Step Controller / Perturbance

- Control Action: Change any settable quantity on any controllable device existing in the power-flow base case.
- Basic Requirements
  1. Value changes by %, absolute, or relative to original value.
  2. Time input: start time
- State change Requirements
  1. Generator inertia must be handled correctly
  2. Starting Generator Mechanical power should be definable.
- Examples
  1. Step load up 5% at t_1
  2. Open branch at t_1
  3. Increase P_{ref} by 25 MW at t_1

Ramp Controller / Perturbance

- Control Action: Change any non-binary settable quantity on any controllable device existing in the power-flow base case.
- Basic Requirements
  1. Value changes by %, absolute, or relative to original value.
  2. Time inputs: start time, ramp A time, hold time, ramp B time
  3. NOTE: For single ramp operation, hold time and ramp B time are zero.
- Examples
  1. Ramp P_M +5% of a non-governed generator at t_1 over t_2 seconds
  2. Ramp P_{ref} to 60 MW from t_1 to t_2, hold for t_3 seconds, then ramp down 5 MW over t_4 seconds.

Definite Time Controller (DTC)

- Will be defined in an external `.dtc` file to allow for easier integration into simulation.
- Control Action: Change the status bit on any controllable device(s) existing in the power-flow base case based on any other value in the system.
- Basic Requirements
  1. Binary or 'Analog' settable reference input(s) (bus voltage, MW output, system frequency ...)
  2. Threshold inputs: **set level** L_S (turn on), **reset level** L_R (turn off)
  3. Time inputs: **set time** (time $\pm$ L_S before turning on), **reset time** (time $\mp$ L_R before turning off), **reclose time** (time required after a reset before a set can be performed)
  4. NOTE: reclose time can be set to zero, but will only act on next time step.
- Feature Requests
  1. Ability to add custom control law
  2. Ability to use arbitrary Inputs
  3. Ability to trigger Steps or Ramps (**?**)
- Basic Example: Using a voltage sensitive base case with an available shunt cap; ramp real power of a load. When bus voltage at the cap drops below 0.95 PU for 30 seconds, insert cap.
- Advanced Example: Using a voltage sensitive base case with a wind power plant (WWP) and an available shunt cap on the low side of the WPP transformer; ramp WPP up and commensurate hydro down. When WPP high-side voltage drops below 0.95 for 30 seconds **AND** WPP MW export is positive, insert cap.

Capacitor Group (Cap Bank)

- ≈A DTC with multiple cap references.
- Control Action: Change status bit(s) on a finite set of shunt capacitors existing in the power-flow base case.
- Basic Requirements
  1. Group can have a variable amount of capacitors.
  2. Capacitor status controllable via bus voltage.
  3. Order of Caps switched in can be defined.
- Feature Requests
  1. Ability to add custom control law
  2. Ability to use arbitrary Inputs
- Example
  1. Starting with a voltage sensitive base case, ramp real power on a load in a region where two or more shunt caps are available. When reference bus voltage for the cap group drops below 0.95 for 30 seconds, insert one of the available caps. Wait n_1 seconds. If voltage still below 0.95 insert additional cap.

Generator Group (Discrete Power Plant)

- ≈ A DTC with multiple generator references.
- Control Action: Change status bit(s) and total P_{gen} on a finite set of generators existing in the power-flow base case.
- Basic Requirements
  1. Group can have a variable amount of generators.
  2. Generator status and P_{gen} controllable via P_{ref} value sent from scheduling controller.
  3. Ability to add custom control law.
- Feature Requests
  1. Ability to use arbitrary Inputs
- Examples
  1. Starting with any base case, ramp Pref and some load equally. When all generators in group are operating above 80%, bring on new generator and give some load (initial mechanical power).

Power Plant Agent

- Control Action: Change a single generator object in the base case such that it **acts** like multiple generators.
- Basic Requirements
  1. Change Pmax, Qmax, H, Pm, Pgen as appropriate ...
- Feature Requests
  1. Ability to add custom control law
  2. Ability to use arbitrary Inputs
- Examples
  1. Same as Generator Group Case
- May be easier to code in a separate file (the `dtc` file).

Automatic Generator Control

- Only one allowed per area
- Control Action: Change status bit(s) and total P_{gen} on a finite set of generators existing in the power-flow base case.
- Basic Requirements
  1. ACE calculated by:

     $$\mathrm{ACE} = \sum_{i=1}^{N} \mathrm{P}_{\mathrm{gen}_i} - \sum \mathrm{P}_{\mathrm{load}} - 10\beta\Delta\omega$$

     (Or as a sum of station control error SCE)
  2. Generator status and P_{gen} controllable via P_{ref} value sent from scheduling controller.
  3. Ability to add custom control law
- Feature Requests
  1. Ability to use arbitrary Inputs
- Examples
  1. In a multi-area system where each area has a scheduled tie-lie flow, cause some kind of perturbance and allow AGC to act to eliminate ACE and restore system frequency (load frequency control LFC).