International review of Standards and Labelling programs for Distribution Transformers

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**Study Summary**

◆ **International Experience**

- International review is part of the steps required to set a MEPS in Chile
- The review seeks to answer:
  - What type of programs are there?
  - What are the technical aspects of these programs (scope, definition of requirements, test method)?
  - How do these programs compare?
  - How this information will be used in our project?

◆ **Results of the Study:**

- 14 countries with programs, 23 types of different programs and 2 reference testing methods
I - Types of MEPS and labelling programs
Mandatory labelling programs

These labels provide information, with a scale or a set of similar classification, which allows the user to compare the performance of power among different products.

◆ Programs in Brazil, India

◆ Information about:
  - Make, model, type of TD
  - Capacity (kVA)
  - Class of tension (kV)
  - Lost without load, load, 50% load (India)

Note: in Chile, there is such a labelling program for a variety of industrial motors and household products (1-10HP)
Programs of voluntary labelling (label of endorsement)

These labels identify products that stand for the performance of a defined requirement of efficiency (higher than the baseline)

- Programs in the US, Japan, China
- Energy Star – in development

Conclusion: Labelling programs inform the user but do not guarantee the adoption of more efficient technology. In the case of TD, international experience shows that these programs have a more significant impact in combination with other programs. They have the advantage of allowing definition of requirements for procurements made by utilities.
A MEPS or energy efficiency standard will remove a part of the market that does not meet a minimum level of energy efficiency / performance

- Most common programs: found in (almost) every country review - (compulsory or voluntary)
- When required, type of policy the more powerful to ensure the transformation of the market

The project will investigate a combination of a MEPS with a complementary program (push and pull mechanism)
2-Scope of programs of MEPS and labelling

- Liquid-Filled Only
- Dry-Type Only
3-Comparison of test methods

2 Families of test standards:

- **IEC: 19 Parties to the standard 60076.** The review focuses on:
  - Part 1: Generalities
  - Part 2: Immersed in fluid for transformers temperature rise

- **IEEE: 90 standards and guides in the family C57.12.** The review focuses on:
  - C57.12.00: General requirements for distribution, power, and regulating transformers, liquid
  - C57.12.80: Standard terminology for distribution and power transformers
  - C57.12.90: Code of trial for distribution, power, and regulating transformers, liquid
Aspects

- Testing in general condition requirements
- Measurement of no-load losses (PSC)
- Measurement of load losses (PCC)
- The efficiency calculation

2 examples to illustrate the study
Loss Measurement

◆ Comparison of:
  - Reference temperature
  - Temperature correction formula
  - Measurement tolerances
  - Test current
  - Method of measuring resistance
  - Winding temperature

◆ Example: Reference temperatures (difference the more important and difficult to reconcile)

◆ Without load: IEC: 75C - IEEE: 20C
◆ With load: IEC: 75C - IEEE: 85C
Efficiency Calculation

Comparison of:

- Capacity definition
- Efficiency definition

\[ \text{IEC Efficiency} = \frac{\text{input} - \text{losses}}{\text{input}} \]

\[ \text{IEEE Efficiency} = \frac{\text{output}}{\text{output} + \text{losses}} \]

Same result in the calculation of efficiency for a given transformer, only need to convert the capacity when it refers to a transformer IEC or IEEE.
Process of “Dual Logo” IEC-IEEE

- IEC and IEEE have acknowledged the need for harmonization, as well as the benefits and challenges of a harmonized standard.
- Process of "double logo" working groups to establish common standards that carry the logo of the standard IEC / IEEE.
- It already exists for the following standards of power transformers:
4-Performance metrics

- Transformer performance metric is a key element of the definition of EE program
- The metric is closely related to the design of the TD

- Performance metrics can be applied to the design of the core, winding, or to the sum of the two.
Evolution of efficiency/loss with load Factor

Fuente: SEAD
Performance Metrics

- **Maximum no-load/load losses**: defines 2 limitations in each design (one in the core, one in the winding)
- **Maximum combined losses**: defines a limitation unique to the sum of no-load losses and losses of load in a specified load point.
- **Minimum efficiency**: represents the ratio of the output / input. % efficiency must be declared at a specified load point (50% in most cases) *
- **Peak Efficiency Index (PEI)**: maximum efficiency of a given transformer design, regardless of a specified load point.

*Energy Star is developing a series for minimum efficiency of different load factors – still in discussion with the interested parties.*
Performance Metrics
# Summary the advantages and disadvantages

<table>
<thead>
<tr>
<th>Performance Metrics</th>
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<th>-</th>
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<tbody>
<tr>
<td>Load Losses/ no load losses</td>
<td>- It does not require the specification of a load point</td>
<td>- Restricts technological flexibility / design</td>
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<td>- Commonly used in procurement practices</td>
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<td>Total maximum loss / percentage efficiency</td>
<td>- Combining NLL and LL in a metric that provides maximum technological flexibility / design</td>
<td>- It requires a specific load point</td>
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<td>- It allows designs with optimized cost</td>
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<tr>
<td>Peak Efficiency Index (PEI)</td>
<td>- It does not require the specification of a load point in the regulation</td>
<td>- It has not been used in regulation of transformers (power transformers only)</td>
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Comparison of Programs levels for MEPS and labelling

Requirements of MEPS for distribution transformers 3 - phase liquid type

Efficiency (IEC Definition, 50% Load)

kVA Rating

Fuente: SEAD
Comparison of Program levels of MEPS and labelling - high efficiency

High efficiency requirements for TD 3 - phase liquid type

<table>
<thead>
<tr>
<th>Efficiency (IEC Definition, 50% Load)</th>
<th>kVA Rating</th>
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<tbody>
<tr>
<td>USA MaxTech</td>
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<td>China - Grade 1, AMDT</td>
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<td>Europe Draft T2 (2021)</td>
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<td>Australia Draft HEPL</td>
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<td>India 5 Star</td>
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<td>Israel HEPL</td>
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<td>USA MEPS 2016</td>
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<td>Japan Top-Runner</td>
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<td>Australia HEPL 2004</td>
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<td>Korea, HEPL</td>
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Fuente: SEAD
The LBNL report presents the information found in the review of international programs.

In addition, the Ministry of Energy will consider:

- Practices in Chile regarding test methods and metrics of performance (survey RIVER)
- Participation in the market of different types of transformers
- Comments from participants on:
  - Scope
  - Test Methods
  - Performance Metrics