TURBINE TIPS

Turbine Tips provided by **Pond and Lucier, LLC.** ®
634 Plank Road, Suite 103 Clifton Park, NY 12065
Phone: 518.371.1971 Fax: 518.371.1756 E-mail: pal@pondlucier.com

February, 2002

What is the difference between ***droop*** and ***isochronous*** operation?

Many gas turbines manufactured by ***General Electric*** afford the operator two choices: ***droop*** or ***isochronous*** operation. There is often a selector switch or operator interface screen allowing the operator to choose **<u>either</u>** governing mode.

The differences between these two control modes should be understood. In the ***droop*** mode (which is typical for smaller gas turbine generators operating on large power grids), the turbine control system works in concert with the other on-line governors on the system to share ***proportionally*** load demand ***changes***. This sharing is done based upon the base load rating of each generator to the overall capacity of the grid.

<u>Example:</u>

Assume that all generators on a power grid are operating in the ***droop*** mode with the same **<u>4 percent</u>** speed regulation. Refer to **<u>Figure 1</u>** below. Assume also that one of the generators is rated at **<u>50 megawatts</u>** (call it **Unit #1**) and is synchronized on a grid whose total generating capacity is **<u>8000 megawatts</u>**. The speed governor for **Unit #1** will take 50 ÷ 8000 or **<u>.625%</u>** of any load demand changes that should occur. For example, assume that **Unit #1** is currently generating 37 MW. If the grid is operating at 60.00 Hz and an increase in demand of 5 MW occurs, **Unit #1** will **<u>increase</u>** its power output by: (.00625) (5) = .03125 MW. **Unit #1** will then be generating 37.03125 MW. The other generators, with their own 4 % droop characteristic, will share proportionally the remainder of the load change (that is, 5 MW minus .03125 = 4.96875).

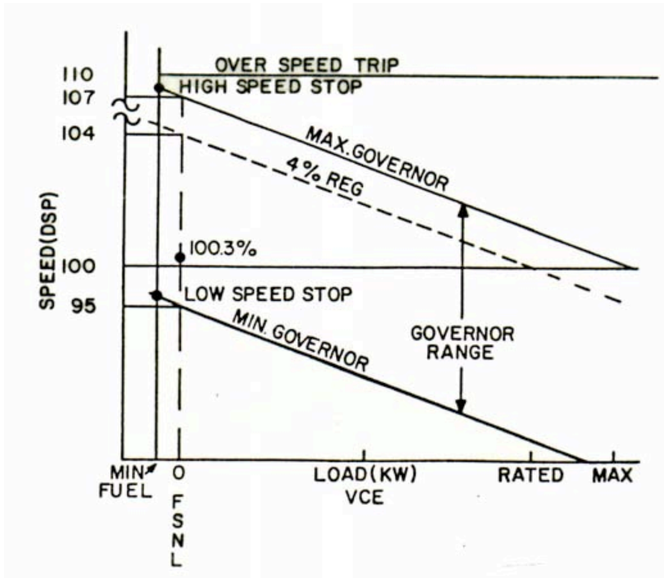


Figure 1: Speed Droop Curves for Gas Turbine Governor Using Typical Speedtronic™ System

In the above example, something happens to grid frequency as well. Assume that the frequency is 60.00 Hz when the additional load of 5 MW came on the grid. In this example, the system frequency would ***droop*** the following amount:

60.00 - [(.04) (60) (5) ÷ 8000] = 60.00 - .0015 = **59.9985 Hz**

If the operator increases the setpoint on **Unit #1** as the other governor setpoints remain steady, the frequency will return to 60.00 Hz and all of the new load of 5 MW will be transferred to **Unit #1**.

Below is a simplified sketch of a ***droop*** style governor for a gas turbine. The two input signals are the actual turbine **speed** (called **NHP**) and the load setpoint (called **DSP**). The "feedback" signal from the amplifier output is called **VCE**. If **DSP** is held constant and **NHP** reacts be decreasing (speed droops because of the increase in load, see above), the _**VCE** value must increase to balance the operational amplifier (Op Amp). Thus, with the **DSP** constant, the governor will respond to generate **37.03125 MW** and droop with the rest of the grid to **59.9985 Hz**.

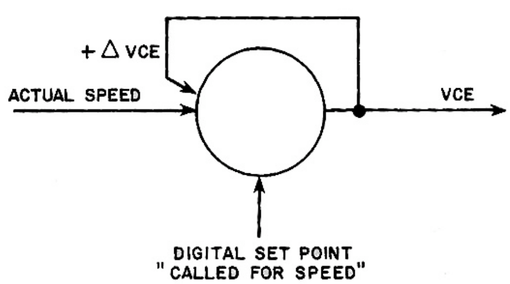
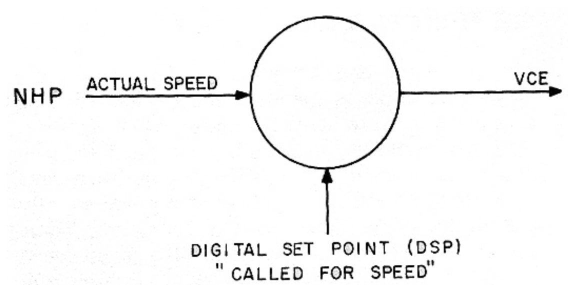


Figure 2: Speed Droop Mode

In some small power grids (like on Caribbean islands), automatic frequency control is accomplished often by operating the largest turbine/generator in the grid in the ***isochronous*** mode. With one unit in the ***isoch*** mode, any changes in load demand will try to reduce system frequency. This attempt to "droop" will be first "noticed" by the turbine operating with an ***isochronous*** governor (call it **Unit #2**). This ***isoch*** governor will immediately notice a slight decrease in speed (frequency) and increase output (VCE here) to increase fuel flow to generate more power. The **isoch** machine will "pick up" all of the new load demand (5 MW in our example above). This happens before the ***droop*** governors can react. In our example, the power output from **Unit #1** would remain steady, at its current setpoint of 37 MW, but the ***isoch*** machine would increase its output by 5 MW.

Below is a simplified schematic which shows the result of switching to the ***isochronous*** mode. Assume that the **Digital Setpoint (DSP)** is set to generate a particular load by a ***droop*** governor. A switch is thrown that opens the **_ VCE** feedback and also temporarily disables the **DSP** signal (at its existing value), putting **Unit #2** in the ***isochronous*** mode. Any load change thereafter that tries to cause speed (frequency) to change will not be allowed. The **isoch** machine will respond to sustain system frequency at **60.00 Hz.**



Later, if desired, the ***isoch*** machine can return to the ***droop*** mode by returning the selector switch to this mode of operation. Then all governors will be operating again in the droop mode and sharing load changes in proportion to their base load rating.

Any questions? Give ***PAL Engineering*** a call and perhaps we can help if your machines are not governing properly.