



## **Energy Efficiency Regulations and Requirements for Distribution Transformers Sold in the United States**

### **Introduction**

It is the purpose of this document to make users aware of legislation and regulations affecting distribution transformers. This document is not intended to be an exhaustive explanation of the Federal or State regulations or requirements pertaining to distribution transformers. The citations and links in this document will aid the reader in finding the relevant statutory passages.

### **Background**

The US Secretary of Energy was mandated in Part C of Title III of the Energy Policy and Conservation Act (EPCA) to prescribe testing procedures and energy conservation Standards for transformers if the Secretary determines that Standards would be technologically feasible, economically justified, and would result in significant energy savings.

### **US Code of Federal Regulations (C.F.R.)**

The regulations pertaining to Low-voltage dry-type distribution transformers, Medium-voltage dry-type distribution transformers, and Liquid-immersed distribution transformers at the time this paper was published are listed below.

From the United States Code of Federal Regulations

Title 10 – Energy  
Chapter II – Department of Energy  
Subchapter D – Energy Conservation

Part 429      Certification, Compliance and Enforcement for Consumer Products and Commercial Industrial Equipment

Part 431<sup>1</sup>    Energy Efficiency Program for Certain Commercial and Industrial Equipment – Subpart K – Distribution Transformers

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<sup>1</sup> Definitions of distribution transformers found in 10 CFR 431.192 [https://www.ecfr.gov/cgi-bin/text-idx?SID=286dfeb4d342de00d1a2348acd9e5a84&mc=true&node=se10.3.431\\_1192&rgn=div8](https://www.ecfr.gov/cgi-bin/text-idx?SID=286dfeb4d342de00d1a2348acd9e5a84&mc=true&node=se10.3.431_1192&rgn=div8) or <https://www.govinfo.gov/content/pkg/CFR-2006-title10-vol3/xml/CFR-2006-title10-vol3-sec431-192.xml>. Energy Conservation Standards appear in 10 CFR 431.196 <https://www.govinfo.gov/content/pkg/CFR-2013-title10-vol3/xml/CFR-2013-title10-vol3-part431.xml#seqnum431.191>

Numerous requirements are noted within the latest versions of 10 CFR 429 and 10 CFR 431. For covered distribution transformers, the requirements of 10 CFR 429 and 10 CFR 431 shall prevail and are not fully identified herein.

At the time of publication, the above government regulations can also be found at: <http://www.gpo.gov>, and [http://www1.eere.energy.gov/buildings/appliance\\_standards/product.aspx/productid/66](http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/66)

## Products Covered by the Federal Regulations

Certain distribution transformer products are deemed “covered products” under 10 CFR 431 and subject to the requirements of 10 CFR 429 and 10 CFR 431, which include federally mandated minimum efficiency levels. These efficiency levels are commonly referred to as “DOE Efficiency Levels.”

Distribution transformers falling within the scope of these regulations are defined in 10 CFR 431.192<sup>2</sup>:

“*Distribution transformer means* a transformer that—

1. Has an input voltage of 34.5 kV or less;
2. Has an output voltage of 600 V or less;
3. Is rated for operation at a frequency of 60 hz; and
4. Has a capacity of 10 kVA to 2500 kVA for liquid-immersed units and 15 kVA to 2500 kVA for dry-type units.”

Furthermore, 10 CFR 431.192 further defines these transformers:

“*Low-voltage dry-type distribution transformer means* a distribution transformer that—

- (A) Has an input of 600 volts or less;
- (B) Is air-cooled; and
- (C) Does not use oil as a coolant.”

“*Medium-voltage dry-type distribution transformer means* a distribution transformer in which the core and coil assembly is immersed in a gaseous or dry-compound insulating medium, and which has a rated primary voltage between 601 V and 34.5 kV.”

“*Liquid-immersed distribution transformer means* a distribution transformer in which the core and coil assembly is immersed in an insulating liquid.”

Note: Mining Transformers are a separate equipment class within distribution transformer regulations, and currently, there are no Standards for these products. A future rulemaking is possible if these designs experience increased use outside their intended application (i.e., loophole).

Definition: “*Underground mining distribution transformer means* a medium-voltage dry-type distribution transformer that is built only for installation in an underground mine or inside equipment for use in an underground mine, and that has a nameplate which identifies the transformer as being for this use only.”

The regulations of 10 CFR 429 and 10 CFR 431 provide various definitions, requirements, and exclusions to the class of Distribution Transformers. Certain types of *excluded* transformers are shown in the list below.

The following transformers are excluded from the regulations in 10 CFR 431.192:

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<sup>2</sup> <https://www.ecfr.gov/cgi-bin/text-idx?SID=286dfeb4d342de00d1a2348acd9e5a84&mc=true&node=sp10.3.431.k&rgn=div6>

“The term “distribution transformer” does not include a transformer that is an—

1. Autotransformer
2. Drive (isolation) transformer
3. Grounding transformer
4. Machine-tool (control) transformer
5. Non-ventilated transformer
6. Rectifier transformer
7. Regulating transformer
8. Sealed transformer
9. Special-impedance transformer
10. Testing transformer
11. Transformer with tap range of 20% or more
12. Uninterruptable power supply transformer
13. Welding transformer”

Specific definitions for each of these types of transformers may be found in 10 CFR 431.192. The Department of Energy (DOE) regulations allow the above exemptions because they recognized the diversity of applications requiring distribution transformers. There are certain areas where it may not have been appropriate to impose efficiency requirements.

### **Transformer Impedance Ranges**

Transformer impedance ranges are also mentioned in statute. The definitions in 10 CFR 431.192 include tables for “Normal Impedance Ranges,” a definition for “Special-Impedance Transformers,” and an exclusion for “Special-Impedance Transformers.”

### **Refurbishment or Rewinding of Existing Distribution Transformers**

The regulation of these services currently does not fall under the scope of the energy-efficiency regulations. Customers are advised to consider the replacement of older transformers with newer energy-efficient transformers if it is economically advantageous to do so.

### **Geographic Scope**

The efficiency Standards apply to all covered equipment per 10 CFR 431 and manufactured in or imported into the customs territory of the United States, including the District of Columbia, Puerto Rico, or any possession of the United States.

### **DOE Efficiency Levels**

Distribution transformers manufactured and distributed in commerce, as defined by [42 USC 6291\(16\)](#), must meet the energy conservation Standards specified in the Code of Federal Regulations at [10 CFR 431.196](#).

US 10 CFR 431.196 identifies the following minimum efficiency levels of covered products:

## Low-Voltage Dry-Type Distribution Transformers

(2) The efficiency of a low-voltage dry-type distribution transformer manufactured on or after January 1, 2016, shall be no less than that required for their kVA rating in the table below. Low-voltage dry-type distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
		750	99.23
		1000	99.28

**Note:** All efficiency values are at 35 percent of nameplate-rated load, determined according to the DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.

## Liquid-Immersed Distribution Transformers

(2) The efficiency of a liquid-immersed distribution transformer manufactured on or after January 1, 2016, shall be no less than that required for their kVA rating in the table below. Liquid-immersed distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
10	98.70	15	98.65
15	98.82	30	98.83
25	98.95	45	98.92
37.5	99.05	75	99.03
50	99.11	112.5	99.11
75	99.19	150	99.16
100	99.25	225	99.23
167	99.33	300	99.27
250	99.39	500	99.35
333	99.43	750	99.40
500	99.49	1000	99.43
667	99.52	1500	99.48
833	99.55	2000	99.51
		2500	99.53

**Note:** All efficiency values are at 50 percent of nameplate-rated load, determined according to the DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.

## Medium-Voltage Dry-Type Distribution Transformers

(2) The efficiency of a medium- voltage dry-type distribution transformer manufactured on or after January 1, 2016, shall be no less than that required for their kVA and BIL rating in the table below. Medium-voltage dry-type distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase				Three-phase			
kVA	BIL*			kVA	BIL		
	20-45 kV	46-95 kV	≥96 kV		20-45 kV	46-95 kV	≥96 kV
	Efficiency (%)	Efficiency (%)	Efficiency (%)		Efficiency (%)	Efficiency (%)	Efficiency (%)
15	98.10	97.86		15	97.50	97.18	
25	98.33	98.12		30	97.90	97.63	
37.5	98.49	98.30		45	98.10	97.86	
50	98.60	98.42		75	98.33	98.13	
75	98.73	98.57	98.53	112.5	98.52	98.36	
100	98.82	98.67	98.63	150	98.65	98.51	
167	98.96	98.83	98.80	225	98.82	98.69	98.57
250	99.07	98.95	98.91	300	98.93	98.81	98.69
333	99.14	99.03	98.99	500	99.09	98.99	98.89
500	99.22	99.12	99.09	750	99.21	99.12	99.02
667	99.27	99.18	99.15	1000	99.28	99.20	99.11
833	99.31	99.23	99.20	1500	99.37	99.30	99.21
				2000	99.43	99.36	99.28
				2500	99.47	99.41	99.33

\*BIL means basic impulse insulation level.

**Note:** All efficiency values are at 50 percent of nameplate rated load, determined according to the DOE Test Method for Measuring the Energy Consumption of Distribution Transformers under Appendix A to Subpart K of 10 CFR part 431.

## Distribution Transformers will be tested in accordance with Appendix A to Subpart K of Part 431

[https://www.ecfr.gov/cgi-bin/text-idx?SID=286dfcb4d342de00d1a2348acd9e5a84&mc=true&node=ap10.3.431\\_1196.a&rgn=div9](https://www.ecfr.gov/cgi-bin/text-idx?SID=286dfcb4d342de00d1a2348acd9e5a84&mc=true&node=ap10.3.431_1196.a&rgn=div9)

## Reporting of Products to DOE

Manufacturers are required to report their designs (basic models) to DOE annually or when adding/removing models from their catalog. The designation of what constitutes a basic model or models is at the discretion of the submitting company. Company policies vary, but one must bear in mind that if a basic model fails verification testing the entire family of that basic model grouping also fails.

The DOE Certification Compliance Management System (CCMS) is the archive for certification reporting. The database may be searched here: [https://www.regulations.doe.gov/certification-data/#q=Product\\_Group\\_s%3A\\*](https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*)

Complete information about the Department of Energy's Appliance and Equipment Standards Rulemaking and Notices for Transformers can be found at [https://www1.eere.energy.gov/buildings/appliance\\_standards/standards.aspx?productid=55&action=view\\_current](https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=55&action=view_current)

## **California State Distribution Transformer Regulations**

Due to Federal preemption under EPCA, States may not establish regulations for any DOE covered product, including transformers. (Preemption extends to products DOE defines as exempt from regulations.) States may, however, require reporting of products to their own databases. Thus, the energy-efficiency regulations for distribution transformers in California are *identical* to Federal regulations. California regulations for these products are cited in the California Title 20 Appliance Efficiency Regulations<sup>3</sup>. The California Energy Commission requires reporting of Distribution Transformers to their Modernized Appliance Efficiency Database System (MAEDbS). The MAEDbS may be searched here: <https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx>

## **Local/Municipal Requirements**

Municipalities typically do not have their own efficiency requirements for transformers due to Federal preemption but may employ other types of local ordinances independent from energy efficiency. Check with local authorities when specifying a transformer for a specific location with the following in mind:

- 1) Some localities require that transformers not exceed a given sound power (i.e., noise) level. Note that most manufacturing facilities test for sound pressure, not power, so pressure must be converted to power for proper review. Transformers being built to address sound power can abate sound levels through means other than physical design, such as using enclosures, being placed inside a building, etc. One should double-check with local AHJs when specifying transformers for a known location to review the design and plan accordingly.
- 2) Some localities require transformers to be painted.

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<sup>3</sup> <https://www.energy.ca.gov/rules-and-regulations/appliance-efficiency-regulations-title-20>