

Energy Efficient Transformers Whitepaper 2010

Summary:

The Energy Act of 2005 mandates transformers manufactured in the USA after January 1, 2007 to have efficiencies as defined by the NEMA TP-1 standard when loaded to 35% of maximum. In 2009, transformer manufacturers introduced CSL-3 or C-3 transformers that operate more efficiently than required by the Energy Act of 2005.

Definitions:

TP-1 – Defines standard for the energy efficiency performance of transformers.

TP-2 – Defines the test procedures for meeting the requirements of TP-1

TP-3 – Defines the labeling of transformers specified in TP-1.

Energy Star[®] – Is a 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 TP standards and procedures.

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.



Over the past decade, ENERGY STAR has been a driving force behind the more widespread use of such technological innovations as LED traffic lights, efficient fluorescent lighting, power management systems for office equipment, and low standby energy use.

With the passing of the Energy Act of 1992, H.R. 776, the Department of Energy (DOE) set guidelines for using more efficient electrical devices to reduce energy consumption.

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 TP-1 units 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.

The ENERGY STAR label was used on transformers before 2007 to identify the product as voluntarily meeting the TP-1 efficiency standard. After January 1, 2007 all transformers are required to meet the TP-1 standard and the ENERGY STAR logo no longer applies. The EPA mandated that manufacturers may not use the logo on transformers after May 1, 2007.

Definition of TP-1 Transformers

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 Class I Efficiency levels of TP-1-2002.

With a 35% load and a temperature of 75 degrees Centigrade

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 C802.2 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.

TP-1 Efficiency levels

| Single Phase | |
|---------------------|-----------------------------|
| KVA | 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 | Efficiency Level (%) |
| 15 | 97.0 |
| 30 | 97.5 |
| 45 | 97.7 |
| 75 | 98.0 |
| 112.5 | 98.2 |
| 150 | 98.3 |
| 225 | 98.5 |
| 300 | 98.6 |
| 500 | 98.7 |
| 750 | 98.8 |
| 1000 | 98.9 |

Definition of CSL-3 Transformers

Unlike the TP-1 standard there is no legal definition of a CSL-3 or C3 transformer. NEMA has developed a specification for a “NEMA Premium Efficiency Transformer” which formalizes the efficiencies offered by most manufacturers. These efficiency levels are calculated to have a 30% lower efficiency loss than a TP-1 transformer. CSL-3 transformers are significantly more expensive to purchase than TP-1 transformers but will have a lower lifecycle cost because the original purchase price is more than off-set by the operational savings over twenty or thirty years.

CS-3 Efficiency levels

| Single Phase | |
|---------------------|-----------------------------|
| KVA | Efficiency Level (%) |
| 15 | 98.39 |
| 25 | 98.60 |
| 37.5 | 98.74 |
| 50 | 98.81 |
| 75 | 98.95 |
| 100 | 99.02 |
| 167 | 99.09 |
| 250 | 99.16 |
| 333 | 99.23 |

| Three Phase | |
|--------------------|-----------------------------|
| KVA | Efficiency Level (%) |
| 15 | 97.90 |
| 30 | 98.25 |
| 45 | 98.39 |
| 75 | 98.60 |
| 112.5 | 98.74 |
| 150 | 98.81 |
| 225 | 98.95 |
| 300 | 99.02 |
| 500 | 99.09 |
| 750 | 99.16 |
| 1000 | 99.23 |