INTAS

Task 2.1

Worldwide and EU technical standards and legislative framework **for Transformers**

Angelo Baggini angelo.baggini@unibg.it – **Franco Bua** franco.bua@ecd.it – **Annalisa Marra** annalisa.marra@ecd.it

06–10–2016

CAPRI

Co-funded by the Horizon 2020 programme of the European Union

TRANSFORMERS FANS

INTAS

INDUSTRIAL AND **T**ERTIARY PRODUCT TESTING AND **A**PPLICATION OF **S**TANDARDS (INTAS)

INTAS is a project funded by the EU's Horizon 2020 programme.

Its aim is to help solve difficulties that Market Surveillance Authorities (MSAs) and market actors face in establishing and verifying compliance of large industrial products subject to the requirements of Ecodesign Directive.

Background

- Large products represent some of the highest savings potentials of all products regulated under the Ecodesign Directive.

- There is difficulty for market actors face in establishing and verifying compliance with Eco-design requirements:
  - lack of expertise within MSAs for these particular products,
  - lack of person and financial resources,
  - lack of experience in testing large products,
  - lack of available laboratories.

- A general call from Industry associations and member states for more, and better, market surveillance to take place in the Union

Aims

- Support European Member State MSAs deliver compliance for large products
- Support industry to be sure of what their obligations are under the Ecodesign Directive and to deliver compliance
- Foster a common European approach to the delivery and verification of compliance

Work flow

1. **Landscape of testing avenues (WP2)**
2. Defining an effective compliance framework for MSAs and manufacturers (WP3)
3. Evaluation of compliance assessment methodology (WP4)
4. MSA collaboration and strategic capacity building (WP5)

WP2 - Final scope

1. Landscape of testing avenues (WP2):

INTAS monitors and analyses current testing practices in Europe and the rest of the world, and reviews test standards, facilities, procedures and methods already in place for large products with a specific focus on power transformers and fans.

WP2 - Final scope

to **define the state of the art** existing
on (large products) energy performance testing avenues
at EU and worldwide level

1. **Legislation and standardisation**
2. Lab Facilities
3. Accreditation bodies
4. Commercial practices
5. Market surveillance practices

Scope

To identify

- current EN/IEC/ISO technical standards and national EU legislative documents (including documents referred to uncertainty and lab accreditation and management)
- lack of technical standardization or legislative tools to help MSA in testing large products

The purpose is to locate such tools in other economies that are not present in European legislation or standards and assessing their relevance and if to be incorporated.

Such tools may include, but are not limited to:

- Identification of size and type of product
- Standardised methods of collecting mandatory information requirements, for both market inspectors and end users
- Evaluating energy performance
- Classifying and testing unique, very large, or customised products

Method and geographical focus

Method

- Desk research primarily carried out by the Group A and B leaders, **with assistance when required from relevant partners**

Where

- The primary geographical focus of this research was:
  - International level standards
  - EU
  - U.S regulation and standards
  - Australian and New Zealand regulation and standards
  - Other developed economies

Report

- Main document (umbrella)
  - Executive summary
  - 1. Introduction
    - 1.1 Objectives
    - 1.2 Contents
  - 2. Technical standards
    - 2.1 IEC standards
    - 2.2 ISO standards
    - 2.3 EN standards
    - 2.4 IEEE standards
  - 3. Legislative documents and programs
  - 4. Lab accreditation and management
    - 4.1 Certification and Inspection
    - 4.2 Testing laboratories
    - 4.3 Measurement uncertainty
- Annex A Transformers
  - Report
  - Database
- Annex B Fans
  - Report
  - Database

Report Annex A - Table of content

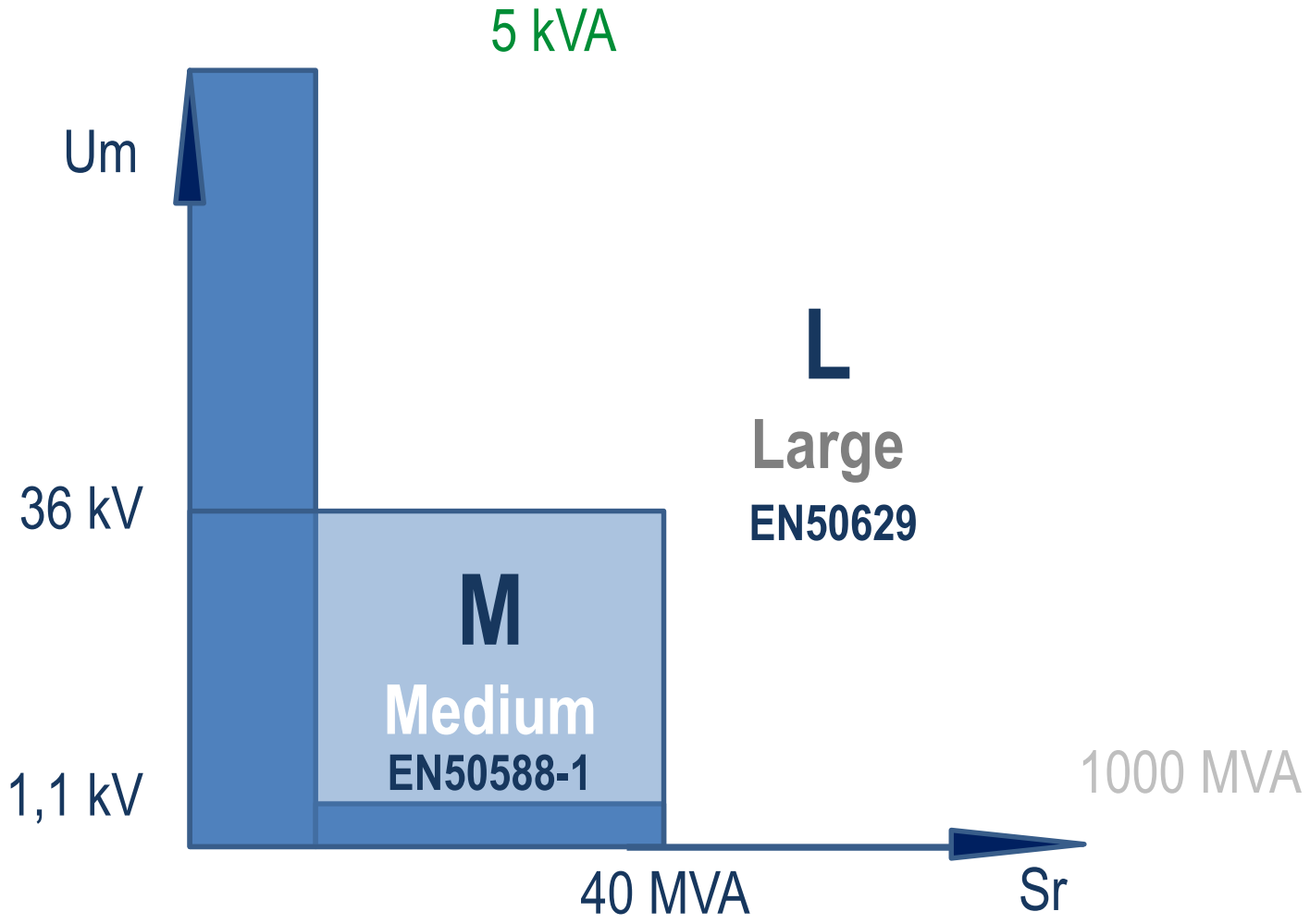
- Introduction
- Scope
- Power transformer background
- Technical standards
- Main standard contents
- Standardized measurement method
- Legislative documents and programs
- Database

Scope

- Technical boundaries
  - The same of the EU Regulation 548/14 **BUT including MPT**

- Geographical boundaries
  - Australia and New Zealand
  - Brazil
  - Canada
  - China
  - European Union
  - India
  - Israel
  - Japan
  - Korea
  - Mexico
  - United States of America
  - Vietnam

Power transformer (re-)classification



Technical standards

- IEC standards
  - 20 docs
- EN standards
  - 3 (+20) docs
- IEEE standards
  - 6 docs
- National standards
  - 26 docs

Legislative documents and programs

- European Union
- United states of America
- Other countries

Legislative documents and programs

European Union Level

- **EU Ecodesign Directive 2009/125/EC**
- **EU Regulation n° 548/2014**
- Low Voltage Directive (LVD) 2014/35/EU
- EMC Directive 2014/30/EU

Legislative documents and programs

USA Level

- DOE 78 FR23335
- DOE 71 FR 24972
- CFR Title 10: Energy subpart K – Distribution transformers

Legislative documents and programs

Legislation at other country level

- Australia and New Zealand
- Brazil
- Canada
- China
- India
- Israel
- Japan
- Korea
- Mexico
- Vietnam

Main findings

In the EU and in the major economies main standards and legislative tools to help MSA in testing power transformers are available.

Important background differences exist

Main findings

Country	Ref.	EP Index	Notes	f_N
Australia and New Zealand	IEC	Efficiency @ 50% load	Mandatory MEPS	50 Hz
Brazil	IEC	Losses @ 50% load	Draft MEPS for dry type	60 Hz
Canada	NEMA IEEE	Efficiency @ 50% load	Mandatory MEPS for dry type Voluntary for liquid filled	60 Hz
China	IEC	Losses @ 100% load	Mandatory MEPS	50 Hz
European Union	EN (IEC)	Losses @ 100% load (S_R < 3150 kVA) PEI (SR ≥ 3150 kVA)	Mandatory MEPS	50 Hz
India	IEC	Losses @ 100% load and Losses @ 50% load	Mandatory MEPS and labelling scheme for certain liquid immersed	50 Hz
Israel	IEC	Losses @ 100% load	Mandatory MEPS	50 Hz
Japan	IEC	Total loss @ 40% (SR ≤ 500 kVA) Total loss @ 50% (SR > 500 kVA)	Mandatory labelling	50-60 Hz
Korea	IEC	Efficiency @ 50% load	Mandatory MEPS	60 Hz
Mexico	IEEE	Efficiency @ 100% load	Mandatory for liquid filled	60 Hz
USA	IEEE	Efficiency @ 50% load	Mandatory MEPS and labelling	60 Hz
Vietnam	IEC	Efficiency @ 50% load	Mandatory MEPS	50 Hz

Background differences

- Rated power definition
- Reference temperature
- Rated frequency
- Rated maximum voltages of the equipment

INTAS
INDUSTRIAL AND TERTIARY PRODUCT TESTING AND APPLICATION OF STANDARDS
Co-funded by the Horizon 2020 programme of the European Union
TRANSFORMERS
FANS

Background differences

Rated power definition

IEC 60076-01 2011 Power trasformers

IN

RATED POWER PRIMARY

$$\eta = \frac{IN - losses}{IN}$$

ANSI C57.12.01-2005

OUT

RATED POWER SECONDARY

$$\eta = \frac{OUT}{OUT + losses}$$

Background differences

Rated power definition

Standard	EN (IEC)	IEEE
Rated power	50 kVA	
Efficiency (%)	97.12%	
Eff. equation	(50 – TL)/50	50 / (50 + TL)
No load losses + Load Losses (TL)	1.440 kW	1.482 kW

Same rated power and efficiency @ same loading point and other conditions.

Backgrounds

Rated power definition

Standard	EN (IEC)	IEEE
Rated power	50 kVA	48.6 kVA
No load losses	0.190 kW	
Load Losses	1.250 kW	
Eff. equation	(50 – (0.190 + 1.250))/50	48.6 / (48.6 + (0.190 + 1.250)
Efficiency (%)	97.12%	97.12%

Same losses

Background differences

Reference temperature

Standard/Regulation	Ref. Temperature
EN (IEC)	75°C
EU Regulation	75°C
IEEE	85°C
US DOE	55°C

Comparison between reference temperatures for liquid immersed transformers

Background differences

Rated frequency

- At lower frequencies (50 Hz):
  - At lower frequencies, more core material (and conductor material consequently) is needed, making the transformer larger and more expensive.
- At higher frequencies (60 Hz):
  - At higher frequencies, both the no load and load losses feature higher eddy current losses.

Background differences

Rated maximum voltages of the equipment

The energy performance of medium power transformers is not the same when operated on electricity systems with different rated voltages. Other conditions being equal:

- the lower the rated voltage of the LV winding / the higher the expected losses / the larger the quantity conductor material.
- The higher the rated voltage of the MV winding / the higher the expected losses.

Other main findings

- Some key aspects need further development in standardisation and regulation:

  - Exception formalisation (how manage possible extemptions)
  - Which/how data shall be made public and how in the perpesctive of MSA
  - Declared value definition confirmation
  - Measurement uncertainty mandatory limits
  - Very low power factor loss measurements
  - Repaired transformer definition
  - Cooling consumption treatement
  - Declaration of conformity template