(DRAFT)

Burden Calculations of 33kV CT in a 33/11kV Sub Station.

Transformer rating : 10 MVA

(Refer Guideline and Note on Page no. 03 and 04)

a). Distance between CT and Relay= 40 meters
b). Conductor used = 2.5 mm^2 copper
c). Connection scheme= 4-wire
d). Relay Burden= 20 m Ω or 0.020 Ω (at 5A input)
e). CT secondary resistance, R=0.2 Ω for 100 turns
R for full terminal i.e. 240 turns = 0.002x240 = 0.48 Ω R
for half terminal i.e. 120 turns = 0.02x120 = 0.24 Ω

Calculation:

Step1 for resistance of conductor:

Given, L= 40 m, A= 2.5 mm^2 or $2.5x10^{-6}$ m^2**,**
Also we know ρ= 0.0216 μΩm
Putting these values in

$$R = \frac{\rho L}{A}$$

We get, R = $\frac{(0.0216x10^{-6}\ \Omega\ m)x(40\ m)\ x1.2}{2.5x10^{-6}\ m^2}$ = 0.415 Ω

Step2 for total burden of CT at 240 turns:

= Resistance of Conductor+ Resistance of Relay+ Resistance of CT secondary
= 0.415+0.020+0.48 Ω
= 0.915 Ω

Total burden in terms of VA at input of 5A
$=I^2xR=(5)^2x0.915$= 22.875 VA (**say 30 VA**)

for total burden of CT at 120 turns:

(i.e. CT connected to 200/5, one 10 MVA Power transformers connected to one CT)
= Resistance of Conductor+ Resistance of Relay+ Resistance of CT secondary
= 0.415+0.020+0.24 Ω
= 0.675

Total burden in terms of VA at input of 5A
$=I^2xR=(5)^2x0..675$= 16.875 VA (**say 20 VA**)

S#	**Burden Calculation for CT (in VA)**					
a) CT connected at 240 turns:						
	MF M	Ampere Meter	Volt Meter	Energy Meter	CT Circuit	Total
	7	0.5	0.5	1	22.875	≈ 30 VA
b) CT connected at 120 turns:						
	7	0.5	0.5	0.1	16.875	≈ 25 VA

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33kV CT Knee point voltage calculation in a 33/11kV Sub Station.

Transformer rating:10 MVA

(Refer Note on Page no. 04)

CT Knee Point Voltage can be calculated using the formula;

V_{kp} = K x I_f/CTR x (CT burden)

Where,
K = Constant, conventionally taken as 2.0
V_{kp} = The minimum Knee Point Voltage
I_f = Maximum Fault Current at the location, in Amperes
CTR = CT Ratio
CT burden= RCT + RL + RR
RCT = CT Secondary Winding Resistance, in Ohms
RL = 2-way Lead Resistance, in Ohms
RR = Relay Burden, in Ohms

Case: (400)/5 A (3 turns in PC)
RCT= 0.5 Ω
RL= (2x100x0.00863)=1.726 Ω
RR= 0.02 Ω
CT burden= 0.5 + 1.726 + 0.02 =2.246 (2.25 Ω)

Fault level = 10000 kVA/8.35%
I_f ≥ 119760 kVA/√3x 33kV = 2097 A (2100 A say)

For CTR 200/5 A

V_{kp} = 2 x(5/200) x 2100 X 2.25 = 236.35 V
Hence 250 V is acceptable.

For CTR 400/5 A
V_{kp} = 2 x(5/400) x 2100 X 2.25 = 118.125 V

S#	CTR	V_{kp}
1	200/5 A	236.35 V
2	400/5 A	118.125 V

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Guideline for calculating CT and PT Burden

CALCULATION OF CT BURDEN

The actual burden on CTs is arrived by the resistance of the pilot conductors, the protection relays and internal coil resistance.

A). **Resistance of Conductor:**

The resistance of a conductor (with constant cross-sectional area) can be calculated as:

$$R = \frac{\rho L}{A}$$

Where, ρ=resistivity of conductor material(given typically at +20°c)in μΩm
L=length of conductor (in m)
A= cross-sectional area (in mm^2)

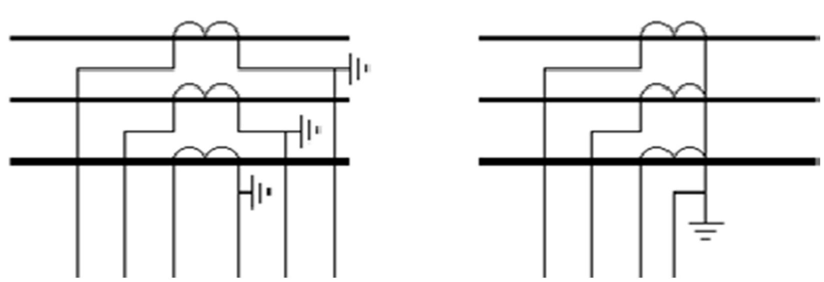
Then "R" will be obtained in ohms

Usually conductor used in pilot wire is copper.
For copper (Cu)
Resistivity ρ (at 20°c)=0.0178 μΩm
Resistivity ρ (at 75°c)=0.0216 μΩm
Temperature co-efficient (α)of copper=0.0039

As R is proportional to temperature, so the resistance should be calculated at the worst case temperature. Normally 75°c is used for calculations.

After calculating R for copper pilot wire at 75°c, we get resistance per meter of copper conductor cable as:

2.5 mm^2	**conductor**	=	0.00863 Ω/m
4.0 mm^2	**conductor**	=	0.00541 Ω/m
6.0 mm^2	**conductor**	=	0.00360 Ω/m



6-wire   4-wire (mostly adopted in JKPDD)

For 6-wire connection, the total length of wire naturally will be two times the distance between CT and the relay. However in many cases a common return conductor is used. Then instead of multiplying the distance by 2, a factor of 1.2 is typically used .This rule only applied to the 3-ø connection. The factor 1.2 allows for a situation where up to 20% of the electrical conductor length including terminal resistance, uses 6-wire connection and at least 80% 4-wire connection.

B). **BURDEN OF RELAY**

The burden of the relay i.e. the relay input impedance must be checked with the relay manufacturer user manual /Technical data.

If given in (VA), has to be converted in resistance ($VA=I^2R$)
Where I=Rated secondary current (1 or 5 A)
OR
Mostly CT Burden is given in VA, so all burdens calculated should be calculated as per
$P=I^2R$, I=Rated secondary current (1 or 5 A)

C). I**NTERNAL BURDEN OF CT WINDING:**

Internal secondary coil resistance of the CT is so small that it can generally be neglected.

Note:

1. *This Guideline has been uploaded on the website for the purpose of comments only, pending approval by Technical Committee of the Distribution Corporation.*
2. *The information is for the purpose of guidelines only. Since errors and omissions cannot be ruled out, the practicing Engineers are requested to refer to the original standards and decide Burden/Knee point on case to case basis.*