

पावर ग्रिड कारपोरेशन ऑफ इंडिया लिमिटेड

(भारत सरकार का उद्यम)

POWER GRID CORPORATION OF INDIA LIMITED

(A Government of India Enterprise)



पावरग्रिड

केन्द्रीय कार्यालय : "सौदामिनी" प्लॉट नं. 2, सेक्टर-29, गुरुग्राम-122 001, हरियाणा
फोन : 2571700 - 719, फैक्स : 2571760, 2571761 तार 'नेटग्रिड'
Corporate Office : "Saudamini" Plot No. 2, Sector-29, Gurgaon-122 001, Haryana
Tel. : 2571700 - 719, Fax : 2571760, 2571761 Gram : 'NATGRID'

संदर्भ संख्या/Ref. Number

C/ENGG/HVDC/RP800/203/0472

Date: 16/08/2017

ABB AB
HVDC
SE-771 80 Ludvika
Sweden

Kind Attn.: Mr. Andrew McGlade, Project Manager
Ms. Renuka Gera (GM) TBG, BHEL New-Delhi

Subject: ± 800 KV, 6000 MW HVDC terminals associated with HVDC Bipole link between Western region (Raigarh, Chhattisgarh) and Southern region (Pugalur, Tamil Nadu)- North Trichur (Kerala)
Specification No.: CC-CS/651-SR2/HVDC-3063/7/G10
AC Filter Current Transformer

NOA No.: CC-CS/651-SR2/HVDC-3063/7/G10/NOA-II/5817, CC-CS/651-SR2/HVDC-3063/7/G10/NOA-III/5818
CC-CS/651-SR2/HVDC-3063/7/G10/NOA-IV/5819, CC-CS/651-SR2/HVDC-3063/7/G10/NOA-V/5820
CC-CS/651-SR2/HVDC-3063/7/G10/NOA-VI/5821 all dated 08.06.2016

Dear Sir,

कृपया उपरोक्त विषय पर आपके पत्र संख्या TM-RP1-170441 दिनांक 02.08.2017 का अवलोकन करें दस्तावेजों पर टिप्पणियों / अनुमोदन संलग्नित पेज में दिया गया है

In reference to your letter no: TM-RP1-170441 dated 02.08.2017. We are here in conveying comments/ approval on the drawings/ documents listed in attached sheet. For approval/ comments code of each drawing/ documents, please refer the category indicated in remarks column.

अगर हमारे द्वारा बौद्धित संशोधन के अलावा आप कोई संशोधन करना चाहते हैं तो कृपया उसे पूर्ण तर्कसंगति के साथ हाईलाइट करें एवं दस्तावेज को पुनः अनुमोदन हेतु दुबारा प्रेषित करें

In case of any modification other than those desired by us are carried out, the same shall be highlighted clearly in the Drawing/ Document with full justification thereof and resubmitted for approval.

दस्तावेजों में जो टिप्पणी / अनुमोदन दिया गया है उससे संविदाकार अपनी संविदा जिम्मेदारियों से समय-समय पर लागू भारतीय स्टेचुयरी कानून के अंतर्गत उसकी जिम्मेदारियों जैसे डायमैनशन की यथार्थताएं निर्माण में इस्तेमाल की गई सामग्री वजन मात्राएं अभिकल्प ब्यौरा (design details) असम्बल फिट्स निष्पादन ब्यौरा और सामग्री पुर्ति से मुक्त नहीं होगा तथा क्रेता का इस संविदा के अधीन कोई भी अधिकार प्रतिबंधित नहीं होगा

Approval/ comments conveyed herein neither relieves the Contractor of his contractual obligation and his responsibilities for correctness of dimensions, material of constructions, weight, quantities, design details, assemble fits, performance particulars and conformity of the supplies with the Indian Statutory Laws as may be applicable, nor does it limits the Purchaser's right under the Contract.

सधन्यवाद

Thanking you.

Yours faithfully

(B. B Mukherjee)

(बी. बी. मुखर्जी)

AGM (Engg-HVDC)

अपर महाप्रबंधक (अभि. एचवीडीसी)

C/ENGG/HVDC/RP800/203/0472

21/8/17
Date: 16/08/2017

Sl No.	Document No./ Drawing No.	Document Title	Category of Approval
1	1JNL494530 REV C	AC Filter Current Transformer- Raigarh-Pugalur	CAT I

CATEGORIES: -

- I Approved.
- II Approved with comments.
- III Returned for correction.
- IV For Information.

Generally in order /Not in order-For Type test reports

HVDC**±800kV, 6000MW HVDC Raigarh – Pugalur Terminals****Document Transmittal**

ABB, HVDC
RP800 Project Office
4th Floor, Plot No. 58
Sector 44, Gurgaon – 122001.
India

Transmittal No: TM-RP1-170441
Issue Date: 2017-08-02

Managed by: S, Neerajsingh

To: Powergrid (RP800) - Engineering

Attn: Mr. B.B. Mukherjee, AGM (Corporate Engineering)

Cc: Mr.R.N. Singh, Executive Director (RP800), Mr.Rajeev K Chauhan (ED-Engineering),

Enclosed please find the following documents for Approval

Documents of TM-RP1-170441

Doc No	Revision	Title	Document Kind	For Info / Approval	Customer comments due Date	EQ class	Station
1JNL494530 - RoR	B	AC Filter Current Transformer - RoR for Raigarh - Pugalur	Record of review	Approval	2017-08-23	072	Raigarh - Pugalur
1JNL494530	C	AC Filter Current Transformer for Raigarh - Pugalur	Requirement specification	Approval	2017-08-23	072	Raigarh - Pugalur

Best Regards.
Neeraj Singh
Document Control
E-mail: neerajsingh.s@in.abb.com

The above documents are submitted for approval / comments as per the requirements of GCC Clause 20.3.1 read with SCC GCC Clause 20.3.2.



Project: $\pm$ 800 kV, 6000MW HVDC Raigarh – Pugalur Terminals

Document id: 1JNL494530-ROR Rev.B

Record of Review – Document Comment Sheet

Contract No:	CC-CS/651-SR2/HVDC-3063/7/G10/CA-I/5817-5821	Reviewer Initials	Name	Company / Dept
ABB Document No & Rev:	1JNL494530 Rev. -, 1JNL494530 Rev. A; 1JNL494530 Rev. B	RK	Rakesh Kintali	ABB, HVDC
ABB Transmittal No:	TM-RP1-170021, TM-RP1-170206; TM-RP1-170359			
Date	2017-01-27, 2017-05-15; 2017-06-30			
Document Title:	AC Filter Current Transformer			
Station :	Raigarh - Pugalur			
POWERGRID Letter No	C-ENGG-HVDC-RP800-203-0032, C-ENGG-HVDC-RP800-203-0220; C-ENGG-HVDC-RP800-203-0393			
Date	2017-02-14, 2017-05-15; 2017-07-18			

Cat.	II
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No	Page/ Chapter/ Rev	Initials / Date	Comments from POWGRID	Open / closed	Initials / Date	ABB / BHEL clarifications
1a)	1//Rev. 0	2017-02-14	Include in Routine test "Oil Leakage test "as per TS clause 6.11.4.1	Closed	RK/ 08/06/2017	This test is same as that of "Enclosure tightness test at ambient temperature" given in clause 9.7 of RS. The test will be as per clause 7.3.7 of IEC 61869-1, under which sub-clause 7.3.7.2 describes leakage test for oil filled current transformers.
1b)						
2a)	1//Rev. 0	2017-02-14	Correct the date of acceptance type test given on page 16 of 19 to 28 July 2008	Closed	RK/ 08/06/2017	Has been updated to July 28, 2008.
2b)						
3a)	1//Rev. 0	2017-02-14	Include following Type test as per TS Clause 6.11.3.1.(a) (a) Fast transient test	Closed	RK/ 08/06/2017	ABB understands Fast transient test is Multiple chopped impulse test on primary terminals. As per Clause 6.8 of IEC 61869-1, this test is applicable for CTs with $U_m \geq 300$ kV class. The test is not applicable as all the CTs specified in the RS are with $U_m < 300$ kV class.



Project: $\pm$ 800 kV, 6000MW HVDC Raigarh – Pugalur Terminals

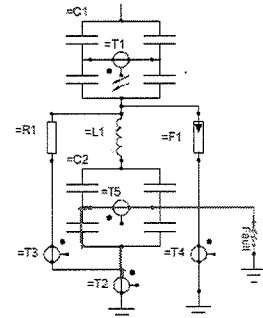
Document id: 1JNL494530-ROR Rev.B

Record of Review – Document Comment Sheet

No	Page/ Chapter/ Rev	Initials / Date	Comments from POWGRID	Open / closed	Initials / Date	ABB / BHEL clarifications
3b)						
4a)	1//Rev. 0	2017-02-14	The CT's shall withstand the discharges of filter banks after ground fault in line with TS clause 6.11.2.2 .11.(a) . Kindly confirm	Closed	RK/ 08/06/2017	ABB confirm that CT's will withstand the discharges of filter banks after ground fault.
4b)						
5a)	1//Rev. 0	2017-02-14	Kindly provide Basis/2eference for converter transformers (F2CT)& HP3 (C2 CT) currents data given in section 3 in the document.	Closed	RK/ 26/4/2017	For F2CT: 100 A rated primary current for Conv. Transf. (F2 CT) is based on the typical current that will give the energy in the arrester F2. The dynamic current, I_{dyn} is set to 20 kA and has high margin. The peak current for the arrester in series with the CT is only 10 kA. For HP3 (C2 CT) 2 A rated primary current is chosen based on the unbalance currents at the trip level. 83 kA I_{dyn} is based on that HP3 C1 High voltage capacitor is charged with rated voltage times 1.41, and a ground fault at the worst case, i.e. at midpoint of the capacitor. Internal inductance in the capacitor and inductance in the short circuit loop has been considered.



Record of Review – Document Comment Sheet

No	Page/ Chapter/ Rev	Initials / Date	Comments from POWGRID	Open / closed	Initials / Date	ABB / BHEL clarifications
5b)	1/Rev.A	2017-05-15	Please show by circuit diagram for fault current in case of ground fault at mid point of HP3 C2 capacitor.	Closed 203-0220	RK/ 08/06/2017	The Fault current path for HP3 C2 is shown below.  Kindly note that transient current for HP3 T5 CT is conservatively given based on transient current of HP3 T1 OCT.
6a)	1//Rev. 0	2017-02-14	On page 15 of 19 In the document modify IEC clause to 7.3.8.2 (It is applicabe to oil/Liquid filled CT).	Closed	RK/ 08/06/2017	ABB understand that the comment is about the clause given in sub-clause 9.7 of RS. Supplier performs only the applicable test as per clause 7.3.7 of IEC 61869-1 given in RS, and 7.3.7.2 is sub-clause of 7.3.7.
6b)						
7a)	1//Rev. 0	2017-02-14	Include Ac filter performance Report, AC filter steady state rating report & AC transient rating report in Reference list on page 18 of 19.	Closed	RK/ 08/06/2017	The requirement specification is intended for suppliers. The rating and performance reports will not be provided to suppliers. The required technical information is already specified in the RS, hence they were not added in the reference list.
7b)						



Project: $\pm$ 800 kV, 6000MW HVDC Raigarh – Pugalur Terminals

Document id: 1JNL494530-ROR Rev.B

Record of Review – Document Comment Sheet

No	Page/ Chapter/ Rev	Initials / Date	Comments from POWGRID	Open / closed	Initials / Date	ABB / BHEL clarifications
8a)	1/Rev.0	2017-02-14	Extended current rating shall be in line with IEC 61869-2, clause 5.6.201	Closed	RK/ 26/4/2017	CTs are designed and tested for accuracy at 120% rated primary current in line with IEC 61869-2. Extended current rating is applicable only if the rated continuous thermal current, including harmonics given in item 3.3 of clause 4.1 of RS is greater than 120% of rated primary current.
8b)	1/Rev.A	2017-05-15	In response of 8(a), Please provide CT of higher current rating than required rated continuous thermal current, including harmonic rms value.	Closed 203-0220	RK/ 08/06/2017	The primary current ratings were chosen based on continuous thermal current and standard values of rated primary current given in clause 5.201 of IEC 61869-2. The primary current rating were given less only for the CTs with continuous thermal current value of 301 and 408 at Raigarh station. This is because they were given the nearest standard primary current value of 300 and 400 as per clause 5.201 of IEC 61869-2. However the CTs are designed for 120% rated primary current of 360 and 480 which are higher than the rated continuous thermal current of 301 and 408, which are worst case currents including over load conditions.
9a)	1/Rev.A	2017-05-15	Approval of document is subject to approval of AC filter performance Report, AC filter steady state rating report & AC transient rating report.	Closed 203-0220	RK/ 08/06/2017	Noted
9b)						
10a)	1/Rev.A	2017-05-15	5.5 Terminal Remove the text "If box dont not include any electronic equipment's .other material of the box than metallic is accepted. Refer TS clause-3.6.1. Also " <u>Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled</u> " in line with TS part4 section GTR clause-18.2.Include underline highlighted text in section 5.5 of the document.	Closed 203-0220	RK/ 08/06/2017	RS has been updated accordingly. The secondary terminal box will be as per clause 2.4 of TB-391-316-013-Rev 01, Junction box for AC yard equipments which was approved by PGCIL.
10b)						
11a)	1/Rev.A	2017-05-15	Clause 4.2: Provide calculation/Justification for static load, showing that load is sufficient for this particular application	Closed 203-0220	RK/ 08/06/2017	The static load given was as per ABB base solution in line with IEC 61869-1. Please note that as per Clause 5 of 1JNL355427, Mechanical requirements for Apparatuses Terminals for HVDC, for AC and DC filter equipment with operating voltage less than 145 kV and current rating less than 750 A the terminal force shall be 750 N, which is less than specified 1250 N.



Project: $\pm$ 800 kV, 6000MW HVDC Raigarh – Pugalur Terminals

Document id: 1JNL494530-ROR Rev.B

Record of Review – Document Comment Sheet

No	Page/ Chapter/ Rev	Initials / Date	Comments from POWGRID	Open / closed	Initials / Date	ABB / BHEL clarifications
11b)						
12a)	1//Rev. B	2017-07-18	For comments see inside the document	Open 203/393	RK/ 27/07/2017	-
12b)						
12a)	1//Rev. B	2017-07-18	Item 3 of Clause 4.1.1: Rated continuous extended current...	Open 203/393	RK/ 27/07/2017	RS has been updated accordingly.
12b)						

±800kV, 6000MW HVDC Raigarh – Pugalur Terminals Raigarh - Pugalur	Document number, revision 1JNL494530, C		Page 1 of 19	Language en
	Status Approved	Resp.dept TSE	Class.no FE - 072	
	Approved Maduko Chibuike, 2017-08-01			
Prepared Rakesh K, 2017-07-27				
Title AC Filter Current Transformer for Raigarh - Pugalur				
Summary				

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	पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड POWER GRID CORPORATION OF INDIA LIMITED			
± 800KV, 6000MW HVDC Terminals Associated With HVDC Bipole Link Between Western Region (Raigarh, Chhattisgarh) and Southern Region (Pugalur, Tamil Nadu) - North Trichur (Kerala)				
Approved in Category :	☒ I	☐ II	☐ III	☐ IV
Signature :	Checked by	Verified by	Reviewed by	
Date :	16/8/17			

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Title AC Filter Current Transformer for Raigarh - Pugalur	

1. General

This document constitutes the Requirement Specification for the ± 800 kV, 6000 MW HVDC Raigarh – Pugalur Terminals (RP800) Project. The AC Current Transformers will be installed at Raigarh and Pugalur converter stations.

The current transformers installed in the AC filters are used for protection purposes.

The equipment shall comply with the requirements in this specification and in General requirements for main circuit apparatus [1]. In case of conflicting information, this specification shall prevail.

The equipment shall also comply with applicable requirements given in section 6.11 and 6.15 of the customer's technical specification. The customer's Technical Specifications are found in the enclosure to this RS. In case of any conflict between this RS and Customer Technical Specification, the supplier shall inform ABB for a final decision.

Alterations from the Standard Requirement Specification are printed in *italic* font.

2. Quantities

2.1 Raigarh Converter Station

Pos.	Reference Designation	Description	Quantity
01	=P(1,2,3,4).WT.T8	Transformer arrester current transformer	12
02	=W1.Z(1,2,3,4,5,6).Z1.T2	HP12 AC filter current transformer, T2	18
03	=W1.Z(1,2,3,4,5,6).Z2.T2	HP12B AC filter current transformer, T2	18
04	=W1.Z(1,2,3,4,5,6).Z3.T2 =W1.Z(2,5).Z4.T2	HP24/36 AC filter current transformer, T2	24
05	=W1.Z(1,2,3,4,5,6).Z3.T3 =W1.Z(2,5).Z4.T3	HP24/36 AC filter current transformer, T3	24
06	=W1.Z(1,3,4,6).Z4.T2	HP3 AC filter current transformer, T2	12
07	=W1.Z(1,3,4,6).Z4.T3	HP3 AC filter current transformer, T3	12
08	=W1.Z(1,3,4,6).Z4.T4	HP3 AC filter current transformer, T4	12
09	=W1.Z(1,3,4,6).Z4.T5	HP3 AC filter current transformer, T5	12
10	=W1.Z(1,3,4,6).Z5.T2	AC Shunt bank current transformer	12
89	Spares	Spares for pos. 02, 03, 04, 06, 10	1
90	Spares	Spares for pos. 05	1
91	Spares	Spares for pos. 07	1
92	Spares	Spares for pos. 08	1
93	Spares	Spares for pos. 09	1
94	Spares	Spares for pos. 01	1

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Title AC Filter Current Transformer for Raigarh - Pugalur	

2.2 Pugalur Converter Station

Pos.	Reference Designation	Description	Quantity
01	=P(1,2,3,4).WT.T8	Transformer arrester current transformer	12
02	=W1.Z(1,2,4,5).Z1.T2	HP12 AC filter GND CT	12
03	=W1.Z(1,2,4).Z2.T2	HP12B AC filter GND CT	15
	=W1.Z(3,6).Z1.T2		
04	=W1.Z2.Z3.T2	HP24/36 AC filter GND CT	12
	=W1.Z(3,5,6).Z2.T2		
05	=W1.Z2.Z3.T3	HP24/36 AC filter L2 & R2 CT	12
	=W1.Z(3,5,6).Z2.T3		
06	=W1.Z(1,4).Z3.T2	HP3 AC filter GND CT	6
07	=W1.Z(1,4).Z3.T3	HP3 AC filter R1 CT	6
08	=W1.Z(1,4).Z3.T4	HP3 AC filter F1 CT	6
09	=W1.Z(1,4).Z3.T5	HP3 AC filter C2 unbalance CT	6
10	=W1.Z(2,3,4,5,6).Z4.T2	Shunt capacitor GND CT	24
	=W1.Z(3,5,6).Z3.T2		
95	Spares	Spares for pos. 02, 03, 04, 06, 10	1
96	Spares	Spares for pos. 05	1
97	Spares	Spares for pos. 07	1
98	Spares	Spares for pos. 08	1
99	Spares	Spares for pos. 09	1
100	Spares	Spares for pos. 01	1

3. Standards

The current transformers shall unless otherwise specified herein, be designed, rated and tested in accordance with the standards:

- IEC 61869-1, Instrument transformers – Part 1: General requirements
- IEC 61869-2, Instrument transformers – Part 2: Additional requirements for current transformers

IEC 60044-1 is canceled and replaced by IEC 61869-1 and IEC 61869-2.

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Title AC Filter Current Transformer for Raigarh - Pugalur	

4. Technical data

4.1 Electrical data

4.1.1 Raigarh Station

Reference Designation		=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z(1,2,3,4,5,6).Z3.T3 =W1.Z(2,5).Z4.T3	=W1.Z(1,3,4,6).Z4.T3	=W1.Z(1,3,4,6).Z4.T4	=W1.Z(1,3,4,6).Z4.T5
Location		Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
1	Voltages						
1.1	Highest voltage for equipment (U_m), rms	kV	24	24	24	24	36
1.2	Base voltage for creepage distances phase to earth, rms and maximum continues voltage to ground at primary winding (U_s)	kV	< 1	< 1	< 1	< 1	17.2
1.2.1	Minimum creepage distance	mm	N.A. ¹	N.A. ¹	N.A. ¹	N.A. ¹	740
2	Rated frequency	Hz	50	50	50	50	50

¹ The creepage distance should be based on the flashover distance.

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Title AC Filter Current Transformer for Raigarh - Pugalur	

Reference Designation			=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z(1,2,3,4,5,6). Z3.T3 =W1.Z(2,5).Z4.T3	=W1.Z(1,3,4,6).Z4. T3	=W1.Z(1,3,4,6).Z4. T4	=W1.Z(1,3,4,6).Z4. T5
Location			Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
3	Currents							
3.1	Rated primary current	A	100	300	400	20	300	2
3.1.1	Rated continuous extended current	A	--	360	480	--	--	--
3.2	Rated secondary current	A	1	1	1	1	1	1
3.3	Rated continuous thermal current, including harmonics, rms values	A	--	301	408	20	--	--
3.3.1	Major harmonic currents, rms values	n/A	--	1/267.13E+00 11/ 98.97E+00 13/ 95.04E+00 5/ 12.26E+00 9/ 11.95E+00 7/ 10.30E+00 3/ 7.57E+00 15/ 5.51E+00 25/ 4.96E+00 17/ 2.53E+00	25/330.09E+00 1/168.94E+00 23/146.78E+00 27/ 53.17E+00 13/ 40.75E+00 35/ 25.97E+00 21/ 25.25E+00 29/ 19.99E+00 37/ 19.85E+00 11/ 18.28E+00	3/ 18.62E+00 5/ 6.96E+00 13/ 1.41E+00 1/ 1.26E+00 11/1.20E+00 7/725.78E-03 25/366.08E-03 9/301.04E-03 4/269.57E-03 23/255.31E-03	--	--
3.4	Maximum transient current, peak values	kA	20	180	16	0.25	104	83
3.4.1	Time to peak	μs	8	17	389	9.7	15.4	8

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Title AC Filter Current Transformer for Raigarh - Pugalur	

Reference Designation			=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z(1,2,3,4,5,6). Z3.T3 =W1.Z(2,5).Z4.T3	=W1.Z(1,3,4,6).Z4. T3	=W1.Z(1,3,4,6).Z4. T4	=W1.Z(1,3,4,6).Z4. T5
Location			Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
3.5	Minimum current-time area before saturation	As	3.2	--	--	--	--	--
4	Insulation levels							
4.1	Lightning impulse withstand level, primary winding	kV	125	125	125	125	125	145
4.2	Switching impulse withstand level primary winding	kV	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
5	Test Voltages							
5.1	Test voltages, power frequency withstand test 60 s.							
5.1.1	Primary winding	kV	50	50	50	50	50	70
5.1.2	Secondary windings	kV	3	3	3	3	3	3
5.2	Test voltages, Partial Discharge measurements							

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Reference Designation		=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z(1,2,3,4,5,6). Z3.T3 =W1.Z(2,5).Z4.T3	=W1.Z(1,3,4,6).Z4. T3	=W1.Z(1,3,4,6).Z4. T4	=W1.Z(1,3,4,6).Z4. T5
Location		Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
5.2.1	Voltage level 1 (max. 10 pC or 50 pC)	kV	24	24	24	24	36
5.2.2	Voltage level 2 (max. 5 pC or 20 pC)	kV	16.6	16.6	16.6	16.6	24.9
5.3	RIV test voltage	kV	N.A.	N.A.	N.A.	N.A.	N.A.

Reference Designation	=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z(1,2,3,4,5,6). Z3.T3 =W1.Z(2,5).Z4.T3	=W1.Z(1,3,4,6).Z4. T3	=W1.Z(1,3,4,6).Z4. T4	=W1.Z(1,3,4,6).Z4. T5
Location	Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
6 Data for the combined cores						
6.1 Number of cores		2	2	2		2
6.2 Ratio		300:1	400:1	20:1		2:1
6.3 Rated burden	VA	10	10	10		10
6.4 Accuracy class		0.5& 5P20	0.5& 5P10	0.5& 5P10		0.5& 5P20
7 Data for the protection cores						
7.1 Number of cores		2			2	
7.2 Ratio		100:1			300:1	
7.3 Rated burden	VA	10			10	
7.4 Accuracy class		5PR20			5PR20	

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4.1.2 Pugalur Station

Reference Designation			=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z2.Z3.T3 =W1.Z(3,5,6).Z2.T3	=W1.Z(1,4).Z3.T3	=W1.Z(1,4).Z3.T4	=W1.Z(1,4).Z3.T5
Location			Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
1	Voltages							
1.1	Highest voltage for equipment (U_m), rms	kV	24	24	24	24	24	36
1.2	Base voltage for creepage distances phase to earth, rms and maximum continues voltage to ground at primary winding (U_s)	kV	< 1	< 1	< 1	< 1	< 1	17.2
1.2.1	Minimum creepage distance	mm	N.A. ¹	N.A. ¹	N.A. ¹	N.A. ¹	N.A. ¹	740
2	Rated frequency	Hz	50	50	50	50	50	50
3	Currents							
3.1	Rated primary current	A	100	400	400	20	300	2
3.2	Rated secondary current	A	1	1	1	1	1	1
3.3	Rated continuous thermal current, including harmonics, rms values	A	--	378	393	20	--	--

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Reference Designation		=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z2.Z3.T3 =W1.Z(3,5,6).Z2.T3	=W1.Z(1,4).Z3.T3	=W1.Z(1,4).Z3.T4	=W1.Z(1,4).Z3.T5
Location		Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
3.3.1 Major harmonic currents, rms values	n/A	--	1/344.06E+00 49/113.36E+00 47/ 91.84E+00 25/ 40.33E+00 13/ 32.02E+00 11/ 14.23E+00 37/ 10.81E+00 27/ 10.57E+00 3/ 9.85E+00 35/ 9.54E+00	25/330.09E+00 1/168.94E+00 23/146.78E+00 27/ 53.17E+00 13/ 40.75E+00 35/ 25.97E+00 21/ 25.25E+00 29/ 19.99E+00 37/ 19.85E+00 11/ 18.28E+00	3/ 18.77E+00 5/ 6.55E+00 11/ 1.22E+00 13/844.19E-03 1/643.51E-03 7/491.83E-03 23/465.40E-03 25/278.06E-03 35/252.39E-03 47/225.45E-03	--	--
3.4 Maximum transient current, peakvalues	kA	20	205	16	0.25	104	83
3.4.1 Time to peak	µs	8	17	414	9.7	15.4	8
3.5 Minimum current-time area before saturation	As	3.2	--	--	--	--	--
4 Insulation levels							
4.1 Lightning impulse withstand level, primary winding	kV	125	125	125	125	125	145

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Reference Designation		=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z2.Z3.T3 =W1.Z(3,5,6).Z2.T3	=W1.Z(1,4).Z3.T3	=W1.Z(1,4).Z3.T4	=W1.Z(1,4).Z3.T5
Location		Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
4.2	Switching impulse withstand level primary winding	kV	N.A.	N.A.	N.A.	N.A.	N.A.
5 Test Voltages							
5.1	Test voltages, power frequency withstand test 60 s.						
5.1.1	Primary winding	kV	50	50	50	50	70
5.1.2	Secondary windings	kV	3	3	3	3	3
5.2	Test voltages, Partial Discharge measurements						
5.2.1	Voltage level 1 (max. 10 pC or 50 pC)	kV	24	24	24	24	36
5.2.2	Voltage level 2 (max. 5 pC or 20 pC)	kV	16.6	16.6	16.6	16.6	24.9
5.3	RIV test voltage	kV	N.A.	N.A.	N.A.	N.A.	N.A.

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Reference Designation	=P(1,2,3,4).WT.T8	See clause 2.1	=W1.Z2.Z3.T3 =W1.Z(3,5,6).Z2.T3	=W1.Z(1,4).Z3.T3	=W1.Z(1,4).Z3.T4	=W1.Z(1,4).Z3.T5
Location	Converter Transformers, (F2 CT)	HP12 (T2), HP12B (T2), HP24/36 (T2), HP3 (T2), Shunt bank (T2) (GND)	HP24/36 (L2&R2 CT)	HP3 (R1 CT)	HP3 (F1 CT)	HP3 (C2 CT)
6 Data for the combined cores						
6.1 Number of cores		2	2	2		2
6.2 Ratio		400:1	400:1	20:1		2:1
6.3 Rated burden	VA	10	10	10		10
6.4 Accuracy class		0.5& 5P20	0.5& 5P10	0.5& 5P10		0.5& 5P20
7 Data for the protection cores						
7.1 Number of cores		2			2	
7.2 Ratio		100:1			300:1	
7.3 Rated burden	VA	10			10	
7.4 Accuracy class		5PR20			5PR20	

4.2 Other data

Static withstand load according to IEC 61869-1, clause 6.7, load class I. For current transformers with a highest voltage for equipment below 72.5 kV, the static withstand load shall be 1250 N.

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5. Design

5.1 General

The current transformers shall be of the oil insulated top core, solid insulated type or hair pin type. The oil insulated top core or hair pin type shall be provided with the following accessories:

- oil indicator

For oil insulated Current Transformers the insulating oil to be used for instrumental transformer shall confirm to IS-335 / IEC 60296

The current transformers shall be provided with lifting eyes to facilitate rapid installation and replacement.

5.2 RIV Design

The current transformers shall be free of external corona at the maximum continuous voltage.

5.3 Cores and windings

Each core shall be provided with its own secondary winding, which shall be electrically completely isolated from other windings. The combined core is protection core fulfilling both specified measuring and protective transformer requirements.

5.4 Earthing

The current transformers shall be provided with earthing connections in accordance with Mechanical Requirements for Apparatuses Terminals for HVDC [2].

5.5 Terminals

The high voltage terminals shall be provided with terminal pads in accordance with Mechanical Requirements for Apparatuses Terminals for HVDC.

The current transformer shall be provided with a weatherproof secondary terminal box fulfilling the requirements *for IP55*, requirements in General requirements for main circuit apparatus clause 6 and *junction box for AC yard equipments [5] clause 2.4*. Facilities shall be provided in the terminal box for short-circuiting and earthing of secondary terminals.

The secondary terminal clamps and the earthing clamps shall be suitable for connection of up to 6 mm² conductors.

The terminal markings shall be in accordance with IEC 61869-2, clause 6.13.201.

5.6 Insulators

The color of the insulators shall be according to General requirements for main circuit apparatus.

The minimum creepage distance is determined according to General requirements for main circuit apparatus. The base voltage for creepage distance is specified in clause 4.1.

Bushing/Insulators shall conform to requirements of TS Clause 6.15.

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5.7 Transient current capability

The current transformers shall be designed for the transient current specified in clause 4.1.

If necessary for limiting the voltage over the primary terminals, surge diverter devices such as spark gaps shall be provided. *The maximum external secondary circuit impedance at 15 kHz is 15 Ω .*

5.8 Seismic requirements

Seismic requirements shall be in compliance with the General requirements for main circuit apparatus.

5.9 Failure rate guarantee

In addition to all other warranties, the supplier warrants that the availability of the goods is equal to or better than the following, provided manpower, instruments and equipment are as specified in the supplier's maintenance and repair manual.

- MTBF: $5 \cdot 10^6$ hours, corresponding to a failure rate of 0.20% per year.
- Scheduled Maintenance every year shall not exceed 1 hour by 2 men.
- Maximum time for exchange to spare 12 hours with a crew of 2 men.

5.10 Surface treatment

The surface treatment shall be in compliance with the General requirements for main circuit apparatus.

5.11 EMC Design

The secondary system of the current transformer shall comply both in terms of emission requirements and immunity requirements as specified in IEC 61869-1, clause 6.11 and in IEC 61000-6-5.

6. Nameplates

General requirements on the nameplates may be specified in General requirements for main circuit apparatus. The information on nameplates shall be in accordance with IEC 61869-2, clause 6.13.202.

Each nameplate shall be provided with a circuit diagram.

7. Environment

The current transformers will be installed outdoors in the switchyard.

The environment conditions are specified in General requirements for main circuit apparatus.

8. Quality program

The quality program shall be according to General requirements for main circuit apparatus.

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9. Routine tests

The determination of errors shall be performed after the other routine tests.

9.1 Power-frequency voltage withstand tests on primary terminals

As per IEC 61869-2, clause 7.3.1.

9.2 Partial discharge measurement

As per IEC 61869-1, clause 7.3.2.

9.3 Power-frequency voltage withstand tests between sections

As per IEC 61869-1, clause 7.3.3.

This test is applicable for current transformers with more than one section/connection on primary. The test shall be between two conductors when primary have reconnection.

9.4 Power-frequency voltage withstand tests on secondary terminals

As per IEC 61869-1, clause 7.3.4.

9.5 Test for accuracy

As per IEC 61869-2, clauses 7.3.5.201 to 7.3.5.206.

9.6 Verification of markings

As per IEC 61869-1, clause 7.3.6.

9.7 Enclosure tightness test at ambient temperature

As per IEC 61869-1, clause 7.3.7.

This test is not applicable for solid type current transformers.

9.8 Pressure test for the enclosure

As per IEC 61869-1, clause 7.3.8.

This test is only applicable for gas insulated current transformers.

9.9 Inter-turn overvoltage test

As per IEC 61869-2, clause 7.3.204.

9.10 Determination of secondary winding resistance

As per IEC 61869-2, clause 7.3.201.

Applicable for current transformer with PR, TPY and PXR classes.

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9.11 Test for rated knee point e.m.f. (Ek) and exciting current at Ek

As per IEC 61869-2, clause 7.3.203.

Applicable for current transformer with PX and PXR classes.

9.12 Determination of the remanence factor

As per IEC 61869-2, clause 7.5.1.

Applicable for current transformer with PR, TPY and PXR classes.

9.13 Determination of the secondary loop time constant.

As per IEC 61869-2, clause 7.3.202.

Applicable for current transformer with PR and TPY classes.

9.14 Measurement of capacitance and dielectric dissipation factor

Not applicable for transformer with a highest voltage for equipment less than or equal to 72.5 kV.

9.15 Sealing test

The tightness of oil insulated current transformers shall be verified by a suitable test. The test procedures shall be subject to approval by ABB HVDC and shall be included in the ITP.

10. Type tests

Certified type tests reports from tests already performed on a similar (or identical) design may be accepted in lieu of performing new type tests, *if performed later than July 28, 2008*. To be applicable, both the design and testing requirements have to comply with this Requirement Specification. The justification for compliance shall be made by means of a Type Test Summary Report (TTSR), sufficiently detailed regarding similarities and differences in design and testing, to facilitate and support an approval of reports from previously performed type tests.

The type test reports shall include the information required in IEC 61869-1 clause 7.2.1.2.

The certified type test reports and supporting TTSR shall be referred to in the ITP and submitted together with the ITP for approval.

All the dielectric type tests shall be carried out on the same instrument transformer, unless otherwise specified.

All the type tests shall be carried out on a maximum of two specimens.

10.1 Short-time current tests

As per IEC 61869-2, clause 7.2.201.

10.2 Temperature-rise test

As per IEC 61869-2, clause 7.2.2.

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10.3 Impulse voltage withstand test on primary terminals

As per IEC 61869-2, clause 7.2.3.1.

10.4 Lightning impulse voltage test on primary terminals

As per IEC 61869-1, clause 7.2.3.2.

10.5 Switching impulse voltage test

As per IEC 61869-1, clause 7.2.3.3.

This test is not applicable for current transformers with a highest voltage (U_m) less than 300 kV.

10.6 Wet test for outdoor type transformers

As per IEC 61869-1, clause 7.2.4.

10.7 Electromagnetic Compatibility test

10.7.1 RIV test

As per IEC 61869-1, clause 7.2.5.1.

Not applicable to current transformers with highest voltage for equipment below 123 kV.

10.7.2 Test on secondary systems

As per IEC 61000-6-5.

EMC tests on secondary system are only required if it includes any electronic equipment.

10.8 Test for accuracy

As per IEC 61869-2, clauses 7.2.6.201 to 7.2.6.206.

10.9 Verification of the degree of protection by enclosures

As per IEC 61869-1, clause 7.2.7.

10.10 Enclosure tightness test at ambient temperature

As per IEC 61869-1, clause 7.2.8

This test is only applicable for gas insulated current transformers.

10.11 Pressure test for the enclosure

As per IEC 61869-1, clause 7.2.9.

This test is only applicable for gas insulated current transformers.

10.12 Protective current transformer classes for transient performance

As per IEC 61869-2, Annex 2B.

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10.13 Thermal stability test

Thermal stability test i.e. application of rated voltage and rated current simultaneously by synthetic test circuit.

Not applicable for transformers with a maximum continuous voltage (U_s) less than 1 kV.

10.14 Thermal co-efficient test

Thermal co-efficient test i.e. measurement of tan-delta as a function of temperature (at ambient and between 80°C and 90°C) and voltage (at 0.3, 0.7, 1.0, and 1.1 $U_m/\sqrt{3}$).

This test shall be performed for oil filled CTs ≥ 72.5 KV class.

11. Verifications

The below design verifications are to be performed by means of verifying reports in lieu of performing corresponding tests. The reports shall be sufficiently detailed in its justification to facilitate and support the approval of each clause to be verified. Additionally mounted equipment shall be duly considered when influence is applicable.

The verification reports and its supporting documents, e.g. reports on previous tests etc., shall be referred to in, and submitted with, the ITP. If verifications are still “to be done” at the submittal of the ITP, the text “To be verified” shall be written in the ITP.

11.1 Transient current capability

Fulfillment of the dynamic current capability shall be verified.

11.2 Seismic requirements

Fulfillment of the seismic requirements shall be verified.

12. Enclosures

Customer Technical Specification Part-2, Chapter 6, Section 6.11 AC Instrumental transformers and Section 6.15 HVAC Insulators, Bushings, Buses And Hardware.

13. References

- [1] 1JNL355425, General requirements for main circuit apparatus
- [2] 1JNL355427, Mechanical Requirements for Apparatuses Terminals for HVDC
- [3] IEC 61869-1, 2007, Instrument transformers – Part 1: General requirements
- [4] IEC 61869-2, 2012, Instrument transformers – Part 2: Additional requirements for current transformers
- [5] TB-391-316-013, Junction box for AC yard equipments

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14. Revision History

Rev. C	Prepared Rakesh K, 2017-07-27	Approved
Revision text - Item 3.1.1 of Clause 4.1.1 has been included and marked		

Rev. B	Prepared Rakesh K, 2017-06-08	Approved Chibuike Maduko, 2017-06-29
Revision text - Clause 5.5 has been updated and marked as per RoR comment. - Reference document added and marked in clause 13		

Rev. A	Prepared Rakesh K, 2017-03-22	Approved Chibuike Maduko, 2017-05-02
Revision text - Date has been updated and marked in clause 10.		

Rev. --	Prepared Rakesh K, 2016-09-06	Approved Chibuike Maduko, 2016-10-26
Revision text -		