Dry-type transformers for safety, reliability and environmental impact for F&B

Danang Birowo
ABB’s transformer heritage
A long pioneering history

The combined experience of 700 years of transformer manufacturing

- Asea
- Ansaldo/Ital Trafo/IEL/ OEL/OTE
- BBC
- GE, USA
- National Industri
- Strömberg
- Westinghouse
- Kuhlman
- Trasfor (in 2011)
- GE General Electric (2016)
ABB Transformers at a glance

Global leader in transformer business

- **$5 billion** in revenue per year
- **~17,000** employees
- Revenues in **~ 100 countries**
- **72 factories** around the world
- **Complete range** of power and distribution transformers, components and services
- **Voltage range** up to 1200 kV AC and 1100 kV DC
Transformers
One-stop shop supplier

IEC, ANSI, IEEE standards and other local standards (e.g. JB, CSA, GOST)

The most complete range of transformers, components and services
Service

**ABB can do:**
- Installation
- Testing commissioning
- Site Test
- Spare Parts
- Preventive Maintenance

ABB Indonesia did the installation, Testing Commissioning Energize 1,008,000 kVA (1008 MVA) biggest transformer in Indonesia
At Paiton Energy
**What is a Dry Transformer?**

**ABB** Manufactures a transformer which does not use any kind of liquid for insulation and cooling. Windings are encapsulated under vacuum, in epoxy resin reinforced with fibre glass net. ABB’s **vacuum cast coil transformer** is the most technologically advanced design for extreme conditions. ABB has design and manufacturing flexibility to produce for optimum space utilization and special requirements.

These transformers…

– meet **strict parameters** with respect to electrical system demands.

– are virtually **maintenance free**.

– are manufactured in accordance with **industry and international standards** including ISO 9001 and ISO 14001.
Advantage of Dry Type Transformer

1. No Fire Hazard
2. Safety for people and property
3. Outage customer costs
RS PGI Cikini Terbakar, Kerugian Rp280 Juta


Fadli menjelaskan pencekan api terjadi di ruang patologi anatomi RS PGI Cikini.

"Penyebab kebakaran adalah korsleting listrik pada travo", ujar Fadli.

Metro

Kebakaran Blok M Plaza Akibat Trafo Meledak

Si jago merah herniaan dapat dikendalikan, Api berbaris pinjam sudah pukul 07.30.

Bisnis - Penyebab kebakaran di basement Blok M Plaza, Jakarta Selatan, pada Rabu 30 September 2019 pagi, yakni meledaknya sebuah trafo listrik.


Akiot dan kejadian itu, selama umur dan kebakaran itu, trafo listrik yang memanfaatkan kebakaran itu, yakni sesuatu yang melaba pla.

Advantage of Dry Type Transformer

4. Ecological and Environmentally Friendly
5. Maintenance & Pollution Free
6. Suited for damp and/or contaminated -
Advantage of Dry Type Transformer

No risk of leakages of inflammable or contaminating substances such as oil or silicon.
No oil recycle.
Advantage of Dry Type Transformer

7. Excellent resistance to short circuit effect

8. Excellent capacity to support over load

9. Excellent performance toward seismic Phenomena
10. Saving Costs give lower installation related costs

- IDR Rp ???
- no separate room for distribution transformers needed
  
  \[20m^2 \text{ at } \ldots \text{Rp/m}^2 = \text{ Rp} \ldots \]
- no oil pit
  
  \[\text{ Rp} \ldots \]
- no fire fighting system require
  
  \[\text{ Rp} \ldots \]
- no fire-proof door for transformer room
  
  \[\text{ Rp} \ldots \]
- shorter distance to LV cabinets: reduced cabling costs
  
  \[20m \text{ instead of } 70m \Rightarrow 50m \text{ LV cable savings at } \text{ Rp/m} = \text{ Rp} \ldots \]
- reduced losses in LV cables
  
  \[50m \text{ less LV cable losses-150W,20 years-26MWh,Rp/MWh = } \text{ Rp} \ldots \]
- reduced insurance fees – dropout, follow-up and reputation costs in case of fires and oil leakage

  \[\text{ Rp} \ldots \]

- Less Maintenance: no need periodic maintenance to change the oil (oil purifying) every year

  \[\text{ Rp} \ldots \]
- No need schedule electrical shutdown for transformer maintenance

  \[\text{ Rp} \ldots \]
Advantage of Dry Type Transformer

11. Easy Installation
### Comparison: DRY vs OIL MAINTENANCE

<table>
<thead>
<tr>
<th>MAINTENANCE</th>
<th>FREQUENCY</th>
<th>OIL TRAFO</th>
<th>DRY-TRAFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil-tightness</td>
<td>monthly</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Level</td>
<td>monthly</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Porcelain Insulator Cleaning</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Surface Cleaning</td>
<td>annually</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Connections Tightness</td>
<td>annually</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Painting State</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Analysis (regular oil filtering or replacement, if needed)</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>SILICAGEL (Check and Replace)</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Accessories Checking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buchholz relay</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Over-Pressure Relay</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Oil Level</td>
<td>annually</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Thermometer</td>
<td>annually</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

- Every maintenance operation requires "DE-ENERGIZING" the transformer.
- More elements to be checked, higher...
- …failure probability
- …expenses in spare parts
Dry Transformer
Applications

Public Works
- Hospitals
- Airports
- Shopping centers
- Food & Beverage
- Office Buildings

Special Industries
- Ships
- Mining industry
- Undergrounds / trains
- Wind Power applications
- Application with rectifiers
ABB dry-type value opposed to dry-type competitors

World class technologies
Three advanced winding insulation systems and many other technologies such as
Internally water cooled system for outdoor Enclosure IP55
Amorphous cores steel eco dry type transformer 35% lower than standard
UL certified transformer, ANSI C57.12 & IEEE Standard, with On Load Tap changer

Widest portfolio
Abilities include a full line of LV magnetics,
MV transformers for distribution and rectifier duty,
MV iron and air core reactors, as well as the first ever dry-type transformer for sub-transmission.
From 10 kVA up to 63 MVA; From 220 V up to 72.5 kV
On Load Tap Changer available, up to 23 taps ± 18% regulation range

Special application
Everything from 48 pulse, converter duty to completely sealed dry-types for underground networks, excitation, arc furnace, rectifier, harmonic load
we have done it all and can help make your unique application safer.
Class E3,C2,F1, Insulation Class H, Outdoor IP55

©ABB
April 1, 2019 | Slide 16

We can and have done it all; we are your one-stop shop for transformers
Dry Transformer

Electrical insulation system

Thermal Class

- It indicates the maximum temperature that a material can admit without changing its characteristics
- The temperature rise admitted in windings will depend on the insulation material thermal class

<table>
<thead>
<tr>
<th>thermal class</th>
<th>max. temp. admitted by the insulation material (°C)</th>
<th>average max. temperature rise in windings (°K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>105</td>
<td>65</td>
</tr>
<tr>
<td>(B)</td>
<td>130</td>
<td>80</td>
</tr>
<tr>
<td>(F)</td>
<td>155</td>
<td>100</td>
</tr>
<tr>
<td>(H)</td>
<td>180</td>
<td>125</td>
</tr>
<tr>
<td>(C)</td>
<td>220</td>
<td>150</td>
</tr>
</tbody>
</table>

- Oil
- Dry
Dry Transformer

Classes

**Environmental Class:**
- **E0** Normal indoor installation, no condensation, no considerable pollution
- **E1** Limited pollution, occasional condensation e.g. off circuit periods
- **E2** Heavy pollution, frequent condensation

**Climate Class:**
- **C1** Lowest ambient temperatures:
  - operation – 5°C
  - storage and transport - 25°C
- **C2** Lowest ambient temperatures:
  - operation –25 °C
  - storage and transport at –25°C

**Fire Class:**
- **F0** No special requirements except typical characteristics for dry-type transformers
- **F1** Increased demands
  - All materials practically free of halogens
  - Limited formation of fumes
  - Limited contribution with calorific energy to the source of fire
  - Self extinguishing transformer fire
Dry transformers
K Factor, Harmonics Transformers

Defining K Factor

K-factor is a weighting of the harmonic load currents according to their effects on transformer heating, as derived from ANSI/IEEE C57.110

A K-factor of 1 indicates a linear load (no harmonics). The higher the K-factor, the greater the harmonic heating effects.

The K-factor is a number derived from a numerical calculation based on the summation of harmonic currents generated by the non-linear load. The higher the K-factor, the more significant the harmonic current content.

Standard K Factors:
K=1 (linear loads)
K=4, 9, 13, 20, 30, 40, or 50 (non-linear loads)

Usual K Factor x load features

K=1 (Linear Loads) typically indicated for application where the harmonic current producing equipment is less than 15%.
Typical loads: Standard Lighting, LV Motors

K=4 (Non-Linear Loads) Electronic equipment represents up to 35% of the total load:
Example of loads: Induction heating equipment, UPS with optional input filtering, PLCs and solid state controls, etc.

K=13 (Non-Linear Loads)
Electronic equipment represents up to 75 per cent of the total load:
Typical loads: Telecommunications equipment, Multiwire receptacle circuits in general care areas of health care facilities, UPS without input filtering, etc
We can make your local initiatives, global ones

ABB Dry-type transformers
Global producer with focus factories: 15 sites in 14 countries
ABB Vacuum Cast : Common Technology

Common Design System (CDS)
Common Technical Standards
– Materials
– Productions
– Processes
– Procedures & Instructions
Common Key Machineries
– HV Winding
– Vacuum Casting
– Core Cutting

- Routine
  - Winding resistance
  - Voltage ratio
  - Vector relationship
  - Impedance and load loss
  - No-load loss and current
  - Separate-source voltage
  - Induced over-voltage
  - Partial Discharge

- Type
  - Lightning Impulse
  - Temperature Rise

- Special
  - Sound Level
  - Short Circuit (3rd party)
Accessory (Optional)

- Surge arrester
- Digital thermometer
- Plug-in Bushing
- Cooling fan
- Enclosure
- Extension bus-bar
Certification
Certifications

- ISO 9001:2000
- KS A 9001:2001

- ISO 14001:2004
- KS A 14001:2004

Certifications from
- Lloyd’s Register

KEMA Type Test Certificate
Certifications – Type Test

- **KEMA Type Test -2006**

- Short-Circuit withstand test (3 s)
Certifications – Type Test

VIBRATION Qualification Certificate

Delivered on: 21-12-2006
Ref: GAMESA ELECTRIC Test Specification number ID904143, Item 02, dated 11-02-06

Laboratory Name: VIRLAB, S.A.
Laboratory Address: Polígono Industrial de Acero, Zona B - 34
Agüera 24
20159 ASTIBAU (SPAIN)

Equipment tested: A Dry Transformer, Type UTE 250 kVA, 24 AT / 20 kV 400V, manufactured by ASEA BROWN BOVERY, S.A., serial number LKKE600041T, according to equipment drawing LKKE160437-CR, Issue 1 of 07-04-05

The overall dimensions and the weight of the transformer are as indicated below:
- 2250 mm high x 1500 mm wide x 910 mm deep
- 4540 kg

We hereby certify that the equipment listed above has been tested in our laboratory of Acero between the 4th and the 8th of October 2006, according to Gamas Electric document number ID904143, Item 02.

The Transformer has satisfactorily passed the tests it has undergone, no structural discontinuities being detected.

In our report number 261264 of VIRLAB, S.A., is included all the information obtained, with tables, photographs and so on.

VIRLAB representative
Mr. JUAN ANTONIO FEREZ
Laboratory Manager

Certificate number 261264
Type Test Certificates

- Short Circuit Test

---

**Test report**

No B 125-06-CT-EE-01E

Page 1 of 17

**Ability to withstand the dynamic effects of short circuit**

**TEST OBJECT:** Dry type three-phase transformer

**LOCATION:** DTE 2350/24 AF

**REQUESTED BY:** ABB, Power Technology, S.A.
Correra de Madrid km 314 - 50012 Zaragoza (España)

**MANUFACTURER:** ABB, Power Technology, S.A.

**STANDARD:** IEC 60076.11:2004

**RECEPTION DATE:** September 14th 2006

**TESTS DATE:** September 18th to 21st 2006

The test object has been subjected to the tests required by the applicant, applying the procedures specified in the standard indicated before.

**THE PRESENT REPORT CONSISTS OF:**

- No of pages: 17 (and annex of 10)
- Photographs: Annex
- Oscillograms: Annex

---

Agustin Ramos Luis Martinez
Test Chief Head of Electrical Equipment Laboratory

Este documento es una copia en pdf de la Hoja original.

Barakaldo, December 3rd 2007

©ABB
# Seismic certificate

## CERTIFICATION OF TEST

**CERTIFICATION NO.:** 2017-K-015

**SESTEC at Pusan National university, Mulgeum, Yangsan, Kyungsangnam, South Korea.**

Tel: 051-510-8180, Fax 051-510-8181, Web: seismic.kced.or.kr

---

<table>
<thead>
<tr>
<th>1. CLIENT NAME</th>
<th>: ABB Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDRESS</td>
<td>: 49, 3gongdan.4-ro, Seobuk-gu, Cheonan-si, Chungcheongnam-do, 31093, Korea</td>
</tr>
</tbody>
</table>

| 2. USE OF CERTIFICATION | : Seismic performance evaluation |

| 3. TEST SAMPLE NAME | : Vacuum cast coil dry type transformer |

| 4. DATE OF TEST | : 2017. 08. 10. |

| 5. TEST METHOD USED | : ICC-ES AC156 : 2010 (Sds = 6.37 m/s², z/h = 1) |

| 6. TESTING ENVIRONMENT | : Temperature : (29.7 ± 1.4) °C, Relative humidity : (77 ± 5) % |

| 7. TEST RESULTS | : PASS. Refer attached files. |
## ABB Dry transformers

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual production capacity</td>
<td>Around 30,000 MVA</td>
</tr>
<tr>
<td>Annual sales</td>
<td>Around 650 MUSD</td>
</tr>
<tr>
<td>Employees</td>
<td>Around 1,800</td>
</tr>
<tr>
<td>Five Focus Factories</td>
<td>Global presence</td>
</tr>
<tr>
<td>ABB world market share</td>
<td>23 %</td>
</tr>
</tbody>
</table>

- Complementing technologies dedicated to specific market demands
- Nearly 45 years of experience - Experience is very important
- Proprietary technology and R&D departments
ABB dry transformers reference list

...power the biggest and tallest buildings of the world

Burj Khalifa, Dubai: 828m
72 transformers
750 – 2’000 kVA, 11/0.4 kV

Shanghai World Financial Center: 492 m
3 transformers
12’500 kVA, 35/10.5 kV
Food & Beverage

- Sriboga
- Singha
- Nissin

©ABB
Building Reference

Marina Bay Singapore

Signature Tower Kuala Lumpur
Bank Indonesia  
Shangrila Hotel  
Sultan/Hilton Hotel  

World Trade Center  
Menara Astra  
Sequis Tower
Airport Reference in Indonesia

- Husein Sastra Negara
- Sukarno Hatta (Kereta Antar Terminal)
- Jambi Air Nav
- Tanjung Pinang
Infrastructure

LRT Palembang
18 units Rectifier Transformers 3520 kVA, 3 winding 20kV/585/585 V, High Duty Class VI 300% in 1 minute

Terminal Passenger Train
Sukarno Hatta Airport
Google Wen #2 - Singapore

Scope of Supply (2016 ~ 2018)

22/0.415kV 2850kVA x 22 units
22/0.415kV 2300kVA x 5 units
22/0.415kV 2500kVA x 5 units
To be supplied
22/0.415kV 2850kVA x 7 units (2018.Sept.)
22/0.415kV 2850kVA x 8 units (2018.Dec.)

Total 47 units
Marine

...power the largest ships on the oceans

Oasis of the seas:
World’s largest cruise ship,
4000 passengers
Length: 360m; Width: 47m

Transformers: 6 x 11700 / 2 x 5850kVA
24 pulse, AFWF

AIDA Diva:
2500 passengers & 646 crew members
Gross tonnage 68.500 GT,
Length 252 m, width 32 m
Main Diesel 36 MW, propulsion 24.5 MW

Transformers: 2x2 units 8.8 MVA/11kV,
24-pulse, AFWF
## Oil & Gas

### Bayu Undan  East Timor Sea

<table>
<thead>
<tr>
<th>Units</th>
<th>KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>2500</td>
</tr>
<tr>
<td>8</td>
<td>1600</td>
</tr>
<tr>
<td>1</td>
<td>800</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>315</td>
</tr>
<tr>
<td>11</td>
<td>250</td>
</tr>
<tr>
<td>7</td>
<td>200</td>
</tr>
</tbody>
</table>

Troll Field, Bayu Undan

### Natuna Sea

[Shell logo]

[PremierOil logo]

[Image of oil rig]

[Image of fertilizer plant]

©ABB
Utility Power Generation

Excitation Transformer

Kendal Industrial Park
A Cost-Competitive Location for Global Market

Paiton Energy
12 MVA & 10 MVA and More than 50 units Distribution Transformer
ABB Dry Transformers

Advantages

✓ No. 1 Transformer supplier in the world
✓ One Global Factory – Wherever you need us, we are close to you
✓ Experience more than 45 years For dry type
✓ Technology & Quality Leading Company
✓ Common Technology for the same products for Safety & Reliability
✓ H-Class Solid Epoxy Insulation System (180℃)
✓ Climatic, Environmental and Fire Behavior classes qualified (E3-C2-F1)
✓ Strong Characteristics to Withstand Short-Circuit, Overload and Lightning/Switching Surges
✓ Partial Discharge Free
✓ Supported by After sales service team

✓ Contact Person: Danang.Birowo@id.abb.com / +62 8161892787
So let’s talk