In-house Repair of Hydro-generator Stator Winding

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- Multi-purpose facility on Columbia River on Washington-Oregon border
- Powerhouse has sixteen 164MVA generators
Fault and Damage

- Placing Unit in-line, generator at rated speed and voltage
- LL Fault occurred:
  - >13kA in A and B phase
  - Tripped by multiple elements of DMFR relay
Repair Decisions

- Contract or in-house forces?
  - Contracting difficulty encountered
  - In-house with technical direction

- With rotor in or out?
  - In – remove 2-3 poles
    - shorter duration, cramped workspace
  - Out – disassemble machine
    - much longer duration, easier access
Materials and Tooling

- On-hand at project
  - Spare top and bottom stator bars, insulating caps, polyester roving, spare pole collars
- On-hand at nearby projects
  - Slot closing wedges, fillers, polyester felt, field coil lifting jig
  - Test equipment, induction brazing equipment
- To be ordered
  - Mica tape, insulating, semiconducting, and weeping epoxies, brazing filler metal, copper for pole group connections
Lashing and Cap Removal
Bar Removal
Slot Prep/Bar Test
Bar Insertion
Slot Wedging
Brazing Mock-ups
Lashing Bars and Brazing
Bottom Cap Installation
Taping Pole Group Jumpers
Top Cap Installation
Testing – In-process and Final

- Overpotential (hipot) spare bars
- Slot paint resistance to ground
- Top bar side resistance to ground
- Ripple spring compression
- Overpotential (hipot) bars after wedging
- Resistance of all brazed joints
- Field winding pole drop
- Both Rotor and Stator - winding resistance, insulation resistance/polarization index, final overpotential (ac)
Lessons Learned

- Rotor in or rotor out?
  - Out: allowed more work space but much longer outage
  - In: cramped but could pull and push bars against rim
- Careful Spare Bar measurements
  - Checked width but not depth, spare bars were slightly shallower than old ones resulting in lots of top filler to wedge slot tightly.
Lessons Learned (cont’d)

- **Material orders**
  - Order early and notify team of supply problems

- **Technical Direction**
  - More emphasis on what not to do
    - Collateral damage expands repair scope
  - Clear descriptions of work
    - Sketches, photos, and mock-ups help ensure all parties have clear understanding of work

- **Crew consistency and craftsmanship**
Questions?
Cause of Fault
Field Coil Removal
Pole Body Insulation
Re-assembling Coil