Revision of C57.143-2012

Guide for Application of Monitoring Equipment to Liquid Immersed Transformers and Components

Mike Spurlock Chairman

Participants, Patents, and Duty to Inform

- All participants in this meeting have certain obligations under the IEEE-SA Patent Policy.
  - Participants [Note: Quoted text excerpted from IEEE-SA Standards Board Bylaws subclause 6.2]:
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  - "Should inform the IEEE (or cause the IEEE to be informed)" of the identity of "any other holders of potential Essential Patent Claims" (that is, third parties that are not affiliated with the participant, with the participant's employer, or with anyone else that the participant is from or otherwise represents)
- The above does not apply if the patent claim is already the subject of an Accepted
- Letter of Assurance that applies to the proposed standard(s) under consideration by
- this group
  - Early identification of holders of potential Essential Patent Claims is strongly encouraged
  - No duty to perform a patent search

SCOPE: This guide covers identification of the key parameters that can be monitored for obtaining an indication of the condition of liquid-immersed transformers. It covers the cost/risk benefit analysis, sensor application, and monitoring systems application. This guide does not cover interpretation of monitoring results (??).

Purpose: The purpose of this document is to provide guidance to those who specify, apply, install, and use on-line monitoring equipment on liquid-immersed power transformers and their components.

Some suggestions made to date from a small group of dedicated individuals;

1) Reorder some of the chapters & rewrite some of the chapters (4, 5 & 6)
2) A discussion re; on-line versus off-line and things to consider when developing a monitoring plan. V-C NOTE: **in other words WHY do you want to do this?**
3) Communications needs a lot of work, not just protocols but, architecture deployed, cyber security requirements, firewalls,
4) Advances on 'modeling of data into information.
5) Sampling rates (of a sensor/monitor) versus data transfer,
6) Archiving and reporting by exception, alarm & data management.
7) Operational data and non-operational (monitoring) data.
8) Do we maintain a section on instrument transformers (section 4.3)?

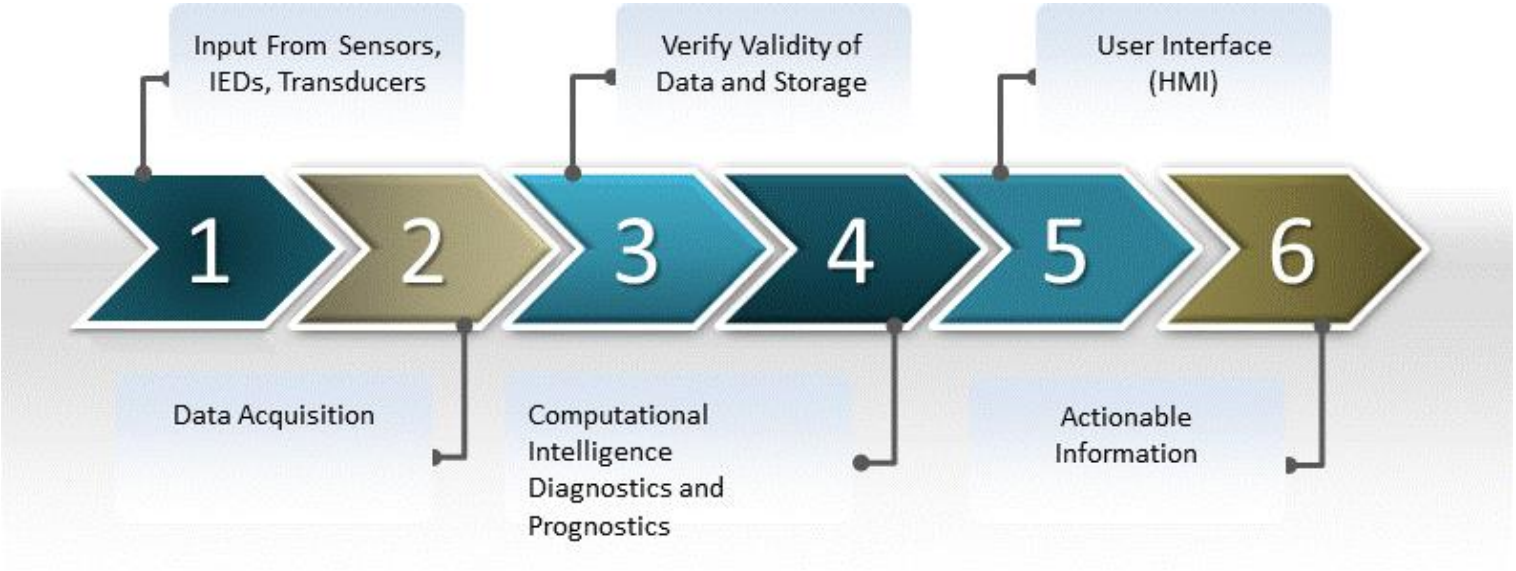
Some suggestions made to date from a small group of dedicated individuals;

1) Standardize the format for sensors to include;
    1) Available technologies Concept of a "SENSOR Catalogue" ?? ref, CEA Report 485 T 1049, December 1996
    2) Caution notes
    3) Difference due to on-line versus off-line data, (timeliness, quality, accuracy??)
    4) Detection time versus report time of each technology
    5) Applications (new versus retrofit) . Cigre TB 343 "Recommendations for Condition Monitoring and Condition Assessment Facilities for Transformers" (April 2008) should be consulted by those who volunteer to help in this Chapter.
    6) Temperature monitoring: *Cigré, TB 659 Transformer Thermal Modeling June 2016, contains a great deal of* ***additional NEW*** *information with regard to locations of direct winding temperature locations in the winding of both core form and shell form transformers*
    7) *Caution urged when suggesting unique, and potential patentable topics, into a guide. This is not the place for a dissertation on valves or where sensors/monitors should be installed, that discussion is between the function desired by the owner and the OEM of the sensor/system suggested*

BACK UP SLIDES

TICM Definition

- **<u>TICM:</u> is the process of using transformer fundamental knowledge, sensing, data acquisition and processing systems to collect raw or pre-processed data, store it, and translate it to a common actionable output, that describes the unit's and/or component's condition, with the use of analytical techniques.**



TICM Process and main sub-processes

TICM Stakeholders Identification

	Time Frame	Primary User	Required Outcome
1	Immediate Short term	SYSTEM OPERATOR • Emergency operation • Emergency maintenance • System operation	STATUS WITH REGARD TO • Safety • Continuity • Reliability
2	Medium term	MAINTENANCE & PLANNING • Planned maintenance • Replacement planning • "Intensive care" and "early warning"	STATUS WITH REGARD TO • Maintenance need • Short term replacement
3	Long term	STRATEGIC ASSET MANAGEMENT • Long term evolution • Grid extension • Replacement strategy	STATUS WITH REGARD TO • Degradation evolution • Maintenance optimization • Long term replacement need

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Overview

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1.2 Purpose

2. Normative references

3. Definitions

4. Surveillance needs of high-voltage transformers and accessories

- 4.1 General
- 4.2 Power transformers
- 4.3 Instrument transformers NOT in TB 630
- 4.4 Bushings
- 4.5 Load Tap Changers

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   - 1.2 Chapters Organization
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- 2.2 TICM in the Future Power System
- 2.3 User's Needs Identification

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   - 3.1 TICM Stages
   - 3.2 Required Features of a TICM System
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   - 3.4 TICM Generic Model
   - 3.5 Stakeholder and Their Needs

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5.2 Dissolved gas-in oil analysis
5.3 Moisture in oil
5.4 Partial discharge
5.5 Transformer temperatures
5.6 Winding temperatures
5.7 Load current and voltage
5.8 Insulation power factor
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3.6.2 Static and Dynamic Parameters
3.6.3 Database Requirements
3.7 Functional Transformer Model
- 3.7.1 Methodology
- 3.7.2 Transformer Subsystems
- 3.7.3 Transformer Failure Modes and Defect Types

3.8 Transformer Information Model
- 3.8.1 Transformer Condition
- 3.8.2 Condition and Recommended Action
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Annex A (informative)
Bibliography

Annex B (informative)
Bushing power factor and capacitance, Relative Power Factor/Tan δ

Annex C Partial discharge: electrical and acoustic methods

Annex D (informative) Direct winding temperature

Annex E (informative)
Communications protocols for on-line monitoring equipment

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8. CONCLUSION AND RECCOMENDATIONS

9. BIBLIOGRAPHIC REFERENCES

10. ANNEX A – TRANSFORMER MAIN SUBSYSTEMS FMEA Example

11. ANNEX B - IEC 61850 LOGICAL NODES FOR MONITORING

12. ANNEX C – WG WORLD WIDE SURVEY

13. ANNEX D – TRANSFORMER MONITORING CASES EXAMPLES

14. ANNEX E – INTELLIGENT INTERPRETATION METHODS