 800MVA.

SGB-SMIT POWER MATLA

SGB-SMIT POWER MATLA (Pty) Ltd is owned by SGB-SMIT (GmbH) and Power Matla.

SGB-SMIT, is the largest independent and pure-play transformer manufacturer in the world, with headquarters in Regensburg, Germany. They are represented on 5 continents in 8 countries with plants in Germany, the Netherlands, USA, Romania, Malaysia, India, China and the Czech Republic. With transformer expertise since 1913 they produce transformers ranging from 50 kVA up to 1,200 MVA.

Power Matla (Pty) Ltd is a locally owned black empowered company with investments in various portfolios within the renewable energy, ICT, mining and power utilities markets providing good shareholder value and solid returns.

The company consists of Large Power Transformers manufacturing plant in Pretoria and Distribution Transformers plant in Cape Town and supplies a full range of transformers, from generator step-up to transmission and distribution transformers. The range includes three-phase and single-phase units, auto-transformers, arc-furnace, locomotive and traction transformers, miniature sub-stations, NECRT's as well as shunt reactors.

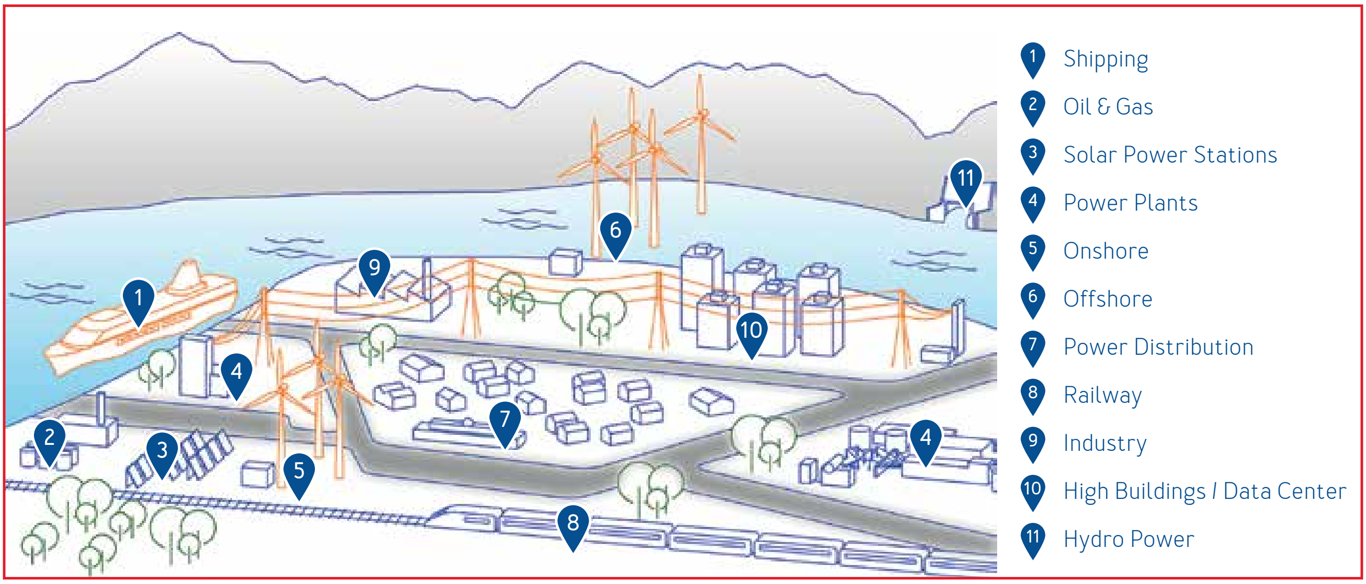
"CUSTOM DESIGNED"

Every SGB-SMIT POWER MATLA unit is custom-made from standardised design elements and using uniform manufacturing operations. This flexible, but well co-ordinated approach ensures the highest quality of design and construction for all our transformers and makes the best possible use of the valuable knowledge and experience gained over the years and best practices developed in our factory.

The Large Power Transformer factory in Pretoria is a well-equipped factory and is amongst the biggest and most sophisticated transformer manufacturing plants within the Southern Hemisphere and one of two large transformer manufacturers within sub-Saharan Africa.

The Distribution Transformers factory in Cape Town has been manufacturing distribution transformers and miniature substations for more than 60 years.

SMALL, MEDIUM AND LARGE POWER TRANSFORMERS ALL OVER THE WORLD



OVERVIEW

SGB-SMIT POWER MATLA's fully equipped laboratory is situated at the company's Pretoria operation. The laboratory, which has been in existence since 1972, forms part of the Large Power Transformers Business Unit and offers a large variety of services to the company as well as outside customers from various industries within South Africa as well as some countries within Africa, namely Namibia, Kenya and Mozambique at present. The main activities of the laboratory are testing of materials for power and distribution transformers. The testing of transformer oil forms a large part of the test activities.

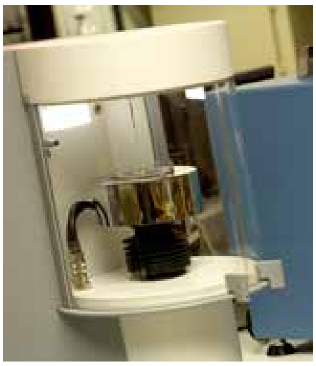
All laboratory work is carried out in stringently controlled conditions and complies with local and international standards ensuring that we meet customer requirements.

MISSION AND VISION

The SGB-SMIT POWER MATLA laboratory mission statement is to establish a facility that will:

- be internationally recognised
- be the most technologically advanced laboratory of its kind in Africa
- have sufficient resources to offer customers a quick return of their test results
- cover a diversity of tests to support transformer manufacturing
- develop a high competency of personnel

The vision is to be the preferred service provider for laboratory related services for our targeted markets.



ENHANCING TRANSFORMERS LIFE EXPECTANCY

ENHANCING TRANSFORMERS LIFE EXPECTANCY

Transformers are rated amongst the more expensive assets in their specific networks.

Care through planned preventive maintenance programs is recommended. Maintenance should include comprehensive oil testing as defined in your quality system

Maintenance and evaluation of results to be based upon internationally accepted guidelines, ie ASTM; IEC; Doble; ABB and SGB-SMIT.

Test results should be used for the following:

- Re-establish maintenance frequency
- Evaluate expected performance of family of transformers
- Method to plan the replacement of transformers

It is also extremely important to avoid these pitfalls to ensure proper maintenance of transformers:

- Ensure proper sampling of the oil
- Qualified and competent technician to take oil sample
- Proper oil sample container – no leaks - gastight

REASONS FOR A TRANSFORMERS LIFE EXPECTANCY TO BE SHORTENED

A Transformer's life will be shortened through the following, but not limited to:

- Moisture
  - Free water can lead to flashovers
  - Dissolved water will accelerate cellulose and oil decay
- Acids
  - Will lead to sediment deposits eventually sludgeing
- Solid Particles
  - Half the distance in high electrical field
  - Can lead to flashovers
- Electrical Faults
  - Can lead to flashovers and possible explosions
  - Can lead to transformer trip conditions
- Thermal Faults
  - Normally a slow death of a transformer
  - Leads to oil and cellulose decay

TRANSFORMER LABORATORY TESTING

LABORATORY TESTING

The laboratory performs a wide variety of tests on transformer oil. The results of these tests enables one to locate possible faults in transformers as an integral part of preventative maintenance.

The laboratory started with Dissolved Gas Analysis (DGA) in 1979. These tests were only done for as part of our internal tests of a transformer.

During the period 1986 to 1987 these tests were expanded and Dissolved Gas Analysis (DGA) and general oil testing was done for both internal use as well as external customers.

The laboratory personnel have a vast amount of experience in evaluating techniques used in assessing the health of transformer. The laboratory has three sections namely:

Oil Laboratory
Cellulose Laboratory
Metal Laboratory

The above includes but is not limited to transformer oil testing, cellulose testing and various material analysis.

PURPOSE OF INSULATING OIL IN TRANSFORMERS

There are four main purposes of insulating oil in transformers:

- The transformer oil acts as an insulator of High Electrical Stress Areas. The oil acts as a arc quencher.
- The transformer oil also acts as a Cooling Agent since high oil temperature affects the cellulose mechanical strength
- Insulating oil acts as a carrier of Vital Life Information. When there is oil and cellulose decay, by-products are formed.
- Insulating oil is also a carrier of Protective agents and additives.

Oil protects the solid insulation by serving as a barrier between paper and the damaging effects of oxygen and water.

As oil ages the ability to fulfill some of the aforementioned functions is compromised.

Regular testing of transformer oil will assist in preventing the formation of decay products.

TRANSFORMER OIL TESTING

DISSOLVED GAS ANALYSIS (DGA)

Analysis of dissolved gases in transformer oil is being recognised world wide as being an essential diagnostic tool for the early detection of incipient faults in transformers. It is an extremely cost effective method to monitor the condition of power transformers.

An automated head space sampler coupled to a gas chromatograph is used to extract the dissolved gases from the transformer oil.

Analysis is performed in accordance with IEC 60599. A computer database is established for each transformer and, in time, a full history of the transformer is built up. Thereby gassing trends can be monitored. The results obtained from the gas chromatograph is applied to various calculations. These are based on internationally accepted methods and standards. The mathematical results of the calculations are used to diagnose possible faults or normal aging. Information is plotted to produce trends of gases tested over periods of time. Faults identified could then be of a thermal or electrical nature.

The laboratory report includes recommendations for actions to be taken by the customer.

WHY DO WE TEST?

The purpose of testing of transformer oil is to show an indication of the following:

- Thermal faults
- Electrical faults
- Ageing

Gases originate from the following:

- Oil decay process – elevated temperatures
- Cellulose ageing
- Catalytic reactions
- Exposure of oil to sunlight
- May be formed during repair of the equipment.

FREQUENCY OF TESTING

It is recommended that Dissolved Gas Analysis (DGA) testing should be carried out once a year under normal conditions. The frequency shall be increased if a fault appears to be developing due to factors like, for example, constant overloading of equipment.

TRANSFORMER OIL TESTING

OIL QUALITY

The testing of transformer oil is part of a preventative maintenance plan, also known as condition monitoring. The oil inside a transformer forms an integral part of the insulation system, but is unfortunately subject to quick deterioration if the preventative maintenance schedule is not adhered to. Adverse load conditions also affect the oil. It is therefore common practice to have the oil tested annually under normal operating conditions and more frequently when faults are suspected.

The three main components which are subject to deterioration and contamination in a transformer are the paper, which is used for conductor insulation; the pressboard, which is used for the major insulation and winding support; and the insulating oil.

Certain tests also give an indication of the condition of the transformer itself and, if interpreted correctly, and acted upon, can prevent failure or unnecessary outages.

This group of oil quality tests is required to monitor the oil in order to ensure that it is suitable for continued service.

Ensure that a suitable range of tests is performd in order to achieve maximum benefit of the test outage. Insist on a test report with a full traceability chain to International Measuring Standards issued in accordance with a recognised quality system.

EXTENDED OIL QUALITY

This is a group of tests that complement the oil quality tests and it is recommended after analysing the oil quality results.

It concentrates on the oil quality extended tests that will confirm if there is a presence of impurities and polar substances.

The tests do not convey the status regarding the cellulose insulation.

TRANSFORMER OIL TESTING

AGE ASSESSMENT TESTING

This is a group of tests that will include Furanic determination which is linked to the aging of paper to assess the transformer's aging properties.

This set of tests cnveys the status of the cellulose in the transformer.

As the transformer ages, it affects the tensile strength and the degree of polymerisation of the paper i.e. the mechanical strength of the paper deteriorates therefore leading to failure.

FREQUENCY OF TESTING

The frequency of tests is determined by factors such as:
- The type and class of equipment
- The load on the equipment
- History of operation, etc

If a fault appears to be developing then more frequent testing is recommended to monitor the condition of the oil.

A history of test results are maintained by us allowing for trend analysis.

MINIMUM SAMPLE VOLUMES AND TEST STANDARDS

Our list of tests offered is featured below: All tests are done in accordance with the IEC/ASTM standards.

- Dissolved Gas Analysis
- Acidity
- Colour
- Dielectric Strength
- Water Content
- Dielectric Dissipation Factor
- Resistivity
- Density
- Interfacial Tension (IFT)
- Furanic Determination (Sub-contracted)
- Sediment Determination
- Sludge Determination
- PCB Quantitative
- Corrosive Sulphur

CELLULOSE LABORATORY TESTING

CELLULOSE LABORATORY

The Cellulose Laboratory carries out the following tests, namely:

- Degree of Polymerization – 1 of 3 Laboratories in South Africa
- Moisture Content (Paper & Blocks) measured by Quartz halogen moisture balance.
- Water content - measured by automatic Karl Fischer titration.

DEGREE OF POLYMERIZATION

Cellulose is used throughout transformers in the form of insulating paper and boards and is a polymeric material.

The degree of polymerization (DP) refers to the number of repeat of units in the chain. In order to evaluate the aging of a transformer, this happens when a transformer is subjected to a severe fault such as overheating or arching; the polymers will also be degraded, as the shorter length chains are formed this lowers the average degree of polymerization.

The factors which affect degradation are as follows:

- Primary causes are, heat, oxygen, water and the presence of an effective catalyst.
- Secondary causes of paper aging are mechanical stress and sludge.

CELLULOSE LABORATORY TESTING

CONCLUSION

Furan content is a reasonably good predictor of DP. New transformer oil should have < 20 ppb furans. A sample of insulating paper is obtained for direct testing of DP. The sample is dissolved in a special solution and the viscosity is measured by passing the dissolved paper through a small orifice. The viscosity measured has a direct relationship to the DP of the paper.

This is the most practical method of measuring the the remaining life of the transformer. This method will require that an outage for the transformer needs to be arranged and that the unit is opened.

For transformers that will remain in service, DP testing is impractical It is recommended rather to test oil for furanic results.

Results and conlcusions that can be drawn from the tests are:

- New paper – DP value of approximately 1200
- After drying and/or processing

WATER AND MOISTURE IN CELLULOSE

Although „water and oil don't mix", this cliché statement isn't necessarily true in the engineering sense. Water can exist as, for example, free water which is mostly found at the bottom of the tank and dissolved water (water in solution) which increases when oil starts dissolving water at high temperature.

Water, even in microscopic amounts, has been found to cause most of the electrical breakdowns than any other impurities. Conductor used to manufacture windings for power transformers have the following characteristics.

It can enter into the insulating system during the opening of the transformer tank during installation, the precipitation of water from the atmosphere on the inner tank surfaces or even decomposition of cellulose, just to name a few.

We should always bear in mind that water, which is a polar liquid, is always present in insulation. The laboratory uses automated volumetric titration to measure water in cellulose and moisture balance (gravimetric method) to measure the volatile substance that can be found in cellulose.

CELLULOSE LABORATORY TESTING

CONCLUSION

Water is enemy number one in transformer aging and affects the insulation properties of cellulose in the transformer.

Water content in oil can be estimated by using the operating temperature of the transformer and also the water content in oil.

Transformers should be maintained regularly and the water content should always be kept within the allowable recommendation according to international standards, this will retard the degradation of solid insulation.

METAL LABORATORY

METAL LABORATORY TESTING

The laboratory tests the following metals:

- Hardness (nuts, copper bars, other special steel)
- Electrical Grain Orientated Steel Testing (core steel)
- Conductor Testing (Copper/Aluminium strand and Continuously Transposed Conductor (CTC))

CORE STEEL TESTER

SGB-SMIT POWER MATLA is the only company within Africa able to perform transformer core-steel testing with Brockhaus equipment.

This equipment determines the magnetic properties of electrical steel and other soft magnetic materials and can be configured to measure coil systems and evaluation according to IEC 69404 ff and ISO ASTM for measurement with an Epstein frame and sheet measuring coil.

METAL LABORATORY

EPSTEIN FRAME

The purpose of this instrument is to measure the properties of ferromagnetic materials which are largely used in transformers and electric motors. The magnetic properties measured by the instrument include:

The B-H curve (hysteresis loop) properties as a function of peak magnetic induction (flux density). The B-H curve can then be used to determine the hysteresis loss component of the material at various flux densities.

Iron losses intrinsic to the material, at various frequencies and peak field strengths. This allows for the separation of the material into its key components, namely the eddy current losses, hysteresis losses and excess/ anomalous losses.

The excitation power requirements of the material. This property is instrumental in determining the magnetising current required by the material in order to set up the magnetic flux in the core.

A higher grade core steel such as highly permeable and domain refined electrical steels, have lower excitation requirements i.e. a lower excitation current is required to set up the flux in the core.

SINGLE SHEET SENSOR TESTER (SST) 250 X 250MM

Similar to the Epstein Frame Tester, this unit measures the magnetic properties of ferromagnetic material, with the added capability of measuring internal stresses of the material sustained during handling.

In addition, the Epstein Frame Tester requires at least 16 laminations, approximately 300mm x 70mm in dimensions to perform a single sample test, whereas the SST requires a single lamination, 250mm x 250mm in dimensions.

The results of the magnetic properties measured using the SST can be converted to equivalent Epstein Frame results; however, converting the results of the Epstein Frame to equivalent SST is not possible.

The SST is the latest technology in core steel measurement, but many standards still enforce Epstein Frame Test results.

Included in this measurement is:

- Flux density value
- Saturation density value
- Typical ion loss alue

METAL LABORATORY

FRANKLIN TESTER

The Franklin tester measures the total current which flows through the insulation coating of the sample when pressure is applied via several contacts. Conversion of the measured value is according to an equivalent surface resistance. This is especially suitable for quality control of insulation coating.

This equipment determines the surface insulation resistance of coated electrical steel sheets, punched parts and individual samples.

From the measured current above all 10 electrodes the resistance coefficient is calculated.

This instrument is used to determine:

- The maximum current permitted by the insulating material
- The surface resistance of the insulating material per unit of area
- Insulation surface resistance distribution
- The thickness of the insulation coating

ADVANTAGES OF ACCURATE CORE STEEL PROPERTY MEASUREMENTS

Material properties as guaranteed by the supplier can be verified, reducing the frequency of deviations in measured losses from the values guaranteed based on material properties.

Optimisation of the core design through the use of materials with better stacking factors

Insulation resistance measurement of samples taken from the stacking line. This helps with the early detection of materials with poor insulation, thus reducing the incurrence of additional inter- lamination losses due to short circuits between stacked core laminations.

Such losses lead to higher no-load losses being measured during testing.

The SGB-SMIT POWER MATLA laboratory is the only local South African company that can offer core steel testing.

METAL LABORATORY

CONDUCTOR TESTING

The types of measurements that can be carried out on copper, aluminium and CTC conductor include the following:

- Dimensional measurements (or both single metal conductors and CTC).
- Radius
- Resistivity
- Blisters, flakes, chemical discoloration, surface stretches, scratches, dents and burrs
- Hardness/0.2% Proof stress

CONDUCTOR PROPERTIES

Electrical conductor used to manufacture windings for power transformers have the following characteristics:

- Low resistivity
- Mechanical strength
- Defned shape
- Chemical properties
- Good machined finish
- Malleability

HARDNESS TESTING

Hardness testing for both nuts and copper bars using a Rockwell tester.

This is the property of a metal which gives it the ability to resist being permanently deformed (bent, broken, or have its shape changed when a load is applied

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Subject to technical changes.

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