

## Energy Efficient Transformers Whitepaper – DOE-2016

Revised January 2019

### Summary

Since January 1, 2007 low voltage transformer manufacturers have been required to meet the US Department of Energy (DOE) efficiency levels as defined by Energy Act of 2005 for all “Distribution Transformers”. As of January 1, 2016 the specific efficiency levels were increased from the original “TP1” levels to the new “DOE-2016” levels.

The Energy Act mandates specific types of low voltage dry-type transformers manufactured and sold in the USA to have efficiencies as defined by the 10 CFR Part 431 Standard when loaded to 35% of maximum capacity.

### Efficiency levels TP1 and DOE-2016

#### Single Phase

| kVA  | TP1 & DOE Efficiency Level (%) |
|------|--------------------------------|
| 15   | 97.7                           |
| 25   | 98.0                           |
| 37.5 | 98.2                           |
| 50   | 98.3                           |
| 75   | 98.5                           |
| 100  | 98.6                           |
| 167  | 98.7                           |
| 250  | 98.8                           |
| 333  | 98.9                           |

#### Three Phase

| kVA   | TP1 Efficiency Level (%) | DOE-2016 Efficiency Level (%) |
|-------|--------------------------|-------------------------------|
| 15    | 97.00                    | 97.89                         |
| 30    | 97.50                    | 98.23                         |
| 45    | 97.70                    | 98.40                         |
| 75    | 98.00                    | 98.60                         |
| 112.5 | 98.20                    | 98.74                         |
| 150   | 98.30                    | 98.83                         |
| 225   | 98.50                    | 98.94                         |
| 300   | 98.60                    | 99.02                         |
| 500   | 98.70                    | 99.14                         |
| 750   | 98.80                    | 99.23                         |
| 1000  | 98.90                    | 99.28                         |

### Definitions

- DOE-2016** Defines the standards required starting January 1, 2016 for the energy efficiency performance of transformers
- TP-1** Defines standard for the energy efficiency performance of transformers from January 1, 2007 until December 31, 2015
- Energy Star<sup>®</sup>** A voluntary US government-backed program helping businesses and individuals protect the environment through superior energy efficiency
- CSL-3** Candidate Standard Level 3, one of the five levels of efficiency standards evaluated for transformer operation. (Replaced by DOE-2016 levels)
- NEMA** National Electrical Manufacturers Association developed the TP standards and procedures

***Low-voltage dry-type distribution transformers are defined as follows:***

- Input voltage of 34.5 kilovolts or less
- Output voltage of 600 volts or less
- Rated for operation at a frequency of 60 Hertz
- Rated capacity of 15 kVA to 1000 kVA
- Air-cooled

These transformers must meet the 10 CFR Part 431 Efficiency levels with a 35% load and a temperature of 75 degrees Centigrade.

Efficiencies are determined at the following reference conditions:

- (1) For no-load losses, at the temperature of 20°C, and
- (2) For load losses, at the temperature of 75°C and 35 percent of nameplate load.

***Transformers not covered by efficiency standard***

- Autotransformer
- Drive (isolation) transformer
- Grounding transformer
- Machine-tool (control) transformer
- Non-ventilated transformer (TENV)
- Rectifier transformer
- Regulating transformer
- Sealed transformer
- Special-impedance transformer
- Testing transformer
- Transformer with tap range of 20 percent or more
- Uninterruptible power supply transformer
- Welding transformer
- Surface and above ground mining transformers (added for 2016)
- Transformer with multiple primary windings (added for 2016)

***History***

In 1992 the US Environmental Protection Agency (EPA) introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first labeled products. Through 1995, EPA expanded the label to additional office equipment products and residential heating and cooling equipment. In 1996, EPA partnered with the US Department of Energy for particular product categories. The ENERGY STAR label is now on major appliances, office equipment, lighting, home electronics, and more. EPA has also extended the label to cover new homes and commercial and industrial buildings.

The Energy Policy Act of 2005, signed on August 8, 2005, requires all “Distribution Transformer” and all “low-voltage, dry-type distribution transformer” manufacturers to produce only units

that meet the 10 CFR Part 431 efficiency requirements. During 2013 the DOE updated the Energy Policy Act of 2005 to raise the efficiency levels for three phase transformers, single phase transformers remained at TP-1 levels. The new levels were required starting January 1, 2016. Transformers not meeting the new requirements but manufactured before these rulings can be sold until the stock is depleted. The manufacturing date of a transformer can be found on the nameplate on each unit.

### ***Canadian Requirements***

Since January 1, 2005, dry-type distribution transformers are subject to Canada's Energy Efficiency Act and Regulations. These regulations require that dry-type transformers sold in Canada meet minimum energy performance levels of the CAN-CSA C802.2 and report energy efficiency verified performance data to Natural Resources Canada (NRCan). Transformers that meet the TP-1 efficiency standard also meet the Canadian C802.2.12 standard. The CSA C802.2 requirements have a slightly different list of exempt units from the DOE-2016 standard.

In January 2018 the Ontario province started requiring units sold to meet Reg. 404/12 efficiency levels. These levels are “harmonized” with the DOE-2016 levels. As of May 1 2019 all of Canada will require the same harmonized levels of efficiency defined in the updated C802.2.18.

The Canadian regulations also require manufacturers to have the efficiency testing verified by an independent testing facility. Jefferson units are labelled showing ETL verified, or CSA verified to comply with this requirement.

### ***Are there any transformers with higher efficiency than the DOE-2016?***

Some discussions have started on defining the next level of efficiency for distribution transformers but there are no official standards defined. At this time designing higher efficiency transformers requires more expensive processes and would have a longer payback than DOE-2016 units.