Moisture & Oxygen Management, 
Online Monitoring, Diagnostics and 
Life management of Power 
Transformers

New perspective on transformer life management by “remote monitoring” and controlling moisture and oxygen of its insulation system.

15th – 17th June 2020 | LIVE WEBINAR

“Good. Expand my horizon on diagnostic power transformer”
Tenaga Nasional Berhad

“Excellent Instructor, excellent course”
TNB – Distribution

Instructor give many new knowledge and useful knowledge for my work”.
PEA Thailand

“New solution to analyze the moisture in oil”.
Sarawak Energy

“Concepts & Contents very useful. Very Good workshop”
Sabah Electricity

ENERGY1 ASIA LIVE WEBINAR
Due to the recent developments with COVID-19 we have, for the health and safety of our speakers and attendees, our selected courses now available online. This will enable you to view the courses from the comfort of your location while still benefitting from the depth of knowledge provided at our online courses.

LIVE WEBINAR
New solution and techniques.
Experience real time monitoring
Demonstration of the IIoT based transformer monitoring system.

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In collaboration:
The primary focus of the 3-day LIVE WEBINAR will be on the sources, causes and effects of moisture & oxygen on transformer insulation life and incipient failure modes. It will be demonstrated that laboratory periodic oil analysis is limited and not always adequate, while continuous online monitoring has increasing potential and many significant advantages.

**Moisture & Oxygen Management:**
From sources of moisture and oxygen ingress to methods of their removal this masterclass explores various aspects of transformers life cycle management. There will be focus on the area of detrimental effects of moisture and oxygen on transformer insulation, methods of water and oxygen measurement and assessment. Substantial time will be dedicated to various parameters used to describe moisture in oil/paper insulation. The trainer will take the audience through a number of transformer failure cases caused by the presence of water. He also will provide an in-depth overview of online as well as off-line water and oxygen measurement techniques used by leading electric utilities and analytical laboratories. Variety of water removal methods and associated equipment will be discussed and studied in detail and on practical examples. The audience will learn about many innovative solutions brought in the field of predictive condition monitoring of power transformers.

**Online monitoring & diagnostic:**
Transition to digital utility (smart grid, industry 4.0, etc) is immanent and it is hard to imagine that in the very near future engineers will not be exposed to online monitoring of their essential assets, such as transformers, power lines and substation switchgear. As technology keeps evolving with new features (communication protocols, sensors, advanced analytics, etc) on a daily basis, the trainer will be discussing new ways of data management and delivery, complementing traditional SCADA with Industrial Internet of Things (IIoT) with the emphasis on architecture, reliability and security. Successful implementation of online monitoring, fault identification and isolation, transformer life extension will also be covered by the trainer.

Participants will have the opportunity to experience real time monitoring as the trainer will demonstrate the IIoT based transformer monitoring system - the first in the world, which uses non-conventional innovative methods for temperature, moisture and oil quality monitoring.

**Choosing the best potential vendor:**
A number of transformer online monitoring solutions providers is increasing. More and more owners and operators of electrical equipment make decision towards incorporating online monitoring technologies in their asset management practices. There are also new international standards requiring now to specify basic means of online monitoring into transformer purchasing agreements. A choice of the right solution has never been more challenging as there are no reviews or web resources where you could go and find out a recommendation on selection of the most appropriate, reliable, and cost-effective equipment for your needs. This course will give attendees techniques and strategy on how to select right partner/OEM and never regret about the investment.

The webinar is filled with numerous case studies, practical industry examples and real time monitoring demonstrations. Participants will be able to expand on the knowledge gained elsewhere and will develop new perspective on the whole subject of transformer life cycle management.

**Advance your knowledge and learn about:**
- Various sources of moisture and oxygen found in transformers.
- New parameters used for moisture assessment.
- Seven myths of moisture assessment are still believed to be a reality.
- New methods of transformer dehydration and gas removal.
- A connection of moisture parameters and oil quality.
- What needs to be monitored?
- Health indices and their most relevant use.
- New diagnostic methods which cannot be found in any other course, standards or guidelines.
- Transformer’s enemies are in check.
- Smart sensors for Internet of Transformer Things.
- Machine learning for transformer monitoring and diagnostics
- Techniques and strategy on how to select right partner/OEM and never regret about the investment.

**This program is intended for:**
Those working in the asset management of electrical plant, project management and design of high voltage substations and will provide an in-depth knowledge and understanding of moisture phenomenon in large power transformers as well as advances in online transformer condition monitoring:
- Electrical asset engineer/manager who wants broader and more in-depth understanding of maintenance needs and failure modes.
- Chemist/ Scientist involved in cellulose, oil, H2O, O2 and DGA – all organic and physical chemistry.
- Utilities R&D involved in developing of new technologies for condition-based maintenance and operation of electric plant.
- IT and OT staff involved in implementing and maintaining the OMS (online monitoring system) for their plant.
- Anyone who is involved in developing and implementing life maintenance strategies of transformers.
- All levels who have interest in intelligent transformer monitoring and diagnostics.
DAY 1

Moisture Management in Transformers

Water in Transformers - So What?

- Accelerated paper aging
- Vapor bubbles evolution
- Corrosion of core and tank
- Progressive consumption of oil additives
- Decrease of insulation breakdown strength
- Reduction of transformer life

Many Faces of Water in Transformers

- “Water” vs “moisture”
- Free, bound, dissolved and active
- Water content of oil
- Water content of paper
- Relative humidity and relative saturation
- Dew point
- Water activity and water potential
- Water-in-oil solubility

Sources of water contamination

- Residual after factory processing
- Atmospheric water vapor
- Leaking gaskets and valves
- Faulty dehydration system (silica gel breathers, air cells)
- Chemical decomposition of water and oil

Moisture equilibrium in paper/oil system

- Development of moisture equilibrium diagrams
- Equilibrium diagrams for mineral oil
- Equilibrium diagrams for natural and synthetic esters
- Use and misuse of moisture equilibrium theory

Off-line laboratory moisture assessment

- Karl Fisher titration method
- FTIR spectroscopy
- Oil sampling for water assessment
- Lab instrumentation for water measurement
- Reporting water content
- IEEE and IEC Guidelines on water in transformers

Dielectric Frequency Response of Power Transformers

- Dielectric Response methods:
  - Recovery Voltage Measurements (RVM)
  - Polarization and Depolarization Current (PDC) measurement
  - (“IR measurements as function of time”)
  - (C & PF measurement as function of frequency
- Test records and report
- Measurement analysis and interpretation
  - Theory and validation
  - Non-moisture related factors influencing the DFR measurements
  - Examples of typical measurement challenges

Off-line drying of power transformers

- Methods and instrumentation
  - Vapor phase drying
  - Drying by Low frequency heating

Oxygen in Power Transformers

- Sources of oxygen ingress
- Detrimental effects of oxygen in transformers
- Oil oxidation and mechanism of sludge formation
- Accelerated paper aging
- Oil preservation system
- Degassing of transformer oil
- Combined impact of oxygen, water and temperature on transformer insulation life

Field experience with moisture assessment: Case studies

DAY 2

Online Transformer Monitoring and Diagnostics 1

What is online continuous monitoring?

- On-load vs online continuous

Why online monitoring (OM)?

- Prevention of incipient faults
- Identification of manufacturer’s defects
- Determination of utilization factor and overloading capacity
- Life extension and management of transformer life cycle
- Improvement of grid reliability
- Assistance in ranking and health indexing of transformer fleet
- Assistance in replace/repair/refurbish decisions
  - Challenges and barriers to Online Monitoring

What transformer components to monitor?

- Core
- Windings
- Liquid insulation
- Solid insulation
- LTC
- Bushings
- Cooling system

Which parameters could and should be monitored?

- Load
- Voltage
- Temperatures
- Moisture
- Dissolved gases
- Dielectric dissipation factor
- Oil flow rate and oil level
- Partial discharge
- Environment and weather

Sensors, transducers and intelligent monitoring devises: How to select?
Online Transformer Monitoring and Diagnostics 2
Diagnostic methods and algorithms for Online Monitoring
• Thermal models
• DGA - Dissolved Gas Analysis
  o Fault severity and fault type classification methods
  o Duval triangles and pentagons
  o IEEE and IEC guidelines for DGA
  o Energy weighted approach to DGA (R-DGA)
  o Online vs off-line DGA diagnostics
  o Single gas and multi gas online monitors
• Moisture models
• LTC tap position and motor current models
• Bushings leakage current, capacitance and DDF models
• Cooling efficiency diagnosis
• Electrical and acoustic PD models
• Identification of sensor’s drift and malfunction

Big data, Machine Learning and AI for Online Monitoring.
Business case for online monitoring: Costs and benefits of online monitoring.

Information communication for Online Monitoring – past, present and future.

Online monitoring (OM) and Smart Grid – Does OM make transformer smarter?
Online monitoring and Industrial Internet of Things (IIoT)
Online monitoring equipment markets and trends

On-line moisture monitoring
• Moisture sensors: how to select
• Pitfalls of using equilibrium diagrams for online moisture monitoring
• Moisture Cloud Algorithm

On-line drying of oil filled transformers
• Industrial absorbent materials and their use for moisture dehydration
• Self-dehydrating breathers
• Mobile dry-out systems
• Permanently connected dryers

Field experience with online transformer monitoring:
Case studies

During the 3-day masterclass the trainer will be sharing:
Photographic and video evidence, graphs, charts and diagrams, as well as wealth of knowledge related to:

• Transformer failure investigation at one of the largest Australian power stations;
• Bubble evolution insight a transformer insulation system;
• Installation of various sensors and oil reclamation plants;
• Moisture assessment of scrapped and onload transformers;
• Collecting and processing oil and paper samples for moisture analysis;
• Design and implementation of online monitoring solutions.

Choosing the best potential vendor:
The trainer will also guide participant on how to choose the best potential vendor on moisture and O2 online monitoring, online drying technologies and what to look for when selecting, online winding/hot spot temperature monitoring.

Industrial Internet of Things (IIoT) monitoring system:
The trainer will demonstrate an IIoT based monitoring system - the first system on the market which uses minimum hardware (low cost) and allows a user to perform:

• Continuous monitoring of oil/paper insulation quality/degradation,
• Accurate monitoring of absolute water content (ppm), relative saturation, water in oil solubility and dielectric breakdown voltage,
• Detection of pump and fans failure,
• Oil level and leak detection,
• Thermal performance and cooling efficiency,
• Enhanced loading and aging estimations,
• Sensor failure and drift detection,
• Prediction of remaining life,
• More accurate load forecasting and
• Drying efficiency monitoring.
Online Continuous Transformer Monitoring, Diagnostics and Life Management (3 Days) LIVE WEBINAR

Registration Form

<table>
<thead>
<tr>
<th>[LIVE WEBINAR]</th>
<th>Per Participant</th>
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<tr>
<td>Online Continuous Transformer Monitoring, Diagnostics and Life Management</td>
<td>USD 1599</td>
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<tr>
<td>Full 3 Days <strong>(Recommended)</strong></td>
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- The above live webinar investment fee is inclusive of course material.
- The above investment fee is excluding of SST 6%.

If you or your company is facing travel restrictions, we may be able to arrange the training at your preferred location for remote participation or conduct the training in-house with minimum 10 pax. Please contact ihtraining@petro1.com.my to discuss this possibility.

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