



**DEPARTAMENTO DE  
PROTECCION y COMUNICACIÓN**  
**Coordinación de Pruebas y Mediciones**

**Pruebas al Transformador T-3**

**Subestación: Llano Sánchez**

**Fecha de Prueba: 22-Octubre-2017**

**Prueba Realizada por: Ing. Josué Martínez**

A handwritten signature in dark ink, appearing to be "JM", located to the right of the text "Prueba Realizada por: Ing. Josué Martínez".

**Informe Realizado por: Ing. Julio Ruíz C.**

**Fecha: 13-Noviembre-2017**



# INSULATION TESTS AUTO TRANSFORMERS WITH TERTIARY



DATE 10/22/2017

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AMBIENT TEMP. 30.4 °C

JOB # 92832

SUBSTATION LLANO SÁNCHEZ

HUMIDITY 71.9 %

ASSET ID T-3

POSITION LLANO SÁNCHEZ II - PATIO 230KV

TEST STATUS

EQUIPMENT LOCATION

MFR	ILJIN	REASON	Routine
SER NO	11TI009001	WEIGHT	93,700 Kg
YEAR	2011	WINDING MATERIAL	Cu
CLASS	OA/FA/FA	OIL VOLUME	31,000 l
COOLANT	OIL	OIL TEMP	48 °C
BIL	750 kV	IMPEDANCE	9.14 %
PHASES	3	WEATHER	Sunny
CONFIGURATION	YNynd1		
TYPE	OPEN-CONSER		

BUSHING NAMEPLATE						
DSG	SERIAL NUM	MFR.	TYPE/CLASS	KV	AMPS	YEAR
H1	11F0269-03 AEI	TE	Other	230		
H2	11F0269-04 AEI	TE	Other	230		
H3	11F0269-08 AEI	TE	Other	230		
H0	1000031151	ABB	O+C	34.5		
X1	11F0256-55AEF	TE	Other	115		
X2	11F0256-47AEF	TE	Other	115		
X3	11F0256-50AEF	TE	Other	115		
X0		NONE	NONE			
Y1	1000031147	ABB	O+C	34.5		
Y2	1000031149	ABB	O+C	34.5		
Y3		NONE	NONE			
Y0		NONE	NONE			

VOLTAGE (KV)		MVA	RATED I	# TAPS	NOMINAL	CHANGER	TAP SETTING
L-L	L-G						
PRIMARY: 230	133	100	251.02	5	3	Off Load	
SECOND: 115	66	100	502.04	1			
TERTIARY: 34.5		60	1,004.09	1			

COMMENTS:

TRANSFORMER OVERALL TEST SET UP									TRANSFORMER OVERALL TEST RESULTS							
Test No.	INSULATION TESTED	Test Mode	Test Lead Connections				TEST kV	DFR	Capacitance C (pF)	POWER FACTOR %			DIRECT		%VDF	IR
			HV	Red	Blue	Gnd				Measured	@ 20°C	Corr Factor	mA	Watts		
1	C <sub>H</sub> + C <sub>HT</sub>	GST-GND	H+L	T		G	10.00	✓	13,275.20	0.23	0.30	1.270	49.9874	1.1610	0.02	G
2	C <sub>H</sub>	GSTg-RB	H+L	T		G	10.00	✓	6,393.31	0.29	0.36	1.270	24.0319	0.6875	0.01	G
3	C <sub>HT</sub> (UST)	UST-R	H+L	T		G	10.00	✓	6,888.15	0.18	0.23	1.270	25.8340	0.4707	0.01	G
4	C <sub>HT</sub> '		Test 1 Minus Test 2						6,881.89				25.9555	0.4735		Valid
5	C <sub>T</sub> + C <sub>HT</sub>	GST-GND	T	H+L		G	10.00	✓	14,662.50	0.20	0.25	1.270	55.2556	1.0980	0.02	G
6	C <sub>T</sub>	GSTg-RB	T	H+L		G	10.00	✓	7,780.60	0.21	0.27	1.270	29.3085	0.6220	0.01	G
7	C <sub>HT</sub> (UST)	UST-R	T	H+L		G	10.00	✓	6,888.97	0.18	0.23	1.270	25.7908	0.4733	0.01	G
8	C <sub>HT</sub> '		Test 5 Minus Test 6						6,881.91				25.9471	0.4761		Valid
9	C <sub>H</sub> '		C <sub>H</sub> Minus HL Bushings						2,940.72				18.0780	0.5270		
10	C <sub>T</sub> '		C <sub>T</sub> Minus T Bushings						7,117.13				23.5150	0.4789		
Oil Test 1	Overall Oil Test	UST-R	T	H+L		G						0.300				
Oil Test 2	LTC Chamber Oil Test	UST-R	T	H+L		G						0.300				

0.191  
0.241  
0.149  
1  
0.166  
0.174



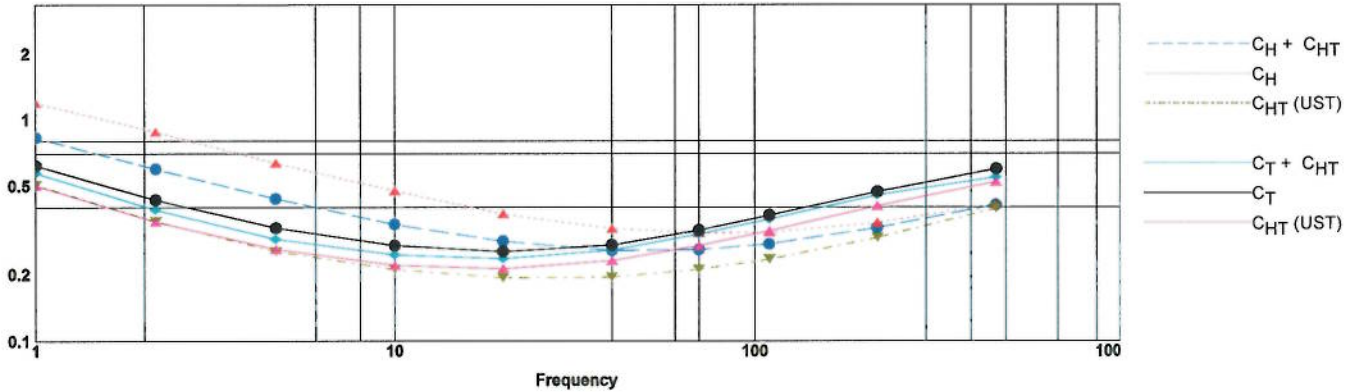


# INSULATION TESTS AUTO TRANSFORMERS WITH TERTIARY



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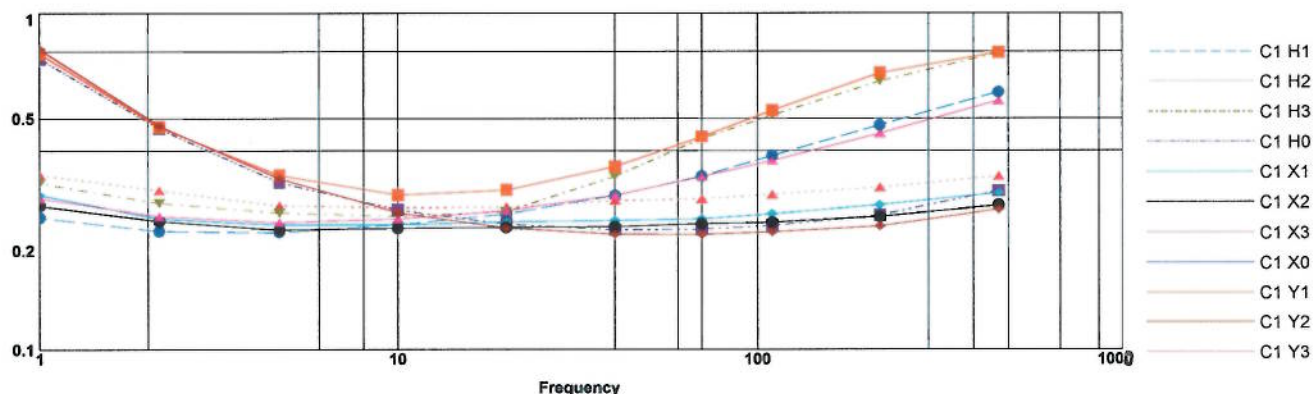
FREQUENCY SWEEP GRAPH



Transformer - Bushing C1 Tests

Test No.	Bushing Nameplate					Test Mode	TEST kV	DFR	Capacitance C (pF)	POWER FACTOR %			DIRECT		%VDF	IR
	Dsg.	SERIAL #	CAT. #	PF	Cap. (pF)					Measured	@ 20°C	Corr Factor	mA	Watts		
HI kV	16	H1	11F0269-03 AEP	0.32	533.0	UST-R	10.00	✓	522.27	0.25	0.41	1.646	1.966	0.0486	0.01	G
	17	H2	11F0269-04 AEP	0.30	530.0	UST-R	10.00	✓	527.97	0.28	0.47	1.646	1.989	0.0566	0.01	G
	18	H3	11F0269-08 AEP	0.32	533.0	UST-R	10.00	✓	531.41	0.28	0.46	1.646	1.999	0.0553	0.02	G
	19	H0	1000031151	0.24	335.0	UST-B	10.00	✓	332.39	0.24	0.39	1.646	1.253	0.0295	0.02	G
LOW kV	20	X1	11F0256-55AEP	0.27	514.0	UST-R	10.00	✓	512.80	0.25	0.41	1.646	1.930	0.0485	0.02	G
	21	X2	11F0256-47AEP	0.27	517.0	UST-B	10.00	✓	515.21	0.24	0.40	1.646	1.939	0.0468	0.01	G
	22	X3	11F0256-50AEP	0.31	512.0	UST-R	10.00	✓	510.54	0.25	0.41	1.646	1.924	0.0478	0.01	G
	23	X0				UST-R	10.00	✗				1.646				
T kV	24	Y1	1000031147	0.23	335.0	UST-B	10.00	✓	332.13	0.24	0.39	1.646	1.252	0.0295	0.02	G
	25	Y2	1000031149	0.23	335.0	UST-B	10.00	✓	331.34	0.23	0.38	1.646	1.245	0.0289	0.02	G
	26	Y3				UST-R	10.00	✗				1.646				
	27	Y0				UST-R	10.00	✗				1.646				
28						UST-R		✗				1.646				

FREQUENCY SWEEP GRAPH









# TRANSFORMER POLARIZATION INDEX (PI) TEST



DATE 10/22/2017 PAGE 1  
AMBIENT TEMP. 32 °C JOB # 928832  
SUBSTATION LLANO SÁNCHEZ HUMIDITY 65 % ASSET ID T-3  
POSITION LLANO SÁNCHEZ II - PATIO 230KV TEST STATUS \_\_\_\_\_  
EQUIPMENT LOCATION BARRA D

## NAMEPLATE DATA

MFR ILJIN CLASS OA/FA/FA PHASES 3  
SER NO 11TI009001 COOLANT OIL REASON Routine  
YEAR 2011 TANK TYPE OPEN-CONSER WEIGHT 93700 kg  
WINDING MATERIAL Cu  
OIL VOLUME 31,000 l  
OIL TEMP 45 °C  
IMPEDANCE 9.14 %  
WEATHER Sunny  
BIL 750

Diagram # 7 (ANSI)

	VOLTAGE (kV)		MVA	RATED I	# TAPS	NOMINAL	CHANGER	TAP SETTING
	L-L	L-G						
PRIMARY:	230	133	100	251.02	5	3	DETC	
SECOND:	115	66	100	502.04	1			
TERTIARY:	34.5		60	1,004.09	1			

COMMENTS:

TEST VOLTAGE: HIGH TO LOW+GND 10 KVDC LOW TO HIGH+GND 10 KVDC HIGH+LOW TO GND 10 KVDC  
CORE/COIL TEMPERATURE 45 °C Enter TCF Manually: ☐ TEMP. CORR. FACTOR TO 20°C, TCF 3.15 LIQUID 5.600  
Use Instrument PI / DAR Value: ☐

MINUTES	TRANSFORMER					
	HX VS Y		HX VS T		Y VS T	
	READING (megohms)	CORR. VALUE (megohms)	READING (megohms)	CORR. VALUE (megohms)	READING (megohms)	CORR. VALUE (megohms)
0.25	13,850.00	77,560.00	8,510.00	47,656.00	9,170.00	51,352.00
0.50	28,200.00	157,920.0	14,070.00	78,792.00	21,000.00	117,600.0
0.75	37,900.00	212,240.0	15,240.00	85,343.99	27,500.00	154,000.0
1.00	47,500.00	266,000.0	17,050.00	95,480.00	34,100.00	190,960.0
2.00	64,900.00	363,440.0	17,900.00	100,240.0	44,600.00	249,760.0
3.00	73,800.00	413,280.0	19,120.00	107,072.0	47,000.00	263,200.0
4.00	79,500.00	445,200.0	17,920.00	100,352.0	51,000.00	285,600.0
5.00	83,700.00	468,720.0	19,420.00	108,752.0	52,400.00	293,440.0
6.00	88,800.00	497,280.0	19,710.00	110,376.0	53,800.00	301,280.0
7.00	92,200.00	516,320.0	18,840.00	105,504.0	54,500.00	305,200.0
8.00	95,200.00	533,120.0	19,990.00	111,944.0	51,100.00	286,160.0
9.00	98,400.00	551,040.0	19,950.00	111,720.0	53,400.00	299,040.0
10.00	101,100.0	566,160.0	20,400.00	114,240.0	55,900.00	313,040.0
P. I.	2.13		1.20		1.64	
D. A. R.	1.68		1.21		1.62	

TEST EQUIPMENT USED: MIT1025

TESTED BY: JOSUE MARTINEZ



# TRANSFORMER POLARIZATION INDEX (PI) TEST

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INSULATION CONDITION	POLARIZATION INDEX (PI)
DANGEROUS	< 1.0
POOR	1.0 to 1.1
QUESTIONABLE	1.1 to 1.25
FAIR	1.25 TO 2.0
GOOD	> 2.0

## NOTES:

PI ranges from IEEE C57.152-2013

Polarization Index should not be used to assess insulation in new power transformers (IEEE C57.152-2013)

The polarization index for insulation liquid is always close to 1. Therefore, the polarization index for transformers with low conductivity liquids (e.g. new mineral oil) may be low in spite of good insulation condition. (IEEE C57.152-2013)

INSULATION CONDITION	DAR 60/30 SEC
QUESTIONABLE	1.0 - 1.25
GOOD	1.4 to 1.6
EXCELLENT	> 1.6

## NOTES:

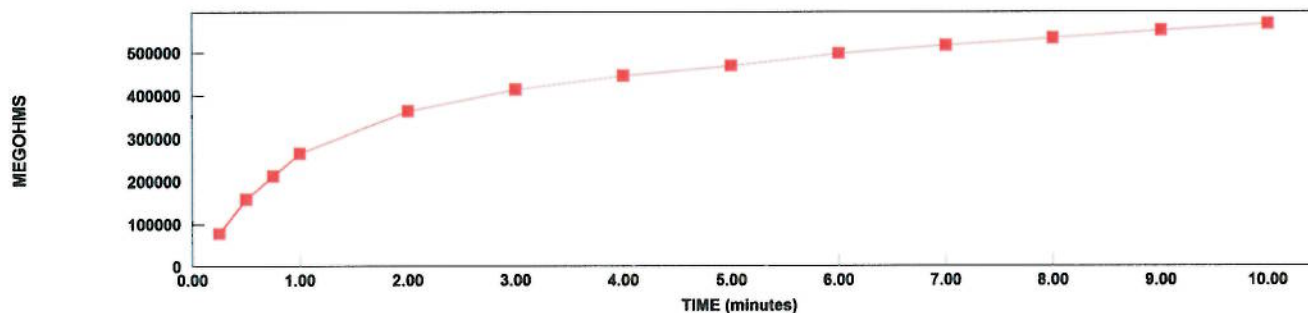
DAR ranges from A Stith In Time (Megger, 2006)

These values must be considered tentative and relative - subject to experience, over time

DATE 10/22/2017 TEMPERATURE 32 °C HUMIDITY 65 % EQPT. LOCATION BARRA D  
SUBSTATION LLANO SÁNCHEZ POSITION LLANO SÁNCHEZ II - PATIO 230KV

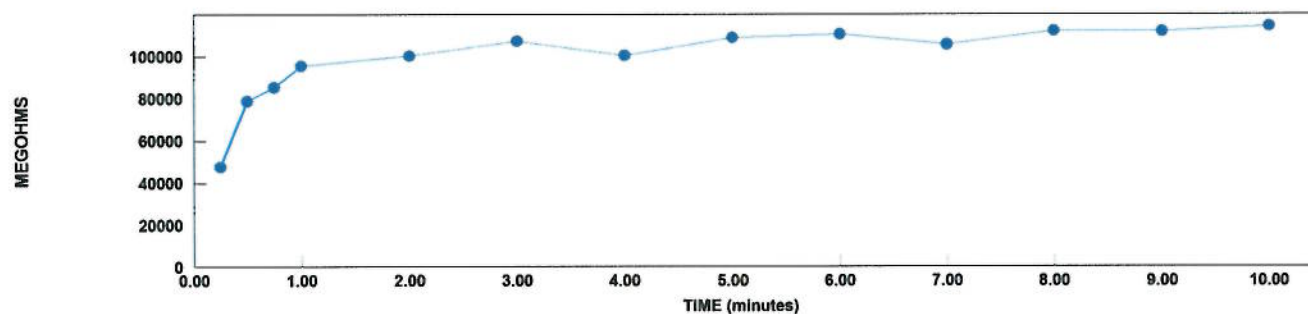
## POLARIZATION CURVE

HX VS Y : Red Square



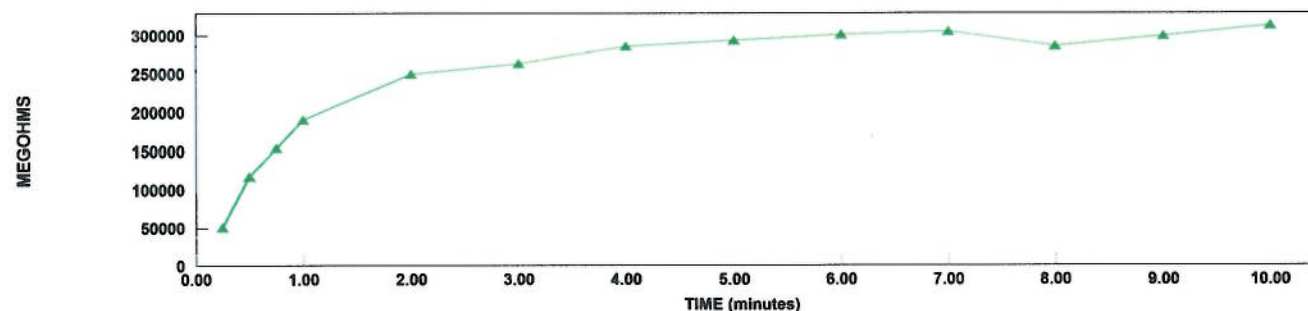
## POLARIZATION CURVE

HX VS T : Blue Circle



## POLARIZATION CURVE

Y VS T : Green Triangle





# TRANSFORMER POLARIZATION INDEX (PI) TEST



PAGE 3

COMMENTS:

No podemos evaluar esta prueba ya que se hizo a otro voltaje 10 kV. Los Indices de Polarización unos aumentan y otros disminuyen, esto ha ocurrido desde p  
anteriores. Darle seguimiento en la siguiente prueba que se realice con 5 kV.

DEFICIENCIES:





# TRANSFORMER WINDING RESISTANCE TEST



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AMBIENT TEMP. 34 °C JOB # 928832

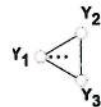
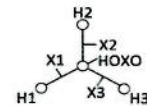
SUBSTATION LLANO SÁNCHEZ HUMIDITY 51 % ASSET ID T-3

POSITION LLANO SÁNCHEZ II - PATIO 230KV TEST STATUS

EQUIPMENT LOCATION BARRA D

MFR ILJIN WEIGHT 93700 kg  
SER NO 11TI009001 WEATHER Sunny  
YEAR 2011 BIL 750 kV  
TYPE OPEN-CONSER IMPEDANCE 9.14 %  
CLASS OA/FA/FA REASON Routine  
PHASES 3 Max Wdg Diff (%): 5

OIL VOLUME 31000 l  
OIL TEMP 45 °C  
WINDING TEMP 47 °C  
CORRECT TO ☒ 75 °C  
COOLANT OIL



TRANSFORMER DEMAGNETIZED

Diagram # 7 (ANSI)

	VOLTAGE (kV)		MVA	RATED I	RECOMMENDED TEST I	# TAPS	NOMINAL	CHANGER	TAP SETTING	WINDING MATERIAL
	L-L	L-G								
PRIMARY:	230	132.791	100	251.02	10.0A	5	3	DETC		Cu
SECOND:	115	66.395	100	502.04	10.0A	1				Cu
TERTIARY:	34.5		60	1,004.09	10.0A	1				Cu

## HIGH VOLTAGE WINDING RESISTANCE

Show Graph ☐

Units: Ω

#	TAP	Current (amp)	Nameplate Voltage	Corrected Resistance to 75°C			Reading Stability %	Winding Difference %	
				H <sub>1</sub> - H <sub>0</sub>	H <sub>2</sub> - H <sub>0</sub>	H <sub>3</sub> - H <sub>0</sub>			
1	1		241,500						
2	2		235,750						
3	Nominal		230,000						
4	4	9.5489	224,250	0.761	0.761	0.760	99.9950	0.165	0.692/0.692/0.691
5	5		218,500						

## LOW VOLTAGE WINDING RESISTANCE

Show Graph ☐

Units: Ω

#	TAP	Current (amp)	Nameplate Voltage	Corrected Resistance to 75°C			Reading Stability %	Winding Difference %	
				X <sub>1</sub> - X <sub>0</sub>	X <sub>2</sub> - X <sub>0</sub>	X <sub>3</sub> - X <sub>0</sub>			
6	Nominal	10.0057	115,000	0.389	0.385	0.386	99.9879	1.167	0.354/0.350/0.351

## TERTIARY WINDING RESISTANCE

Show Graph ☐

Units: Ω

#	TAP	Current (amp)	Nameplate Voltage	Corrected Resistance to 75°C			Reading Stability %	Winding Difference %	
				Y <sub>1</sub> - Y <sub>2</sub>	Y <sub>2</sub> - Y <sub>3</sub>	Y <sub>3</sub> - Y <sub>1</sub>			
7	Nominal	10.0235	34,500	0.574			99.9809		0.522

COMMENTS: Todos los valores son buenos y parecidos a los del 2016. Además cumplen con la norma IEEE.

DEFICIENCIAS:

Form Number and Date: 56353, REVISED 11/23/2016

Serial Number: 3831\_0116

Firmware Information: 310

Calibration Date: 1/22/2016





# THREE PHASE TTR TEST WITH TAP CHANGER



DATE 10/22/2017 PAGE 1

AMBIENT TEMP. 35 °C JOB # 928832

SUBSTATION LLANO SÁNCHEZ HUMIDITY 52 % ASSET ID T-3

POSITION LLANO SÁNCHEZ II - PATIO 230KV TEST STATUS Pass

EQUIPMENT LOCATION BARRA D

**NAMEPLATE DATA** HAS TERTIARY ☒ ALLOWED ERROR 0.5

MFR ILJIN CLASS OA/FA/FA PHASES 3

SER NO 11T1009001 COOLANT OIL REASON Routine

YEAR 2011 TANK TYPE OPEN-CONSER WEIGHT 93700 kg

WINDING MATERIAL Cu

OIL VOLUME 31,000 l

OIL TEMP 45 °C

IMPEDANCE 9.14 kV

WEATHER Sunny

BIL 750 %

Diagram # 7 (ANSI)

Detect Transformer Type

	VOLTAGE (kV)		MVA	RATED I	# TAPS	NOMINAL	CHANGER	TAP SETTING
	L-L	L-G						
PRIMARY:	230	133	100	251.02	5	3	DETC	
SECOND:	115	66	100	502.04	1			
TERTIARY:	35		60	989.74	1			

COMMENTS:

## HIGH SIDE TAPS TO LOW SIDE NOMINAL TURNS RATIO TESTS

#	TAP H/L	Voltage H/L		Test V	TTR	H <sub>1</sub> - H <sub>0</sub> / X <sub>1</sub> - X <sub>0</sub>				H <sub>2</sub> - H <sub>0</sub> / X <sub>2</sub> - X <sub>0</sub>				H <sub>3</sub> - H <sub>0</sub> / X <sub>3</sub> - X <sub>0</sub>			
						Actual TTR	% Error	I exc mA	Phase (Deg)	Actual TTR	% Error	I exc mA	Phase (Deg)	Actual TTR	% Error	I exc mA	Phase (Deg)
1		241,500	115,000		2.100												
2		235,750	115,000		2.050												
3		230,000	115,000		2.000												
4		224,250	115,000	80	1.950	1.951	0.03	0.8	-0.11°	1.949	-0.03	0.5	-0.11°	1.950	0.02	0.8	-0.11°
5		218,500	115,000		1.900												

## HIGH SIDE NOMINAL TO LOW SIDE TAPS TURNS RATIO TESTS

#	TAP H/L	Voltage H/L		Test V	TTR	H <sub>1</sub> - H <sub>0</sub> / X <sub>1</sub> - X <sub>0</sub>				H <sub>2</sub> - H <sub>0</sub> / X <sub>2</sub> - X <sub>0</sub>				H <sub>3</sub> - H <sub>0</sub> / X <sub>3</sub> - X <sub>0</sub>			
						Actual TTR	% Error	I exc mA	Phase (Deg)	Actual TTR	% Error	I exc mA	Phase (Deg)	Actual TTR	% Error	I exc mA	Phase (Deg)
1		230,000	115,000		2.000												

COMMENTS: Prueba buena, los valores obtenidos están dentro de lo permitido por la Norma IEEE.

DEFICIENCIAS:

# Prueba de Alarmas y Disparos

Número de prueba	LLST3-8-17	Clima	Soleado
Fecha	22-oct-17	Temp. Ambiente	36°C
Subestación	Llano Sanchez	Humedad Relativa	52%
Equipo	T3		
Realizada por	Josué Martínez		

VALORES DE AJUSTE ENCONTRADOS PARA LAS ALARMAS Y DISPAROS (°C)						
Termómetro	Etapas 1	Etapas 2	Bomba	Alarma	Disparo	Observaciones
Aceite				95	105	
Bobina de Alta	75	85		95	105	
Bobina de Media	75	85		95	105	
Bobina de Baja						

VALORES DE PRUEBA PARA LAS ALARMAS Y DISPAROS (°C)						
Termómetro	Etapas 1	Etapas 2	Bomba	Alarma	Disparo	Observaciones
Aceite				95	105	sale en gabinete del Tx y CC
Bobina de Alta	76	86		95	105	sale en gabinete del Tx y CC
Bobina de Media	76	86		95	110	sale en gabinete del Tx y CC
Bobina de Baja						

Protección	Alarma	Disparo	Observaciones
Sobrepresión repentina en el transformador	<input type="checkbox"/>	<input checked="" type="checkbox"/>	sale en gabinete del Tx y CC
Buchholz del transformador	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	sale en gabinete del Tx y CC
Bajo nivel de aceite	<input checked="" type="checkbox"/>	<input type="checkbox"/>	sale en gabinete del Tx y CC
Alto nivel de aceite	<input type="checkbox"/>	<input type="checkbox"/>	
Bajo nivel de aceite en el Tap Changer	<input type="checkbox"/>	<input type="checkbox"/>	
Valvula de seguridad de presión	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	sale en gabinete del Tx y CC
Falta AC	<input checked="" type="checkbox"/>	<input type="checkbox"/>	sale en gabinete del Tx y CC
Falta DC	<input type="checkbox"/>	<input type="checkbox"/>	
Bulbo y foso de sonda	Se revisaron y tenían aceite.		

Protecciones del Tap Changer	Fase A		Fase B		Fase C	
	Alarma	Disparo	Alarma	Disparo	Alarma	Disparo
Sobrepresión repentina del Tap Changer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Flujo inverso del Tap Changer (Buchholz)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Resultado de la Prueba

☒ Prueba buena

☐ Prueba regular

☐ Prueba deficiente

## Observaciones

las alarmas salen principal y respaldo.