

Energy Efficient Transformers Whitepaper – DOE 2016

Summary:

Since January 1, 2007 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 are increasing 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		Three Phase		
KVA	TP1 & DOE Efficiency Level (%)	KVA	TP1 Efficiency Level (%)	DOE 2016 Efficiency Level (%)
15	97.7	15	97.00	97.89
25	98.0	30	97.50	98.23
37.5	98.2	45	97.70	98.40
50	98.3	75	98.00	98.60
75	98.5	112.5	98.20	98.74
100	98.6	150	98.30	98.83
167	98.7	225	98.50	98.94
250	98.8	300	98.60	99.02
333	98.9	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[®]** – Is 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.
- NEMA** – National Electrical Manufacturers Association developed the TP standards and procedures.

Definition of “Distribution Transformers” per 10 CFR Part 431

Distribution transformers are defined as follows;

- Having an input voltage of 34.5 kilovolts or less
- Having an output voltage of 600 volts or less
- Are rated for operation at a frequency of 60 Hertz

Low-voltage dry-type distribution transformers are defined as follows;

- Having an input voltage of 600 volts or less
- Are air-cooled
- Do not use oil as a coolant.

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
- 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.
- Step up transformer (added for 2016)
- Surface and Above ground Mining transformers (added for 2016)
- Data centers
- 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 after January 1, 2007. Transformers manufactured before January 1, 2007 can still be sold until the stock is depleted. The manufacturing date of a transformer can be found on the nameplate of each unit.

During 2013 the DOE updated to the Energy Policy Act of 2005 to raise the efficiency levels for 3 phase transformers, single phase transformers stay at TP-1 levels. The new levels are required starting January 1, 2016.

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 C802.2-06 standard and report energy efficiency verified performance data to Natural Resources Canada (NRCan).

The Canadian regulations also require manufactures to have the efficiency testing verified by an independent testing facility. Transformers that meet the TP-1 efficiency standard also meet the Canadian C802.2 standard.

As of January 2015, the Canadian officials have not announced any plans to change the transformer efficiency requirements. We expect they will announce a matching program by the end of 2015 and require transformers sold in Canada to meet the same efficiencies and the DOE within six months after the announcement.

What about CSL3 and NEMA Premium?

For the past few years some customers demanded units with higher efficiency than TP-1 standard. This led to product offerings for the CSL3 or C3 or NEMA Premium products. The new DOE 2016 efficiency levels are very close to the CSL3 levels but do not require higher efficiency levels for the single phase units.

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.