



TURBINE TIPS

Turbine Tips provided by Pond and Lucier, LLC. ®

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Subject: What is the function of the thumbwheel on the GE/MAC programmer?

Applies to: General Electric MS5001L & LA and MS3002F gas turbines.

In the late 1960s, GE shipped approximately 1000 gas turbines that utilized an exhaust-temperature control system commonly called the **GE/MAC**. In fact, these turbines were often referred to by clients as “GE/MAC” machines. The systems included the following four primary components:

- Temperature-Averaging Cabinet
- Thermocouple amplifier called the GE/MAC *MV/I* (left-side module of Fig. 1)
- GE/MAC *Programmer* (right-side module in Fig. 1)
- Electro-pneumatic transducer, 65EP (shown in Fig. 4 herein)

The *MV/I* received the average of 12 exhaust thermocouples in millivolts (*MV*) and converted it to a milliamperes signal (*I*). Hence, we have the name *MV/I*. The DC milliammeter for the output signal is shown on the front of the *programmer* module in Fig. 1 below.



Fig. 1: GE/MAC Millivolt amplifier and programmer

This MA signal was then sent out to an electro-pneumatic transducer called **65EP** (See Fig. 4 below). **65EP** in turn sent the proportional air signal fuel regulator (See Fig. 5 herein).

The **MV/I** could be calibrated with the **ZERO** and **SPAN** resistors on the right side of the module. See the chart below.

<i>MV/I Input</i>	<i>MV/I Output</i>	<i>Adjustment</i>
300 °F	10 milliamps	ZERO resistor
700 °F	50 milliamps	SPAN resistor

The GE/MAC system had three operating modes: **START-UP**, **BASE** and **PEAK** temperature control. During start-up, after the firing commenced and flame was sensed, the warm-up period began using the **2W** timer inside **Programmer**. It took 60 seconds for the timer to revolve, holding exhaust temperature at or below **575 °F**. Then the tape on the front of the programmer (See Fig. 3) began to run from 0 to 100 percent, taking approximately 150 seconds (2 _ minutes). During this period, **70TC** allowed the gas turbine rotor to accelerate up to operating speed. The exhaust temperature control range would gradually move to a new range as shown in the chart below.

<i>MV/I Input</i>	<i>MV/I Output</i>	<i>Adjustment</i>
700 °F	10 milliamps	BASE, R103 inside programmer
1000 °F	50 milliamps	R103 above moves the curve parallel.



Fig. 2: GE/MAC Programmer driving up from 0 to 100%

Should the turbine operator notice that the exhaust temperature is going **TOO HIGH** during the run up of **70TC**, he could manually “hold back” the tape using the thumbwheel on the front, as shown in Fig. 4. As **70TC** tape increases, the milliamperes tend to **decrease**. This is, in effect, a useful manual override of the control.



Fig. 3: GE/MAC Programmer Thumbwheel

By pressing a thumb on the wheel it will impede or stop the tape's progress. The operator could later release the thumbwheel after the temperature began to "crest" as airflow increased. This peak temperature would likely occur at a speed of about 3000 to 3400 rpm on the MS5001L/LA turbine.

Note: Exhaust temperature should never exceed 950 °F during start-up.

The output of the **GE/MAC** amplifier is connected to the electro-pneumatic transducer (called **65EP**) shown in Fig. 4 below (circular cover). This device converts the milliamp signal to a proportional air signal.



Fig. 4: Electro-pneumatic Transducer, 65EP (circular cover)

<i>MV/I Input</i>	<i>MV/I Output</i>	<i>65EP Output</i>	<i>Adjustment</i>
700 °F	10 milliamps	3 psig	ZERO in side 65EP on top
1000 °F	50 milliamps	27 psig	SPAN on side of 65EP.

The output of the 65EP transducer sent an air signal to the fuel regulator. See tubing connection at top of Fig. 5 below. This air signal controls the output oil pressure of the fuel regulator (known as Variable Oil Pressure, VCO). VCO was the command signal going to the fuel pump or gas valve to control fuel flow to the gas turbine.

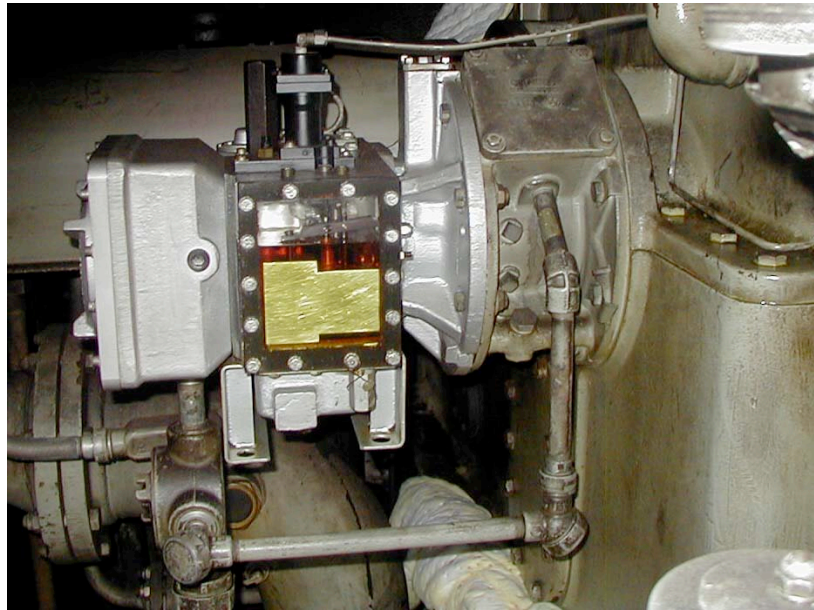


Fig. 5: Air connection atop fuel regulator

Another use of the **GE/MAC** thumbwheel would be to move the **70TC** tape **AHEAD** to give the fuel system a “boost,” if the rotor acceleration was too slow at or near the critical speed (approximately 2800 rpm). Thumbwheel increase will allow more fuel to flow to increase shaft acceleration.

In conclusion, it is good to know that the plant operator has a **MANUAL OVERRIDE** of the **GE/MAC** if needed during start-up of the plant.

For more information on the **GE/MAC** system, contact Dave Lucier of Pond and Lucier, LLC. Cell phone: 518-330-4801 or email: dave@pondlucier.com.