

IEEE PES Transmission and Distribution Conference 2008

Panel Session – "Large Wind Plant Collector Design"

### Wind Farm Collector System Grounding

by

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## Need For Adequate Grounding

A well designed grounding system serves to:

- 1. Establish an effective reference to earth potential for normal operation of
  - electrical & communication equipment
  - controls
  - protective devices (circuit breakers, fuses)
- 2. Limit voltage differences to values that will not cause undue hazards to personnel and equipment
- 3. Protect the wind turbine against lightning damage
- 4. Limit galvanic corrosion due to dissimilar metals















## Collector System Engineering & Design

- Soil Resistivity
  - ranges from 10s to 1000s of ohm-meters
- Size of Cable Neutral/Shield
  - 1/3, 1/2, full size
- Cable Insulation Rating
  - 100%, 133%, 173%
- Expected Fault Duty
  - seeing higher levels due to
    - greater Duty from power offtaker at POI
    - larger park ratings 100s of MW)
- Underground versus Overhead Constructions

















# Connecting the Collector System to the Grid

- Grounding Transformers
  - Provide return path for ground fault current
  - Convert  $\pm$  sequence current to zero sequence current
  - Prevent Voltage Elevation on un-faulted phases
  - Eliminate ferroresonance
  - Create an effectively grounded system
  - Winding Configuration Zig-Zag or Wye-Delta
  - Sizing
    - Feeder Circuits: ~5% of connected feeder load
      - $\therefore$  30MVA collector circuit = 1.5MVA Grounding Transformer

## Connecting the Collector System to the Grid

 Collector Circuits – Feeder Grounding Transformers

-Ground Current Source

-Connected on the WTG Side

-One Per Feeder

















# Connecting the Collector System to the Grid

- Delta Connected Systems
  - Source of ground fault current NO
  - Difficult to detect & locate ground faults
  - Elevated voltages (1.73pu or L-L) on un-faulted phases during fault conditions
    - Results in damaged equipment
      - Arrestors
      - Power Electronics
      - Cable Insulation
  - SOLUTION GROUNDING TRANSFORMERS
  - SOLUTION C-B WITH HIGH SPEED GROUND SWITCH
    - Within ~1 cycle of breaker trip all 3 phases are grounded

# Connecting the Collector System to the Grid

- Grounded-Wye Connected Systems
  - Source of ground fault current YES (Temporarily)
  - Source is removed as the faulted feeder circuit-breaker is tripped
  - WTGs will continue to generate for several cycles until removed from the circuit
    - Faulted feeder remains energized with elevated voltages on un-faulted phases

#### - SOLUTION - GROUNDING TRANSFORMERS

- Continue to supply zero sequence fault current until the fault is cleared thus eliminating over-voltages
- SOLUTION C-B WITH HIGH SPEED GROUND SWITCH
  - Within ~1 cycle of breaker trip all 3 phases are grounded

