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I. Resistive Reach Setting Guidelines

Reference PCC: 100th PCC Meeting

RESISTIVE REACH SETTING GUIDELINES

A. Proposed setting for Phase-earth fault:

a. Calculation of minimum load impedance shall be as per Ramkrishna Committee Recommendation:
   - Maximum load current (Imax) may be considered as 1.5 times the thermal rating of the line or 1.5 times the associated bay equipment current rating (the minimum of the bay equipment individual rating) whichever is lower.
   - Minimum voltage (Vmin) to be considered as 0.85pu (85%).

b. Minimum setting for resistive reach shall be such that it must cover fault resistance, arc resistance and the tower footing resistance.

c. In general, maximum reach setting shall be 80% of the minimum load impedance.

d. Utility should try to set Resistive reach setting < 4.5 times the zone reactive reach setting, however if there is any limitation from relay manufacturer's side then recommendation of OEM may be followed for maximum resistive reach setting.

Resistive reach shall be the maximum of the value determined by the above rules.

B. Proposed setting for Phase-Phase fault:

a. Calculation of minimum load impedance as per the method mentioned above for phase-earth fault.

b. Minimum setting for resistive reach shall be such that it must cover fault resistance and arc resistance.

c. In general, the resistive reach of zone-3 is set less than 80% of minimum load impedance. For power swing consideration, a margin of DR is given. Therefore, it is essential that load should not encroach this DR. In view of this, R3ph–R4ph may be set 60% of minimum load impedance. R2ph and R1ph may be set 80% of R3ph-R4ph respectively.

d. Utility should try to set Resistive reach setting < 3 times the zone reactive reach setting, however if there is any limitation from relay manufacturer's side then recommendation of OEM may be followed for maximum resistive reach setting.

Resistive reach shall be the maximum of the value determined by the above rules.

C. For underground cable, as the fault mechanism and earthling resistance of sheath are different from tower footing resistance of overhead lines, the resistive reach setting of cable may be set as per OEM recommendation. However, effort shall be made to keep the setting within the above mentioned range as far as possible honoring OEM guidelines.

II. Idle (Anti-theft) Charging of Transmission line

Reference PCC: 67th & 107th PCC Meeting

1. ***Distance Protection Setting:*** Time delays for Zone 1, Zone 2 and Zone 3 should be made instantaneous.
2. ***Directional Earth Fault***: Pick Up Current should be set as 120 % of the line charging current of the idle charge length and should be under definite time with instantaneous trip. (Directional feature should be retained)
3. ***Over Voltage setting:***

3.1. For anti-theft charging of 765 & 400 kV lines at charging station end:

- Overvoltage pick up should be below the minimum over voltage setting of all lines from that charging substation.
- The settings shall be more than 105% and preferably just below (say 1 or 2 % below) the minimum over voltage setting of all lines from that substation.

3.2. Overvoltage settings for remote end (open end) substation for anti-theft charged lines:

- The utility may in its discretion keep overvoltage settings at remote end of line and a trip commend may be sent to charging station in order to avoid voltage stress on the equipment (LA, CVT etc.) during overvoltage condition. In such case, the settings shall be greater than the rated voltage of equipment e.g.: for 400 and 765 kV lines it should not be less than 110% and for 220 kV it should be at least 112%.
- In case high voltage is observed at remote end of the line, the affected utility may request respective SLDC or ERLDC to open the circuit for safety of the equipment.

3.3. For anti-theft charging of 220 kV lines, the similar guidelines as given above may be followed.

III. On over voltage setting on 220 kV Lines

PCC Reference: 103rd PCC Meeting

Philosophy for overvoltage protection settings for 220 kV level lines being followed by ER utilities are as follows:

- Powergrid, DVC, WBSETCL & OPTCL informed that overvoltage settings are not enabled at 220 kV level for their systems.
- BSPTCL informed that O/v settings have been enabled in some of the selected substations where overvoltage are being observed.
- CESC informed that the voltage at 220 kV level can be controlled through changing the ICT taps and opined that O/V settings is not required at 220 &132 kV level.

Based on the feedback of all utilities, PCC observed that

- ***In general overvoltage settings is not required at 220 kV level and the same may be enabled on case-to-case basis depending on the local voltage condition.***
- *Further, if the overvoltage setting is kept in service, the tripping of the relay shall be set more than the permissible voltage limit as prescribed in CEA Grid standard. Also, the settings need to be graded in terms of time/voltage for parallel lines connected to the same S/s.*

IV. Transformer backup overcurrent earthfault setting Guidelines

Reference PCC: 105th PCC Meeting

Protection Function	Feature	DVC	CESC	POERGRID	WB
HV/LV side OC stage 1	Directionality	No directional	No directional	Forward	Forward
	Setting are calculated based on fault level of Other side bus of ICT in same Substation	Yes	Yes	Yes	Yes
	Fault level of Remote end Substation also considered in the setting	No	No	No	No
	Coordinated with Remote end substations Line's zone-3 time	Yes	Yes	Yes	Yes
	Time	IEC normal inverse	IEC normal inverse	IEC normal inverse	IEC normal inverse
HV/LV side OC stage 2	Directionality	Not Used	Not Used	Non directional	Non directional
	Setting are calculated based on fault level of Other side bus of ICT in same Substation			No	No
	Fault level of Remote end Substation also considered in the setting			No	No
	Time			Definite	Definite

Based on the practices followed by different utilities in ER, the following guidelines were recommended:

Recommendation:

1. **HV/LV Directional over current low set (stage-1):** For upcoming projects and projects going for R &M may set it as follows:

   Direction- Forward (towards transformer)
   MTA/RCA- for cross polarization may be set as per OEM recommendation
   P.S.-- 130 to 150% of transformer rated current
   Characteristics- IEC normal inverse

TMS- Should be calculated considering LV/HV bus fault level and must be coordinated with remote substation zone-3 time.

TMS HV/LV

$$\frac{(Remote\ end\ Z3\ time + safety\ margin\ of\ 0.1\ to\ 0.2\ sec) * ((\frac{Fault\ current\ contribution\ for\ LV/HV\ bus\ fault}{Pick\ up\ cuurent})^{0.02} - 1)}{0.14}$$

For existing projects their existing philosophy may be followed by the utilities however following must be ensured:

1. Protection coordination with remote end lines zone-3 time
2. Coordination with LV and HV side must be ensured for non-directional OC setting

2. **HV/LV Directional over current high set (stage-2):** For upcoming projects and projects going for R &M may set it as follows:

Direction- Non-directional

MTA/RCA-NA

$$\text{P.S.--} = (110\ to\ 130) * \frac{MVA\ rating}{\%\ impedance * volatge * 1.732}$$

Characteristics- Definite time 50-100 ms

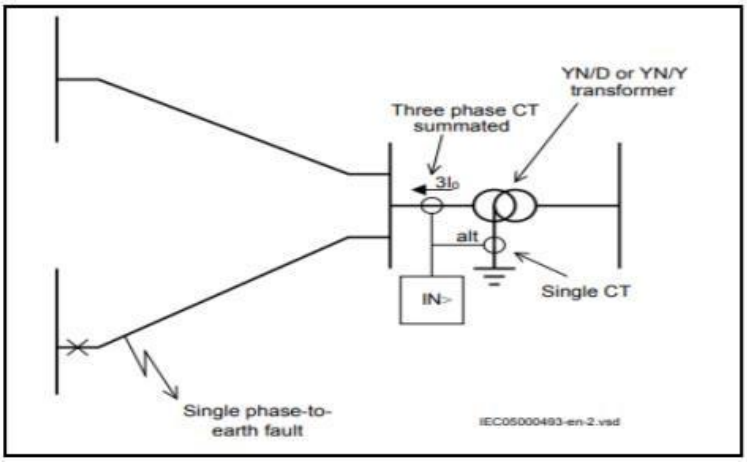
Choice of utilizing the same setting is left with the utilities.

For existing projects their existing philosophy may be followed by the utilities however following must be ensured:

1. Coordination should be such that it should not trip for close in line fault before the line tripping

3. **HV/LV earth fault low set:**

From the analysis of the all utilities practice it is seen that the setting are consistent with the upper limit as proposed in the OCC meeting. However, in the lower limit side it is not directly ensured that for a remote end substation fault the same will not pick up as shown below.


YN/D or YN/Y
transformer
Three phase CT
summated
3I0
alt
IN>
Single CT
Single phase-to-
earth fault
IEC05000493-en-2.vsd

Following the DVC's practice the line DEF and Transformer DEF can be coordinated. The overall recommendation is as follows for the satge-1 setting:

Direction- Forward (towards transformer)
MTA/RCA- for cross polarization may be set as per OEM recommendation
P.S.-- 20 to 50% of transformer rated current. However it must be greater than all line's DEF setting connected to LV/HV side of the Transformer taking into account the applicable ratio correction.
Characteristics- IEC normal inverse
TMS- Should be calculated considering LV/HV bus fault level and must be coordinated with remote substation zone-3 time.

If REF is used then the choice of implementing the above protection may be left with the utility.

$$\text{TMS HV/LV} \quad \frac{(\textit{Remote end Z3 time} + \textit{safety margin of } 0.1 \textit{ to } 0.2 \textit{ sec}) * ((\frac{\textit{Fault current contribution for LV/HV bus fault}}{\textit{Pick up cuurent}})^{0.02} - 1)}{0.14}$$

For existing projects their existing philosophy may be followed by the utilities however following must be ensured:

1. Protection coordination with remote end lines zone-3 time
2. Coordination with LV and HV side must be ensured for non-directional EF setting. In case of non-directional setting, its pick up should be greater than all connected lines in both HV and LV bus.

4. **HV/LV Directional over current high set (stage-2):** For upcoming projects and projects going for R &M may set it as follows:

Direction- Non-directional

$$\text{P.S.--} = (110 \textit{ to } 130) * \frac{MVA\ rating}{\%\ impedance * volatge * 1.732}$$

Characteristics- Definite time 50-100 ms

Choice of utilizing the same setting is left with the utilities.

For existing projects their existing philosophy may be followed by the utilities however following must be ensured:

1. Coordination should be such that it should not trip for close in line fault before the line tripping

5. **Transformer overload protection:**

Direction- Non directional
P.S.- 110 to 120 % of transformer rated current
Characteristics- Definite time and alarm only
TMS- As per transformer OEM guideline or as per utilities choice.

V. Guidelines on Disturbance Recorder(DR) Configuration

Reference PCC: 79th PCC Meeting

	Transmission Line	Guide Lines
Triggering criteria for DR :	Any Start	Internal protection trip signals, external trigger input, analog triggering (any phase current exceeding 1.5 pu of CT secondary current or any phase voltage below 0.8pu, neutral/residual overcurrent greater than 0.25pu of CT secondary current).
DR time window :	minimum 3 seconds.	minimum 2 seconds.
Pre-fault time window (S):		0.5 Sec
Post fault time window (S):		2.5 Sec
Minimum sampling frequency:	1000 Hz	64 Samples Per Cycle
Analog signals as per priority		
A. Mandatory signals:		
	1. Three phase voltage 2. Neutral voltage 3. Three phase current 4. Neutral current	1. Three phase-to-neutral voltages 2. Three phase currents and neutral currents. 3. Neutral Currents 4. Frequency
B. Optional signals:		
	1. Mutual current 2. Check Sync 3. Open Delta	1. Polarizing currents and voltages, if used. 2. Real and reactive power The Minimum parameters to be monitored in the Fault record shall be specified by the respective RPC.
Digital signals as per priority		
A. Mandatory signals:		
	1. Any Start 2. Any trip 3. Z1, Z2, Z3, Z4 pick up 4. Over current and Earth fault pick up 5. Over voltage stage I & II pick up 6. DT send & reverse 7. Carrier send & Receive 8. Main three phase CB open signal 9. Tie three phase CB open signal (where applicable) 10. Power Swing 11. SOTF/TOR 12. LBB 13. A/R L/O 14. Main-1/2 operated 15. Bus Bar trip 16. VT failure 17. Distance Forward & Reverse 18. T1, T2, T3, T4 19. Broken conductor 20. 86A & 86B 21. A/R 1P In Prog 22. A/R Fail 23. STUB/TEED (where applicable)	
B. Optional signals:		
	1. Any External input 2. Any Binary Input	

TRANSFORMER

		Guide Lines
Triggering criteria for DR :	Any Start	Internal protection trip signals, external trigger input, analog triggering (any phase current exceeding 1.5 pu of CT secondary current or any phase voltage below 0.8pu, neutral/residual overcurrent greater than 0.25pu of CT secondary current).
DR time window :	minimum 3 seconds.	minimum 2 seconds.
Pre-fault time window (S):		0.5 Sec
Post fault time window (S):		2.5 Sec
Minimum sampling frequency:	3200Hz	64 Samples Per Cycle
Analog signals as per priority		
A. Mandatory signals:		
	1. Three Phase Currents & Neutral Currents of HV	
	2. Three Phase Currents & Neutral Currents of LV	
	3. Three Phase Currents & Neutral Currents of MV	
	4. I_REF HV	
	5. I_REF LV	
	6. I_REF MV	
	7. Voltages	
	8. Frequency	
	9. Differential Currents	
	10. Restraining Currents	
	11. Low Impedence REF-DIFF - of all windings	
	12. Low Impedence REF-Restraining - of all windings	
Digital signals as per priority		
	1. Any Start	
	2. Any trip	
	3. Differential Trip	
	3. REF Trip HV, MV & LV	
	4. Over-current Trip	
	5. Earth Fault Trip	
	6. Over Flux	
	7. Over Voltage	
	8. Under Voltage	
	9. 2nd Harmonic	
	10. 5th Harmonic	
	11. Frequency Protection	
	12. External Trip Signals	

BUSBAR

		Guide Lines
Triggering criteria for DR :	Any Start	Internal protection trip signals, external trigger input, analog triggering (any phase current exceeding 1.5 pu of CT secondary current or any phase voltage below 0.8pu, neutral/residual overcurrent greater than 0.25pu of CT secondary current).
DR time window :	minimum 3 seconds.	minimum 2 seconds.
Pre-fault time window (S):		0.5 Sec
Post fault time window (S):		2.5 Sec
Minimum sampling frequency:	3200Hz	64 Samples Per Cycle
Analog signals as per priority		
A. Mandatory signals:	1. 3Phase Diff Current	
	2. 3Phase Bias Current	
	3. Neutral Differential Current	
	4. Neutral Bias Current	
B. Optional Signals:	1. Individual Feeder Currenrts if available	
	2. Zone wise Differential and Bias Currents	
Digital signals as per priority		
	1. Any Start	
	2. Any trip	
	3. R-Phase Fault	
	4. Y-Phase Fault	
	5. B-Phase Fault	
	6. Earth Fault	
	7. Check Zone Operated	
	8. Zone 1 BB Fault	
	9. Zone 2 BB Fault	
	10. Trip Bus bar Zone 1	
	11. Trip Bus bar Zone 2	
	12. Trip Breaker Failure Zone 1	
	13. Trip Breaker Failure Zone 2	
	14. Bus bar Differential Blocked	

VI. Local earthing of CT during shutdown of line in DMT scheme

Reference PCC: 104th PCC Meeting

It was recommended that during shutdown of one circuit of any D/C line which are emanating from substations having DMT/DM bus configuration with CT positioned after line side isolators, the bus side isolator of the circuit may be opened before closing the line earth switch. In addition to this, local earthing of the CT may also be carried out as an additional precautionary measure to avoid any unwanted tripping in the substation during fault in the other healthy circuit as well as for safety measures.