IEC TC 14 ACTIVITIES FOR THE DISTRIBUTION AREA WITH IEC ACTAD

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ABSTRACT

In the IEC, the Advisory Committee on Electricity Transmission and Distribution, ACTAD, consists of the chairman, 7 regional experts and 11 representatives from Technical Committees (TC) and Sub Committees (SC) dealing with individual T&D technologies. In these committees, international experts identify the emerging technologies, discuss the issues and develop IEC standards in order to meet the market demands. In the ACTAD, the representatives from committees deal with the coordination issues between TC/SCs to efficiently and effectively implement standardization activities in the IEC. This paper takes IEC/TC 14 as an example of those committees, and briefly summarizes their standardization activities in light of the distribution area.

INTRODUCTION

In the ACTAD (former Sector Board 1), from its establishment, the representatives from 11 (please see Table 1) committees contribute to sharing and solving the issues with regards to the transmission and distribution area. Based on the restructuring recommendation by the Standardization Management Board (SMB) in May 2010, the Sector Board 1, which had provided market-driven priorities for work of the IEC and was composed of industry members, discussed its new transformed structure and identified the TC/SCs to be invited as the members of ACTAD. After October 2011 when the SMB approved the ACTAD's terms of reference, deliverables and work programme, all the TC/SC officers concerned with the work of ACTAD were asked to nominate representatives. In June 2012, the SMB approved the ACTAD 11 representatives from Technical Committees (TC) and Sub Committees (SC) dealing with individual T&D technologies as shown in the Table 1.

In the ACTAD, the regional experts and TC/SC representatives from different technical areas gather every 6 months and discuss the issues with regard to the standardization of T&D technologies. The responsibility of ACTAD members include:

- to identify standardization issues which concern, or may potentially concern, more than one TC/SC in taking into account both technology trends and market needs;
- to give feedback to their own TC/SC to efficiently solve the coordination issues among TC/SC;
- to contribute to the development of ACTAD deliverables such as the future T&D map and guide 111, "Electrical high-voltage equipment in high-voltage substations - Common recommendations for product standards".

Table 1. TC/SC representatives in ACTAD

Hiroshi Okamoto (JP)	TC 8	Representative
Bernd Schulz (DE)	TC 13	Chairman
Yukiyasu Shirasaka (JP)	TC 14	Representative
Jean-Marc Biasse (FR)	SC 17A/SC 17C	Chairman SC 17C
Baoliang Sheng (SE)	TC 22/SC 22F	Representative
Eung-Bo Shim (KR)	TC 28	Representative
Bernhard Richter (CH)	TC 37	Representative
Pascal Tantin (FR)	TC 38	Chairman
Thierry Lefebvre (FR)	TC 57	Chairman
Serge Volut (FR)	TC 95	Secretary
Jianbin Fan (CN)	TC 115	Representative

Fig. 1. Photo from 2nd ACTAD meeting in Singapore

Title of the Technical Committee 14 is "Power Transformers". TC 14 covers the whole technical area of the Power Transformers which have power ratings above 1 kVA single phase and 5 kVA polyphase with a higher voltage winding of 1000 V or more. The power transformers are key components in the power network. This paper describes the activities for the distribution area of the TC14.

ACTIVITIES OF TC 14

TC 14 Scope

The scope of TC 14 is shown below.

Standardization in the field of power transformers, tap-changers and reactors for use in power generation, transmission and distribution.
Generally these transformers have power ratings above 1 kVA single phase and 5 kVA polyphase with a higher voltage winding of 1000 V or more, however the scope includes lower voltage transformers and regulators used in power delivery applications.
Excluded:
- Instrument transformers
- Testing transformers
- Traction transformers mounted on rolling stock
- Welding transformers
- Transformers for applications covered by TC 96.

The scope of IEC TC 14 is including widely of voltage, capacity, etc. for industry, distribution and transmission area.

Existing Standards of TC 14

TC 14 has the following publications (26, based on the end of year 2014). We call these publications as "76 series" of the standards group for the power transformers.

IEC 60076-1 Edition 3.0 (2011-04-20)
Power transformers - Part 1: General
IEC 60076-2 Edition 3.0 (2011-02-23)
Power transformers - Part 2: Temperature rise for liquid-immersed transformers
IEC 60076-3 Edition 3.0 (2013-07-31) *
Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-4 Edition 1.0 (2002-06-06) **
Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
IEC 60076-5 Edition 3.0 (2006-02-07)
Power transformers - Part 5: Ability to withstand short circuit
IEC 60076-6 Edition 1.0 (2007-12-13)
Power transformers - Part 6: Reactors
IEC 60076-7 Edition 1.0 (2005-12-15) **
Power transformers - Part 7: Loading guide for oil-immersed power transformers
IEC 60076-8 Edition 1.0 (1997-10-01)
Power transformers - Part 8: Application guide
IEC 60076-10 Edition 1.0 (2001-05-22) **
Power transformers - Part 10: Determination of sound levels
IEC 60076-10-1 Edition 1.0 (2005-10-17) **
Power transformers - Part 10-1: Determination of sound levels - Application guide
IEC 60076-11 Edition 1.0 (2004-05-27) **
Power transformers - Part 11: Dry-type transformers
IEC 60076-12 Edition 1.0 (2008-11-05)
Power transformers - Part 12: Loading guide for dry-type power transformers
IEC 60076-13 Edition 1.0 (2006-05-24)
Power transformers - Part 13: Self-protected liquid-filled transformers
IEC 60076-14 Edition 1.0 (2013-09-16) *
Power transformers - Part 14: Liquid-immersed power transformers using high-temperature insulation materials
IEC 60076-15 Edition 1.0 (2008-02-27) **
Power transformers - Part 15: Gas-filled power transformers
IEC 60076-16 Edition 1.0 (2011-08-25) **
Power transformers - Part 16: Transformers for wind turbine applications
IEC 60076-18 Edition 1.0 (2012-07-09) *
Power transformers - Part 18: Measurement of frequency response
IEC/TS 60076-19 Edition 1.0 (2013-03-22) *
Power transformers - Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
IEC 60076-21 Edition 1.0 (2011-12-15) * **
Power transformers - Part 21: Standard requirements, terminology, and test code for step-voltage regulators
IEC 60214-1 Edition 2.0 (2014-05-22) *
Tap-changers - Part 1: Performance requirements and test methods
IEC 60214-2 Edition 1.0 (2004-10-14) **
Tap-changers - Part 2: Application guide
IEC/TR 60616 Edition 1.0 (1978-01-01)
Terminal and tapping markings for power transformers
IEC 61378-1 Edition 2.0 (2011-07-26)
Converter transformers - Part 1: Transformers for industrial applications
IEC 61378-2 Edition 1.0 (2001-02-08) **
Convertor transformers - Part 2: Transformers for HVDC applications
IEC 61378-3 Edition 1.0 (2006-04-27) **
Converter transformers - Part 3: Application guide
IEC 62032 Edition 2.0 (2012-06-21) *
Guide for the Application, Specification and Testing of Phase-Shifting Transformers

* Published within the last 3 years (7)
** Under the maintenance work to the new edition (11)

Recent Activities in TC 14

(1) Plenary meeting

TC 14 held the plenary meeting in every year and the last plenary meeting was held in Tokyo, JAPAN on 10th and 11th November, 2014 in conjunction with the IEC General Meeting 2014 Tokyo.

In the plenary meeting, it was discussed on the progress for the every projects included developing the new standards, maintenance of the existing standards, it schedules, etc., the review and revising of the SBP (Strategic Business Plan), new business, etc..

It was also informed the activities, main topics, etc. of the related TC's, AC's, etc. from the liaison member

(2) Maintenance of existing standards

TC 14 has 11 projects of the maintenance works for the existing publications. Please refer to the Table 2.

Now, 11 standards by 26 publications are under the maintenance work, and it is meaning that TC 14 is a very active TC in the IEC. These activities have big relation to the area of CIRED like as IEC 60076-11 for the "Dry-type transformers", IEC 60076-16 for the "Transformers for wind turbine applications".

Table 2. Projects for maintenance work

No.	Project Reference	Current Stage	Working Group	Fcst. Publ.
1	IEC 60076-4 Ed. 2.0	(New)	MT 60076-4	-
2	IEC 60076-7 Ed. 2.0	(New)	MT 60076-7	-
3	IEC 60076-10 Ed. 2.0	ADIS	MT 60076-10	2016-01
4	IEC 60076-10-1 Ed. 2.0	CCDV	MT 60076-10	2015-12
5	IEC 60076-11 Ed. 2.0	(New)	MT 60076-11	-
6	IEC 60076-15 Ed. 2.0	DEC	MT 60076-15	2015-07
7	IEC 60076-16 Ed. 2.0	AMW	MT 60076-16	2017-05
8	IEC 60076-21 Ed. 2.0	AMW	MT 60076-21	2018-02
9	IEC 60214-2 Ed. 2.0	AMW	MT 60214	2016-09
10	IEC 61378-2 Ed. 2.0	AMW	MT 61378-2	2017-09
11	IEC 61378-3 Ed. 2.0	CDIS	MT 61378-3	2015-02

(3) Developing of the new standards

TC 14 has 5 projects for developing of the new standards. Please refer to the table 3.

Now, 5 new standards are under the developing work, and it is also meaning that TC 14 is a very active TC in the IEC. These activities have also big relation to the area of CIRED like as IEC 60076-20 for the "Energy efficiency" and others too.

Table 3. Projects for the new standards

No.	Project Reference	Current Stage	Working Group	Fcst. Publ. Date
1	**IEC 60076-20 Ed. 1.0** Power transformers - Part 20: Energy efficiency	1CD	PT 60076-20	2014-06
2	**IEC 60076-57-1202 Ed. 1.0** Dual Logo IEEE/IEC standard for "Liquid Immersed Phase Shifting Transformers"	ANW	PT 60076-57-1202	2016-04
3	**IEC 60076-22-1 Ed. 1.0** Power transformer and reactor fittings - Protective devices	ANW	WG32	2017-05
4	**IEC 60076-22-2 Ed. 1.0** Power transformer and reactor cooling equipment	ANW	WG32	2017-05
5	**IEC 60076-22-3 Ed. 1.0** Power transformer and reactor fittings - Accessories and fittings	ANW	WG32	2017-05

(4) Next new projects

TC 14 has a plan to develop a new standard or to modify the existing standards as shown below.

(a) IEC 60076-5 will be considered to start the modification of the standard in the near future.

Typical Topics in TC 14

(1) Energy efficiency

TC 14 set up the new project team IEC TC 14/PT 60076-20 on 2011 to develop a new standards of the "Energy Efficiency" as the IEC 60076-20 Edition 1.0 "Power transformers - Part 20: Energy efficiency".

At first, this project was started as focusing to the distribution area. After that, it was set up the new project team as focusing to the transmission area. Finally, these two project teams were merged to develop a new publication for the "Energy efficiency" covering the both area of the distribution and transmission, also including the power stations.

IEC TC 14/PT 60076-20 published the 1st CD document as 14/778/CD dated on 2013-12-20 and the PT is now working to make a revised WD for a 2nd CD document to publish near future. Already, the project team of the PT 60076-20 held the three times of the international meetings after received the national comments from the every member country to the 1st CD document of 14/778/CD.

In the 1st CD document of the 14/778/CD, it is indicated the calculation methods of the efficiency and efficiency index, and also described the energy performance level of the power transformers as "Efficiency" or "Losses".

In the document, there are two calculation methods of the efficiency in accordance with historical reason as the Method A and Method B as shown below,

Method A

$$\text{Efficiency} = \frac{\text{P - Losses}}{\text{P}}$$

Method B

$$\text{Efficiency} = \frac{\text{P}}{\text{P + Losses}}$$

-Efficiency Index, EI_A, general formula of the method A

$$EI_A = \frac{kS_r - (P_0 + P_{c0}) - (k^2P_k + P_{ck}(k))}{kS_r} \quad \text{(pu)}$$

Where:

P0 is the no-load loss measured at rated voltage, rated frequency and on rated tap

Pc0 is the electrical power required by the cooling system for no-load operation

Pk is the measured load loss at rated current and rated frequency on the rated tap corrected to reference temperature according to IEC 60076-1.

Pck(k) is the additional electrical power required (in addition of Pc0) by the cooling system for operation at ,load factor k.

Sr is the rated power of the transformer or autotransformer as defined in IEC60076-1 on which Pk is based

k is the load factor

This approach respects the philosophy of IEC60076 which refers the rated power to the rated voltage and current of one of the transformer windings.

The reference temperature at rated power chosen for the losses shall be in accordance with IEC60076-1

-Efficiency Index, EI_B, general formula of the method A

This formula is only applicable to transformers with natural cooling AN,ONAN,KNAN,GNAN and LNAN

The general way to calculate the efficiency index is given by equation 7. This is different from usual practice of IEC. This method is named Method B

$$EI_B = \frac{kS_u}{kS_u + P_0 + k^2T_fP_k} \quad \text{(pu)}$$

Where:

P0 is the no-load loss measured at rated voltage, rated frequency and on rated tap

Pk is the measured load loss at rated current and rated frequency on the rated tap corrected to reference temperature according to IEC 60076-1.

Su is the rated power of the transformer or autotransformer as defined in IEEE C57.12.80 on which Pk is based. Su is used to distinguish from Sr.

k is the load factor

Tf Is the temperature correction factor used to correct the losses from the standard reference temperature to the reference temperature used for calculation of EI

Following these idea, it is indicated the example of the energy performance level of the power transformers as "efficiency" or "losses".

-Minimum Peak Efficiency Index method A for the liquid immersed transformers

Please refer to the Table 4 for the liquid immersed transformers with Um ≤ 36 kV and Sr ≤ 3150kVA.

Table 4. PEI values for liquid Immersed transformers with Um ≤ 36kV and Sr ≤ 3150kVA

-	Um≤24kV		Um=36Kv	
Rated Power kVA	**PEI Level 1 %**	**PEI Level 2 %**	**PEI Level 1 %**	**PEI Level 2 %**
≤25	97,992	98,445	97,742	98,251
50	98,741	99,014	98,584	98,891
100	98,993	99,194	98,867	99,093
160	99,122	99,281	99,012	99,191
250	99,210	99,363	99,112	99,283
315	99,248	99,395	99,154	99,320
400	99,297	99,439	99,209	99,369
500	99,330	99,465	99,247	99,398
630	99,373	99,500	99,295	99,437
800	99,416	99,532	99,343	99,473
1000	99,431	99,541	99,360	99,484
1250	99,483	99,544	99,418	99,487
1600	99,488	99,550	99,424	99,494
2000	99,489	99,558	99,425	99,502
2500	99,504	99,568	99,442	99,514
3150	99,506	99,572	99,445	99,518

Table 4 indicate the energy performance level for two winding transformers as shown below,

- With Um≤36kV,
- Sr ≤3150kVA,
- With a second winding voltage ≤1.1kV,
- with an deenergised tapping range ≤ 5%,

This IEC 60076-20 will also included the level depend on the method of A or B, frequency like as 50Hz or 60Hz, Dry type transformers, etc. with consideration of the European practice, American practice, and others

The project team of PT 60076-20 will publish the next document as a 2nd CD in near future. Author will introduce this new publication in the conference.

And, this standard would support to improve and to bottom up loss level and energy efficiency of the power transformers. It also would contributed to create a less carbon society.

(2) Joint Work with IEEE

Recently, it is increasing the joint works under the cooperation with IEEE PES / Transformer Committee to develop or to revise new publications like as IEC 60076-57-1202, IEC 60076-16, IEC 60076-21 and IEC 61378-2.

(2) The latest publication

IEC 60076-3 Edition 3.0 (2013-07-31) "Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air" is a latest publication in the TC 14. This standard was modified by the maintenance team of MT60076-3 (Convenor : Yukiyasu Shirasaka, JP) spending about 4 years. This project was started on November 2009 under the cooperation with IEEE and this standard was completely modified compared with the old edition for the existing voltage levels of 800kV and below, and also added the new items like as the insulation levels and for the UHV power transformers exceeding 800 kV of the maximum system voltage, and also standardized the test methods like as the IVPD (Induced voltage test with partial discharge measurement).

The insulation levels in the old edition had been standardized separately as "European practice" and "North American practice". Then, in this project, the insulation levels are standardized one set for the all area with the cooperation of IEEE. Therefore, this project is a good experience to extend the joint work between IEC and IEEE.

CONCLUSION

This paper explains the recent activities of the TC 14, Power transformers, which provide a representative to IEC ACTAD. Although there are differences in its technical areas, strategies and roadmaps, every TC relevant to ACTAD is very active to work for the international standardization. With the cooperation between regional experts and TC representatives, ACTAD will work continuously on the common subjects and coordination issues between the related TCs to maintain the harmonization of standards in IEC on the area of electricity transmission and distribution.

REFERENCES

[1] IEC TC 14/PT 60076-20, 2013, 14/778/CD "IEC 60076-20: Power transformers – Part 20: Energy efficiency", 2013-12-20

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Mr. Shirasaka received his B.S., and M.S., degrees in electrical engineering from Musashi Institute of Technology. He joined Hitachi Ltd. in 1982. Currently, he is Senior Chief Engineer, Hitachi Ltd., Power System Company, Hitachi Works. He is an assistant secretary for the IEC/TC 122, a chairman of the Japanese national committee for the IEC/TC 14, a member of IEC SMB/ACTAD and ACEE, IEEE, CIGRE and a expert for IEC/CIGRE WG's.