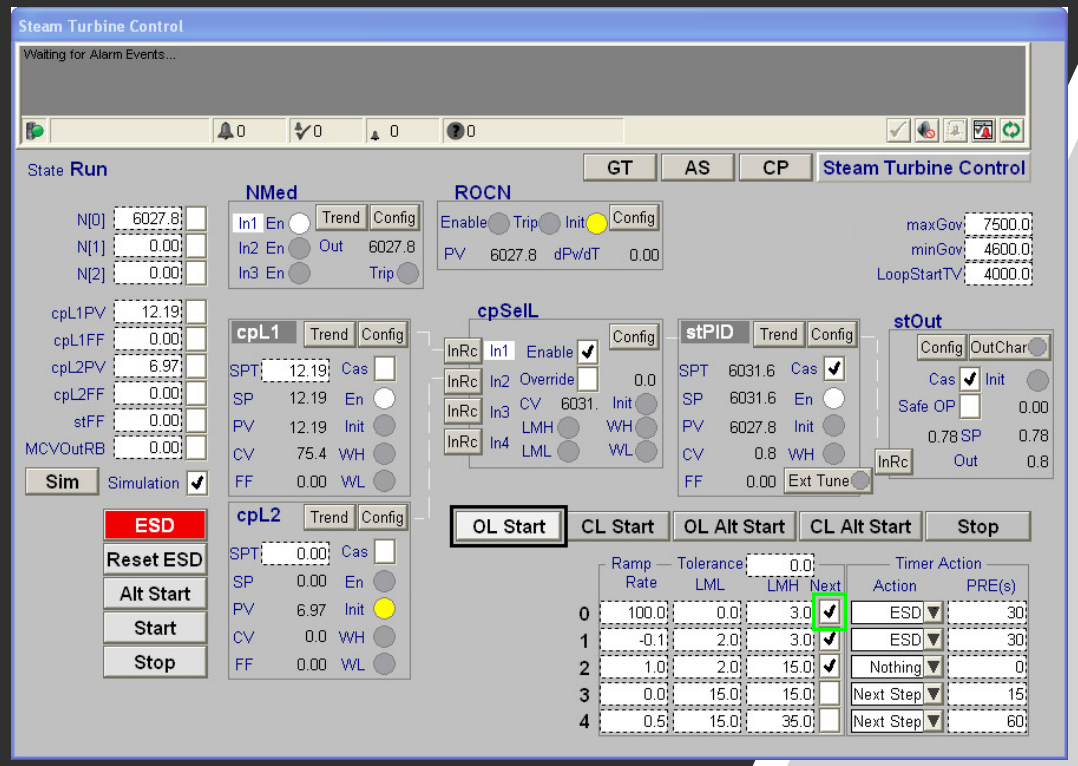
# Steam Turbine Control

# Major Control System Objectives




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

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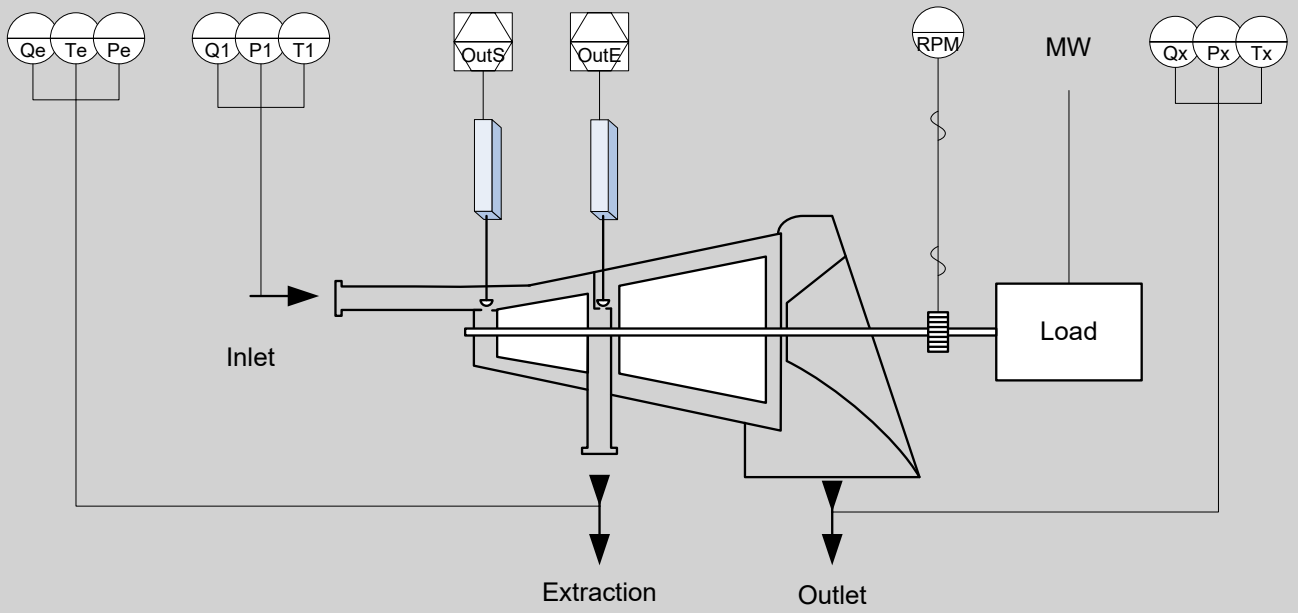
# Steam Turbine & Extraction Control

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

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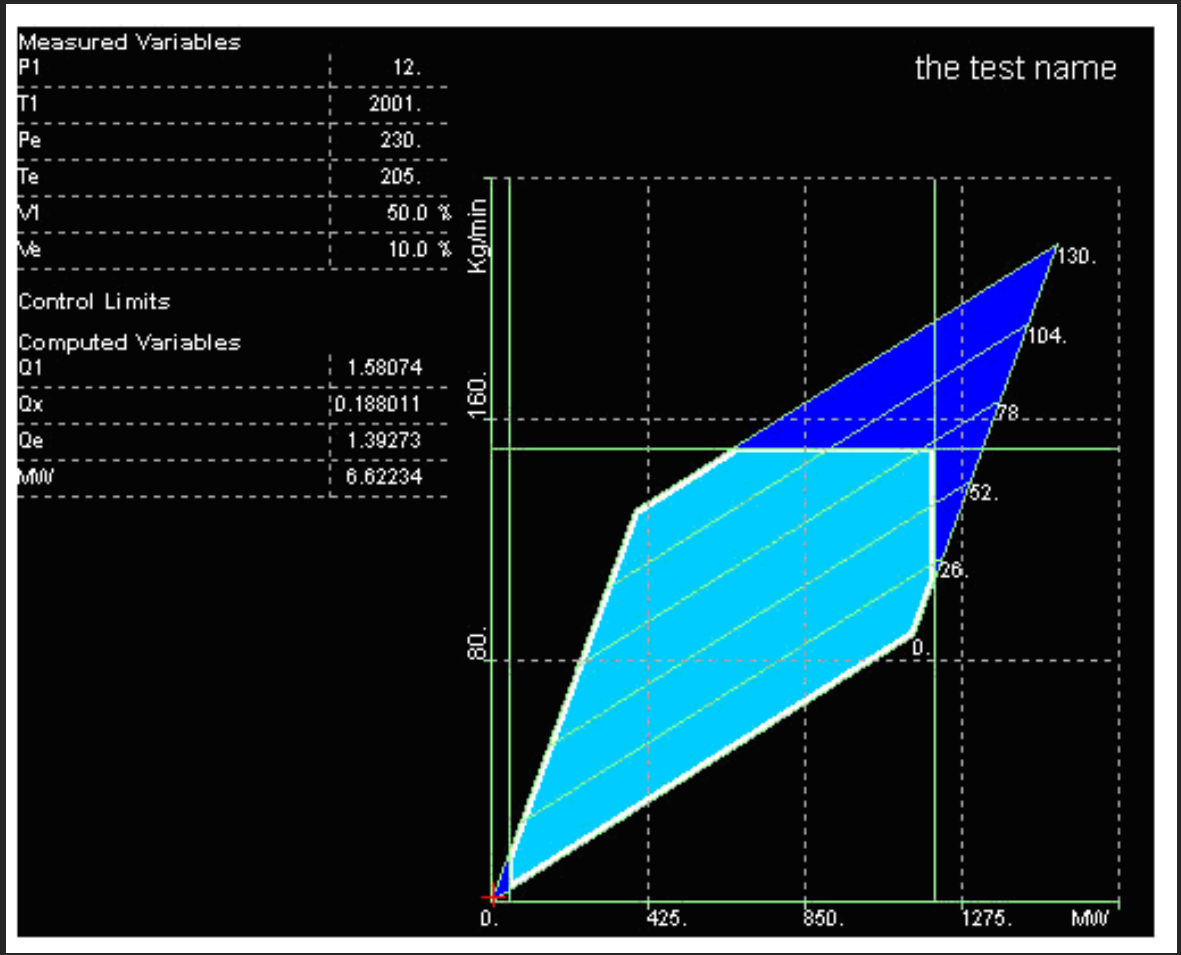
# Extraction Map



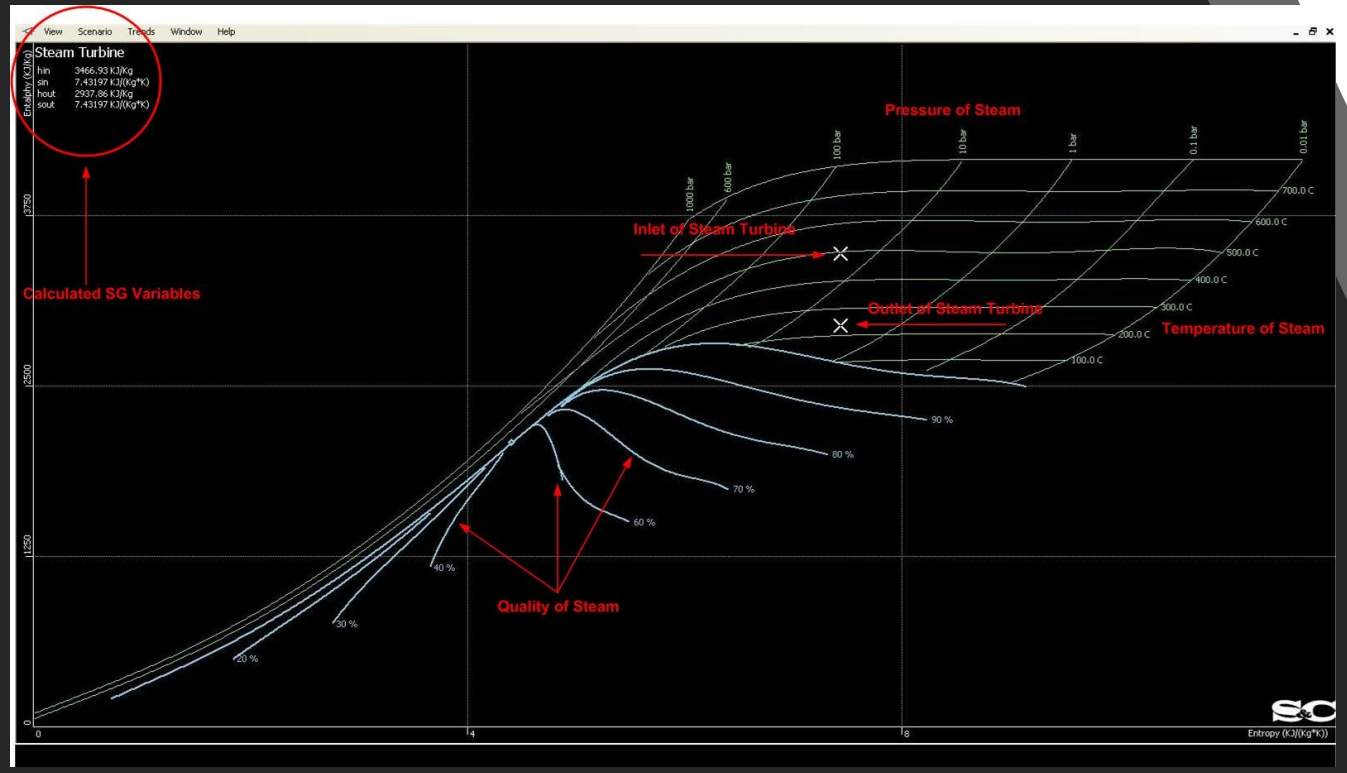

Extraction Map measures the following properties based on OPC signals:

- 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

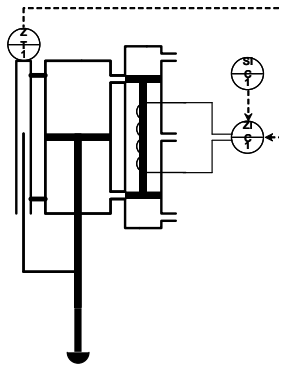
- Shows steam turbine operation.
- Displays entropy versus enthalpy as the main axes and steam quality (%), steam pressure, and steam temperature as subaxes.
- Steam turbine inlet: mark (X) at a higher pressure and temperature.
- Steam turbine outlet: mark (X) at a lower pressure and temperature.
- Calculated variables are entropy in and out as well as enthalpy in and out

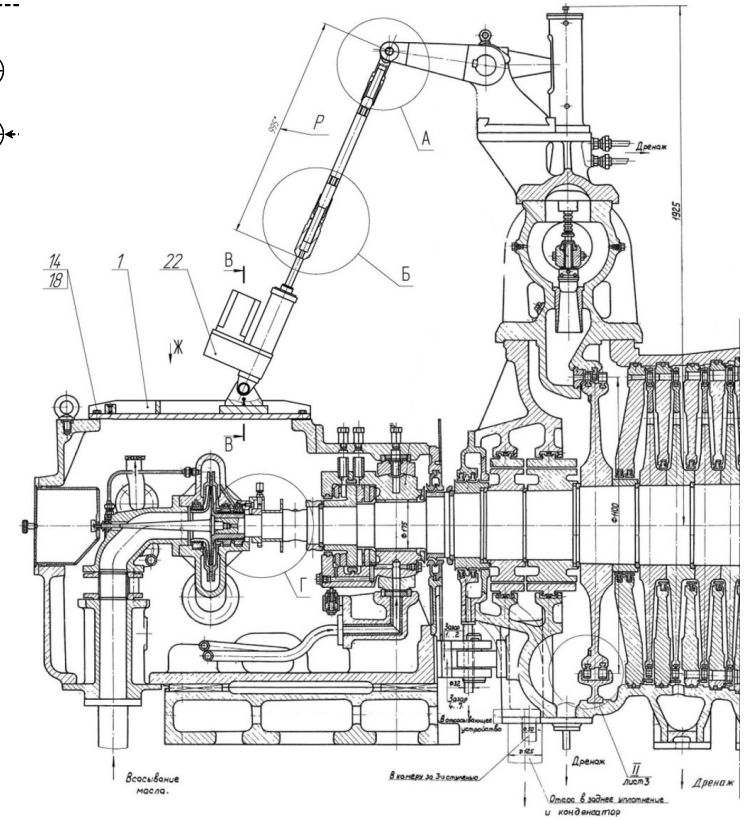
# Retrofit & Replace Hydraulic Speed Controls

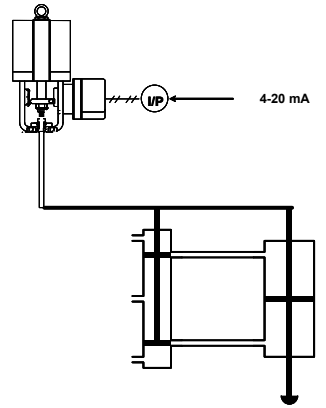
- Goal: Provide tight turbine control and also remove all components related to hydraulic control
- Solution details:
  - Retrofit actuation of existing steam control valves & old hydraulic control systems
  - Patented solution for Exlar actuator – provides full redundancy

# Mechanical Equipment for Turbine Retrofits

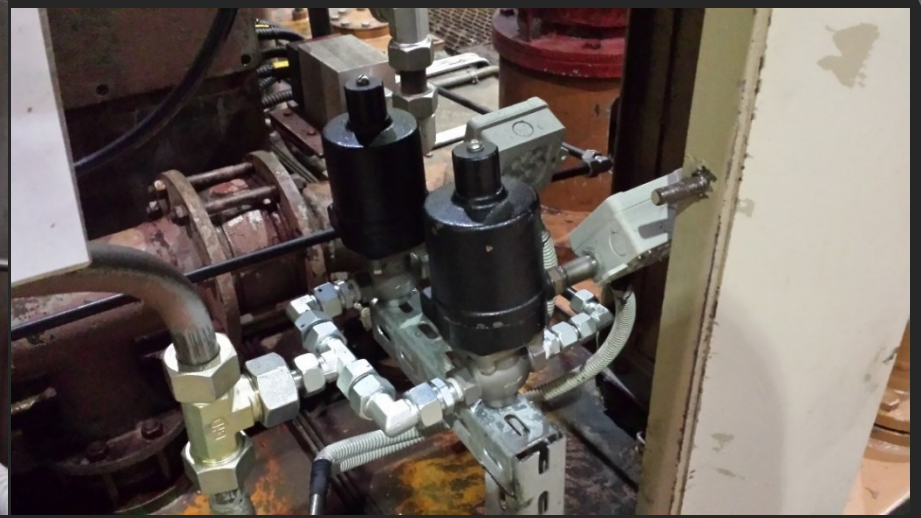
- Complete retrofit kits
- Pneumatic actuator retrofits
- Low pressure hydraulic actuators
- High pressure actuators with dedicated hydraulic power units
- DEHT all electric retrofits
- Speed gears, magnetic pick-ups, and brackets



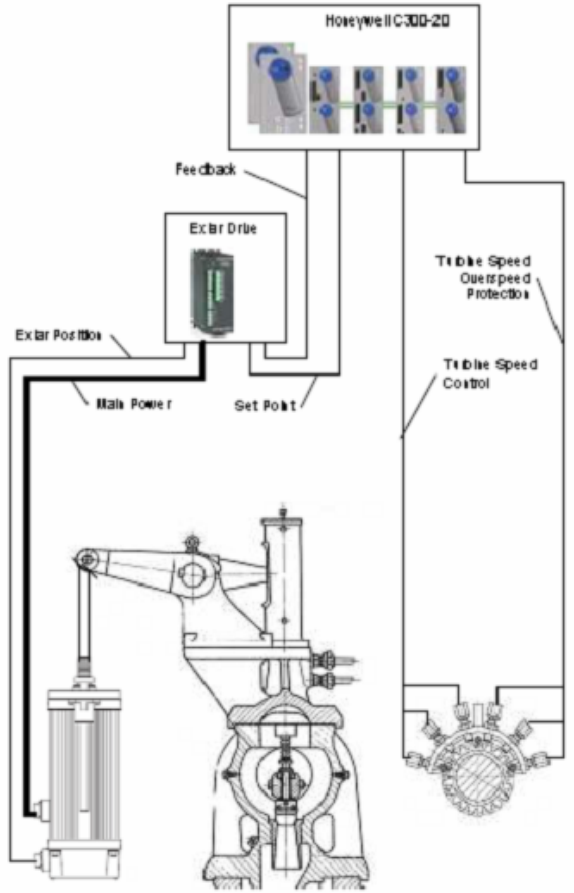


# Direct drive steam valve actuator with solenoid valves for ESD



- 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.