Turbine Controls Update

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Define Project Scope and Objectives

• Address obsolescence
• Best solution for new operational environment (grid requirements)
• Add enhanced control features
  – Improve start-up and loading times
  – Improve turn-down
  – Remote operation and/or dispatch control (AGC)
• Address specific field problems
• Integrate PLC control into DCS
• Reduce system maintenance costs
• Simplify operator training needs
• NERC-CIP compliance
Changing Generation Profiles – Abnormal is the New Normal

2008

2012
Customer Considerations For Vendor Pre-selection

Typical Choices:

- PLC
  - ControlLogix, GE Fanuc PAC, Siemens S7
  - PLC providers do not control hardware
  - Customized system with various control components
- DCS
  - ABB, Emerson, Honeywell, Foxboro, Siemens
- Proprietary system
  - Woodward MicroNet Plus, GE MKV1e, Triconex

Considerations:

- Lifecycle costs
  - Spare parts – availability, future costs, support
- Training
- Technology / platform basis – will this platform be readily available for 10-15 years?
- Migration path for the future
- Dependence on third parties
- Turbine controls native to DCS
Application-Specific Solution

- Application-specific designs
- 100% compatibility with existing field devices
- Fully engineered solution (no field design)
- Drop-in panel replacement (ease of install)
- New cabinets in existing space
- Full factory testing minimizes problems during commissioning
- Maintain existing wire/cable numbers (ease of maintenance)
Turbine Control Features Should Include:

- Advanced control and turbine protection schemes for the CT and ST
- Local and remote operation capability
- Improved data acquisition for predictive maintenance and scheduling
- Integrated BOP control systems
- More precise and reliable fuel control
- Advanced graphical interface
- Historical logging and trending
- Diagnostics for preventative maintenance
Project Solution – Key Elements

Objective is to minimize risk, achieve high-quality and on-time performance

- Project planning
- Application-specific solution
- Complete engineering package
- Update other affected drawings
- Good software control
- Comprehensive testing system
- Installation design package
- Site commissioning plan
Security - NERC CIP

- Is the unit a “critical asset”? 
- Does the new control system need to meet customer’s security policies as well as NERC CIP?
- Cyber security is an ever-changing field — as new threats emerge, new defenses must be developed and implemented
- Critical to keep all assets updated with the latest defenses as legacy systems will be at greater risk
- Change management will be important to assure new resources and patches are certified to not cause problems as they are applied
Cyber Security Latest Revisions

• NERC CIP Ver.5 Update
  – Effective April 1, 2016
  – Moving towards impact-based categorization
  – More assets will fall under NERC CIP
  – High-impact systems will require additional security
Security Center / Vendor Support

- Vulnerability Assessment (VA)
- Patch Management (PM)
- Anti-Virus Defense (AV)
- Malware Prevention (MP)
- System Backup & Recovery (SBR)
- Security Incident & Event Management (SIEM)
- Network Intrusion Detection (NID)
- Network Attached Storage (NAS)
- Router for multiple system connection
Mechanical Overspeed to Electrical Overspeed

Catastrophic damage caused by overspeed...

RETAINER RING FAILED DUE TO OVERSPEED EVENT

DESTRUCTIVE OVERSPEED OF 25 MW STEAM TURBINE GENERATOR

DUVHA, SA USED THEIR TURBINE TO TEST THE OVERSPEED SYSTEM
Overspeed Protection System

Ovation Speed Cards
(OSP System)

Test/Trip Contacts
Controlled by TCS

+24 V

Redundant Power Source

Speed Wheel Assembly

De-energize to Trip Solenoids at TDM

2 of 3 Voting
is Accomplished in
Hydraulic Circuit of
Trip Manifold
6300 Overspeed Protection
2 Out Of 3 Voting “Internal” or “External”
Scope Definition – Solve Problem Items

- Electric actuators
- Trip system upgrades
- Igniter issues resolved
- Dual fuel conversions
- Emission reductions (SCR)
- Power augmentation (inlet fogging, steam injection)
- Improved turn-down
- Electronic overspeed protection upgrades
- Faster starts
Scope Definition – Solve Problem Items

• Flame detection
  – New detectors
    • Water cooling is no longer required
    • Electronics removed from high temperature zone
    • Detection by thermocouples

• New fuel valve
  – Replace pneumatic or hydraulic with an electric

• Generator metering
  – Upgrade multiple individual transducers for V, I, MW, Mvars
  – Replace with modern digital power meter
Generator Metering & Protection

- Upgrade multiple individual transducers for V, I, MW, Mvars
- Replace with modern digital power meter
- Replace generator protection relays with a digital system
Scope Definition – Vibration Monitoring & Protection

• Vibration monitoring & protection systems to monitor existing vibration sensors
• Integrated with turbine control system
• Time to add new/additional probes
• Diagnostic software to help pinpoint problems (existing and future)
Turbine Vibration Monitoring & Protection

- Vibration monitoring & protection systems to monitor existing vibration sensors gas or steam turbines:
  - CSI 6500 Machinery Health™ Monitor
  - Remote or integrated
  - Installation
**Excitation Replacement Project Drivers**

- Does the OEM still support the equipment?
- Can you get spare parts?
- Is there training available on the equipment?
- Will the AVR communicate with new DCS?
- Does the existing equipment provide Power System Stabilizers (PSS)?
- Rotating-to-Static excitation
SFC / LCI Controls

- Same obsolescence issues as the CT controls and exciter controls
- Integrated approach for new controls
- SFC / LCI front-end or the entire package
Auxiliary Retrofit Advantages

- Seamless operator interface
- Enhanced alarms and diagnostics
- Historical trending of generator data to DCS
- Enhanced control options
- Eliminate third-party protocols
- DCS compatibility
- Minimize spare parts inventory
- 24/7 service support
Software – HMI Graphics

- HMI graphics
  - Standard graphics set
  - Willing to customize
  - Review done in advance of FAT
  - Review should include Operations personnel
Testing – Functional Test

Comprehensive testing to ensure all bugs worked out prior to shipment

- 100% hardware testing using actual panel and application software through to HMI
- Software testing using closed-loop simulator
  - Full dynamic simulation of all turbine main parameters (speed, fuel flow, Tx, MW, etc)
  - Use actual hardware or run on virtual controllers
Testing – Simulator

• Start-up and loading – almost identical to actual unit
  ‒ Trends represent realistic conditions
• Ability to freeze simulator data at various operating points
  ‒ no need to “restart” unit
• Fault conditions are easily created
• Used for operator training
• Used for troubleshooting and verification of changes
Start-up and Site Testing

- Review commissioning procedure in advance
- System tuning
- Close coordination with dispatch required
- Possible tests for droop / isochronous response, AGC response, start-up time
- Operations personnel required for system commissioning
## Typical Project Schedule

<table>
<thead>
<tr>
<th>Milestones</th>
<th># of Weeks</th>
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<tbody>
<tr>
<td>Order</td>
<td>0</td>
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<tr>
<td>Design Submittal</td>
<td>12 weeks</td>
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<tr>
<td>FAT</td>
<td>16 weeks</td>
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<tr>
<td>Shipment</td>
<td>20 weeks</td>
</tr>
<tr>
<td>Start Site Activities</td>
<td>24 weeks ARO</td>
</tr>
<tr>
<td>Unit outage</td>
<td>3 weeks</td>
</tr>
</tbody>
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**On-Site Preparation**

- Complete installation design package
- Unit-specific startup procedures
  - Demolition/installation engineering package
  - Commissioning procedures
  - Site planning
- Experienced on-site team for installation & commissioning
- EPC / Turn-key services
Summary – Keys to a Successful GT Controls Retrofit

- Vendor pre-qualification – proven hardware & experienced supplier
- Define scope – include any system improvements
- Application-specific design
- Well-defined engineering deliverables
- Customer participation in design reviews
- 100% testing – dynamic simulation
- Detailed outage planning
- Long-term support
Questions?

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