Envirotran

Critical Load Transformer (CLT)

Superior reliability and efficiency for
the most demanding power applications

EATON
Powering Business Worldwide

Photo courtesy of DuPont Fabros Technology, LLC - Washington, DC

The top priority in critical applications is uninterrupted service. A pad-mounted Envirotran CLT with a tamper-resistant cabinet is ideal for outdoor applications.

Envirotran

CLTs with hardened design for reliability, efficiency, safety and performance.

Envirotran™ Critical Load Transformer (CLT)

Eaton developed the first Cooper Power™ series high fire point transformer in the 1970s. This innovative solution was made possible by the invention of R-Temp™ fluid after the ban of polychlorinated biphenyls (PCBs) in transformer fluids. These designs were further enhanced in the 1990s with the invention and utilization of Envirotemp™ FR3™❶ fluid—a sustainable, nontoxic, dielectric medium that exceeds the U.S. EPA's standard for ultimate biodegradability. The fluid is also essentially carbon neutral throughout its life cycle. With a fire point of 360 °C (much higher than most dielectric options), Envirotemp FR3 fluid has a flawless fire safety record and is the preferred technology in or adjacent to buildings.

In 2010, Eaton launched its line of Envirotran Hardened Data Center (HDC) transformers. Since that time, Eaton's Cooper Power series liquid-filled transformers have efficiently and reliably served more than 2,500 MW of critical data center capacity for millions of hours without any reported downtime caused by a thermal or short-circuit coil failure.

Now, Eaton is excited to announce the launch of its Envirotran Critical Load Transformer (CLT). Three-phase pad-mounted and substation Envirotran CLTs are available up to 35 kV and 12 MVA.

❶ Envirotemp™ and FR3™ are licensed trademarks of Cargill, Incorporated.

Constant improvements to transformer technology provide ultimate reliability

The Envirotran CLT is designed with special attention to surge protection, providing superior performance under stressful electrical environments. The transformer surpasses dry-type transformers in every performance category important to critical applications: reliability, fire safety, loadability, operational life, efficiency, thermal loading and installed footprint.

Surge withstand

Basic lightning impulse insulation levels (BIL) are used to determine the level at or below which a voltage surge should not cause the insulation system to break down. ANSI/IEEE BIL withstand ratings are higher for liquid-filled transformers compared to dry-types, making the design less susceptible to primary failure. Envirotran CLTs provide ultimate protection by increasing the insulation BIL rating at least one level higher than standard liquid-filled transformer ratings and by as many as three levels higher than standard dry-type transformer ratings. **Table 1** shows standard coil BIL ratings by design type.

Table 1: Basic impulse levels

	Coil basic impulse level (BIL) by voltage		
Nominal voltage (kV)	**Standard liquid-filled**	**Standard dry-type**	**Envirotran CLT**
5.0	60	30	95
15.0	95	60	125
25.0	125	110	150
34.5	150	150	200

Reliable power when you need it

Not reliant on an RC Snubber circuit for transient surge protection

After several high-profile, dry-type failures—resulting in millions of dollars of lost revenue—RC Snubber circuits have become increasingly common in certain transformer applications. Resistive (R) and capacitive (C) components are combined in series and then externally applied to the medium-voltage side of the transformer to form what is known as an RC Snubber circuit. This is one remedy to the symptom and not necessarily the most cost-effective cure for all transformer types.

Eaton has performed extensive testing on the effects of transient voltages on similar design Cooper Power series liquid-filled transformers. The results have shown that these enhanced transformer designs are capable of withstanding harsh transient conditions without the need for RC Snubber circuits. Additionally, years of experience in high-reliability applications have led to refinements in enhanced performance designs. Those same design philosophies have now been expanded to our CLT transformer product offering. For more information on this topic, please refer to WP202001.

Temperature and liquid level gauges.

External, pad-lockable drain valve.

Loadability

The cooling system of liquid-filled transformers provides superior protection from severe overloads—overloads that can lead to significant loss of life or failure. Loading guidelines within the IEEE Std C57.154™-2012 standard readily validate the superiority of the liquid insulation system. As the examples show on this page, liquid-filled transformers will tolerate greater overloads for longer periods of time without abnormal loss of insulation life.

Superior overload capability with Envirotran transformers

Assuming:

- 30 °C ambient temperature
- 50% equivalent base load

Overload capability above nameplate without significant loss of life

At 128% overload:

- 8 hours with Envirotran transformer
- 1 hour with dry-type transformer

At 4 hours of overload:

- 150% with Envirotran transformers
- 110% with dry-type

Maintenance and diagnostics

Many facilities opt for or require electrical system component redundancy to ensure maximum uptime for critical loads. While this redundancy prevents a transformer malfunction from directly causing system downtime, associated costs can be substantial. An unexpected transformer failure may affect the facility's reliability and profitability. Therefore, the ability to monitor the electrical and mechanical health of a transformer can reduce costly, unplanned downtime. Dry-type transformers have no reliable or cost-effective means to measure the health or likelihood of an impending failure.

With Envirotran liquid-filled CLTs however, routine diagnostic tests, including key fluid properties and dissolved gas analysis (DGA), can be performed. Although not required for safe operation, test analysis will provide the user with valuable information to schedule repairs or replacements, and minimize the duration and expense of an outage.

Whether it's life expectancy, overload capability or failure predictability, Envirotran CLT transformers outperform every time.

Table 2: Routine maintenance comparison

	Dry-type	Envirotran CLT
Shut-off power	Yes	No
Filter replacement	Yes	No
Vacuum/clean coils	Yes	No
Sealed from elements	No	Yes
Diagnostics testing	No	Yes

Envirotran liquid-filled transformers utilizing Envirotemp FR3 fluid, recognized by the National Electrical Code (NEC), UL, and FM Global, have been installed indoors in various applications for more than 15 years. Containment pan provides easy compliance with electrical codes.

Improve energy efficiency—reduce power consumption

A growing infrastructure poses new challenges and places additional stress on electrical distribution equipment. As global consumption of energy increases, the emission of greenhouse gases subsequently increases. Although the primary focus of any facility manager is typically maximizing uptime and supporting business demand, Eaton is also helping owners and operators of critical application facilities address the challenges of improving energy efficiency and reducing power consumption. These facilities may include hospitals, processing plants, factories and virtually any application where utmost reliability is paramount.

Today, users have become more savvy to operating efficiencies as it affects both the pocket book and the environment. Electrical losses associated with power distribution have a negative impact on a facility's operating efficiency, as well as the owner's bottom line. Facility operators have the opportunity to positively affect the electrical operating efficiency of their assets by making smart choices when choosing medium-voltage power equipment—including transformers.

The liquid advantage

The standardization of Envirotemp FR3 fluid in Envirotran CLTs makes NEC® compliance for indoor transformer applications simple. Envirotran transformers can be installed per the listing restrictions of the fluid, which minimizes the additional installation requirements mandated by the NEC Section 450.23. When the UL® classification guidelines are followed for overcurrent and tank over-pressure protection, the Envirotran CLT can be installed directly in the electrical room of the building.

This eliminates the need for low-voltage cable runs from outside the building, saving significant costs associated with long cable runs and subsequent losses.

- NEC requirements are easily met
- Higher ANSI/IEEE® standard impulse withstand rating
- Higher inherent efficiency levels
- Higher overloadability
- High fire resistance—listed as less-flammable liquid-filled transformer
- Nationally Recognized Testing Laboratory (NRTL) listed and labeled transformer
  - Minimizes additional installation requirements mandated by NEC Sections 450.23 and 450.21
- UL classified, FM approved liquid-filled transformer
  - May be installed indoors as close as 3 feet from a wall and 5 feet from a ceiling
  - No need for fire suppression systems
- Liquid containment systems
  - Eaton provides metal containment pans, making installation simple and cost-effective
  - A sill or curb in the electrical room doorway

Other advantages

- Reduced footprint
- Quieter operation
- Extended life when using FR3 fluid
- Reduced maintenance needs
- Seismic rated

More than just a transformer

Proactive fire safety protection

A leading cause of transformer failure is an insulation system that is no longer able to withstand stresses created during naturally occurring events such as switching impulse, overloading, ferroresonance, secondary short circuit and line faults.

When this occurs, the insulation system may be unable to withstand the stress, generating an internal fault that will continue until it is extinguished. Throughout the duration of the arc, much of the energy (approximately 95%) associated with this event is destroying the materials surrounding the arc.

The remaining energy is heating the surrounding material and may result in an eventful failure. Dry-type transformers can, and have, burned in these scenarios. Less-flammable dielectric fluids (fire point above 300 °C) such as Envirotemp FR3 fluid, greatly reduce the likelihood of fires and fire propagation. With more than 40 years of field experience, there have been no reported Eaton less-flammable fluid-filled transformer failures that have resulted in a fire. Use of an Envirotran CLT can reduce or eliminate the costs associated with water sprinkler systems and fire walls.

Envirotran CLT total life cycle cost advantages

Envirotran CLTs are more efficient than dry-type transformers: typically operating at 20–50% lower losses. This translates to either:

- More power delivered to critical load
- Reduced operating expenses

Dry-type transformers experience losses that are 1.5 to 2 times greater than liquid-filled transformers.

For that reason, they:

- Generate significantly more heat
- Put an increased load on HVAC systems

Envirotran CLTs can reduce HVAC operating expense to cool transformer losses by as much as 40%. **Table 4** provides an example of a large facility with a 30 MW total load.

Table 3: Fire safety comparison

	Dry-type	Envirotran CLT
Overload capability	1	2–4x
Insulation life	1	4–8x
Fires per year	Reported	0
Environmentally preferred	No	Yes
Required floor space	1.1–1.3x	1

Table 4: Cost of transformer losses at 30 MW load

	Dry-type	Envirotran CLT
Efficiency (at 75% loading)	99.39%	99.51%
Total losses (kW)	139	110
Cooling required to remove waste heat (kW) ❶	49.3	39.2
Total waste power from losses (kW)	188.3	149.2
Cost of losses and waste heat energy ($/year) ❷	$131,960	$104,559
Savings in cost of waste energy over 10 years		$274,010

❶ Cooling based on 1.25 kW per ton.

❷ Operating cost calculated at $0.08/kW-hr.

Advantages over dry-type

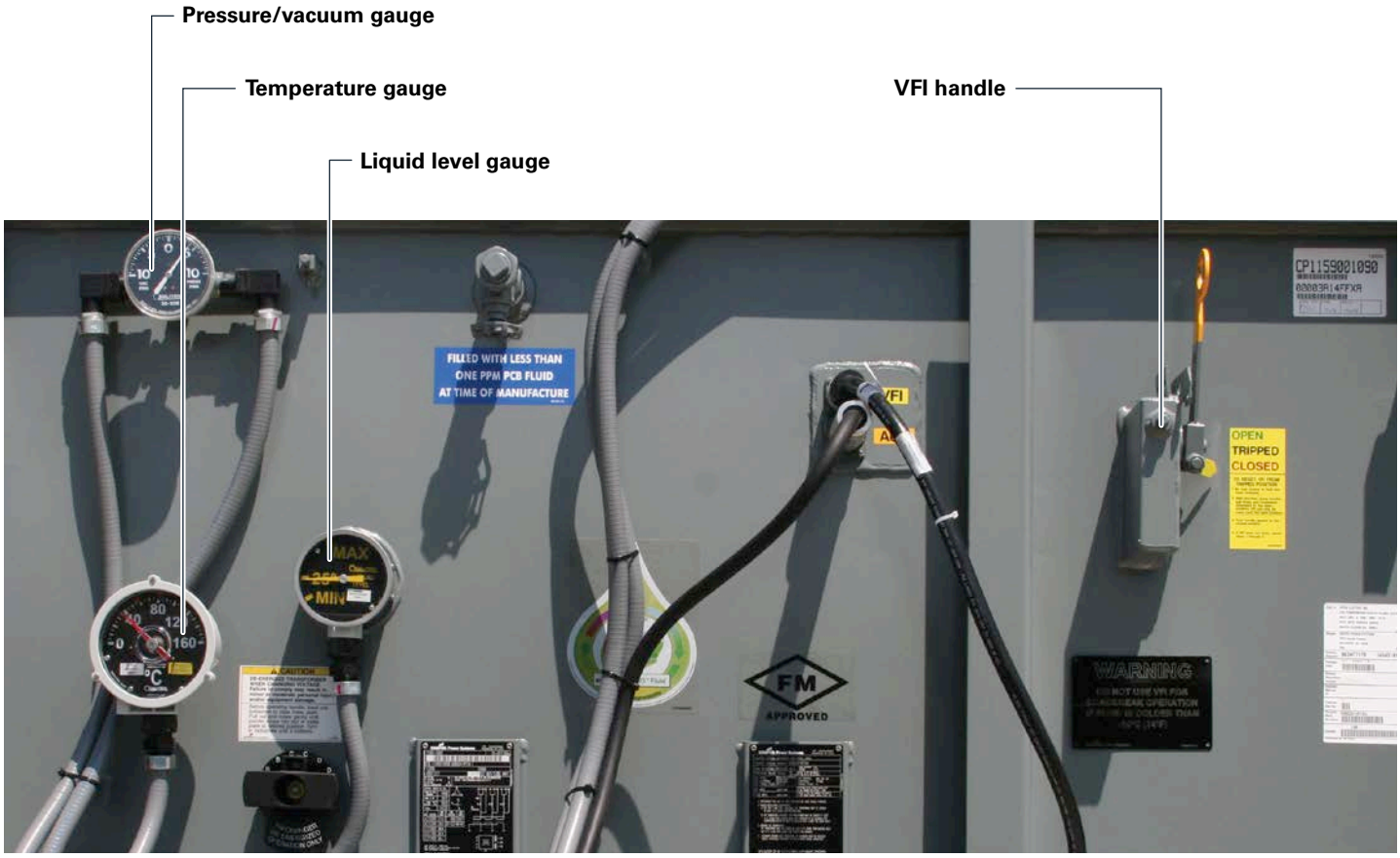
- Up to 50% lower operating costs
- Up to 30% reduction in cooling
- Up to 35% smaller footprint
- Up to 75% quieter
- 60+% higher dielectric strength
- 2–4x more overload capability

Photo courtesy of Archer Daniels Midland Corporation

Install where demand is most critical.

Decrease utility costs by reducing load on HVAC systems.

Systems integration



Medium-voltage system integration

Information is power in critical facility operations. Eaton offers a variety of monitoring solutions for the electrical control room. When specified, Eaton transformers collect and report real-time temperature and information, providing valuable information on the transformer's current and historical conditions. Utilizing sensor data provides facility managers with the ability to preemptively respond to developing situations.

The following accessories (with optional alarm contacts) are available when requested:

- Temperature gauge (with optional alarm contacts)
- Temperature transducer with standard 4–20 mA output
- Pressure/vacuum gauge (with optional alarm contacts)
- Pressure transducer with standard 4–20 mA output
- Liquid level gauge (with optional alarm contact)
- Pressure relief up to 5000 SCFM (with optional alarm contact)

Additionally, the Envirotran CLT is available with an optional, gang-operated, internally mounted vacuum fault interrupter (VFI) that offers the following capabilities:

- Provides primary overcurrent protection
- Provides simple field modification to trip settings
- Allows for easy overcurrent settings adjustments to accommodate changes to transformer loads
- Can also be incorporated into facility communications, providing remote, manual or condition based trip functionality
- Available in 15 kV (12.5 and 16 kA), 25 kV (12.5 kA) and 35 kV (12.5 kA) ratings
- Secondary overcurrent protection to reduce arc flash risk with integrated 50/51 relay

Note: Additional VFI information is available from your Eaton Cooper Power series product sales representative.

Summary

Eaton's Cooper Power series Envirotran CLTs offer an unparalleled combination of reliability, efficiency, safety, performance and operational features, all at an incredible value.

These attributes make the Envirotran CLTs a clear choice when specifying transformers for any critical application environments. **Table 5** summarizes the numerous advantages of these transformers.

With Eaton's Cooper Power series CLT transformers, users will benefit from 50+ years of experience in the development and technical expertise of Envirotemp FR3 Fluid and most of the numerous components that are used in the CLT transformer. Eaton's Cooper Power series transformers include overcurrent protective devices, overvoltage protective devices, terminations, switches, and other components that are designed and tested in-house.

Additionally, because Eaton was originally involved in the development of Envirotemp FR3 Fluid, now manufactured and marketed by Cargill, we understand the nuances and technical interactions between the active components that perform critical protection and switching functionality. Our comprehensive understanding of these products offers users an unparalleled advantage for applications where reliable power cannot be compromised.

For more than a century, electrical industry professionals have counted on Eaton for its expertise and unmatched portfolio of innovative solutions and products.

We are continuously reinventing ways to improve efficiency and reliability to support the growing business demand for power.

Table 5: Envirotran CLT summary

Summary	VPI dry	Cast resin	Envirotran CLT
Location			
Adjacent/attached to buildings	Poor	Poor	Excellent
Indoor	Excellent	Excellent	Excellent
NEC requirements	Low	Low	Low
Carbon footprint	Low	Moderate	Low
Performance			
DOE 2016 efficiency (150 to 2500 kVA)	98.51 to 99.41%	98.51 to 99.41%	99.16% to 99.53% Highest
Reliability	Low	High	Best
Overload capability without accelerated loss of life	0%	0%	12% Best
Life expectancy	Moderate	Moderate/high	Longest
Temperature rise above ambient	150 °C to 80 °C	150 °C to 80 °C	75 °C to 55 °C Lowest
NEMA® sound level (700 to 5000 kVA)	62 to 73 dB	62 to 73 dB	57 to 65 dB Lowest
Voltage withstand (impulse ratings up to 35 kV)	20 to 150	20 to 200	60 to 200 Highest
Financial consideration			
First cost	Moderate	High	Moderate
Energy cost	Moderate	Moderate	Lowest
Installation cost indoor	Low/moderate	Low/moderate	Lowest
Installation cost outdoor	High	High	Lowest
Maintenance	Moderate	Moderate	Lowest
Total life cycle cost	High	High	Lowest

Superior technology reduces operating costs, improves reliability, increases safety and increases operational life.

For Eaton's Cooper Power series
product information, visit
Eaton.com/cooperpowerseries

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