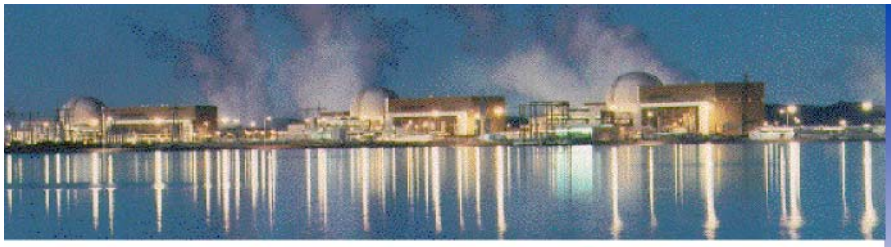
HPI, LLC

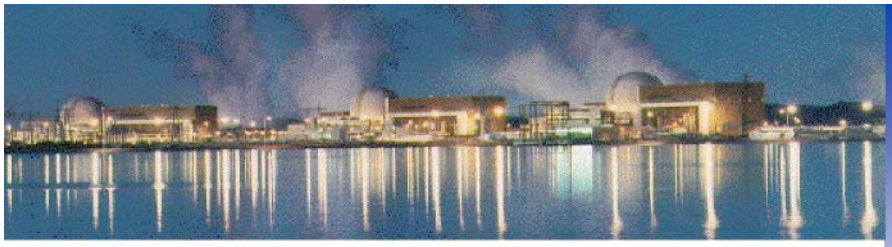


HPI EDG Controls Upgrade Overview

Based on Feedback from the Nuclear Industry

Contents

- **HPI Perspective on EDG Controls Status Across the Nuclear Industry**
- **Dealing with Obsolescence**
- **Benefits of EDG Controls Upgrade Using HPI**



HPI Perspective on EDG Controls Status

Based on Feedback from the Nuclear

Current Status of EDG Governors and Voltage Regulation

- **Primarily analog/mechanical technology, 15-25 years in service**
- **Vendors limiting or eliminating product support for nuclear applications**
- **Cost to maintain spread over O&M budget**
  - Governor overhaul typically costs 30% of of full replacement/upgrade
- **Plants satisfied with replacing/repairing individual components (i.e. electronics, coils, etc.) as they fail**
  - Capital cost avoidance and reduced need for training on new technologies
- **Corporate concerned with viability and continued certification of EDG governor/voltage regulating systems long term**
  - Need to eliminate “hidden” O&M costs
  - Failure of EDG control package during test or actual demand result in:
    - Licensing/operability issues and negative PR, best case
    - Catastrophe, worst case

Problems with Existing Controls

- **Existing equipment is obsolete, or becoming obsolete**
- **Failures result in machine trips and LERs**
- **Calibration increasingly difficult; less experience as staff changes**
- **Poor performance characteristics**
  - Does not control well through various loading scenarios
- **Systems engineering trending difficult**
  - No electronic data for performance evaluation and trending
  - No provision for taking pneumatic data, including time response, from the existing equipment
  - Equipment degradation difficult to detect, since control room not provided with sufficient level of control data
- **High O&M Costs**
  - Reactive maintenance planning for undiagnosed failures
  - Needs to be proactive to control resource expenditures

Opportunity

- **Digital technologies and availability**
  - May not significantly improve already high EDG performance as measured in raw availability numbers, but the new technology can reduce the cost of maintaining such stellar availability.
- **Today's 1E certified digital systems are inherently redundant, fault-tolerant, self-testing and offer a long history of support and multi-industry acceptance**
  - Digitally integrate electro-hydraulic actuator, vibration monitoring, and combined governor/automatic voltage regulator
- **Leverage training simulator to expedite troubleshooting (controls, machine performance) and enhance offline operator training**
- **Redirect staff currently dedicated to manually testing and repairing/replacing failed parts to higher value activities**
- **Enhance ability to locally or remotely troubleshoot and tune**

Result: improved reliability/availability, safer plant, modernized assets, lower operating cost and managed obsolescence

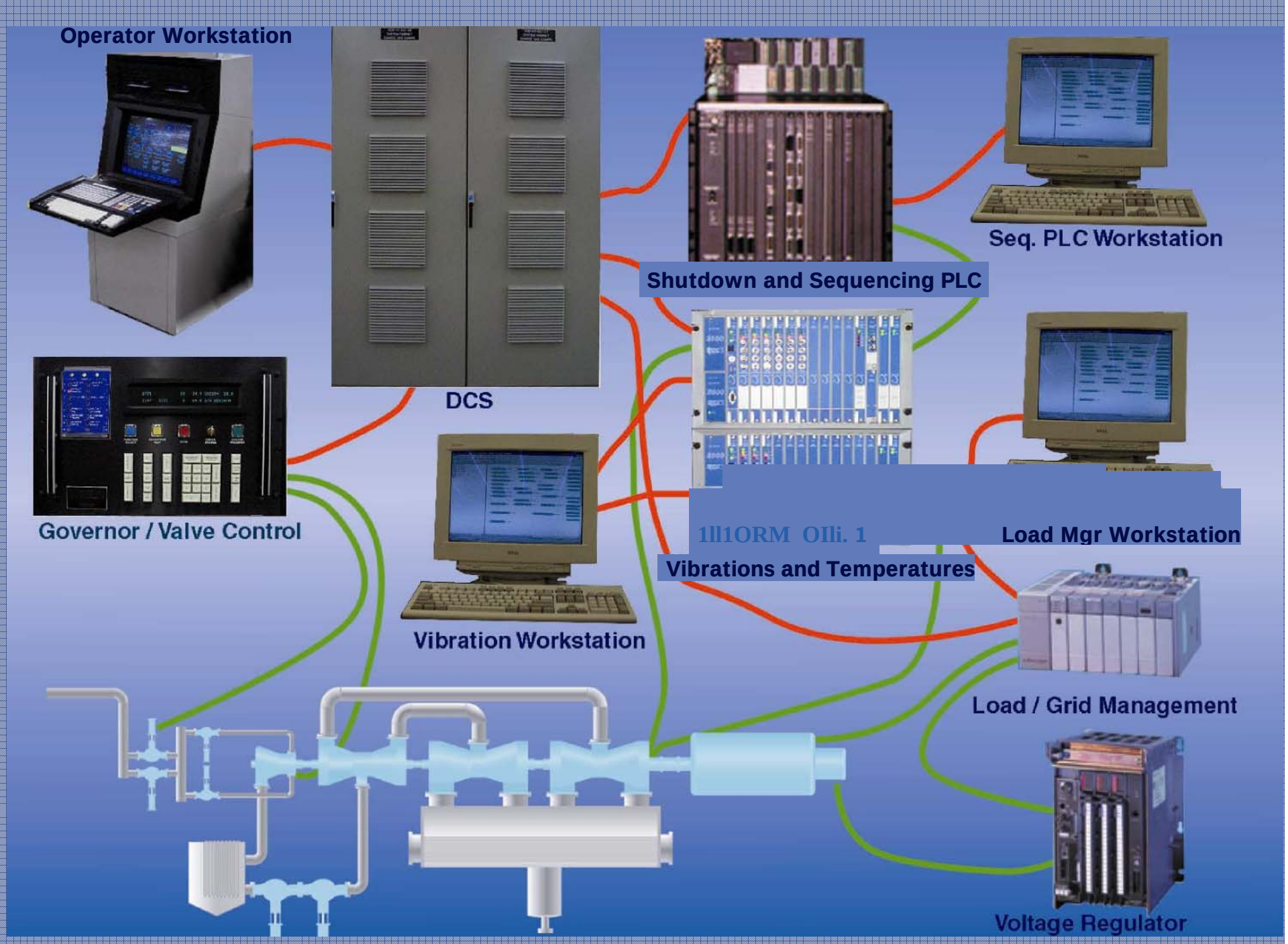
Specific Feedback from Nuclear Industry

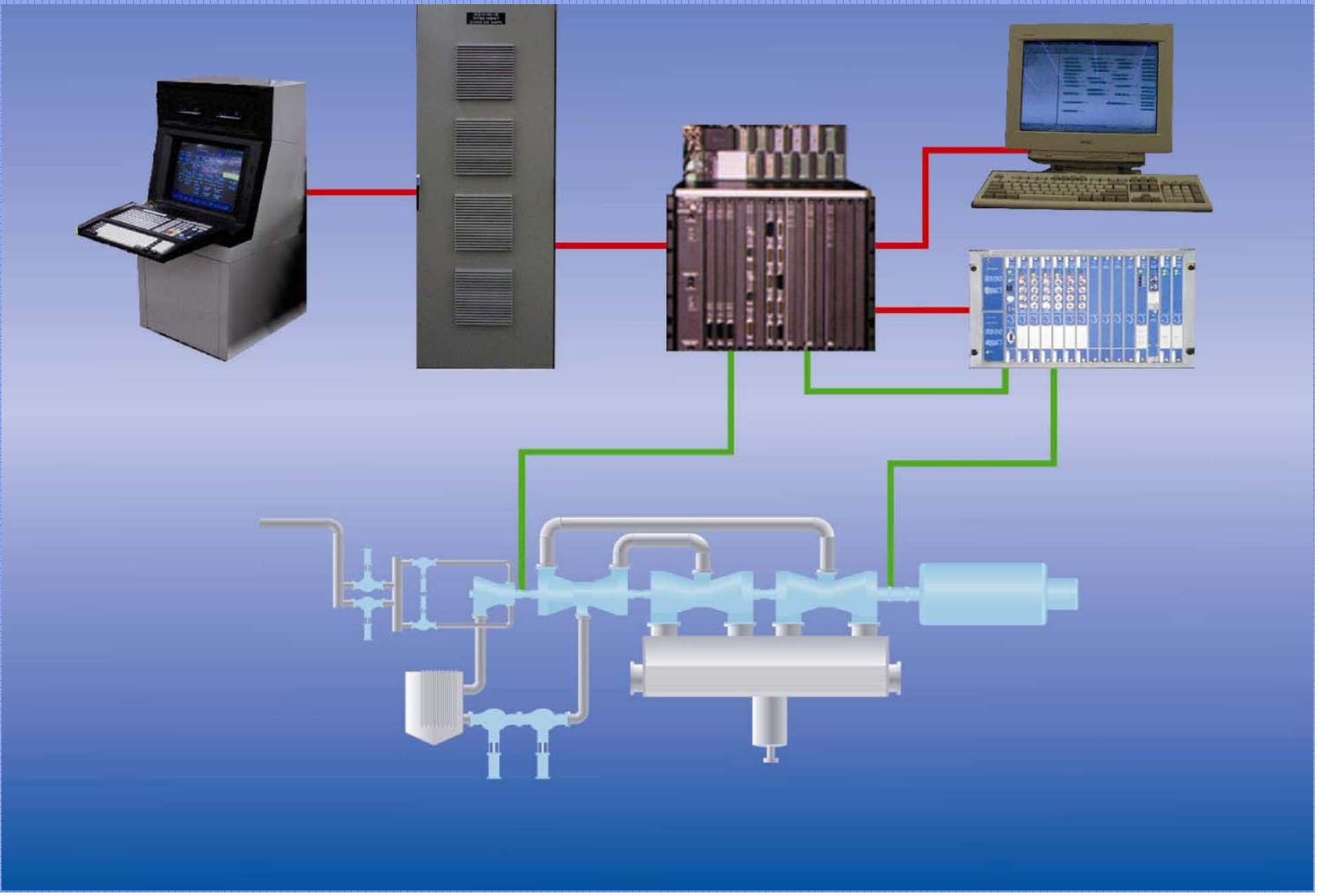
- **Traditional EDG vendors/OEMs have stated in public forum that they are exiting the nuclear market for after-market controls**
- **Vendor support limiting or eliminating product support for nuclear applications**
  - Affecting product development and customer service
- **There is a desire to move to integrated digital controls**
  - Manage obsolescence
  - Take full advantage of automatic online testing and offline simulation
    - Embedded diagnostics replace manual testing
    - Offline testing/simulation reduces fuel consumption, emissions and wear & tear on machine
  - Tighter controls through real-number set-points (i.e. eliminate potentiometer on voltage regulator)
    - Improve fuel rates
    - Reduce emissions
    - Improve operating margins

Specific Feedback from Nuclear Industry

- **More on the desire to move to integrated digital controls**
  - Integration of control components
    - Faster restarts through automated sequencing
    - Steady output by reducing voltage oscillation
  - Automated condition-monitoring maintenance program
    - Continuous software monitoring of all key EDG elements
    - Support predictive maintenance initiatives
  - Increase effective power output to address new plant loads (i.e. FWC pumps)
  - Fewer systems to maintain and troubleshoot (see illustration in next three slides)

D is-integrated
Vs.
Integrated
Turbine and Generator Controls


Operator Workstation
DCS
Shutdown and Sequencing PLC
Seq. PLC Workstation
Governor / Valve Control
Vibration Workstation
Vibrations and Temperatures
Load Mgr Workstation
Load / Grid Management
Voltage Regulator



Complete System Integration Includes:

- Governor
- Electro-hydraulic actuator
- Voltage & Megawatt Control
- Lube System
- Machinery Monitoring & Protection
- Plant DCS Communications
- Breaker control
- Load Management system
- High Speed Trending

All tested and certified as a package to Class 1E requirements

Other Experiences

- **Thousands of plants have reaped the benefits of digital automation of critical systems**
  - Example: plant becomes lowest cost operator in its sector as a direct result of improved reliability through digital controls
  - Example: facility critical machinery runtime extended by 20% between turnarounds due to ability to test on-line and the elimination of mechanical nuisance tripping
  - Example: EDG controls upgrade and consolidation to integrated digital platform accomplished in 5-8 days per machine
- **Countless illustrations of the vast performance improvement and lower operating cost possible with digital controls**

These experiences directly support the need to maintain/improve fleet availability, reduce ongoing MRO costs, minimize LERs, and make optimum use of human resources

All of which will drive bottom line improvement in the business

Where Do We Start? Questions to Ask

- **What is the status of the technology/manufacturers of the systems being considered for replacement?**
- **What is the documented contribution to Unplanned Capability Loss Factor (UCLF) from these systems?**
- **What is the value of associated in-stock spare parts?**
- **What is the annual expenditure on replacement parts?**
- **What is the cost of specialized test equipment and procedures associated with these systems?**

Where Do We Start? Questions to Ask

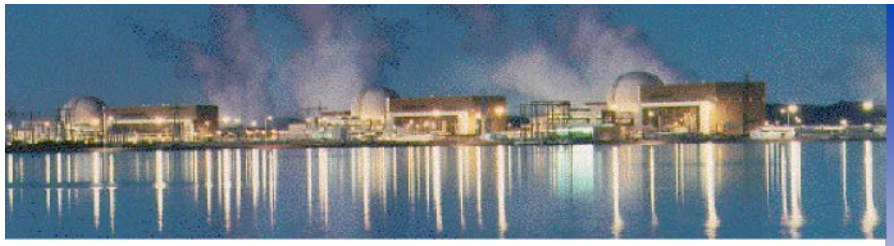
- How many technicians/engineers and instructors are dedicated to these systems?
- How many man-hours are expended each year on surveillance/calibration/repair of these systems?
- What is the station/fleet's assumption regarding the direct and indirect value of UCLF/hour?
- What is the Mean Time Between Failure of these systems?

References

- **Nuclear operators currently managing digital upgrades**
- **Feedback from various owners' sites**
- **EDG Owners Group**
- **EPRI data**
- **HPI utility and process industry experience with applying digital controls**
  - 20,000 systems (125 nuclear)
  - Continuous support of nuclear control platforms for 35 years
- **HPI turbomachinery controls experience**
  - 2000 systems
  - First integrated turbine-generator control (AVR)
  - Class 1 E certified systems
- **NRC Reports**
- **Independent nuclear industry consultants**
- **Feedback from nuclear A&E companies**

Path Forward

- **HPI recommends that the Operator work with a partner whose nuclear experience, ownership of qualified technology, proven track record of support and strategic growth in the nuclear market is suited for delivery of a total EDG Controls Solution**
  - As a next step, HPI can provide a study to include:
    - Confirmation of Operator's corporate objectives and goals associated with EDG
    - Surveys of key sites and interviews with personnel to identify existing and future EDG issues
    - Document ability of digital upgrades to address site and corporate goals
      - *Including parts & labor cost-savings and availability estimates*
    - Recommend budget plan and pilot site(s) as part of draft program for technology deployment
    - Develop design package template for upgrade/retrofits
      - *Including +/-20% cost estimate and schedule*



A High-level Strategy to reduce the affects Of obsolescence through I&C Modernization

Definition of Obsolescence

- **Obsolescence**
  - Loss in the usefulness of a product or system because of the development of an improved or superior way of achieving the same goal.

Is Obsolescence a Problem?

- **If the system can still be maintained and it performs all the required functions then obsolescence is not an <u>immediate</u> problem**
- **Obsolescence is a problem when:**
  - Vendor no longer supports the component or system AND
  - The sub-components are no longer manufactured or available AND
  - Not enough spares to support system

    OR
  - The system does not perform a required/desired function and it cannot be modified to do so

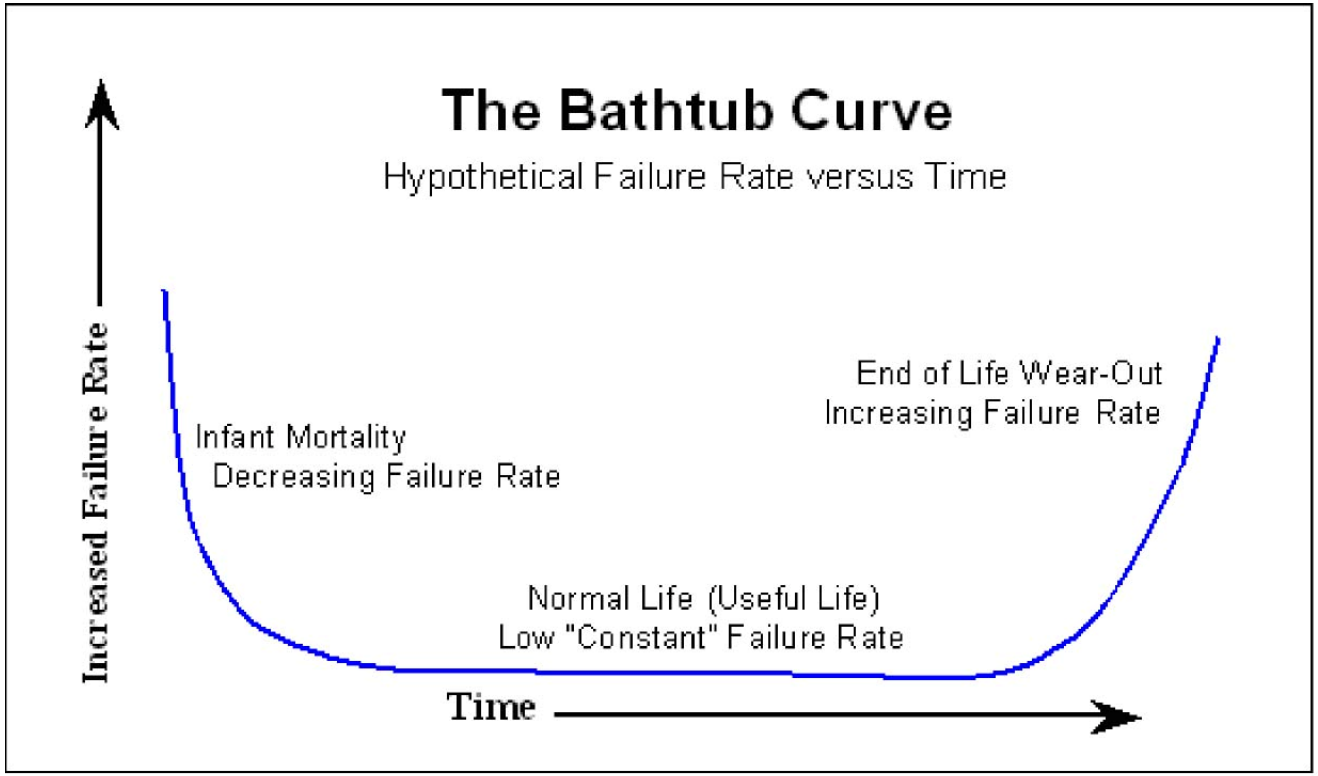
Reasons to Modernize

- Address Obsolescence
- Reduce Maintenance
- No Calibrations
- Fault Tolerance
- Scalability
- Operating Costs
- Improve Reliability
- System Integration
- Increase Functionality
- Accessibility of data
- On line Trending
- Improve Accuracy
- Enhance Safety
- Enhance Performance
- Self Diagnostics
- Algorithm Flexibility
- Control Room Modernization

Other Reasons to Modernize

- System Experts
- Aging Workforce
- Reduced supplier support
- Human Performance Error Reduction
- End of Life Failures (Bathtub Curve)

End of Life Failures



Analog Equipment

- **The original analog equipment has been very reliable and maintainable in most cases (25+ years for some systems)**
- **Unfortunately the cost to maintain these systems are increasing and reliability is decreasing**
- **Age Related Problems**
    - Potentiometers
    - Semiconductors
    - Connectors
    - Cables

Is Modernization the Answer?

- **Early systems were at the beginning of the “digital revolution” in instrumentation**
- **Systems available today are much more capable and are based on industry standards**
  - But, due to the rapid technology advances, digital equipment becomes obsolete faster than the analog equipment it replaces

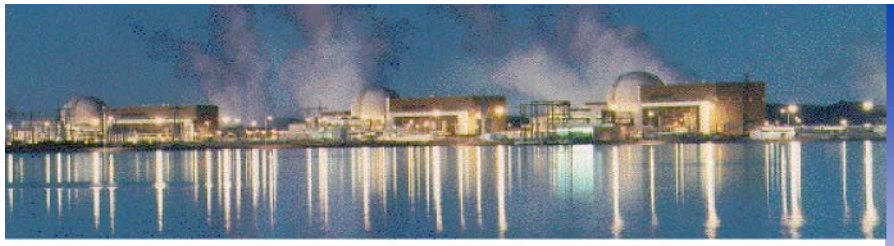
How Does HPI Address Obsolescence?

- Customer Base – over
- 5000 systems
- installed
- Not just Nuclear
- Not PC based
- Same basic system since
- early 1980's
- Upgrade path has been
- proven over the years
- HPI has been making
- safety/critical systems
- from the beginning

(Obsolescence Plan)

- Fault tolerant
- Reliable
- Self Diagnostics
- Uses standard protocols
- (modbus, TCP/IP)
- Scalable/Flexible
- No calibrations required
- Accessibility of data

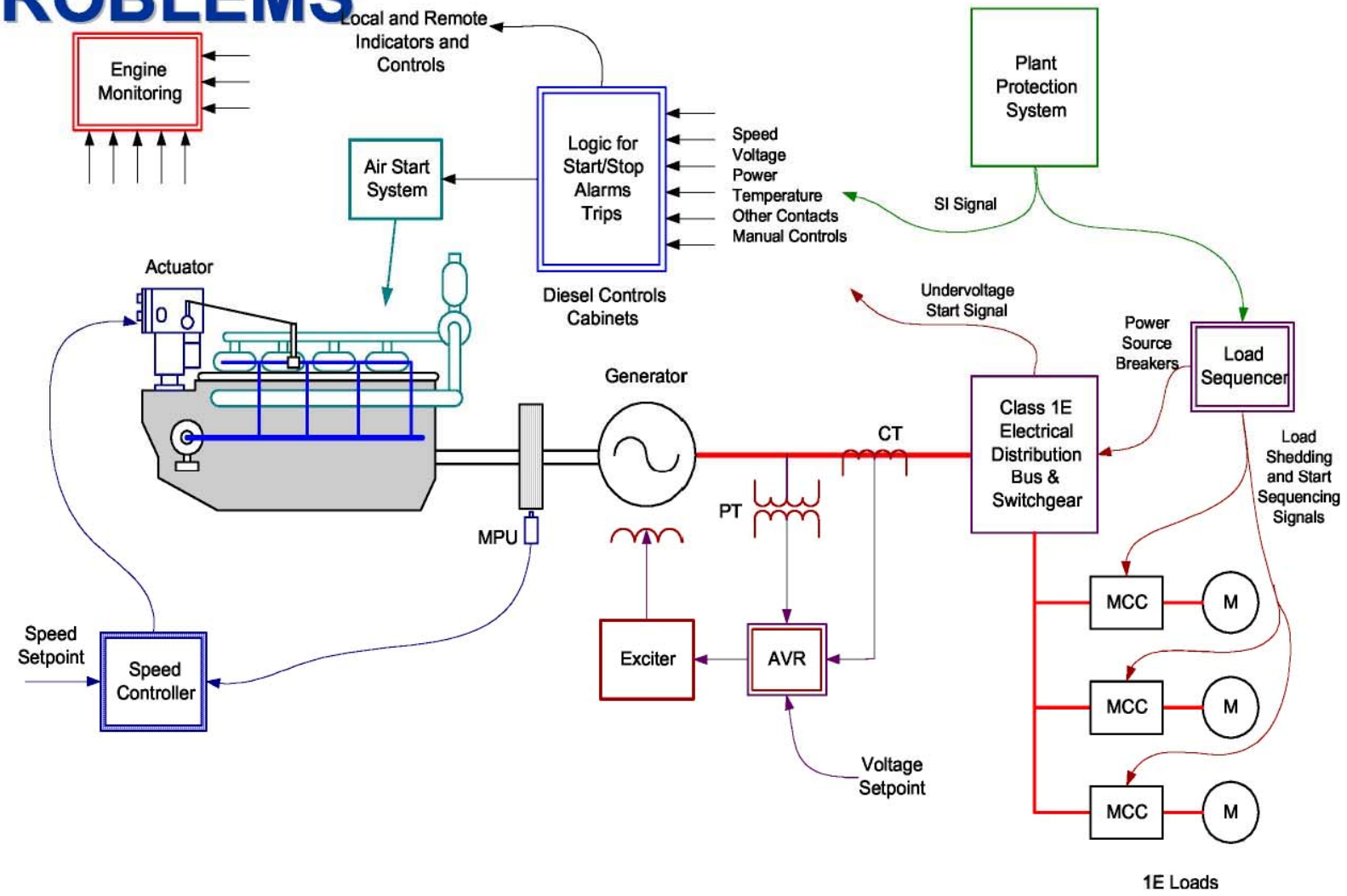
  (OPC)
- On line trending
- HPI makes their own
- hardware



Benefits of Upgrading EDG Controls

Application Control System for Emergency Diesel Engine Management And Load Sequencing

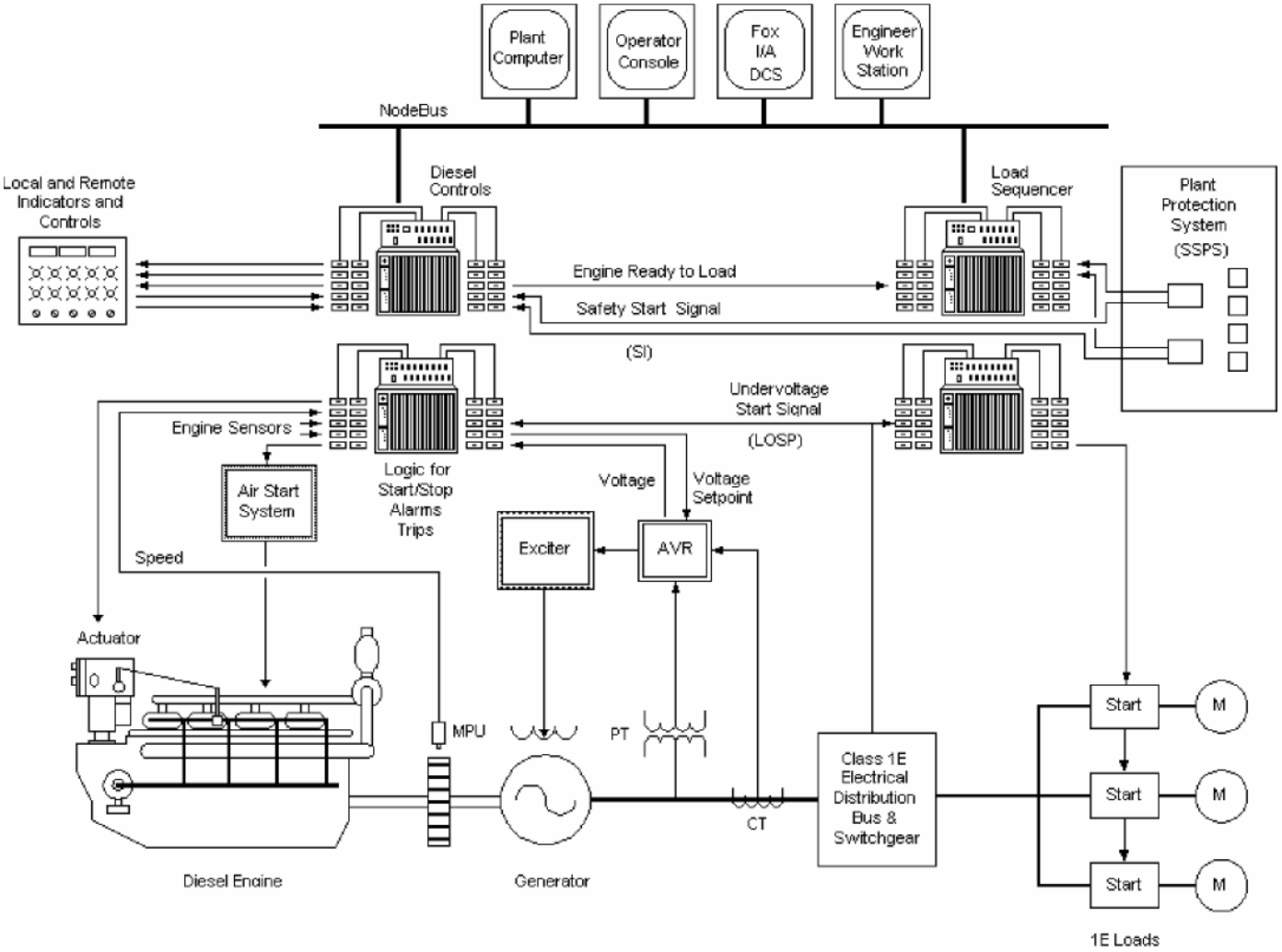
DIESEL CONTROLS/SEQUENCER PROBLEMS



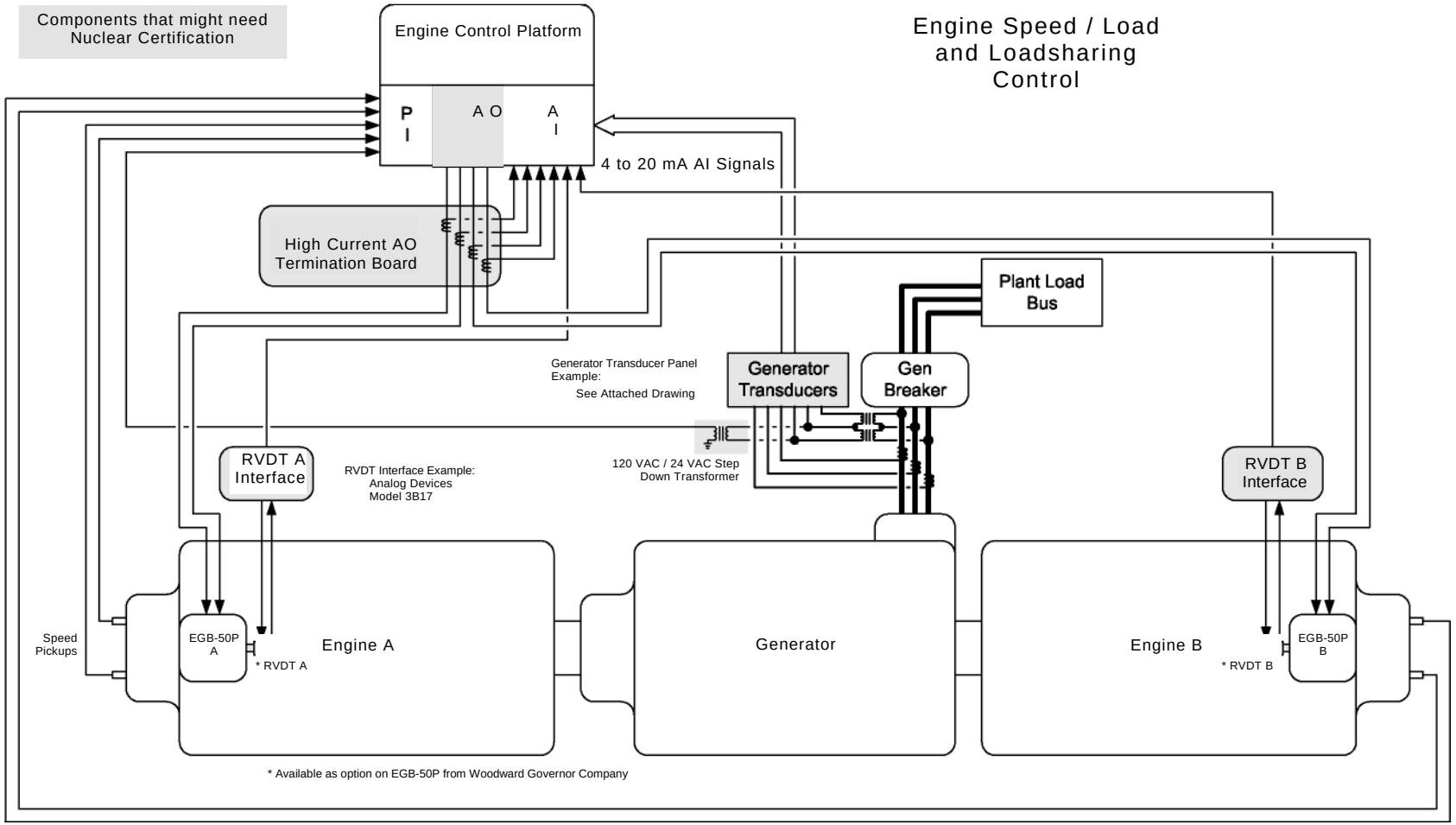
SOLUTION

- **Engine Control Management**
  - Speed Control
  - Start/Stop Logic
  - Protective System
- **Generator Management**
  - Voltage Regulation
- **Load Management**
  - Sequencer

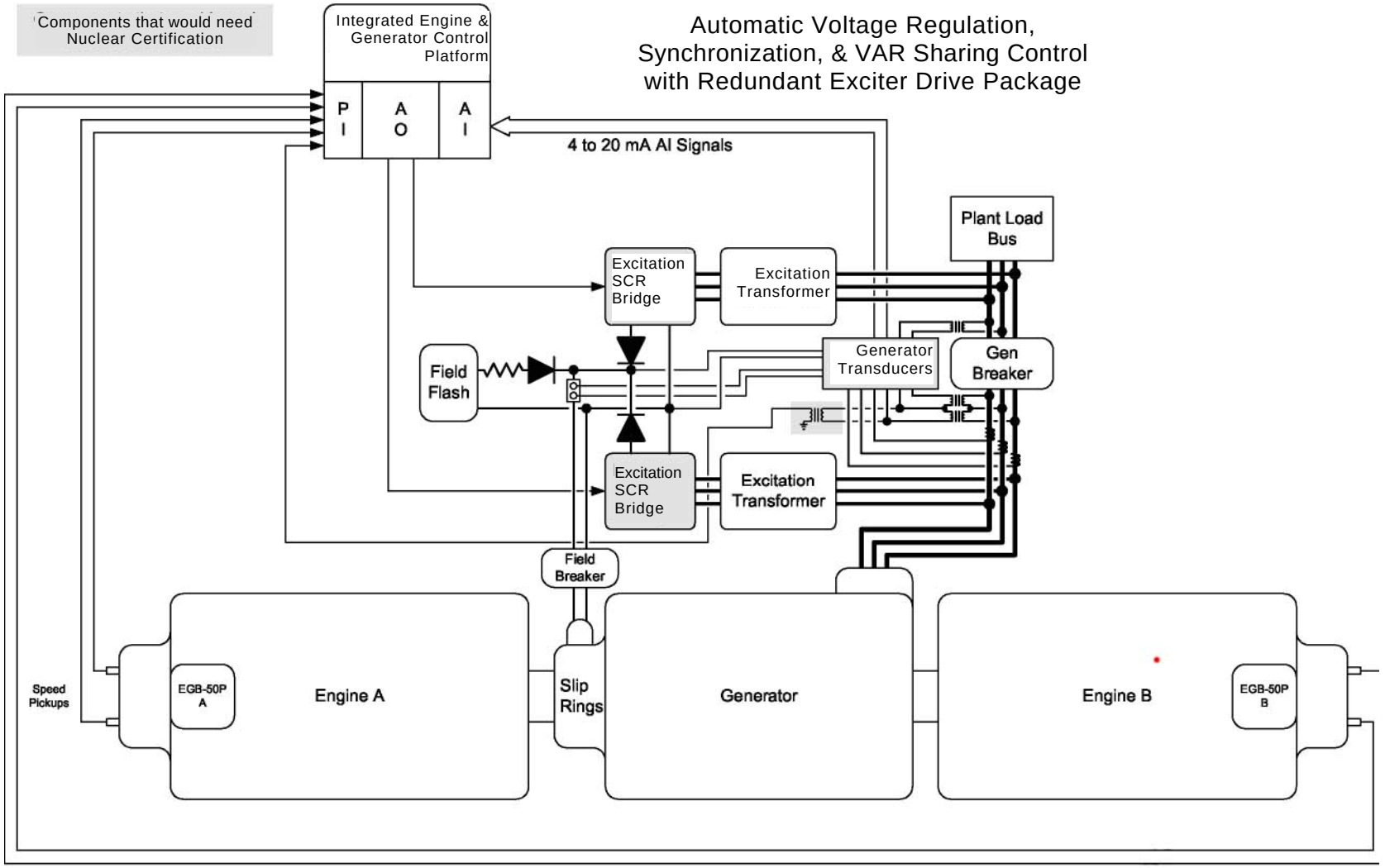
DIESEL / SEQUENCER SYSTEM ARCHITECTURE



Engine Speed Control

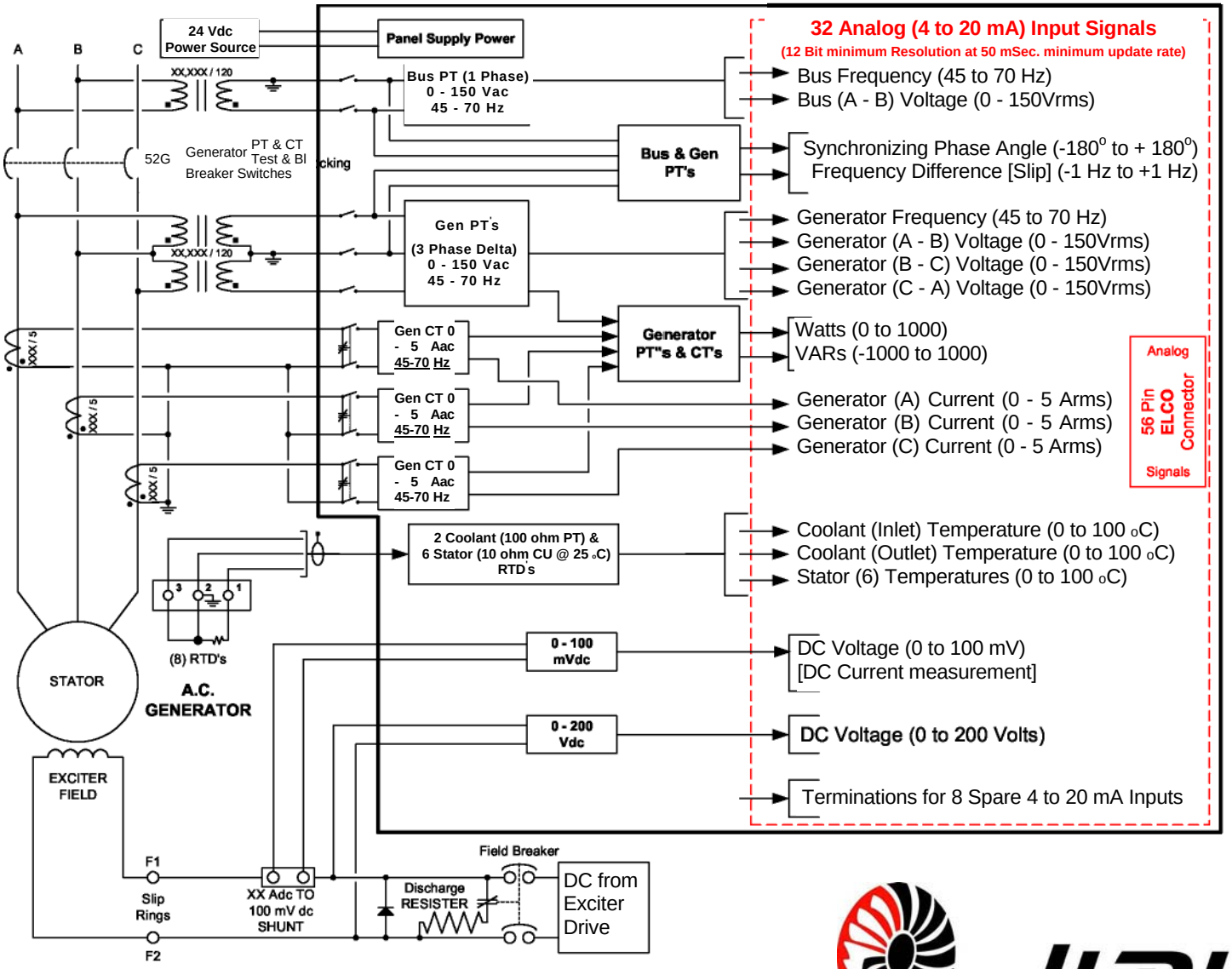


Generator Voltage Control



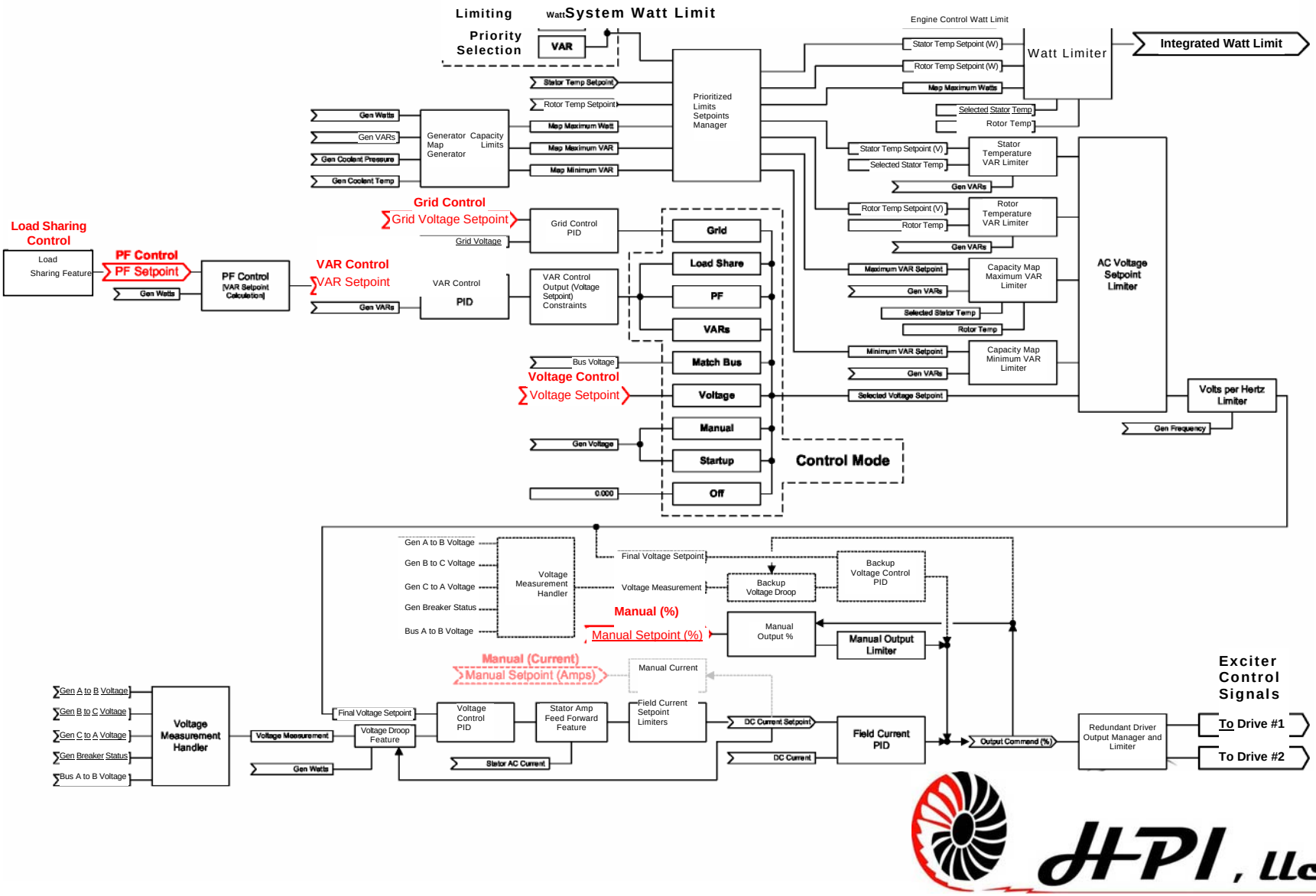
Generator Sensing Panel

Standard Measurement (Transducer Panel level) input signal data, for a Generator Application

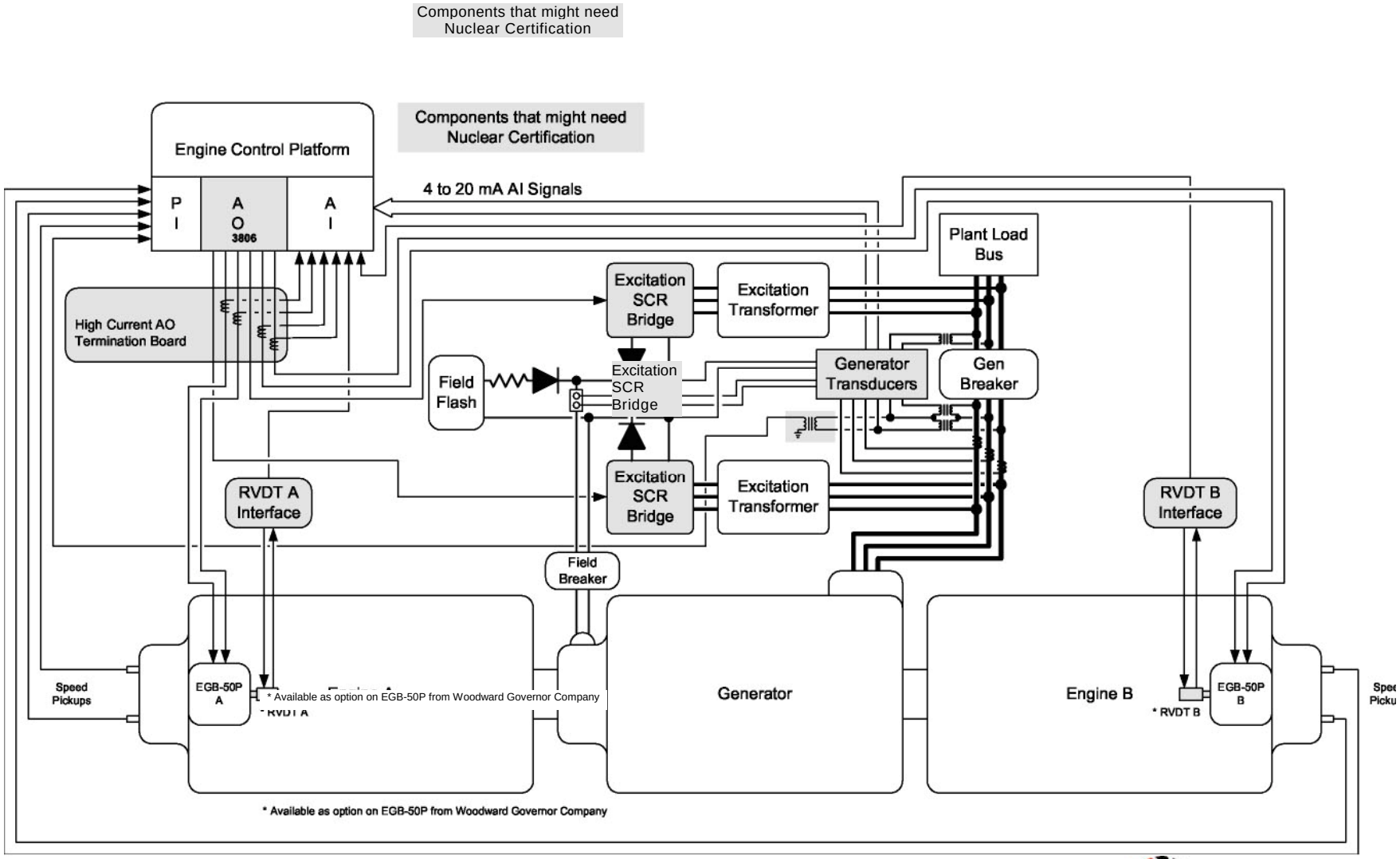


Generator Control Software

Signal Flow Block Diagram for Generator Control Part of an Integrated Diesel Engine driven Generator Control Package



Integrated Control System



Benefits of Fault-Tolerant Controls

- **Obsolescence – eliminate out-dated controls and indicators**
- **Reliability**
  - Improved availability of diesel generator
  - Reduced LERs/LCOs
- **Maintainability – improved alarming of control system problems through self-diagnostics**
- **Surveillance testing – automate test process and data collection**
- **Functionality – better engine monitoring and trending capability**