

Experiment

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3b.

Verifying Zone 1 operation of
Distance Relay.

Oscillogram 1:

① High current is observed in phase-A.

∴ Phase-A - Ground fault.

② $V_{fa} = 228.1 \text{ V}$

voltage of faulted phase-a.

$I_{fa} = 29.80 \text{ A}$

Current of faulted phase-a.

③ Apparent impedance,

$$Z_{app} = \frac{228.1}{29.8} = 7.65 \Omega$$

④ $Z_{app} < \text{Zone-1 setting } (22.91 \Omega)$

∴ Zone 1 fault.

⑤ All 3 zones started fault detection.

All three phases trip for zone-1

Approximate relay decision time = 22ms

Approximate circuit breaker opening
time = 30ms

⑥ Remarks:

(i) Zone-1 of distance relay tripped

for a fault at $\frac{7.65}{28.64} \times 100\%$

$$\frac{7.65}{28.64}$$

≈ 26% of line.

(ii) Actual impedance at 26% of
line = $0.26 \times 28.64 \Omega$
= 7.45Ω .

Oscillogram 2:

- ① High current is observed in phase-a.
 \therefore Phase-A-Ground fault.
- ② $V_{fa} = 232.4 \text{ V}$
Voltage of faulted phase-a.
 $I_{fa} = 23.80 \text{ A}$
Current through faulted phase-a.
- ③ $Z_{app} = V_{fa} / I_{fa} = 9.76 \Omega$.
apparent impedance.
- ④ $Z_{app} < \text{Zone-1 setting } (22.91 \Omega)$
 \therefore Zone-1 fault.
- ⑤ All 3 zones started following fault detection. All the 3 phase trips in zone-1.

Approximate relay decision time
= 23 ms

Approximate circuit breaker
operation time = 27 ms .

⑥ Remarks:

(i) Zone-1 of distance relay tripped for
fault. = $\frac{9.76 \times 100\%}{28.64} \approx 34\%$ of line.

(ii) Actual impedance 34% of line = 0.34×28.64
= 9.74Ω

Apparent impedance measured by relay is close to actual line impedance.

Q8.

$$PT_{ratio} = 33 \text{ kV} / 110 \text{ V}$$

$$CT_{ratio} = 200 : 5 \text{ A}$$

$$Z_{app1} = \frac{V_{pr}}{I_{pr}}$$

$$Z_{app} = \frac{V_s}{I_s} = 2.75 \Omega \text{ (given)}$$

$$Z_{app1} = \frac{V_s \times 33 \times 10^3 \times 5}{110 \times I_s \times 200}$$

$$= Z_{app} \times 7.5$$

$$= 2.75 \times 7.5 = 20.625 \Omega$$

$$Z_{line} = 20 \times (0.03 + j0.3) = 3.6 + j36 \Omega$$

$$\text{Zone-1 setting} = 0.8 \times Z_{line}$$

$$= 0.8(3.6 + j36)$$

$$= 2.88 + j28.8 \Omega$$

$$= 28.944 \angle 84.029^\circ \Omega$$

$$Z_{app1} < \text{Zone-1 setting}$$

Fault is in Zone-1

Q9. Fault Resistance = 9 \Omega

Fault Position	Measured voltage phasor V_A (p.u.)	Measured current phasor I_A (p.u.)	Zero sequence current I_{A0}	Apparent impedance calculated by relay Z_{app}	Comment on their decision.	Zone-1 Trip decision
F1	178.2 $\angle -0.51^\circ$ kV	2611 $\angle 36.04^\circ$ A	487 $\angle -40.15^\circ$ A	1.34 $\angle 35.93^\circ \Omega$	$Z_{app} < \text{Zone-1 Trip}$	Trip
F2	178.7 $\angle -0.31^\circ$ kV	1521.3 $\angle 34.01^\circ$ A	153.3 $\angle -42.24^\circ$ A	1.04 $\angle 35.92^\circ \Omega$	$Z_{app} > \text{Zone-1 Doesn't Trip}$	No trip

$$1618 \angle -34.01^\circ \text{ A}$$