

# Efficiency Products

Reference Data

## Optimizing Envirotran® EF™ Transformer Energy-Efficiency and Cost-Effectiveness

# R215-10-2

### INTRODUCTION

Cooper Power Systems has developed an efficient and cost-effective product line of Envirotran® EF™ transformers. This product, with environmental, fire safety and performance features offers significant value for the user. Cooper recommends this total value proposition, with transformers that meet NEMA® TP 1 efficiency, to fully take advantage of Envirotemp® FR3™ fluid features.

### TRANSFORMER EFFICIENCY AND REDUCED COSTS

Utilities constantly face the challenge to reduce costs. In a competitive, de-regulated environment there is constant pressure to cut capital, operating, and maintenance costs—often by purchasing distribution transformers with reduced efficiency. At the same time, most companies recognize that reducing immediate costs comes at a trade-off with efficiency, and reduced efficiency costs more long-term.

Shown in Figure 1 are design data for several 25 kVA single-phase transformers. Note that the efficiencies are all above 98%. Modern transformers are highly efficient devices. Also, note that for this size transformer, increasing the efficiency much above 99.2% becomes very costly and approaches a practical limit. Choosing design B over design A appears to be justified because there is a significant increase in efficiency with little increase in cost. Also, choosing design C over B appears not justified, as the price increases significantly for a modest increase in efficiency. Figure 2 represents a 300 kVA three-phase pad-mounted unit. The unit carries the same basic curve as a single-phase unit.

Cooper's Envirotran transformers, which meet NEMA TP 1 minimum efficiency levels, are an effective choice to balance first cost and efficiency, while gaining environmental, fire safety, and performance benefits.

### NEMA TP 1 Efficiency

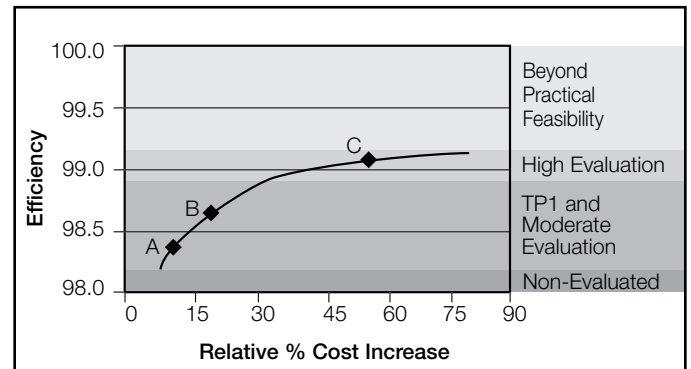
With the passage of the Energy Policy Act of 1992, the United States Department of Energy (DOE) was required to study whether standards for distribution transformers were technologically feasible, economically justified, and would result in significant energy savings. These studies later showed that an efficiency standard, both for dry-type and liquid-filled, would have a significant impact on energy usage.

In response to the governmental efforts, the transformer products section of the National Electrical Manufacturers Association (NEMA) generated a series of standards dealing with transformer efficiency. NEMA is a national trade association, with over 550 members, of which 23 are members of the Transformer Products Division. The standards effort was carried out with the goal of achieving economically responsible energy efficiency

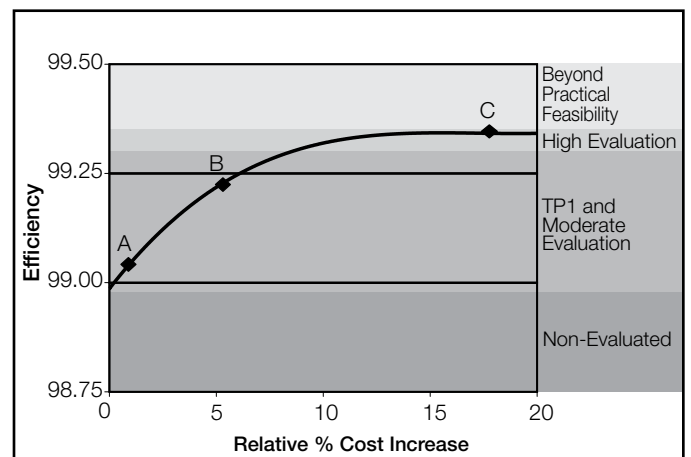
and conservation, using a simplified method to select efficient transformers. The result was a new industry standard, NEMA TP 1, Guide for Developing Energy Efficiency for Distribution Transformers, first published in 1996 and revised in 2002.

The basis used to establish NEMA TP 1 standards was economic payback. Using typical electricity prices, transformer load factors, common transformer design technologies, and costs, the standards were set at levels that would typically result in a three to five year payback. Table 1 (from Section 4 of NEMA TP 1-2002), displays the minimum efficiency levels for single-phase and three-phase liquid-filled transformers. Efficiencies are referenced at 50% load and losses are referenced to temperatures of 55°C (Load Loss) and 20°C (No-Load Loss) – all common design points for a distribution transformer.

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact your Cooper Power Systems sales engineer.



**Figure 1.**  
Cost vs. Efficiency 25 KVA, 7200 V.



**Figure 2.**  
Cost vs. Efficiency 300 KVA, 12470GY/7200 V.

**TABLE 1**  
**NEMA Class 1 Efficiency Levels for Liquid-filled Distribution Transformers**

Reference Condition	Temperature	% of Nameplate Load
Load Loss	55°C	50%
No-Load Loss	20°C	50%
kVA	Single-Phase Efficiency	
10	98.4	
15	98.6	
25	98.7	
37.5	98.8	
50	98.9	
kVA	Three-Phase Efficiency	
45	98.6	
75	98.7	
112.5	98.8	
150	98.9	
225	99.0	
300	99.0	
500	99.1	
750	99.2	
1000	99.2	
1500	99.3	
2000	99.4	
2500	99.4	

The NEMA TP 1 standard has been endorsed by the DOE and is required in many states including Massachusetts, Minnesota, and Wisconsin with the states of California, New York, and Vermont in development.

**ENERGY STAR® VERSUS NEMA TP 1**

The Environmental Protection Agency (EPA) developed an efficiency program for common consumer appliances and electric equipment, known as Energy Star. The Energy Star program requires commercial and industrial (C&I) low voltage transformers to meet minimum efficiency levels.

The low voltage transformer is defined as a unit with both primary and secondary windings designed to operate at system voltages in the low-voltage classes (i.e. less than 1,000 V). Key product criteria for Energy Star labeled “C&I Low Voltage Transformers” follow the requirements defined by NEMA TP 1-2002, Table 4-2, for NEMA Class 1 efficiency levels for dry-type distribution transformers.

Cooper’s Envirotran transformers are classified in the medium voltage class. Therefore, the Energy Star efficiency program does not apply directly to Cooper’s product scope. This also holds true for Cooper Power Systems competition for the equivalent product.

**SUMMARY**

Cooper Power Systems, an industry leader in transformer technology, has introduced revolutionary Envirotran EF transformers, which offer an environmentally responsible choice. The units have high fire point fluid, providing fire safety benefits and a projected life well beyond that of a traditional mineral oil transformer. Envirotran EF transformers are available to meet the nationally recognized NEMA TP 1 efficiency standard, which provides a highly efficient, cost-effective option.

Useful Information Sources

1. NEMA standards are available at [www.nema.org](http://www.nema.org).
2. The Consortium for Energy Efficiency, [www.cee1.org](http://www.cee1.org), includes useful information on energy efficient initiatives and products.
3. Loss Evaluation Formulas: Several sources, using slightly different approaches, include:
  - IEEE® PC57.12.33/D7, “Draft Guide for Distribution Transformer Loss Evaluation”
  - EEI, “Report of the EEI Task Force on Distribution Transformer Evaluation”, April 1981
  - NEMA TP 1, Sections 2 and 3 include a simplified format of Loss Evaluation
  - REA, Bulletin 61-16, “Guide for Economic Evaluation of Distribution Transformers”, Aug 1983

For more information, see data on Envirotemp FR3 fluid properties and CPS catalog section 900-20.

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