As the owner/operator of a hydro pump/storage plant, your generator experiences routine frequency excursions as it changes operating modes. Your current generator protection system often shuts down during these periods, leaving your assets unprotected. ABB generator protection solutions can cost-effectively safeguard your assets during machine startup and shutdown.

Challenges
Your unit was delivered more than 10 years ago and is approaching its first, or perhaps second, protection upgrade. Regulatory requirements, grid modernization phenomena such as subsynchronous oscillations, operational and footprint challenges are all driving the requirements for your next upgrade decision. Your current system has served you well, but aspects of its design will become increasingly problematic:

• It is based on electromechanical or first generation microprocessor generator protection relays deploying antiquated protection philosophies, exposing generation assets to greater risk.
• It shuts down when the frequency is less than 55 Hz, leaving your unit unprotected.
• It does not offer protection against stator or rotor winding earth faults.
• NERC/PRC regulations have significantly increased your disturbance reporting obligations and maintenance efforts.
• It cannot detect and respond to subsynchronous oscillations and subsynchronous resonance coming from your grid connection.
• It is not compatible with the latest protection and control technologies available in the digital world.

Situational analysis/background
Every generation plant needs a protection solution to safeguard its most critical assets during the ramp up, ramp down, and normal operations. Hydro/pump storage generation plants are unique as they produce energy based on market demands, converting generators to motors in order to move water back up to the reservoir during off-peak markets. During pump storage cycle changes the generator converting to a motor makes the machine slow down and reverse, thus the frequency follows the cycle.
Hydro/pump storage units have these particular operating conditions to consider which impact the design of the protection solution:

- Generator operating mode of the unit
- Pump operating mode of the unit
- Back-to-back starting of the unit in pump operating mode
- Electrical braking of the synchronous machine for both generator and pump operating modes

The main differences between the generator and pump operating modes are:

- Change in the direction of the synchronous machine rotation and active power flow change can affect protection functions based on sequence components.
- Synchronous starts cause linear frequency variations of motor current and voltage from 0 to 60 Hz, as well as linear voltage magnitude increase from 0% to 100% at the machine terminals.
- Electrical braking voltage at the machine terminals will be practically zero; this (in effect) disables any frequency tracking features within numerical IEDs that are based on voltage measurements. At the same time, the stator current will have an almost constant magnitude but with frequency variation from approximately 25 Hz down to 0 Hz. Such condition will unquestionably have an impact on many protection functions, and special means are required to prevent unwanted relay operation and provide dedicated protection functionality for this particular operating condition.

Points to consider

- Do you operate as a base load unit or as a peaking unit? If peaking, roughly how many starts per year?
- Is your hydro unit also used for pumped storage?
- What components of your generator protection and control system are original equipment?
- Which components have previously been upgraded? When were the upgrades performed?
- When is your next planned generator outage? Upgrade outage?
- If your generator output exceeds 150 MVA, is your current protection solution capable of protecting 100% of the stator and rotor windings from earth faults?
- Have you been impacted by subsynchronous oscillations or subsynchronous resonance?
- Are you in proximity to:
  - HVDC devices
  - Series capacitance, STATCOM, SVC or other active devices
  - Wind farms
- Are you able to comply with all the requirements of NERC/PRC as it pertains to generator disturbances?

The solution

ABB can deliver the power of one solution for protection and control, increasing capability in a significantly smaller footprint for maximum asset protection during generator startup and shutdown. ABB’s REG670 protection and control solution has a patented frequency tracking algorithm to ensure comprehensive machine protection over a wide range of operating frequency from 10-90 Hz.

Advanced applications

- Generator and unit transformer protection in one protection device
- ABB’s patented turn-to-turn winding detection for ultrafast fault detection and clearance
- ABB’s patented frequency tracking algorithm to protect the asset during generator startup and shutdown
- Smaller footprint, reduced control system wiring and integrated control for flexible automation
- NERC/PRC compliant trending, reporting and display
- Synchronizing and excitation systems for automatic voltage regulations for synchronous generators

Next steps

Arrange a visit from our technical team to discuss

- The latest technological advances in generator protection and control
- Off nominal frequency protection solutions and the impact on your system
- Requirements for your next generator protection and control upgrade and a budgetary estimate for ABB solutions