

Electronic Governor System

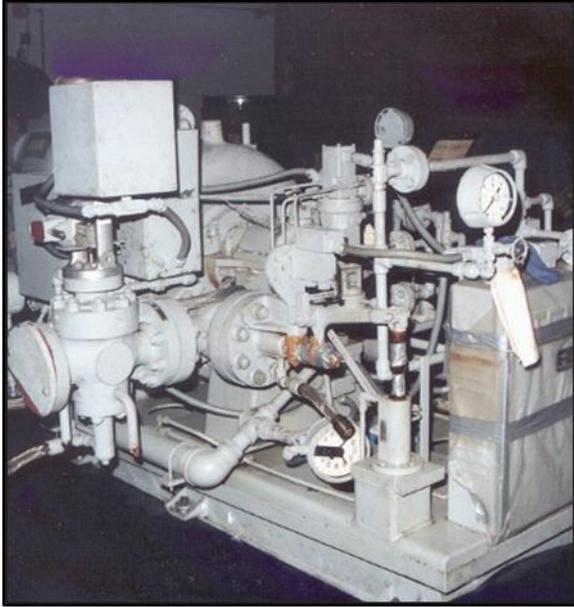
For Steam Turbine Applications

**CURTISS -
WRIGHT**

Steam & Air Solutions



Steam & Air Solutions
WWW.CW-EMS.COM/SAS



Typical Governor Speed Control System

Curtiss-Wright (originally sold under the name Terry® and Dresser-Rand®) quick-start, emergency pump drive steam turbines are installed in nuclear facilities throughout the world. During their 70-plus years of service (the first unit was installed in 1943), these solid-wheel steam turbines have undergone periodic upgrades to incorporate new technology.

As many of these nuclear facilities approach their mid-life extension periods with an expected additional 20-30 years of service, Curtiss-Wright (formally Dresser-Rand®) released its latest advancement in turbine speed control technology – the digital governor system. Curtiss-Wright's digital governor control system combines the proven capabilities of digital controllers with the rugged design of electro-mechanical actuators to address critical concerns surrounding the existing hydraulic speed control system.

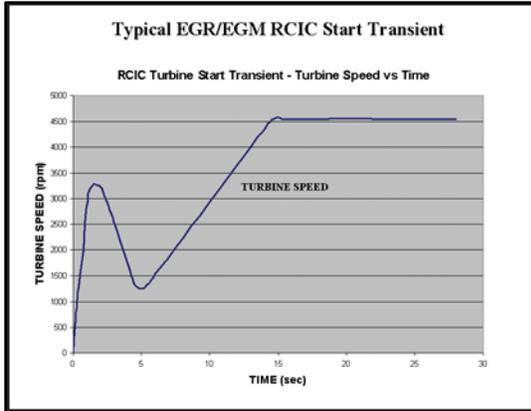
The original (Terry®) steam turbines were supplied with a speed governing system designed to assure rapid, controlled acceleration without over speeding. The controller, supplied by Woodward Governor

Company, incorporated an electronic governor module (EGM), electronic governor regulator (EGR), and remote servo drive that worked in conjunction with the turbine's mechanical linkage and governor valve to control the unit's speed.

The existing governor system has two critical dependencies. First, its reliance on hydraulic pressure to function results in a system that can maintain speed only after the turbine is spinning and supplying oil to the actuator. Second, the components that comprise the system are no longer available for purchase or repair by Woodward.

Curtiss-Wright understands the need to address these critical dependencies and has entered into a teaming agreement with Engine Systems, Incorporated (ESI). The agreement combines the efforts of both the original steam turbine and control system OEMs (ESI is Woodward's only authorized supplier to the nuclear market). Thus, Curtiss-Wright's new digital governor system introduces state-of-the-art technology that eliminates the issues of hydraulic control and component obsolescence. The updated system offers a nuclear-qualified Woodward 505 digital controller supplied by ESI; an electro-mechanical, direct-coupled actuator; a digital servo drive (supplied by Paragon Energy Solutions); and speed probes.

Turbine speed is monitored by a magnetic speed pick-up, which in turn provides a signal to the 505 digital controller. The digital controller provides a 4-20 mA demand signal to the servo drive which controls the electro-mechanical actuator. The actuator is mounted directly to the governor valve stem and includes a built-in internal resolver that provides positional feedback to the controller.



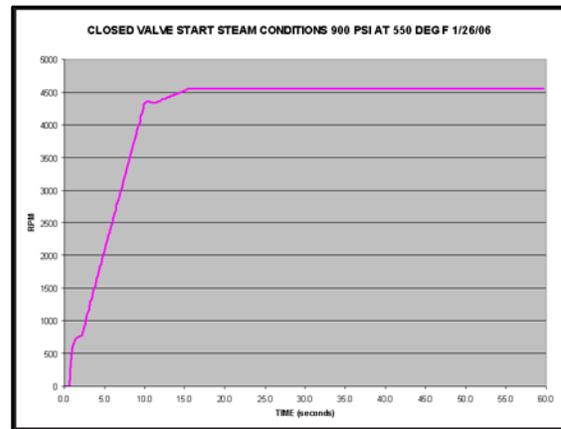
Curtiss-Wright's digital solution eliminates the current EGM, EGR, the remote servo and hydraulic subsystem, the mechanical linkage between the servo and valve stem, the ramp generator signal converter (RGSC), and the voltage dropping resistors. It offers a power supply of 125 VDC, steady-state power consumption of 1 AMP or less, and can be operated in both mild and harsh environmental conditions.

The calibration and maintenance requirements of the current governor system are eliminated with the Curtiss-Wright system. Operators no longer need to check hydraulic tubing for leaks, align or repair mechanical linkages to the valve stem, or replace faulty dropping resistors because all of these components have been eliminated.

The digital control system requires no calibration and low maintenance. System maintenance is relegated to replacement of the aluminum electrolytic capacitors (internally used in the Woodward 505 controller) every 5 to 7 years (services through ESI and Curtiss-Wright) and the replacement of the actuator every 10 years for mild environment applications (less expensive than changing seals, gaskets, and grease).

Testing

The digital governor system underwent comprehensive performance testing at the Wellsville, New York facility. Using a spare nuclear turbine, the system was tested uncoupled to a pump, with a steam pressure of 900 pounds at a temperature of 550 degrees Fahrenheit (steam energy rating of approximately 1,200 pounds). The unit was operated with ramp rates of 30 and 15 seconds in both open valve and closed valve configurations. Additional testing included steady-state testing, load-transient testing, component variation, and lastly, system-limitation testing (ramp-rate variation).



Qualification testing of the Curtiss-Wright digital governor system included the following:

- EMI/RFI to EPRI TR102323 and Reg. Guide 1.180
- Environmental qualification to IEEE323 for turbine mounted components and original Terry® developed design parameters
- Seismic qualification to IEEE 344 and original Terry® developed design parameters
- Commercial grade dedication of digital components meets EPRI TR-106439

The System's actuator and speed probes are qualified for harsh environmental applications (radiation limit of 1×10^6), while the digital controller and servo drive are qualified for mild environmental applications (radiation limit of 5.5×10^3). Seismic qualification criteria for the system is Category 1, and all components meet EMI/RFI requirements. For harsh environmental applications, the Woodward 505 controller and servo drive can be remotely operated up to 1,000 feet from the turbine containment area.

Woodward 505 Controller

The Woodward 505 digital controller has been in use commercially since 1998. The installed user base now exceeds 5,000 units worldwide and includes both steam and gas turbine applications. Curtiss-Wright and ESI will offer the 505 digital controller in a standard two panel design or, if required, in a panel specifically constructed to replace the client's existing control box. The 505 digital controller is supported by ESI's 10CFR50 Appendix B nuclear dedication program.



Actuator

The System's electro-mechanical actuator, made by Curtiss-Wright's Exlar® subsidiary, is based on an inverted roller screw design. This technology has been employed successfully in both commercial and military applications in more than 500 installations. Curtiss-Wright will offer one actuator capable of meeting both mild and harsh environmental requirements, and it will be dedicated to Curtiss-Wright's 10CFR50 Appendix B nuclear dedication program. The actuator design includes a feature for emergency manual stroking of the valve if the plant loses electrical power to the turbine governor system.



Servo Drive

The System's MOOG® servo drive is matched to the electro-mechanical actuator. It, too, has been employed successfully in both commercial and military applications. MOOG® testing included mild environment qualification and meets EPRI-TR-106439. Product dedication is also part of Curtiss-Wright's 10CFR50 Appendix B nuclear dedication program.



Speed Probes

The System's speed probes (supplied by ESI) were tested to IEEE 323, IEEE 344, and Terry's® original design parameters. Part dedication is per ESI's 10CFR50 Appendix B nuclear dedication program. A one- or two-probe configuration can be used with the Curtiss-Wright digital governor system; however, two probes are recommended for redundancy purposes.



Additional Features

The 505 controller includes:

Inputs:

- Two speed inputs
- Six programmable analog inputs
 - Auxiliary input, remote auxiliary setpoint, cascade input, remote cascade setpoint, remote speed setpoint, and load sharing
- 16 contact inputs
 - Shutdown, reset, raise, speed setpoint, lower speed setpoint
- 12 configurable contact inputs

Outputs:

- Two actuator outputs with linearization curves
- Six 4-20mA outputs for meters/readouts
- Eight relay contact outputs
 - Alarm, shutdown, and six configurable

Start Modes:

- Full auto
- Semi-auto
- Manual

Idle / Rated:

- Move between idle and rated speeds

Watchdog System:

- Continual, internal self-diagnostic program

Curtiss-Wright also offers a stand-alone tachometer for emergency manual operation. Should the plant lose power to the digital governor system, the tachometer, which is powered through the speed probe signal, will supply turbine speed readings by which the operator manually controlling the actuator can evaluate proper valve position.

For further information, please contact your local Curtiss-Wright representative:

Curtiss-Wright
Electro-Mechanical Corporation
EMS Division
Steam & Air Solutions
585 Trade Center Parkway
Summerville, SC 29483
Tel: 585-596-3831
Fax: 585-596-3369
www.cw-ems.com/sas



CURTISS - WRIGHT

Contact: 585 Trade Center Parkway
Summerville, SC 29483 / 1-585-596-3831

Steam & Air Solutions 
WWW.CW-EMS.COM/SAS