DRESSER-RAND

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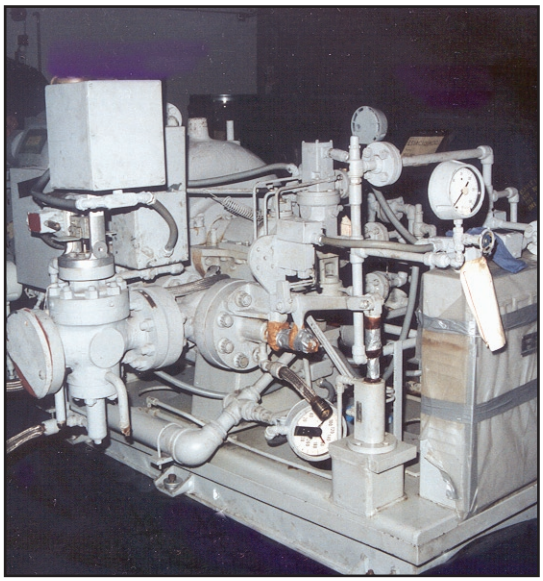
THE DRESSER-RAND DIGITAL GOVERNOR SYSTEM



Typical Governor Speed Control System.

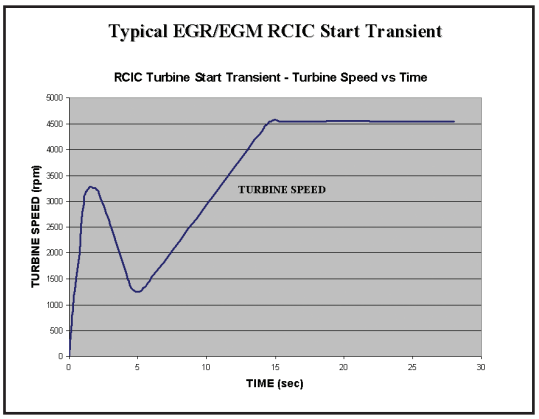
Dresser-Rand (originally sold under the name Terry™) quick-start, emergency pump drive steam turbines are installed in nuclear facilities throughout the world. During their 60-plus years of service (the first unit was installed in 1943), these solid-wheel steam turbines have undergone periodic upgrades to incorporate new technology.

As many of these nuclear facilities approach their mid-life extension periods, and anticipate another 20 to 30 years of service, Dresser-Rand is prepared to release its latest advancement in turbine speed control technology – the digital governor system. Dresser-Rand'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 is its reliance on hydraulic pressure to function that 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 control system are no longer in production and no longer available for purchase or repair.

Dresser-Rand 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, Dresser-Rand'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 servo amplifier; and one- or two-speed probes.



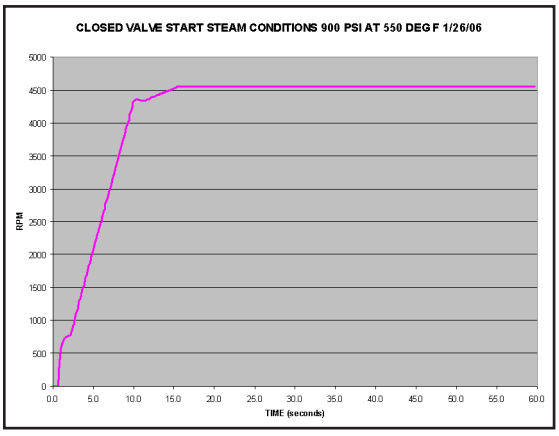
Turbine speed is monitored by a magnetic speed pick-up, which in turns provides a signal to the 505 digital controller. The digital controller provides a 4-20 mA demand signal to the servo-amplifier that controls the electro-mechanical actuator. The actuator, is mounted directly to the governor valve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

Dresser-Rand's new 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 speed converter (RGSC), and the voltage dropping resistors. It offers programmability via laptop computer; a power supply of 120 VAC, 125 VDC, or 250 VAC; 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 new Dresser-Rand 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 no regular maintenance. System maintenance is relegated to replacement of the electrolytic capacitors (internally used in the Woodward 505 controller) every five to seven years (by Woodward services through ESI) and the replacement of the actuator every 10 years (less expensive than changing seals, gaskets, and grease).

Testing

The digital governor system underwent comprehensive performance testing at Dresser-Rand's 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 Dresser-Rand digital governor system is planned to include the following:

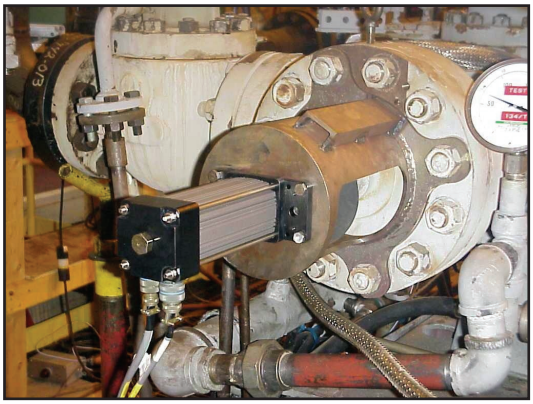
- EMI/RFI to EPRI TR102323 and Reg. Guide 1.180
- Environmental qualification to IEEE 323 and original Terry developed design parameters
- Seismic qualification to IEEE 344 and original Terry developed design parameters
- Software V&V to EPRI-TR-106439 and Reg. Guide 1.152.

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

Woodward 505 Digital 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. Dresser-Rand and ESI will offer the 505 digital controller in a generic control box (inclusive of the power supply and amplifier) or, if required, in a box specifically designed 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 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. Dresser-Rand will offer one actuator capable of meeting both mild and harsh environmental requirements, and it will be dedicated to Dresser-Rand's 10CFR50 Part 21 Configuration Management System. The actuator design includes a bolt on the end of the unit for emergency manual operation if the plant loses electrical power to the turbine governor system.

Servo Amplifier

The System's servo-amplifier is matched to the electro-mechanical actuator. It, too, has been employed successfully in both

commercial and military applications. Testing will include mild environment qualification and software V&V to EPRI-TR-106429. Product dedication will also be part of Dresser-Rand's 10CFR50 Part 21 Configuration Management System.

Speed Probes

The System's speed probes (supplied by ESI) have been tested to IEEE 323, IEEE 344, and Terry's original design parameters. Part dedication will be per ESI's 10CFR50 Part 21 Configuration Management System. A one- or two-probe configuration can be used with the Dresser-Rand digital governor system; however, two probes are recommended for redundancy purposes.

Additional Features

The Woodward 505 digital controller can communicate directly with distributed control systems and laptop computers through two modbus ports, using RS-232, RS-422, or RS-485 connections. 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, and 12 configurable contact inputs)

Outputs:
- Two actuator outputs with linearisation curves
- Six 4-20mA outputs for meters/readouts
- Eight relay contact outputs (alarm, shutdown, and six configurable)

Start modes - full auto, semi-auto, and manual

Idle/Rated - move between idle and rated speeds

Watchdog System - continual, internal self-diagnostic program

Dresser-Rand 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.

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