Project No: G105348906 **Certificate No:** ASTA-TYPE-0002377

Verification of a transformer

Characteristic verified	Clause/ Subclause	Verified tests and ratings	
Rated voltages, U_r	IEC 60076-1	132/ 33/ 11 kV	
No-load loss and No-load current	IEC 60076-1 Clause 11.1.3 e)	26484 W at 90 % rated voltage 54045 W at 110 % rated voltage 0.06 % at 90 % rated voltage 0.41% at 110 % rated voltage	
Rated power, S_r	IEC 60076-2 Clause 7	66/ 52.8 MVA, ONAF/ ONAN	
Rated insulation level	IEC 60076-3 Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4	HV:	U_m 145/ LI 650/ LIC 715/ AC 275 kV
		HVN:	U_m 52/ LI 250/ AC 95 kV
		LV:	U_m 36/ LI 170/ LIC 187/ AC 70 kV
		LVN:	U_m 36/ LI 170/ AC 70 kV
Ability to withstand short-circuit	IEC 60076-5 Clause 4.2	Verified	
Sound pressure level for the transformer @ 1.0 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 11	65 dB(A), Guaranteed 70 dB(A)	
Sound power level for the transformer @ 1.0 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 12	86 dB(A), Guaranteed 88 dB(A)	
Sound pressure level for the transformer @ 0.3 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 11	67 dB(A), Guaranteed 70 dB(A)	
Sound power level for the transformer @ 0.3 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 12	86 dB(A), Guaranteed 88 dB(A)	
Sound pressure level for the transformer @ 2.0 m under no-load current and rated voltage, ONAF	IEC 60076-10 Clause 11	66 dB(A), Guaranteed 70 dB(A)	

APPARATUS TESTED:	A three-phase, 66/ 52.8 MVA, ONAF/ ONAN (100%/ 80%), (132±8×1.25%)/ 33/ 11 kV, 50 Hz, Category II, YNyn0+d, oil transformer. The high voltage winding has 17 taps and the principal tap is tap 9B. The transformer is fitted with a MR on-load tap changer.

STANDARD:

IEC 60076-1: 2011	Clauses 11.1.2.1 i), 11.1.2.2 a) to e), 11.1.3 d), 11.1.3 e), 11.1.4 e), 11.1.4 l), 11.2 to 11.10, 11.12 and 12
IEC 60076-2: 2011	Clauses 6 and 7
IEC 60076-3: 2013+A1: 2018	Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4
IEC 60076-5: 2006	Clause 4.2
IEC 60076-10: 2016	Clauses 11 and 12

and the STL Guide to IEC 60076 Issue 8.0, 1st June 2022, where applicable.

MANUFACTURER:	Zhejiang Jiangshan Transformer Co., Ltd. No.84, Hushan Road, Jiangshan, Zhejiang Province, China
TESTING LABORATORY:	Shenyang Transformer Institute Co., Ltd. Transformer Laboratory, No. 18, Hushitai South Street, Shenbei New Area, Shenyang, Liaoning, China

APPROVED BY: Stephen Yu, ASTA Observer, Intertek China

Issue Date: 23 March 2023

CONTENTS

Photographs: The following photographs are included in this document.

Photograph no:	Description
P001	Measurement of winding resistance after the short-circuit withstand test
P002	Measurement of voltage ratio and check of phase displacement after the short-circuit withstand tests
P003	Measurement of short-circuit impedance and load loss for HV to LV after the short-circuit withstand tests
P004	Measurement of no-load loss and current after the short-circuit withstand tests
P005	Measurement of dissipation factor (tan δ) of the insulation system capacitances after the short-circuit withstand tests
P006	Temperature rise type test arrangement in ONAN condition
P007	Temperature rise type test arrangement in ONAF condition
P008	Chopped wave lightning impulse test for LV line terminal after the short-circuit withstand tests
P009	Full wave lightning impulse test for LV neutral terminal after the short-circuit withstand tests
P010	Chopped wave lightning impulse test for HV line terminal after the short-circuit withstand tests
P011	Full wave lightning impulse test for HV neutral terminal after the short-circuit withstand tests
P012	Line terminal AC withstand voltage test (LTAC) after the short-circuit withstand tests
P013	Applied voltage test for HV windings after the short-circuit withstand tests
P014	Induced voltage test with partial discharge measurement (IVPD) after the short-circuit withstand tests
P015	Short-circuit withstand tests arrangement for HV to LV view 1
P016	Short-circuit withstand tests arrangement for HV to LV view 2
P017	Transformer internal HV winding side view before the short-circuit withstand tests
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P019	Transformer internal HV winding side view after the short-circuit withstand tests
P020	Transformer internal LV winding side view after the short-circuit withstand tests

CONTENTS (continued)

APPARATUS TESTED

A three-phase, 66/ 52.8 MVA, ONAF/ ONAN (100%/ 80%), (132±8×1.25%)/ 33/ 11 kV, 50 Hz, Category II, YNyn0+d, oil transformer. The high voltage winding has 17 taps and the principal tap is tap 9B. The transformer is fitted with a MR on-load tap changer.

TRANSFORMER DETAILS

Manufacturer	: Zhejiang Jiangshan Transformer Co., Ltd.
Rating	: 66/ 52.8 MVA, ONAF/ ONAN
Rated voltage ratio	: 132/ 33/ 11 kV
Manufacturer's serial no.	: 2813612211001
Product type	: Three-phase power transformer
Tapping	: ± 8 steps of 1.25 %, (17 tap positions)
Connection symbol	: YNyn0+d
Rating plate impedance (75°C)	: 14.30 % for HV to LV on tap 9B
Cooling	: ONAF/ ONAN
Dielectric properties	: HV : U_m 145 / LI 650 / LIC 715 / AC 275 kV HVN : U_m 52 / LI 250 / AC 95 kV LV : U_m 36 / LI 170 / LIC 187/ AC 70 kV LVN : U_m 36 / LI 170/ AC 70 kV
Oil mass	: 19800 kg
Total mass	: 86500 kg
Date of manufacture	: February 2023
Windings	: Circular
Winding material	: Wire (Copper)
Insulation system	: Karamay I-30 °C

On-load tap changer

- Manufacturer	: MR
- Model number	: VVSIII400Y-76-10193W
- Serial number	: 2499425
- Rated motor voltage	: 415 V/ 50 Hz
- Rated control voltage	: 240 V/ 50 Hz

Fans:

- Manufacturer	: Zhejiang ERG Technology Joint Stock Cp., Ltd
- Model number	: DBF-7.3Q10
- Rated voltage	: 415 V/ 50 Hz
- Rated speed	: 580 rpm
- Phase	: 3
- Air volume	: 11800 m^3/h
- Total pressure	: 65 Pa

LABORATORY

The tests were carried out at:

Shenyang Transformer Institute Co., Ltd. Transformer Laboratory
No. 18, Hushitai South Street, Shenbei New Area, Shenyang, Liaoning, China

The laboratory accreditation details are:

This Laboratory is recognized by Intertek ASTA for Conformity Assessment to BS EN / ISO / IEC 17025:2017 and Regulations for ASTA Recognized Laboratories, Agreement No. 2019-RTL-L2-319

SCHEDULE OF TESTS

The transformer was tested in accordance with the following standards:

IEC 60076-1: 2011 Clauses 11.1.2.1 i), 11.1.2.2 a) to e), 11.1.3 d), 11.1.3 e), 11.1.4 e), 11.1.4 l), 11.2 to 11.10, 11.12 and 12
IEC 60076-2: 2011 Clauses 6 and 7
IEC 60076-3: 2013+A1: 2018 Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4
IEC 60076-5: 2006 Clause 4.2
IEC 60076-10: 2016 Clauses 11 and 12
and the STL Guide to IEC 60076 Issue 8.0, 1st June 2022, where applicable.

Test	Standard	Clause No.	Page no.
Routine tests			
Measurement of winding resistance	IEC 60076-1	Clause 11.2	18 and 19
Measurement of voltage ratio and check of phase displacement	IEC 60076-1	Clause 11.3	20
Measurement of short-circuit impedance and load loss	IEC 60076-1	Clause 11.4	21 and 22
Measurement of no-load loss and current at rated voltage	IEC 60076-1	Clause 11.5	23
Tests on on-load tap changers	IEC 60076-1	Clause 11.7	26
Leak testing with pressure for liquid-immersed transformers (tightness test)	IEC 60076-1	Clause 11.8	26
Check of the ratio and polarity of built-in current transformers	IEC 60076-1	Clause 11.1.2.1 i)	27 and 28
Check of core and frame insulation for liquid immersed transformers with core or frame insulation	IEC 60076-1	Clause 11.12	29
Insulation of auxiliary wiring (AuxW)	IEC 60076-3	Clause 9	58
Line terminal AC withstand voltage test (LTAC)	IEC 60076-3	Clause 12	57
Applied voltage test (AV)	IEC 60076-3	Clause 10	58
Induced voltage withstand test (IVW)	IEC 60076-3	Clause 11.2	59
Induced voltage test with partial discharge measurement (IVPD)	IEC 60076-3	Clause 11.3	60
Determination of capacitances windings-to-earth and between windings	IEC 60076-1	Clause 11.1.2.2 a)	30
Measurement of d.c. insulation resistance between each winding to earth and between windings	IEC 60076-1	Clause 11.1.2.2 b)	29

GENERAL TEST CONDITIONS *(Continued)*

Routine tests *(Continued)*

11. In accordance with clause 7.2.3 of IEC 60076-3 and clause 4.2.7.4 of IEC 60076-5 the dielectric tests were performed in the following sequences before and after the short-circuit withstand tests:

Test Order	Before short circuit tests	After short circuit tests
1)	Applied voltage test (AV)	Chopped wave lightning impulse test for the line terminals (LIC) and lightning impulse test for the neutral terminals (LIN)
2)	Line terminal AC withstand test (LTAC)	Line terminal AC withstand test (LTAC)
3)	Induced voltage withstand test (IVW)	Applied voltage test (AV)
4)	Induced voltage test with partial discharge measurement (IVPD)	Induced voltage withstand test (IVW)
5)	-	Induced voltage test with partial discharge measurement (IVPD)

Temperature rise type test

12. The temperature rise test was performed on tap 17 applying the total losses of tap 17 and the tapping current of tap 17.

13. The temperature rise test was performed after the short-circuit withstand tests.

14. The load loss, no-load loss and d.c. resistance measurements were used to calculate the total power required for the temperature rise test. The temperature rise results were calculated at the 75^{o}C reference temperature.

15. The transformer was tested in accordance with clause 7.3 of IEC 60076-2 using the short-circuit method.

    The test was performed in ONAF followed by ONAN condition:

    The test was performed in two parts as follows:

    a) Total loss injection-
    The transformer HV winding was subjected to a test voltage sufficient to supply total losses with the LV windings short-circuited together. The test power was maintained until the increase in top oil temperature was below 1 K per hour for a period of 3 hours.
    The corrections of clause 7.13 of IEC 60076-2 were used in determining the top oil and average oil temperature rises

    b) Rated current injection for the HV and LV windings-
    At the completion of part a), the test current was reduced to rated current for 1 hour followed by rapid disconnection of the test supply and the d.c. resistance of the windings were measured to determine their maximum temperatures using the change of resistance method for HV and LV windings.
    The corrections of clause 7.13 of IEC 60076-2 were used in determining the top oil, average oil and winding temperature rises.

16. An Acculoss measurement system ALMS 4100 was used to measure the currents, voltages and power.

17. The HV (B-N) and LV (b-n) winding resistances were measured using a d.c. resistance bridge before and during the hot resistance shutdown.

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of dissolved gasses in dielectric liquid

During various stages of the testing process, oil samples were taken from the bottom of the main tank for electrical and chemical analysis. The results were:

Quantity	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Tan δ at 90 °C (%)	0.13	-	-	-	-	-	-
Electric strength (kV)	59.9	-	-	-	-	-	-
Water content (mg/L)	8.0	-	-	-	-	-	-
DGA (μL/L)							
Σ_{CH}	0.26	0.28	0.32	0.59	0.64	0.69	0.74
H_2	0.00	0.00	0.73	1.52	1.55	1.59	1.66
CO	1.95	2.26	2.39	3.92	4.24	5.61	6.14
CO_2	98.75	108.8	136.1	211.6	228.7	240.1	276.3
CH_4	0.26	0.28	0.32	0.46	0.52	0.56	0.60
C_2H_4	0	0	0	0.13	0.12	0.13	0.14
C_2H_6	0	0	0	0	0	0	0
C_2H_2	0	0	0	0	0	0	0
-	Before all the tests	Before short-circuit tests	After short-circuit tests	After dielectric tests	After ONAN temperature rise test	After ONAF temperature rise test	After long term no load loss test
Date of sample	21 Feb. 2023	24 Feb. 2023	25 Feb. 2023	01 Mar. 2023	02 Mar. 2023	03 Mar. 2023	04 Mar. 2023