TURBINE TIPS
Turbine Tips provided by Pond and Lucier, LLC. ®
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Subject: Use of the Manual VCE Control to Troubleshoot
Applies to: GE Gas Turbines utilizing Speedtronic™ Mark I and II

General Electric gas turbines manufactured during the decade of the 1970s utilized Speedtronic™ Mark I or II control and protection systems. The OEM included a method of "overriding" the control systems with a Manual VCE knob. It was possible to "manually" control fuel flow temporarily to help in the troubleshooting process. Also, you could limit power output of the generator should there be a vibration or overheating problem.

The **MAN VCE** resistor is located on the speed control circuit board called SSZA on the Mark I System. See Fig. 1 below. It is the upper resistor knob. Turning it to the right (clockwise) will eventually decrease or limit VCE voltage, depending upon your intent.

Fig. 1: SSZA card with MAN VCE Resistor

The **MAN VCE** device allows the operator to limit or reduce the fuel command signal (called Variable Control voltage, or VCE) if a problem arises. Two examples of start-up problems might be high exhaust temperature during start-up or excessive vibration through a critical speed.

> A client recently had a problem starting his GE gas turbine. When a MS5001N (with Speedtronic™ Mark I) reached approximately 1900 rpm, the turbine "tripped," because the exhaust temperature exceeded its allowed starting limit. The frequent "trips" made the problem particularly difficult to diagnose, because it was felt that the turbine needed to remain operating so that the system could be tested and analyzed.
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> ***Note***: The client's site personnel were "unaware" that there was a manual control option or the reasons why GE had installed it.
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> ***PAL Engineering's*** team used the ***Turbine Online Problem Solving (TOPS),*** interactive online service, to assist the client in the process. Also, a ***PAL*** engineer was dispatched to the site. Because it would take two days' travel time for the engineer to reach the site, and the client needed the power ASAP, the ***TOPS*** system was employed to expedite the troubleshooting process. When the turbine was next started, with several digital voltmeters employed to monitor specific logic signals and analog values, the turbine was allowed to "keep running" just below the speed where the inadvertent trips occurred. By cutting back VCE from the accelerate limit (approximately 9.5 DC volts) at 1900 rpm using the **MAN VCE** knob (a.k.a. the ***gag***), the troubleshooting process could begin.
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> ***Note:*** When the **MAN VCE** knob is turned, it "unclicks" and initiates an audible ALARM on the panel. The alarm will not clear until the knob is returned to its "click stop" position. However, the turbine will be temporarily in "manual" control so that troubleshooting could begin. In this case, we wanted to run at a safe speed of 2000 rpm (40 percent of rated speed) and exhaust temperature less than 900 degrees F.

On the Speedtronic™ Mark II system, the **MAN VCE** resistor appears on the Start-up control card SSKC as shown in Fig. 2 below. It serves the same function as the one on the Mark I system as explained above.

Fig. 2: SSKC card with MAN VCE resistor

Fig. 3 below plots VCE (fuel flow) versus TIME during the start-up of a typical gas turbine. During the acceleration process, three controls can limit fuel flow. When a control is in charge, its light will be on.

- **BLUE** Light. VCE suppression rate removal (on the Mark I, SSKA card) that allows rpm to increase as the VCE increases at about **.02 volts per second.**
- **AMBER** and **BLUE** Lights together. A speed exponential of **1 percent per second** (or 50 rpm per second). The two lights apply to Mark I only. **AMBER** light only on for Mark II.
- **RED** light. An allowed exhaust temperature exponential rate of **5 degrees F per second.**

It might be necessary to use the **MAN VCE** to limit fuel flow manually in the troubleshooting process.

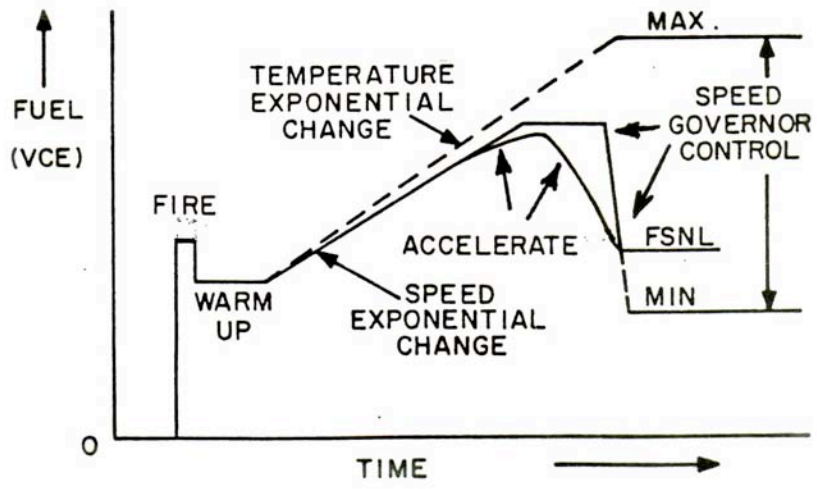

Fig. 3: Start-up Curves showing control of VCE versus Time

Notice in Fig. 4 below that the exhaust temperature typically "crests" at about 800 deg. F during start-up at approximately 3 minutes 15seconds, when the turbine is at about 50 percent speed (which would be about 2550 rpm). If the exhaust temperature goes too high, the turbine might trip on over-temperature. You might want to limit VCE (see right-side axis, reading 10.0 DC volts) to prevent this from happening until the airflow increases and cools the exhaust. Perhaps a **MAN VCE** setting of 9.5 DC volts might be better. Later the accelerate VCE limit could be lowered to this same value.

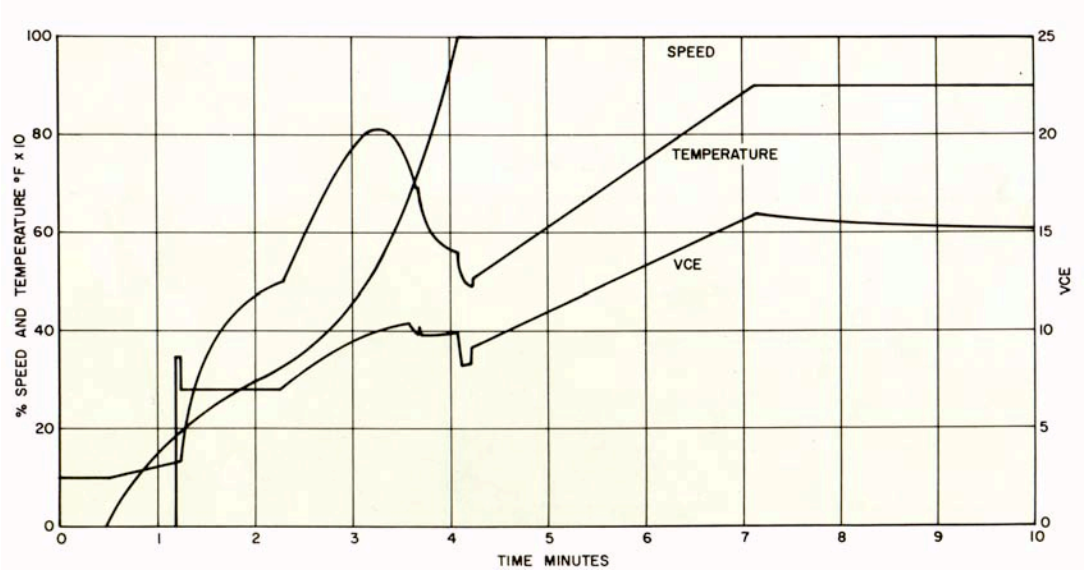

Fig. 4: % Speed, Exhaust Temperature and VCE versus Time during a typical start-up

The MAN VCE knob can be a useful troubleshooting tool. If you have any questions about the uses of the **MAN VCE** knob, please contact Dave Lucier at Pond and Lucier, LLC at dave@pondlucier.com or call 518-371-1971.