TURBINE TIPS
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Ever wonder why Start-up Engineers usually record "start-up" data and plot the related curves when checking out your gas turbine?

Older gas turbines (Speedtronic Mark II and earlier) usually don't have automatic data recording instrumentation. Thus, recording of start-up data is usually done **manually**.

Recording this data will take several plant operators or technicians. Start-up Engineers like to record such variables as turbine **SPEED** (in percent of rated speed or rpm), average turbine exhaust **TEMPERATURE** (degrees F x 10 below in **Figure 1**) and the variable control voltage called **VCE** (shown in units on the right-hand scale). These are all recorded from panel meters every 10 or 15 seconds after a turbine start signal is initiated.

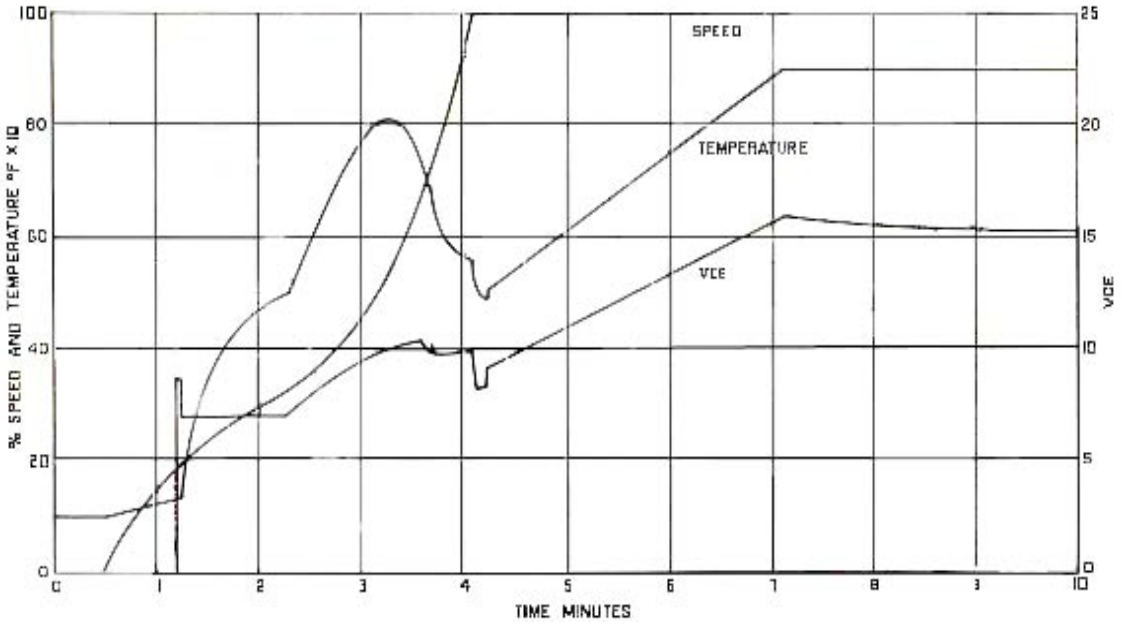

Figure 1: Typical Start-up Curves - Percent Speed, Exhaust Temp and VCE versus Time

The value of recording these three variables is that a start-up "signature" for the gas turbine can be achieved once the data is plotted (see **Figure 1** above). You will need four people to

accomplish the task. One person will operate the stopwatch, and the other three will each record one variable every time the clock master yells "**MARK**!"

Start-up curves reveal a lot about your gas turbine. If the data is plotted consistently on similar graph paper using the same scales, the curves can be periodically compared. It is handy to create a data sheet with columns and rows to record the data for every interval.

It is recommended that start-up data be taken and plotted at least ***annually.*** ***PAL*** engineers prefer to do it every time we visit a site and see a turbine start. Heck, it only takes about 30 minutes to record and plot the data. You should always do this after an outage or whenever the turbine is opened for inspection or repair. ***However, few gas turbine owners do this frequently enough and with the consistency needed for the data to be valuable***. Those who do, can observe the changes and obvious problems associated with such things as:

- Diesel Starting Engine (if applicable)
- Hydraulic Ratchet (if applicable)
- Speedtronic Control Calibrations
- Firing and Flame Detection
- Acceleration Problems (with diesel and/or gas turbine)

Figure 2 below shows another way of recording start-up data. A Start-up Engineer might be interested in investigating a problem during turbine acceleration. Figure 2 compares different data associated with three separate Speedtronic™ circuitboards that "can" control fuel flow through the **Minimum Value Gate**. On a Mark II system, the start-up card has a built-in acceleration exponential. The speed-control card has a circuit that monitors the rate of change of shaft speed (or acceleration). The temperature-control card has an exponential circuit too, that monitors and controls "how fast" turbine exhaust temperature increases during start up.

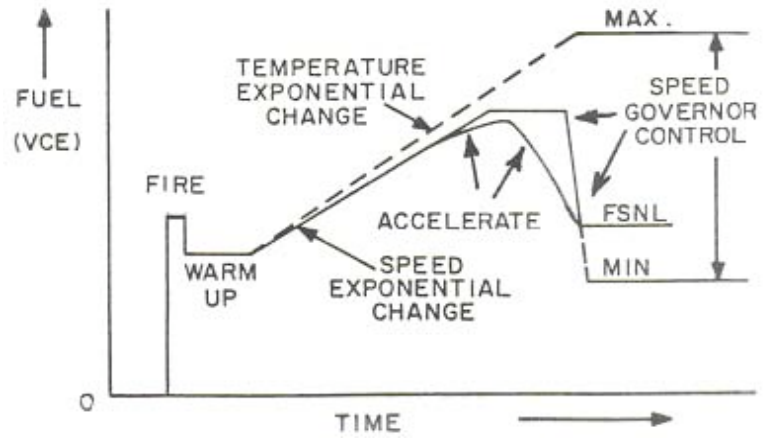

Figure 2: VCE (Fuel) versus Time

The graph below in **Figure 3** depicts pump **STROKE** (in percent) versus turbine **SPEED** (percent) during a typical start up. It should be understood that **Fuel Flow** is a function of two

variables: fuel pump stroke and speed. This applies to variable-displacement fuel pumps (like OilGear or Dennison) on a Speedtronic™ Mark I machine.

In Mark II, fuel flow is measured using magnetic pickups and 60-tooth wheels: one on the turbine shaft and one on the flow divider. On gas-fuel machines, curves of a similar nature can be generated for the Gas Stop/Speed Ratio and Gas Control Valves.

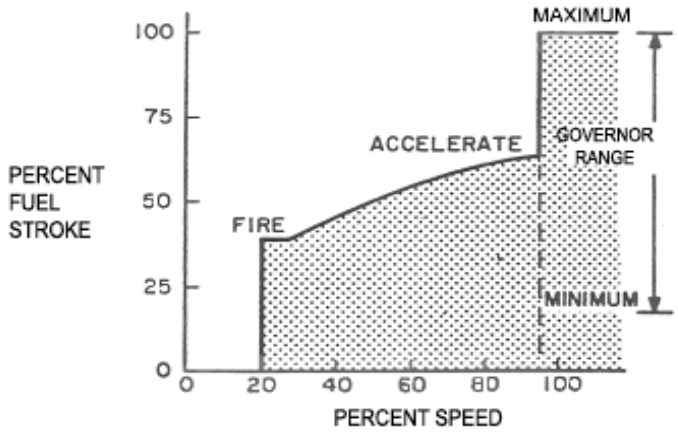

Figure 3: Percent Fuel Stroke versus Percent Speed

All of the above graphs in **Figures 1 - 3** can be generated if you record and plot the related data during turbine start up. Remember, it takes only about 10 minutes to record the data and another twenty clicks to plot it on graph paper. ***This is a valuable exercise.***

In a future Tip of the Month, I'll defend the practice of recording and plotting data during the turbine **Shutdown** sequences.

Any questions? If your machines are not starting properly, give ***PAL Engineering*** a call, and perhaps we can help.