Generator Testing and Condition Assessment

Kleinschmidt

Hydropower
Variety is the Spice of Life

- Generator Configurations Voith Video
  - Vertical, Horizontal, Angled
  - Synchronous
  - Reversible
  - Variable Speed
- Cooling
  - Air, Water, Water Cooled Air
- Windings
  - Coils – Form wound VPI, Resin rich Bars
- Voltage
  - 2.3 kV to 20+ kV, 25 Hz-60 Hz

Generator Design Life vs Actual Life

"Typical" Hydroelectric Unit Design Life: 30-50 years

- Design parameters
  - Starts and Stops
  - Transient events
  - Voltage
  - Temperature
  - Load
- Actual life varies based on use/abuse

Reasons for Generator Degradation

1. Heat

- Overloaded
- Loss of cooling
- Local damage – hot spots

2. Partial Discharge/Corona

- Overvoltage
- Insulation breakdown
- Poor installation

3. Contamination

- Oil
- Water
- Dust/Debris

4. Mechanical Damage

- Foreign material
- Fatigue
- Vibration

Winding Failures

Winding Failures

Winding Failures

Contamination

Mechanical Damage

Mechanical Damage

Mechanical Damage

Failure Prevention

- Rotor and Stator Inspection
  - Regular – annual is recommended
  - After significant events
    - Load rejections
    - Short circuits
    - Synch out of phase
    - Runaway
- Cleaning

Failure Prevention

- Periodic Testing
  - Heat Runs (Temperature Rise)
  - Polarization Index
  - Maintenance Level High Potential
  - Partial Discharge
  - Core Loop
  - El Cid
- Data Trending

GENERATOR AIR COOLER COOLING WATER FLOW RATE DATA

Air Cooler CW Flow Total	gpm	1000
Cooler 1	gpm	125.2
Cooler 2	gpm	110.2
Cooler 3	gpm	280.7
Cooler 4	gpm	275.8
Cooler 5	gpm	197.4
Cooler 6	gpm	95.5

Addressing Potential Failures

- Spares
- Planned Refurbishment
  - Windings
  - Core
  - Clamping System
  - Pole Re-insulation
- Advance Equipment Purchase/Storage
- Combine with Unit Upgrade