

Steam Turbine Control



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Major Control System Objectives

Steam Turbine Control Waiting for Alarm Events											
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State Run						GT	AS	CP	Stear	m Turbine	Control
N(0) 6027.8 N(1) 0.00 N(2) 0.00	In1 Er In2 Er In3 Er	C Trend	d Config 6027.8 Trip	Enable Trip) Init dPv/dT	Config 0.00				maxGo minGo LoopStartT	v 7500.0 v 4600.0 √ 4000.0
cpL1PV 12.19 cpL1FF 0.00 cpL2PV 6.97 cpL2FF 0.00 stFF 0.00 MCVOutRB 0.00 Sim Simulation ✓	CpL1 SPT PV CV FF	Trend 12.19 C 12.19 E 12.19 Ir 75.4 W 0.00 W	Config as n it H /L	cpSelL InRc In1 Enal InRc In2 Overr InRc In3 CV InRc In4 LML	ole 🖌 ide 6031.	Config 0.0 Init WH WL	SPT E SPT E SP E PV E CV FF	Trend 031.6 Ca 031.6 En 0027.8 Ini 0.8 WH 0.00 Ext	Config s 🖌 t O t O t Tune	stOut Confi Cas Safe OP 0.78	g OutChar
ESD	cpL2	Trend	Config -	OL Start	CL	Start	OL Alt	tStart	CL Alt	Start	Stop
Reset ESD Alt Start Start Stop	SPT SP PV CV FF	0.00 C: 0.00 E 6.97 Ir 0.0 W 0.00 W	as in ift H		0 1 2	Ramp Rate 100.0 -0.1	Toleranc LML 0.0 2.0 2.0	e 0.0 LMH 3.0 3.0 15.0	Vext	Timer Action ESD V ESD V	tion PRE(s) 30 30
			<u> </u>		3	0.0	15.0	15.0		ext Step 🔻	15
					4	0.5	15.0	35.0		ext Step 🔻	60

- 1. Increase reliability of machinery and process
- Prevent unnecessary process and machine trips and downtime
- Minimize process disturbances
- Prevent overspeed and overspeed damage
- Simplify and automate startup and shutdown
- 2. Increase efficiency of machinery and process
- Operate at lowest possible energy levels
- Minimize setpoint deviation
- Maximize throughput using all available horsepower
- Optimize load sharing of multiple units in generator applications



Steam Turbine & Extraction Control

- 1. Steam Turbine Control Application (STCA)
- Starts, stops, controls, and protects steam turbines
- Uses PID loops to control valve position to maintain turbine speed set point
- Extraction turbines: maintains turbine speed/power and extraction pressure/flow
- 2. Benefits
- Retrofit existing steam control valves and old hydraulic control systems
- Minimize overspeed and associated damage
- Operate closer to control limits, increasing production





Extraction Map



Extraction Map measures the following properties based on OPC signals:

- P1: HP turbine inlet pressure
- T1: HP turbine inlet temperature
 - Pe: LP header pressure
 - Te: LP header temperature
 - V1: HP control valve position
 - Ve: LP control valve position

The results of computations are:

- Q1: steam inlet flow rate
 - Qx: exhaust flow rate
- Qe: extraction flow rate
- MW: shaft power output

Mollier Diagram for Steam



Steam turbine capability diagram

- Shows steam turbine operation.
- Displays entropy versus enthalpy as the main axes and steam quality (%), steam pressure, and steam temperature as subaxes.
 - Steam turbine inlet: mark (X) at a higher pressure and temperature.

• Steam turbine outlet: mark (X) at a lower pressure and temperature.

• Calculated variables are entropy in and out as well as enthalpy in and out

Retrofit & Replace Hydraulic Speed Controls

- Goal: Provide tight turbine control and also remove all components related to hydraulic control
- Solution details:
 - Retrofit actuation of existing steam control valves & old hydraulic control systems
 - Patented solution for Exlar actuator — provides full redundancy





Mechanical Equipment for Turbine Retrofits

- Complete retrofit kits
- Pneumatic actuator retrofits
- Low pressure hydraulic actuators
- High pressure actuators with dedicated hydraulic power units
- DEHT all electric retrofits
- Speed gears, magnetic pickups, and brackets





Direct drive steam valve actuator with solenoid valves for ESD



- Extremely fast and accurate position control of main actuator
- Improves quality of total speed control loop
- Eliminates need of calibration of analog systems
- Allows redundancy of all electronics (including final driver)



Mechanical Equipment for Turbine Retrofits

Magnetic pickups

- Magnetic pickups are non-contact sensors that convert mechanical motion into a proportional frequency output.
 - Passive sensors
 - Use a magnet and moving gear teeth to generate a pulse that is proportional to speed
 - Have a minimum operating speed
 - Active sensors
 - Require a power source due to amplifier stage built in pickups
 - Operate at very low frequencies due to amplifier

Speed measurement gears

- Designed to meet the specific requirements for the installation.
- Exact dimensions for the shaft and housing are required.
- Normally try to use a 60 tooth gear.
- Existing gears may be used after review of the installation.
- Gears should be balanced to prevent dynamic problems.
- The gears must be constructed of a magnetic material.
 - The gear should be mounted in a location that prevents the thrust from moving the gear away from the magnetic pickups.

