MICROPROCESSOR RELAY DIRECTIONAL CHANGE DURING CURRENT REVERSAL

MICHEAL DAVIS, JR, P.E.
CENTERPOINT ENERGY – HOUSTON, TEXAS
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OVERVIEW OF EVENTS

• An SLG fault occurred on one transmission line of a parallel circuit
  ▪ Fault duration was 83.33 ms (5 cyc at 60 Hz).
• After one end cleared, one terminal of a parallel line operated.
  ▪ There was no fault on this parallel line.
  ▪ A reverse fault appeared to be forward
  ▪ Reverse fault current value was higher than the instantaneous overcurrent pickup value.
PROTECTION ELEMENTS

• The relays used communication schemes and non-communication tripping schemes

• The element that misoperated was a directional ground instantaneous overcurrent element
  ▪ This is a non-communication element meant to under-reach and trip with no intentional time delay
  ▪ 67G1 requires a high pickup value for the current and an established forward direction.
  ▪ The relay uses other elements to establish the direction
TOPOLOGY OF AREA – FAULT CURRENT DIRECTION

Relay with the unintended operated
CONTRIBUTING FACTORS

- This event involved a combination of contributing factors
  - Parallel Lines
  - Location and clearing of the fault
  - Relative strength of the fault current sources
  - Relay philosophy update was needed to account for manufacturer relay logic change
PARALLEL LINES

- There’s a current reversal on the parallel line after an end has cleared
- This is more likely to happen on parallel lines
LOCATION OF FAULT – FAULT CLEARING

• Since the fault was located near a terminal, that relay operated quickly to send a trip
• This led to one of the parallel lines being single-ended
SOURCE STRENGTH

• One end of the line had a much stronger source
• When the current was reversed due to the end opening, most of the fault contribution came from the stronger source
  ▪ This fault current went through the line where the relay misoperated
• This also led to the fault current being above the instantaneous ground overcurrent pickup
DIRECTIONALITY

• It was also realized that the relay settings didn’t account for a change in the directionality logic

• A directional element dropout timer led to the relay still seeing a forward fault when other directional elements dropped out

• This forward decision and the high reverse current led to the ground instantaneous overcurrent element operating
CHANGE IN RELAY LOGIC

- There was a dropout timer added to the relay’s directionality logic for ground directional elements.
RELAY OSCILLOGRAPHY - OVERVIEW
NOTES

• Initially, the torque control was set to 1 since there was no dropout time delay between F32QG and 32GF in the original logic
  ▪ 32GF used to establish forward direction for the ground instantaneous overcurrent tripping element
  ▪ An adjustment can be made by torque controlling with the F32QG element
• The forward ground instantaneous element picking up for a reverse fault would have been difficult to test since studies are usually done to test the forward pickup
LESSONS LEARNED

• Relays and their logic can be updated after the initial company practice is established

• As relays are updated, it’s important to track changes in relay logic and other updates

• There could be logic changes that would change current relaying philosophy
REFERENCES

QUESTIONS/ COMMENTS?