safety factor 3.5

2.4.2.34 The connecting cables between equipment them selves shall be supplied by manufacturer complete with equipment.

2.4.2.35 Number of circuit breakers to be purchased 3sets

Chapter 5

Technical specification for 66kV Shunt Reactors

2.5.1.0	General operating condition	
2.5.1.1	Altitude (above sea level)	1000m
2.5.1.2	Maximum wind speed (average in 10minutes)	35m/sec.
2.5.1.3	Maximum relative humidity	90%
2.5.1.4	Maximum ambient temperature (ultimate value)	+40℃
2.5.1.5	Minimum ambient temperature (ultimate value)	-30℃
2.5.1.6	Maximum temperature difference in a day	25℃
2.5.1.7	Sunlit intensity (wind speed)	0.1w/cm²(0.5m/sec)
2.5.1.8	Thickness of ice coating	10mm
2.5.1.9	Seismic accerlation acting simultaneously by	
	horizontal component	0.3g
	vertical component	0.15g
	and the effect of lead line to the equipment shall be alsoconsidered.	
2.5.2.0	Technical Specification	
2.5.2.1	Type: outdoor single phase,dry type with no core	
2.5.2.2	Rated voltage	$66/\sqrt{3}$ kV
2.5.2.3	Continuous maximum operating voltage(Vm)	$72.5/\sqrt{3}$ KV
2.5.2.4	Rating(single phase)	20MVAR
2.5.2.5	Rated reactance	72.6ohms
2.5.2.6	Rated frequency	50HZ
2.5.2.7	Insulation level	
	BIL(KV.peak value)	325
	chopped wave(KV.peak value)	360

power frequency(KV,rms) 140

2.5.2.8 Losses

The losses shall be below 0.4% of rated capacity under rated current and frequency. $\frac{0.4}{100} \times 20000 = 80$ KW

2.5.2.9 Temperature rise

Under maximum operating voltage and rated frequency.

The average temperature rise shall be below 70℃, the temperature at the hottest spot shall be below 130℃.

2.5.2.10 Permissible tolerance for reactance under rated frequency, the permissible tolerance of resistance shall be within ±5%, and the deviation of reactance between three phases from the average reactance of three phases shall be below ±5%. below ±3%

2.5.2.11 Noise level ≤40dB

(measured at 2 m from the edge of equipment)

2.5.2.12 Vibration amplitude ≤200μm

2.5.2.13 Creepage distance of insulators ≥2175mm

2.5.2.14 Shunt reactors shall be operating outdoor in long period, with salineness 0.25mg/cm²

2.5.2.15 The three phases of reactors are in star connection and in triangular plane layout, and the angles included between the terminals of incoming and out going lines are 180℃

2.5.2.16 Application standards IEC289

2.5.2.17 Number of reactors to be purchased. 3 phases

Chanter 6
Technical specification for 220KV GIS

2.6.1.0 General operating condition

The same as clause 2.2.1.0,chapter 2.

2.6.2.0 Technical Specification

2.6.2.1 Type :All enclosed ,SF_6 insulated,indoor,combined switchgears

2.6.2.2 Connection:transformer—transmission line group in unit connec-

APPENDIX "C"

A COPY OF

TRENCH'S REPORT

TEST REPORT

ABB TRANSFORMATORI SPA

P.O. NO.: 8/51126

DRY TYPE AIR CORE SHUNT REACTOR

524.86 A / 72.6 Ω / 231.1 mH / 20000 kVA

SYSTEM: 66 kV / 50 Hz

T.L. REFERENCE NO.: Q94-88980/42602

TRENCH

SO42602
Comparison of measurements at Trench and at PowerTech

Unit 42602-1 was tested before shipment from the factory at Trench Limited in Toronto during August 2000. The unit was subjected to a full range of tests in the Trench test laboratory as per standards including DC resistance, inductance, losses, impulse and temperature rise. There was an accident during coil transport en route to Vancouver. Therefore the unit was retested at the PowerTech test facility located just outside Vancouver. Table 1 below compares the two sets of loss measurements:

date	Aug-2000	Nov-2000		absolute
Location	Trench	PowerTech	% change	difference
I rated	524.86	524.86		
f (Hz)	50	50		
corrected to	75 C	75 C		
R dc	0.215008	0.21666	0.77%	0.001652
DC losses	59,230.0	59,690	0.78%	460
AC losses	14,698.5	17,210	**17.09%**	**2511.5**
total losses	73,928.5	76,900	**4.02%**	**2971.5**
L (mH)	229.7915	229.17	-0.27%	-0.62
Q factor	269	258	-4.1%	-11

Revised values from PowerTech (Nov 2000)

Table 1

It can be seen that the inductance has decreased slightly and the DC resistance and loss have increased slightly. However, the AC losses have increased more noticeably, 17.09% higher than measured at the Trench laboratory. This has resulted in 2.97 kW increase in total losses.

	Trench	PowerTech	% change	absolute difference
Average T rise	30.4	36.5	20%	6.1

Hot Spot T rise

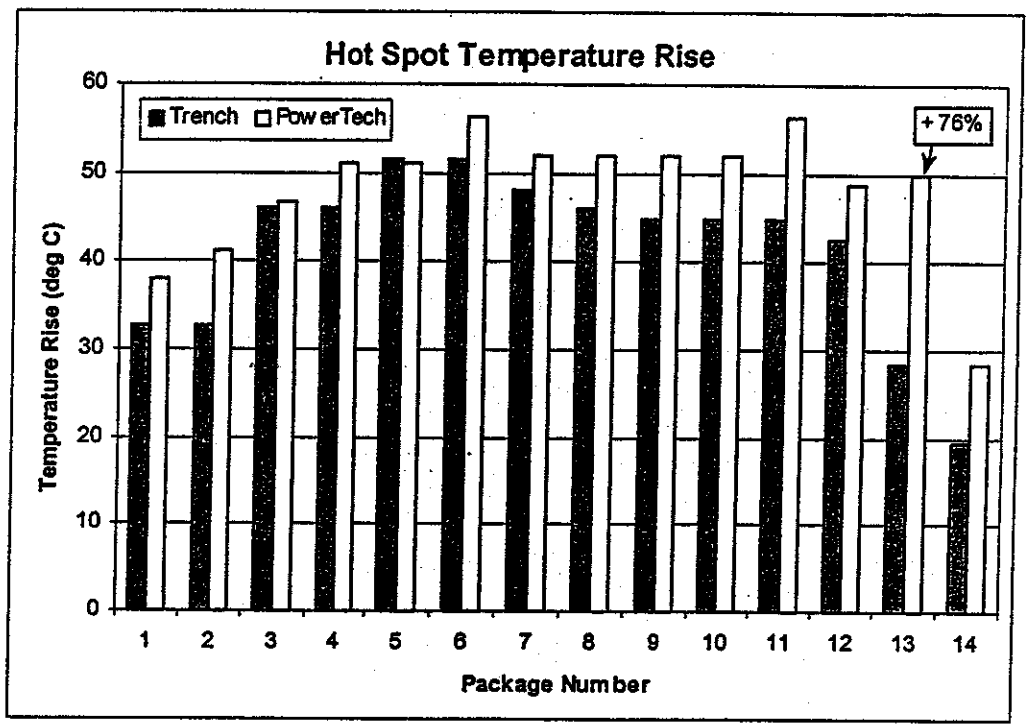
Package #	Trench	PowerTech	% change	absolute difference
1	32.7	38.0	16%	5.3
2	32.7	41.3	26%	8.5
3	45.9	46.7	2%	0.7
4	45.9	51.0	11%	5.0
5	51.5	51.0	-1%	-0.5
6	51.5	56.4	10%	4.9
7	48.2	52.1	8%	3.9
8	45.9	52.1	13%	6.1
9	44.8	52.1	16%	7.2
10	44.8	52.1	16%	7.2
11	44.8	56.4	26%	11.5
12	42.6	48.8	14%	6.2
13	28.3	49.9	76%	21.6
14	19.5	28.3	45%	8.8

Table 2

TRENCH

During a full temperature rise test, both the coil average temperature rise and package hot spot temperature rise were measured as summarised in table 2 above.

It can be seen that there is a significant increase in average winding temperature rise: 20%. It can also be observed that there is a general increase in package hot spot temperature rise; package 13 has the greatest change specifically 22°C or 76% hotter than that measured during Trench's ex-factory tests. The general increase in package hot spot temperature rise is particularly evident when the data is plotted (graph 1).



Graph 1

It is apparent that a significant increase in the temperature profile and total losses has occurred since the unit was originally tested in the factory. This is very significant and indicative of a problem. Such an increase in package losses plus the higher measured temperatures in the packages is indicative of damage to the conductor / insulation system. The net result of such damage is very high internal local heating, which is not directly measurable. Such localised heating will result in insulation degradation leading to further deterioration of the insulation system and more extensive damage. This situation will result in a shortened product life. The problem will grow until the conductor melts and there is a flashover of the reactor. An impact load as experienced by this unit during the accident may have mechanically overstressed the conductor / insulation system in the winding groups, which would in turn be responsible for the increased losses and temperature rise as measured at PowerTech. In conclusion, the reactor is internally damaged beyond repair and should be scrapped.

TRENCH

Signed by:

Richard F. Dudley, P.Eng., Chief Engineer

Michael Sharp, P.Eng., Engineering Manager

Tom Lau, P.Eng., Manager Research & Development

James Twiss, Test Lab Manager

Date: December 5, 2000

Item 4

TRENCH LABORATORY

TEMPERATURE RISE TEST

HEAT RUN # 2000

LAB REPORT REFERENCE # 00-40

SHOP ORDER# 42602 (ORIGINAL S.O 40173-4)

DATE Aug 31- 2000

COIL DATA

I-CONT 524.86 AMPS

INDUCTANCE 231.1 mH

SYSTEM VOLTAGE 66 KV

Items 2 & 3.

Test Laboratory Results

TRENCH

Tested By : Peter Gordon

Date : 30/08/00

Serial Number : 42602-1

Rated Current : 524.86 Amps
Rated Frequency : 50 Hz

Ambient Temperature: 29.0 °C

D.C. Resistance at ambient: 0.182040 Ω

RATED FREQUENCY RESULTS CALCULATED TO 75 °C

D.C. Resistance	0.215008	Ω
D.C. Losses	59230.0	Watts
Stray Losses	14698.5	Watts
Total Losses	73928.5	Watts
Inductance	229.7915	mH
Q Factor	269.0	

DIELECTRIC TESTS

Test between turns across coil: 180 kV (peak) for 1 minute

Impulse test across coil: 325 kV

FUNDAMENTAL & HARMONIC RESULTS CALCULATED TO 75 °C

Frequency (Hz)	Current (Amps)	Inductance (mH)	Reactance (Ω)	Q-Factor	Losses (Watts)
50.0	524.86	229.7915	72.1858	269.0	73928.5

Reviewed By : TRENCH ELECTRIC TEST LAB SUPERVISOR

Date : 30/08/00

****
* TRENCH ELECTRIC LABORATORY *
* TEMPERATURE RISE RESULTS *
* P3R1 *
****

TESTED BY : _____ DATE : 31 AUG 2000

SERIAL NUMBER : 42602 - 1

RATED CURRENT 524.9 AMPS
TEST CURRENT 500.0 AMPS

PART A : COLD TEST RESULTS

COLD D.C. RESISTANCE 0.18204000 OHMS
COLD AMBIENT 29.0 DEG. C

PART B : D.C. SHUTDOWN

TIME(MIN)	D.C. RESISTANCE (OHMS)
1.50	0.21030000
2.00	0.21010000
2.50	0.21000000
3.00	0.20990000
3.50	0.20970000
4.00	0.20960000
4.50	0.20940000
5.00	0.20930000
5.50	0.20920000
6.00	0.20900000
6.50	0.20890000
7.00	0.20880000
7.50	0.20860000
8.00	0.20850000

HOT AMBIENT 41.3 DEG. C

PART C : CALCULATED RESULTS

HOT D.C. RESISTANCE 0.21070933 OHMS

AVERAGE TEMPERATURE RISE AT RATED CURRENT IS
30.5 DEG. C ABOVE HOT AMBIENT

CORRECTION FACTOR TO 40.0 DEG. C RATED AMBIENT IS 0.995006

AVERAGE TEMPERATURE RISE AT RATED CURRENT IS
30.3 DEG. C ABOVE RATED AMBIENT

ACCEPTED BY : _____ DATE : 31 AUG 2000