COOPER POWER
SERIES

Data center solutions

Envirotran™ HDC transformers deliver superior reliability and efficiency for substantial savings everyday

EATON
Powering Business Worldwide

Improve energy efficiency – reduce power consumption.

As the demand for data centers grows, the industry's consumption of energy and subsequent emission of greenhouse gases also increases. Although the primary focus of data center facility managers continues to be maximizing uptime and supporting business demand, Eaton is also helping data center operators and owners address the challenges of improving energy efficiency and reducing power consumption.

Power usage effectiveness (PUE) is the measurement by which the data center industry measures a facility's efficient use of electrical energy. Electrical losses associated with power distribution have a negative impact on a facility's PUE value, as well as the owner's bottom line. Data center operators have the opportunity to positively affect the electrical operating efficiency of a data center by making smart choices when choosing medium-voltage power equipment—including transformers.

Envirotran™ liquid-filled transformers utilizing Envirotemp™ FR3™ fluid, recognized by the National Electric Code (NEC), Underwriters Laboratories (UL®), and FM Global, have been installed indoors in various applications for more than 15 Years.

The liquid advantage

Envirotran™ Hardened Data Center (HDC) transformers

Eaton developed Cooper Power™ series Hardened Data Center (HDC) transformers 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 use of Envirotemp™ FR3™ fluid, a sustainable, nontoxic, dielectric medium which 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.

Eaton's Cooper Power series liquid-filled transformers efficiently and reliably serve 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.

Three-phase pad-mounted and substation Envirotran HDC transformers are available up to 35 kV and 12 MVA.

Constant improvements to transformer technology provide ultimate reliability.

The Envirotran HDC transformer 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 critical to data center application: reliability, fire safety, loadability, operational life, efficiency, thermal loading, and installed footprint.

The standardization of Envirotemp™ FR3™ fluid in Envirotran HDC transformers 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 Sections 450-23. When the UL classification guidelines are followed for overcurrent and tank over-pressure protection, the Envirotran HDC transformers can be installed directly in the electrical room of the data center. 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 three feet from a wall and five feet from a ceiling
  - No need for fire suppression systems
- Liquid containment systems
  - Eaton provided metal containment pans makes installation simple and cost effective
  - A sill or curb in the electrical room doorway
- Reduced footprint
- Quieter operation
- Extended life
- Reduced maintenance needs
- Seismic rated

Envirotran HDC transformers with hardened design for reliability, efficiency, safety, and performance

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

The top priority in data center operations is uninterrupted service. Shown here are pad-mounted Envirotran HDC transformers with a tamper-resistant cabinet for outdoor applications.

Reliability

Insulation impulse withstand, loadability, maintenance, diagnostics, and fire protection are critical when specifying transformers for data center applications.

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 HDC transformers 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.

Not reliant on a RC Snubber circuit for transient surge protection

As a result of several high-profile, dry-type failures - resulting in millions of dollars of lost revenue - RC Snubber circuits have become increasingly common on certain data center transformers design types. 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 a RC Snubber circuit. This is one remedy to the symptom and not necessarily the most cost effective cure for all transformer types. Eaton's Envirotran HDC transformers have both a higher BIL rating than traditional transformers and a more optimum resonant frequency to prevent damage from potentially harmful switching overvoltages. The HDC transformer has a more robust design based on years of experience with applications requiring high reliability by limiting switching overvoltages to less than the insulation protection levels of the complete transformer. 95% of the data center transformer failures investigated by Eaton have been VPI dry-type or cast-coil. In contrast, Eaton's Cooper Power series liquid-filled distribution transformers have experienced no voltage transient failures in data center applications with over 2500 MW of installed capacity. Please refer to WP202001 for more details.

Table 1: Basic impulse levels

	Coil Basic Impulse Level (BIL) by voltage		
Nominal voltage (kV)	Envirotran HDC	Standard liquid-filled	Standard dry-type
5.0	95	60	30
15.0	125	95	60
25.0	150	125	110
34.5	200	150	150

Reliable power when you need it.

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.

Maintenance and diagnostics

Data center designs demand system component redundancy, ensuring maximum uptime for critical IT load. 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 means to measure the health or likelihood of an impending failure. With Envirotran HDC liquid-filled transformers however, routine diagnostic tests, including key fluid properties and dissolved gas analysis (DGA), can be performed. Although testing is not required for safe operation, it will provide the user with valuable information to schedule repairs or replacements, and minimize the duration and expense of an outage.

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

Whether it's life expectancy, overload capability, or failure predictability, Envirotran FR3 fluid-filled transformers outperform every time.

Temperature and liquid level gauges.

External, pad-lockable drain valve.

Table 2: Routine maintenance comparison

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

More than just a transformer

Proactive fire 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 HDC transformer can reduce or eliminate the costs associated with water sprinkler systems and fire walls.

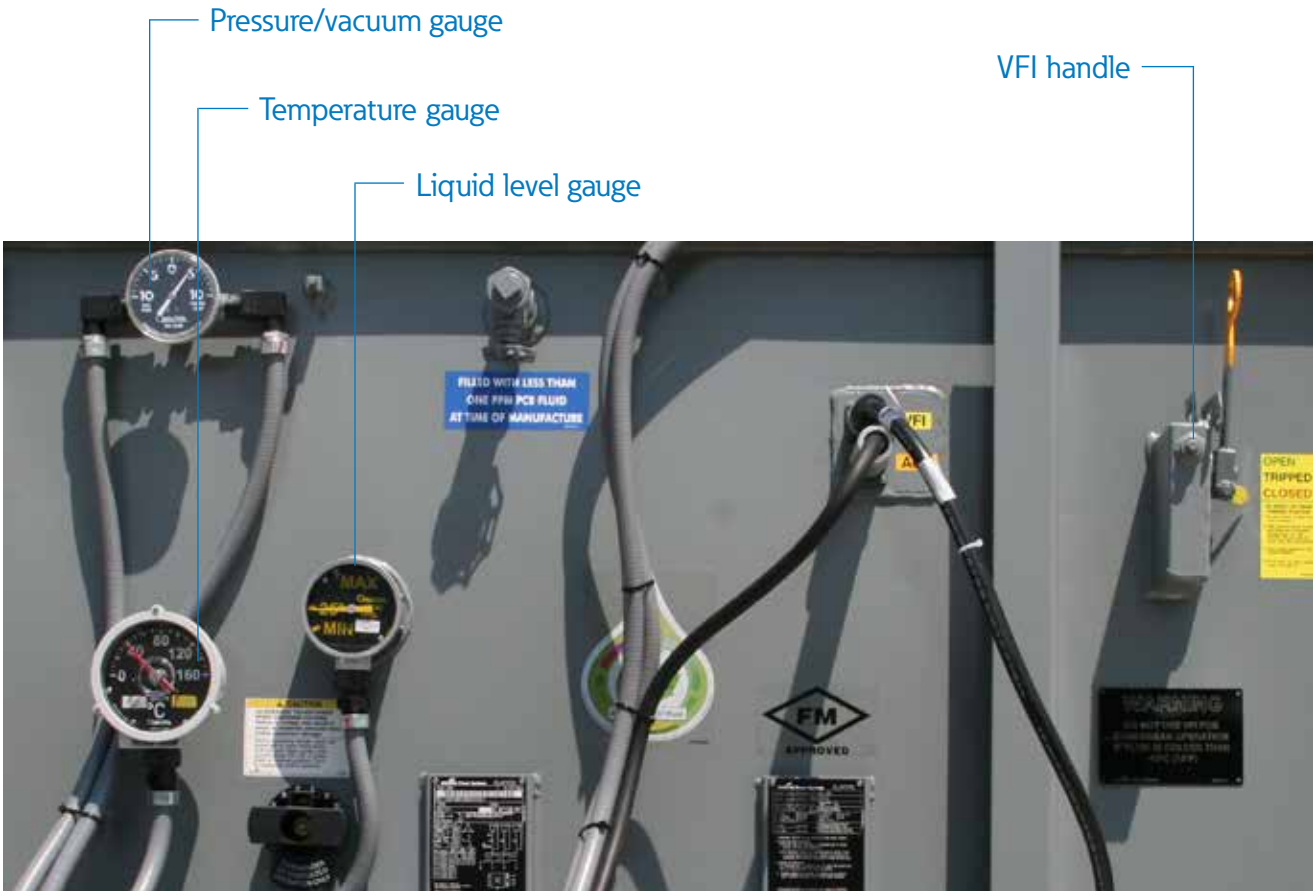
Table 3: Fire safety comparison

	Dry Type	Envirotran HDC
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

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

Containment pan provides easy compliance with electrical codes.

Systems integration



Medium voltage system integration

Information is power in data center operations. Eaton offers a variety of monitoring solutions for the data center 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 data center 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)
- Primary vacuum fault interrupter (VFI)
  - Provides primary over-current protection
  - Provides simple field modification to trip settings
  - Allows changes in server loading and easy accommodation of fault conditions
  - 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

A variety of monitoring solutions and product options available to help protect your assets.

HDC Transformer total life cycle cost advantages

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

- More power delivered to critical IT load
- Reduced operating expenses

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

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 HDC transformers can reduce HVAC operating expense to cool transformer losses by as much as 40%. Table 4 provides an example of an enterprise data center with a 30 MW total load.

Decrease utility costs by reducing load on HVAC systems.

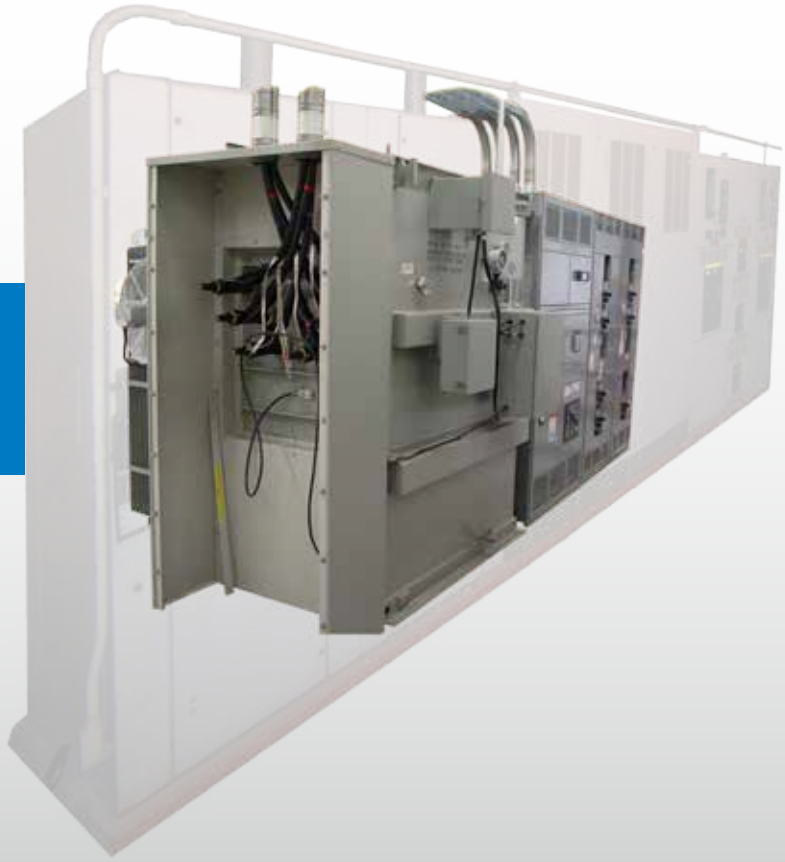
Table 4:
Cost of transformer losses – 30 MW data center load

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

*Cooling based on 1.25 kW per ton
**Operating cost calculated at $0.08/kW-hr

Optimize efficiency. Reduce operating expenses.

Envirotran HDC transformers have up to a **35% smaller footprint** than dry-type transformers.



Summary

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

These attributes make the Envirotran HDC transformer a clear choice when specifying transformers for data centers and other critical application environments. Table 5 below summarizes the numerous advantages of these transformers.

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.

Superior technology reduces operating costs, improves power usage effectiveness (PUE), increases safety, and increases operational life.

Table 5:
Envirotran HDC Transformer summary

SUMMARY	VPI dry	Cast resin	Envirotran HDC Transformer
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

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The clear data center choice

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