NHA 2010 Annual Conference
Governor Maintenance

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Overview

- Governor 101
- O&M Goals
- NERC / Grid Stability
- Preventative Maintenance
- Oils
- Pumps & PMGs
- Training

Governor 101

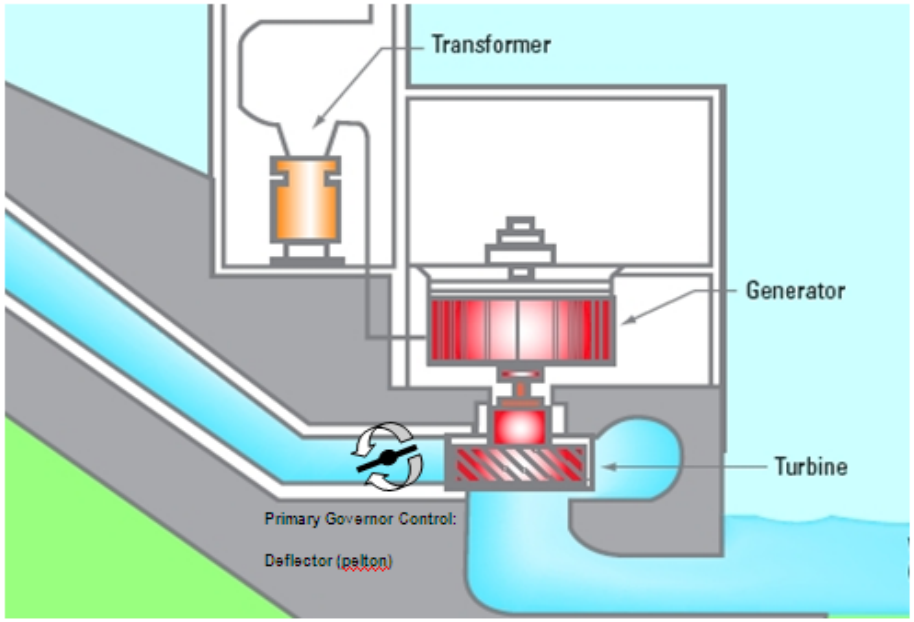
What is a governor?

- A governor is a mechanism that responds to deviations from equilibrium and seeks to restore the system back to equilibrium.

Why do we need them?

- The governor is used to start the turbine, control the speed of the turbine to permit the generator to be synchronized to the grid in a stable and safe manner, and then allows the generator to produce generation and automatically share load with the other units on the grid during frequency excursions.

Governor Interaction at Hydro Plants



Governor Objectives

Actuators:

- Wicket gate position – controls water flow
- Blade angle – optimizes turbine efficiency (Kaplan turbines)
- Deflector / needles – controls water flow & turbine efficiency (pelton turbines)
- Breakers – connects generator to grid

Sensors

- Voltage
- Current/power
- Phase angle
- Actuator position or angle
- Water level

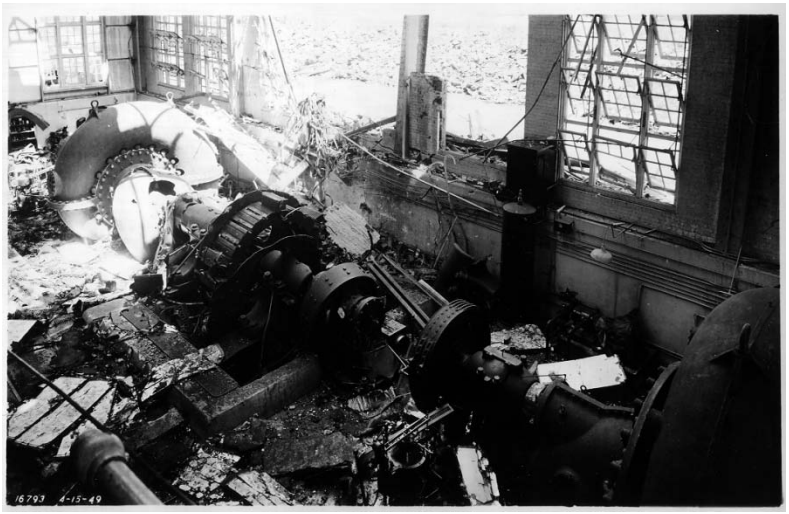
Subsystems:

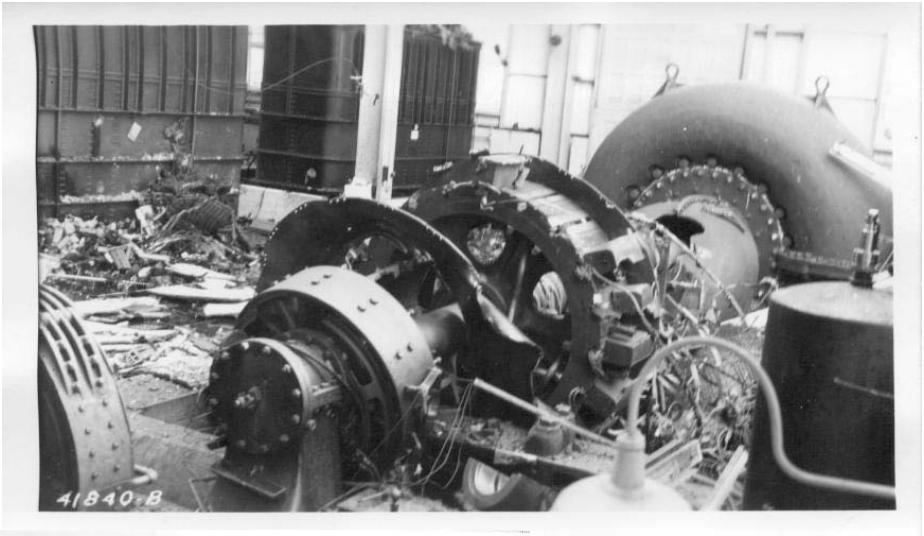
- Mechanical actuation often involves hydraulic amplification subsystems that have internal feedback loops

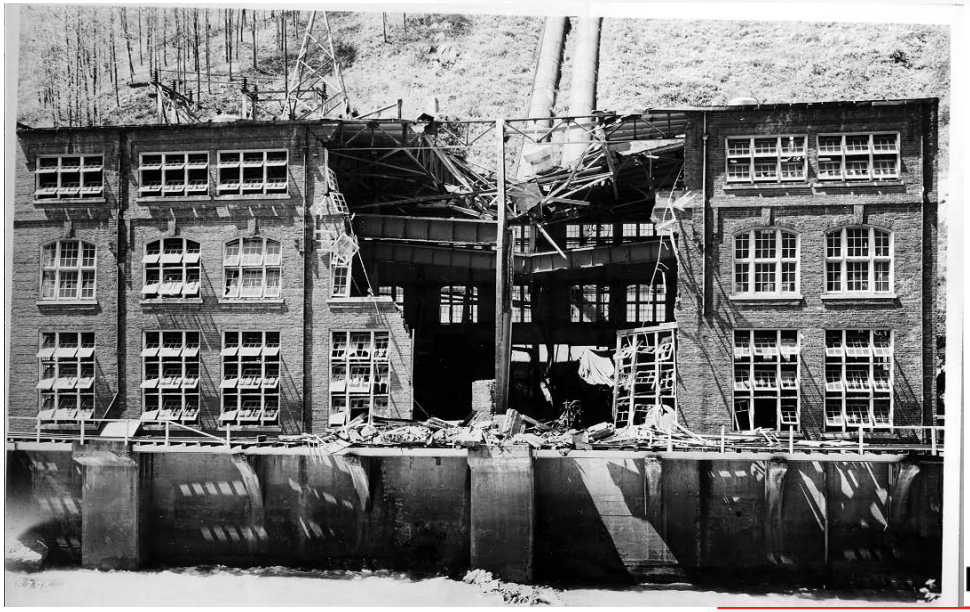
Control goals:

- Synchronize generator phase with grid
- Control the electrical power output from the unit
- Optimize the turbine efficiency
- Provide frequency stability to the grid
- Provide quick response to load changes (one of the fastest responding types of power generation)
- Automate response to hardware failures
- Provide redundancy for control functions
- Support ancillary functions for other stakeholders such as water level control (irrigation needs), flow rates (recreational purposes like rafting)

Not a good day: Ocoee #2 Runaway 4/14/49







O&M Goals:

Reduce Frequency & Duration of Forced Outages

Increase MTBF

- Preventative Maintenance during Planned Outages
- Redundancy in Field Devices, Hydraulics, Controllers

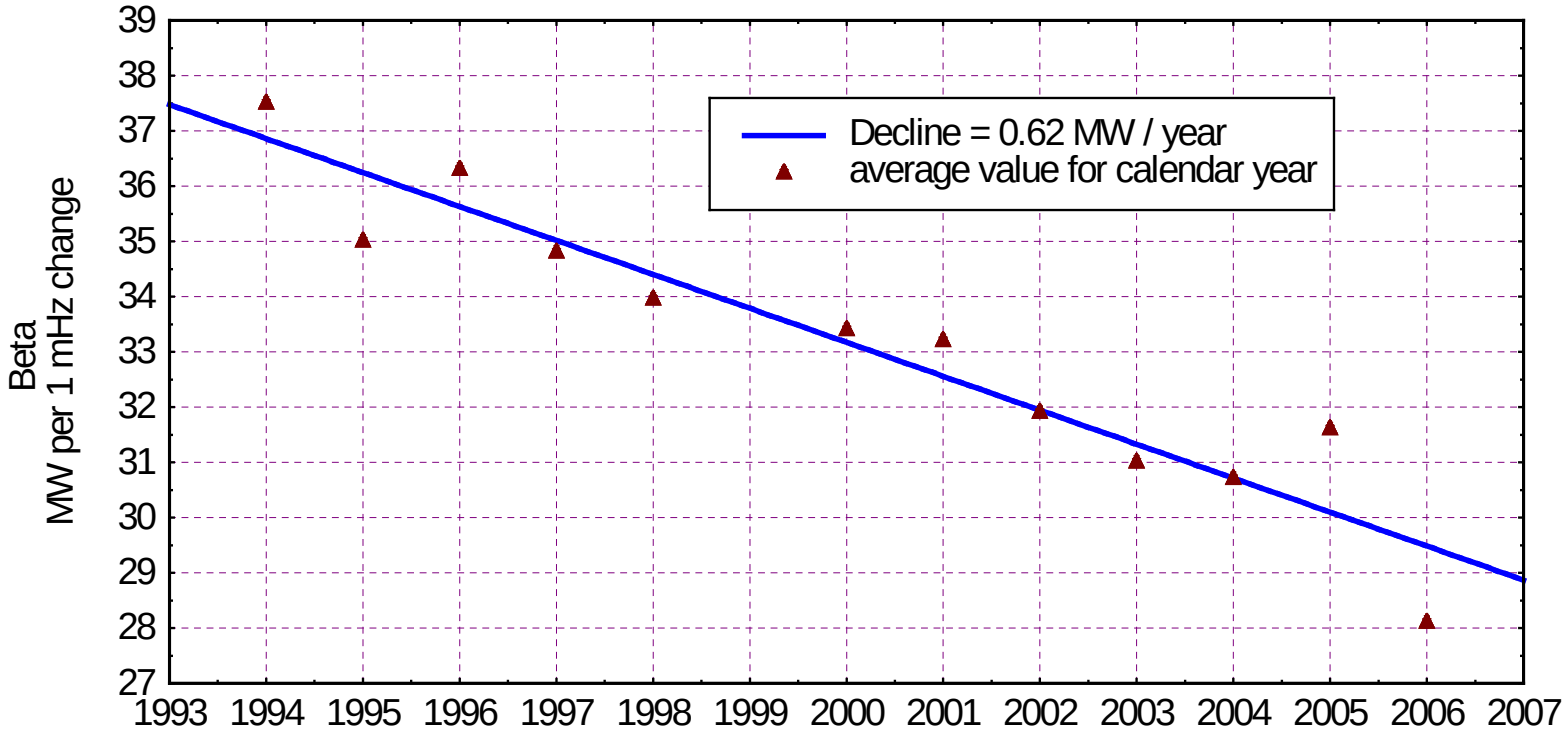
Decrease MTTR

- Quick Troubleshooting
- Critical Spare Parts On-Site
- Quick Access to Other Spares
- Fast Repairs, Local or Factory
- Access to Emergency Support
- Identification of Long Lead Items
- Training of Personnel
- Technical Support
- Field Service

NERC – Grid Stability

- The role of hydro in supporting grid stability
- Proper governor maintenance is important
- Digital conversion not required to pass NERC tests!

Eastern Frequency Response



Frequency Response Declined 24%
While Load and Generation Increased 20%

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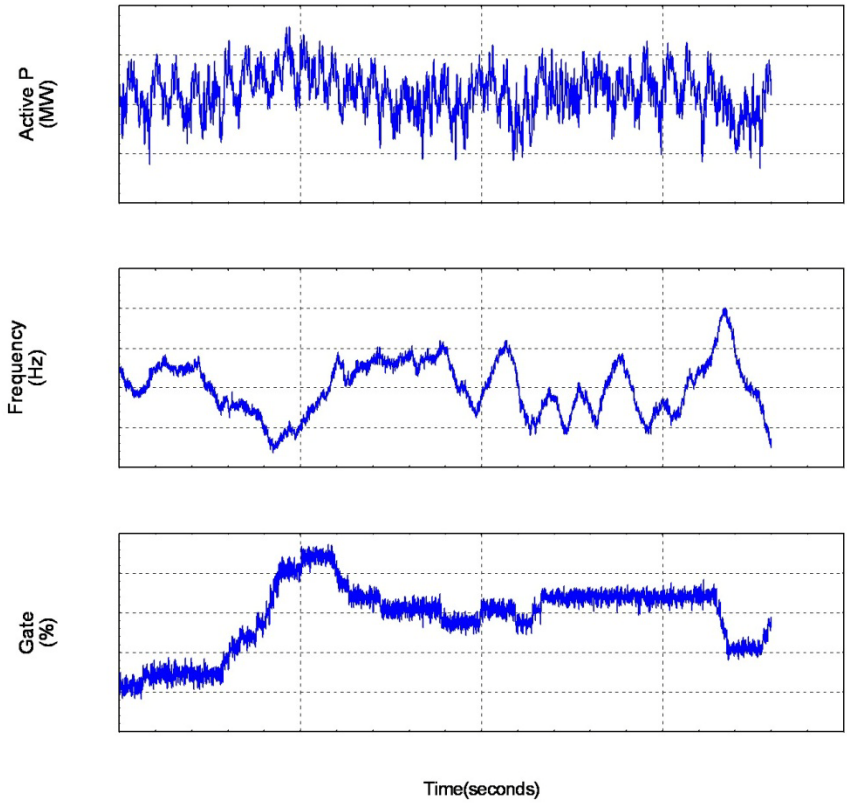
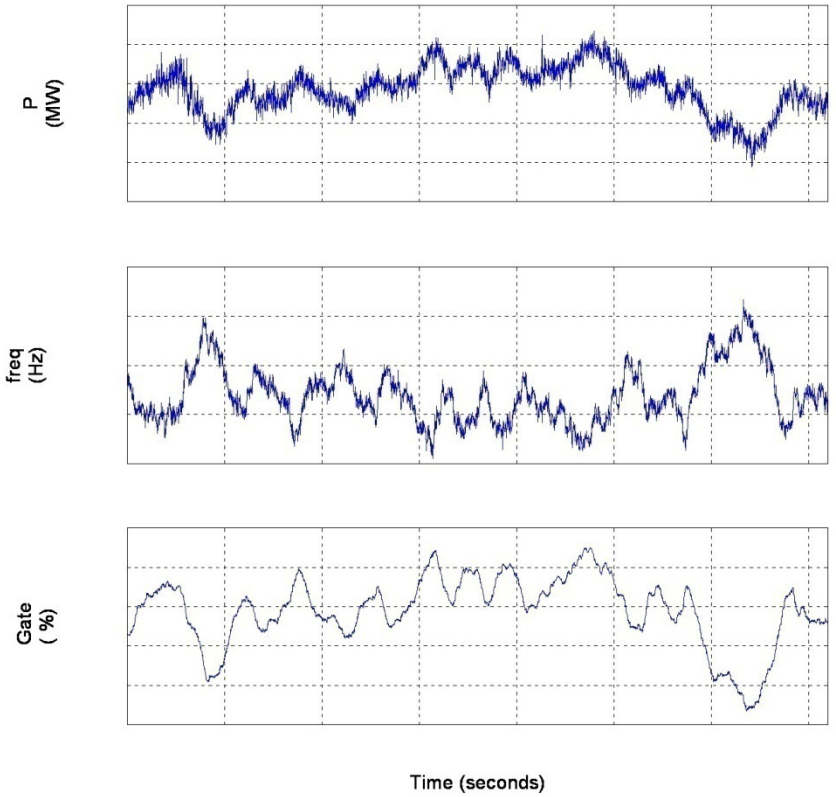
Woodward Mechanical Cabinet



Before Maintenance and Tuning



After Maintenance and Tuning

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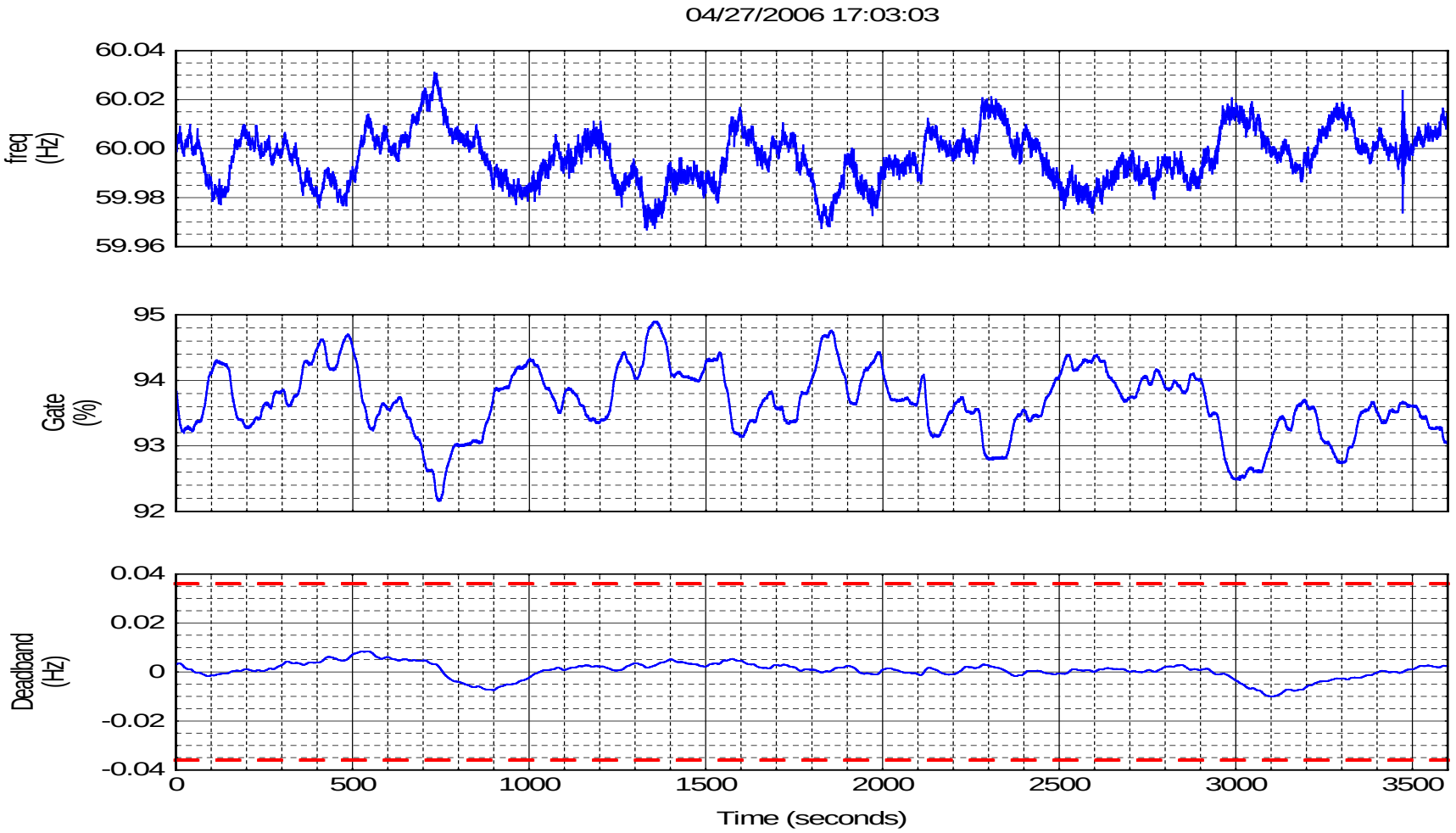
Mechanical Cabinet Passes NERC



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Poor Preventative Maintenance

Mechanical Governors

The two enemies of “classic” governors:

- Friction
- Lost Motion

How to find and eliminate them:

- ✓ Lubrication
- ✓ Monthly inspection
- ✓ Annual governor testing
- ✓ Overhaul as required

Time-Based Maintenance

Weekly

Add oil to all pivot points.

Monthly

Check oil filters
Check dashpot oil level – add dashpot oil if needed

12 Months

Add dashpot oil to strap suspended ballhead
Check ballhead bearings

24-36 Months

Disassemble, clean, inspect, replace worn parts:
Governor pilot valve
Dashpot
Ballhead
Linkages
Lubricate and check movement of governor restoring cable
Check distributing and relay plunger for freedom of movement.

Alternate Approach

TBM ignores actual governor performance:

- Governor wear is not uniform
- Good, useable parts may be discarded
- Annual outage may be unnecessary

TBM widely replaced by Run-To-Failure due to focus on cost reduction:

- Governor maintenance may be neglected
- Poor governor performance exposed only during grid disruption

Governor Health Monitoring provides:

- Simple, quick governor performance verification
- Identification of poor-performing governors
- Lead time to schedule outage, purchase needed parts

Governor Health Monitoring

- An annual test using simple on-line method.
- Allows comparison against past performance.
- Provides tools to tune for peak performance
- Enables scheduling of maintenance or overhaul, as needed. Avoids unnecessary outages.

Digital Governor Maintenance

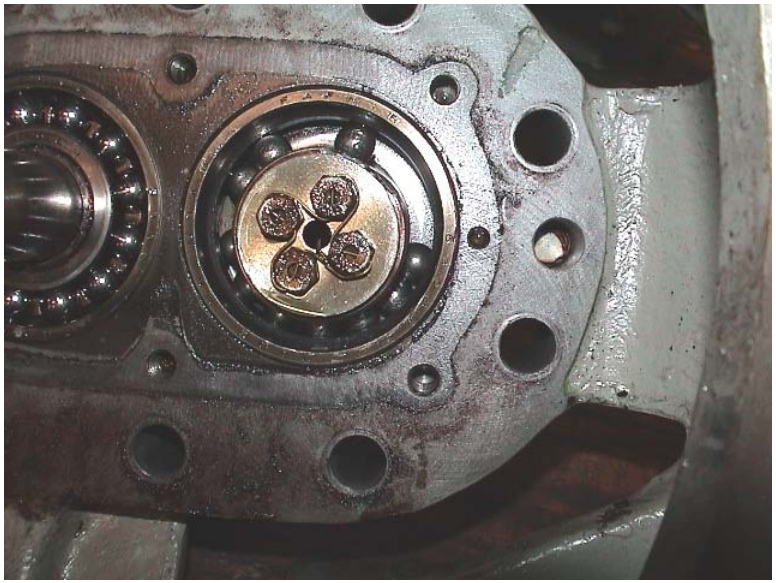
- Oil Cleanliness / Oil Filters / Oil Sample Analysis
- Calibration of Feedback Sensors
- Hydraulic Solenoids - Exercise to minimize silt build-up
- Control Relays - Exercise to verify contacts and wiring
- Servomotors - Check full travel for binding or abnormal operation.
- Fastener Security - Check the torque on all accessible fasteners.
- Corrosion – Inspect electrical terminations, connectors, components.
- Battery Replacement
- Auxiliary Systems: Pumps and SSGs

Oils

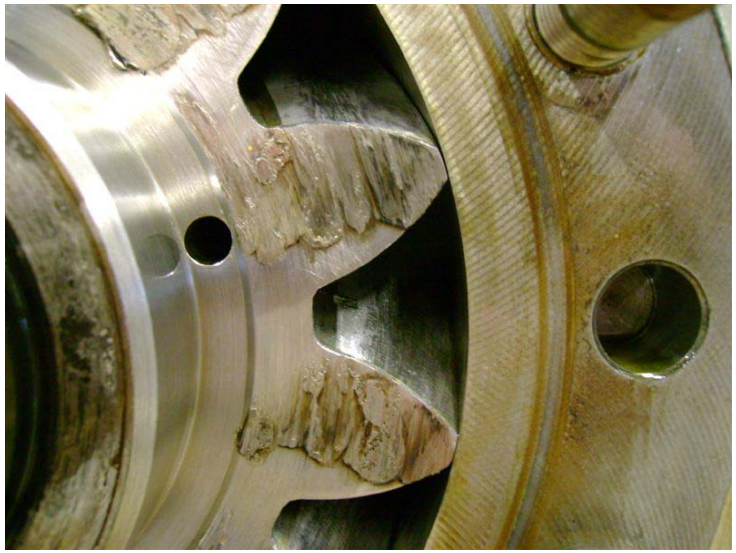
- Contaminated Oil is the #1 Cause of Governor Problems
- Oil Should be Free of Dirt, Air & Water
- When to Change or Clean Oil
  - Appearance
  - Smell
  - Water or other contaminants
  - Viscosity changes
  - Excessive wear
- Kidney Loop Filtration Systems
- Incompatible Oils / Choosing the Proper Oil
- Filter maintenance schedule with Inspection
- Oil sample analysis

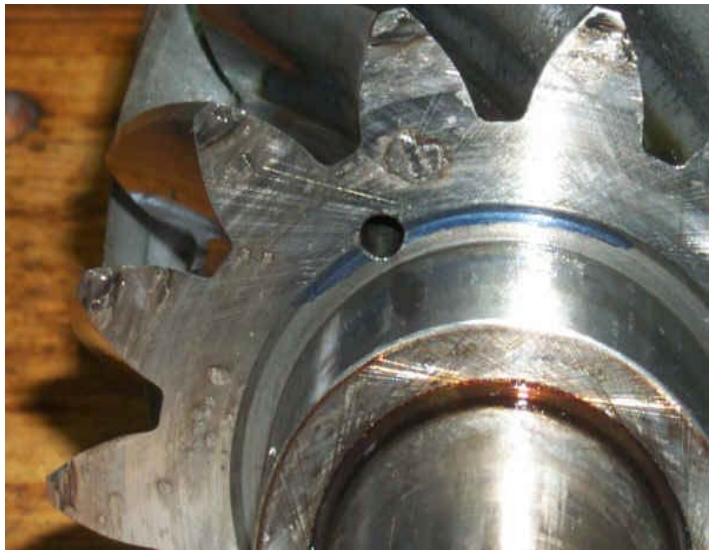
Pumps - Preventative Maintenance

Pump Maintenance Postponed



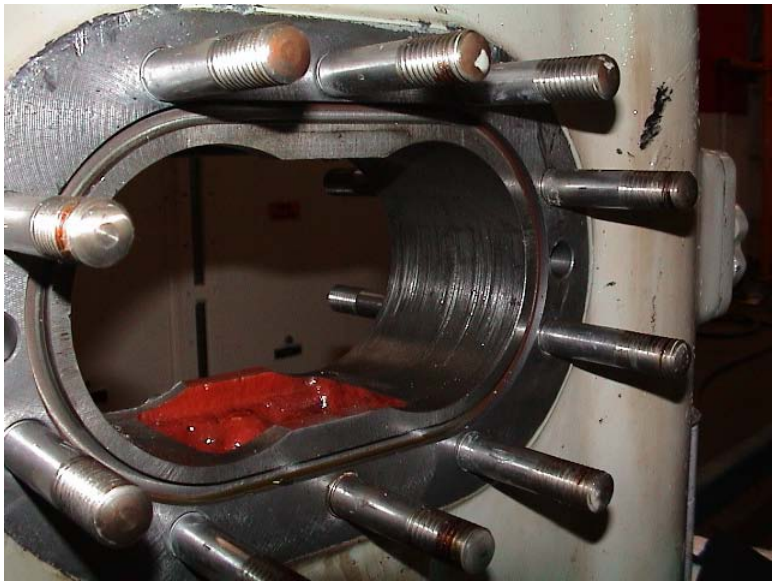
Pumps - Gear Damage

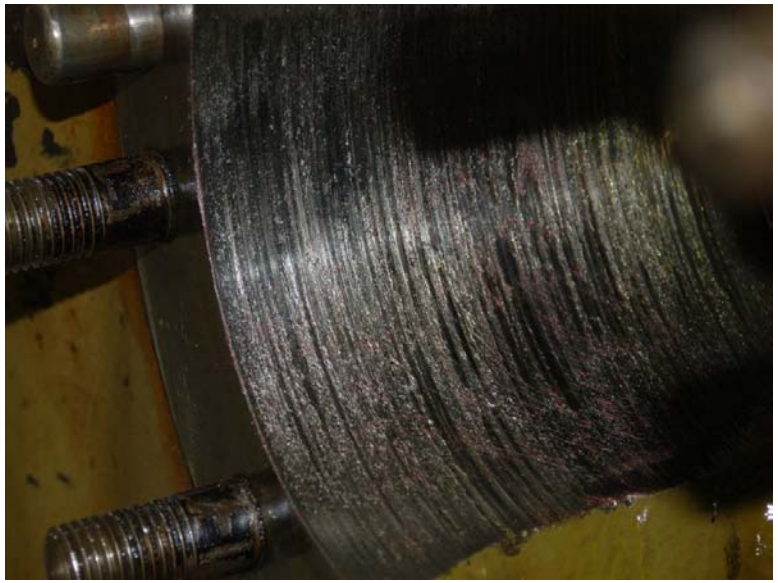




Pumps - Wear Plate Damage

Pumps – Gear Pocket Damage





PMGs

- Verify PMG voltage
- Remagnetize as needed
- Overhaul auxiliary speed switches

PMG Remagnetization

- Woodward
- Pelton

Training

Staff training is critical to reducing downtime and keep governors running at peak performance.

- On-site Training
- Factory Training

On-Site Training

- Comprehensive on-site training classes include governor basics, operations, maintenance, and troubleshooting. Available for all types of governors.

- On-site classes focus on your specific governor installation. Hands-on sessions take place at an existing unit.

- Duration is typically 3 to 5 days, depending on the number of students and the amount of hands-on time desired.

- AGC staff have taught more than 200 training classes worldwide.

Factory Training

Factory Training

Governor School

Thank you for your attention!
Any questions?

- Roger Clarke-Johnson rogercj@americangovernor.com
- Scott Ginesin scottg@americangovernor.com

Overhaul or Upgrade?

Reasons to Maintain …

- Legacy Governor Parts and Service **ARE** Available
- Legacy Governor Training Classes **ARE** Available
- Retrofit Kits that Enhance Performance **ARE** Available

Overhaul or Upgrade?

Reasons to Upgrade …

- Relicensing-Driven Control Upgrades
- Market-Driven Enhancements
- New vs. Old: Technology and O&M Staffs

Digital Conversions

Digital Conversions

PG&E - Chili Bar Dam, CA

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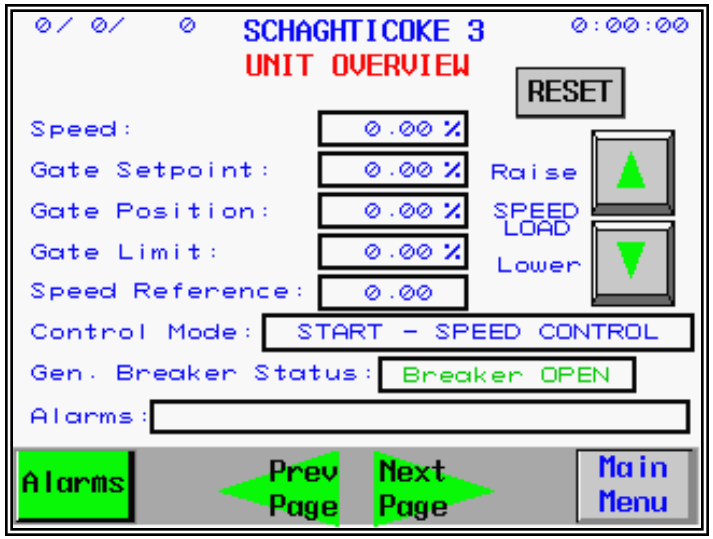
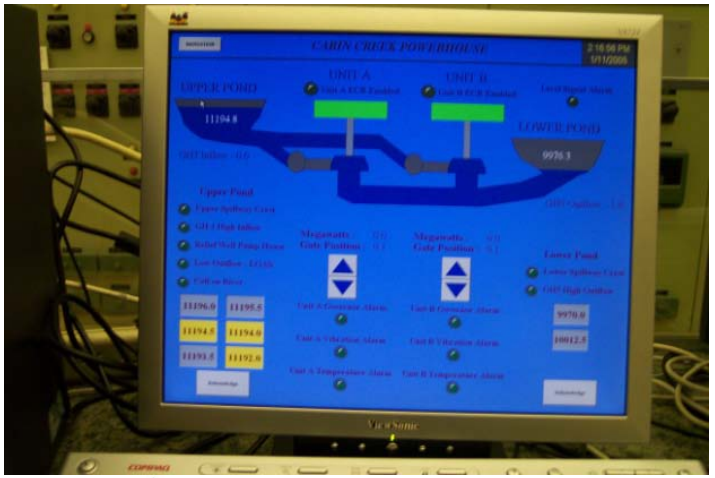
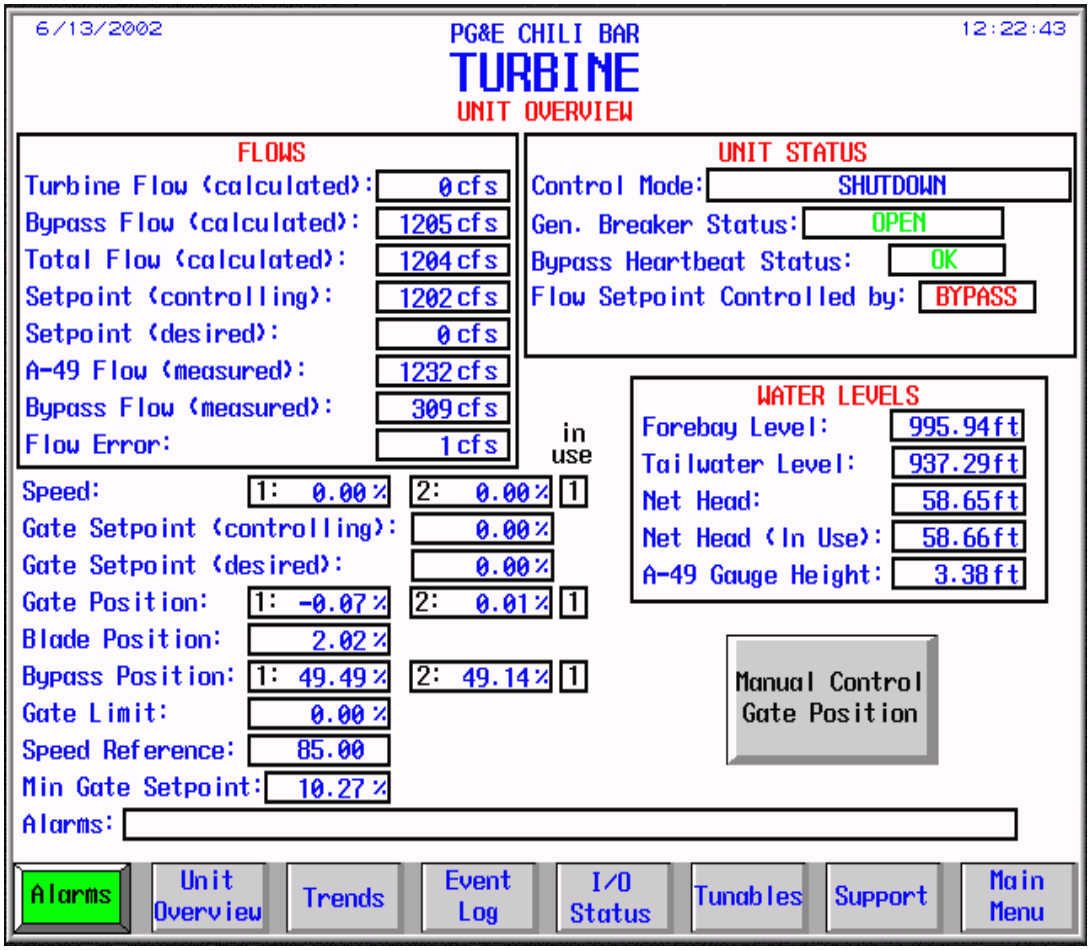
Operator Interface





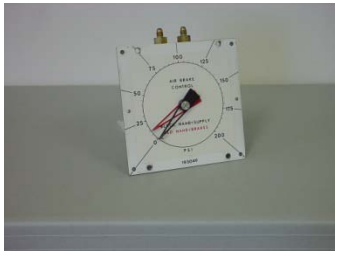
Color Touchscreen HMI



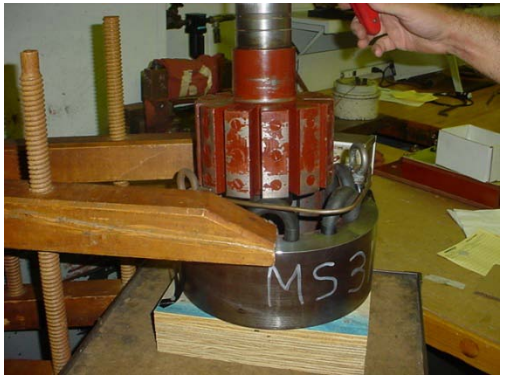
Color Touchscreen Human Machine Interface (HMI) provides easy access to:

- Start/Stop Controls
- Control Mode Selection
- Unit Overview Data
- Trending
- Alarm Event Log
- Status of All Inputs and Outputs
- Tunable Parameters

Governor Parts



Shop Repairs



Field Service

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