

# Wind Generators and Restoration

Presented to Wind Power Integration in Ontario Standing Committee  
February 20, 2008



Walk through conditions of a restoration situation  
(Generator characteristics determine/dictate role)

1. Pre-event (Normal Conditions)
2. Disturbance Event Itself
3. Immediate Post-event
4. Longer term Post-event
  - a. Recovery of Generation (from OPSRP)
  - b. Energize transmission lines (from OPSRP)
  - c. Restore Loads (from OPSRP)
  - d. Synchronize islands (from OPSRP)

- LVRT for wind-generator calibrated & in-service
  - LVRT assists wind generator turbines survive an event, and
  - LVRT may assist an island to survive an event (Occurs with conventional generation, all things being equal, mutual dependency)
- All control systems, such as “MW Output Control limiter”, if so equipped, calibrated & in-service
- All relaying calibrated & in-service (Applies to rest of system also, ex. UFLS 12% @ 59.3 hz & 23% @ 58.8 hz)

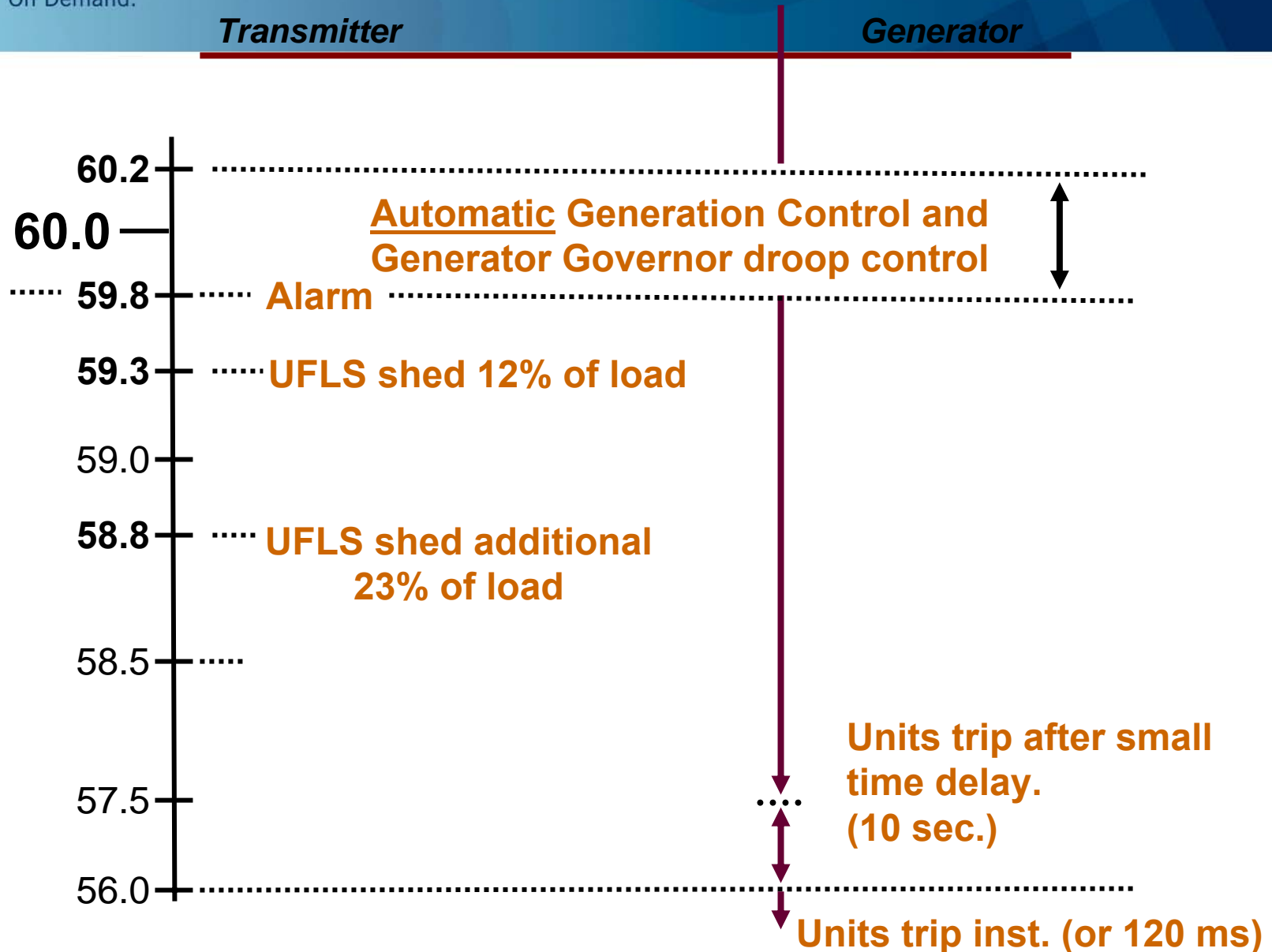
## Acronyms:

*OPSRP = Ontario Power System Restoration Plan*

*UFLS = Under Frequency Load Shedding*

*LVRT = Low Voltage Ride Through technology*

# Under-Frequency Relay Settings



- Initiating event
- Tripping of lines and generators by protections
- Permanent removal of some assets (generators)
- Sometimes formation of islands
- Miss-match of load and generation
- Off-normal frequency (want 60.00 hz, not  $\approx$  )

## Note:

It takes some time for operators at all locations to assess situation, talk to major contacts, grasp an understanding of big picture, plan & respond.

Impact of wind generators on disturbance depends upon their penetration in portion of system that survives: 3 examples

- Bruce x London x Windsor Area:
  - Could postulate this represents a few hundred MWs in perhaps a 3000 to 5000 MW or more island. (At < 3%, wind MW absorbed in normal perturbations)
  - Future: wind generators could represent some 600 MW or more in a 3000 to 5000 MW island. (↑20%)
- Sault St. Marie area: Wind generators could represent 1/3 to 1/2 of surviving generation in island, assuming it survives. (This represents a major proportion with impacts).
- Northwest: 1000's of MW wind generators of in an area where load (net of local generation) is barely over 500 MW. Will impact survival of island.



Objective: Stabilize generation to match load in island at 60 Hz

## 3 Possible Conditions

### Low frequency in island:

- Can't increase wind generation to restore frequency
- If no other conventional MW a/v must cut load to restore frequency
- If wind generation MW is interfering with island freq or with synchronizing, wind generation can only be reduced by cutting equivalent (more) MW of load simultaneously to avoid making low frequency situation worse. (2 related problems: freq and  $\approx$  MW)
- Consumes valuable time, because all actions have to be small so as not to precipitate collapse of the island, and usually have to pause to allow some time for conditions to stabilize.

### High frequency in island :

Can decrease wind (or conventional) generation output, trip individual turbine heads, OR even better spill wind. (Feeder tripping?)

### Frequency balanced in island :

For 2 minutes, in meantime wind (or load) may have changed.

- Island operation: (Characteristics dictate role)
  - Wind generators cannot start up (Black-start or re-start) or operate isolated in an island. Need anchor system to synch to.
- Variability of Output:
  - If already tripped and out-of-service, then wind generator role is to basically wait until sufficient system has been restored to act as a buffer to absorb the variability in wind generator output.
- Specific Issues:
  - **Do not reconnect and/or reload without IESO permission.**
  - Wind gen re-loading on distribution depends on penetration

BUT after an event systems are usually short of MW.

- Stages of restoration:
  - Recovery of generation (excluding wind generation)
  - Energize transmission lines (usually excluding wind generation)
  - Restore loads (usually excluding wind generation)
  - Synchronize islands (usually excluding wind generation)
- The first three stages are interdependent and entail the formation of electrical islands

- Desire to synchronize islands for stability, and timeliness is very important
  - Linking islands can stabilize system to help mitigate against further contingencies.
  - Can consume critical operator time if varying output from generators interferes with synchronizing, requiring operators to have to start over.
  
- Can only be achieved if a window exists when both frequency and phase angle are stable, ie within limit envelop.

Ideally would prefer wind turbines to be able to “back off” to a set-point at a lower level of MW.

This would provide some margin to ride out any drops in wind-speed (spill wind) maintain generator power output at constant MWs.

Also provides room to ramp up if needed, (spill less wind)

- We understand this is an emerging technology, and an optional feature, but power systems could face this predicament in future if no such features were provided in areas with high wind penetration.

Again: No-No's

- **Do NOT reconnect/reload without IESO permission.**
- Distribution similar (if relatively small - no problem).

## Ontario Power System Restoration Plan (OPSRP)

**Version 4.0 issued September 12, 2007.**

1. **Electrical Island** - *formed by disturbance*
  - a. If island unstable due to fluctuating wind disconnect them (you may have to shed load to do so)
  - b. Assess proportion of wind MWs in island (ideally should be less than 5 % of total nominal generating capacity)
2. **System Restoration** - creating an electrical island
  - a. Recommend wind farms be disconnected prior
3. **Synchronizing Electrical Islands**
  - a. If difficulty encountered due to fluctuating wind, disconnect them

*Summary of Appendix D from OPSRP*

# Summary: "But we do need you"

After an event, some generators do not return.  
Power systems are usually short of MW.  
We will need all of the MW you can provide.

**Lastly: Do NOT reconnect/reload without IESO permission.**

Thank you

Questions?