Topics

• GSE Solutions Structural Changes
• Plant Performance Analysis & Improvement with DVR and TSM-Enterprise
• Recent Projects
  - Constellation Energy - Peach Bottom Core Display Hardware Replacement
  - Bruce A&B Simulator Upgrade Project
  - Tokai-2 Safety Systems Upgrade Project
  - KHNP CRI Digital Twin Project

Ravi Khanna
GSE Solutions
Sr. Vice President, Professional Services
Over 22 years of complex software architecture and delivery practices from Defense, Satellite Telecommunications, and Digital Services Consulting to GSE.
GSE Structural Changes

One **corporate** company, 2 **divisions** and 5 solutions **groups**
GSE Today

**GSE Engineering** is a highly experienced team focused on creating innovative ways to meet our customers’ needs using a combination of our industry-leading services and products.

- Engineering design and implementation services
- Simulators that enhance design and performance
- Optimizing plant performance and engineering program applications

**GSE Workforce Solutions** division makes sure the right people and skills are in place for customer operations to run smoothly. Our experts help identify solutions and talent to address workforce gaps.

- Flexible staffing services
- End-to-end workforce management programs
- Knowledge transfer support as aging workforce retire
- Specialized nuclear training programs
Solutions Portfolio

ENGINEERING SERVICES
- Systems Upgrades
- Life Extension
- License Renewal
- Specialty Engineering EOC
- PRA Evaluations

PLANT MODIFICATIONS
- Mechanical, Electrical, I&C
- Civil/Structural
- Fire Protection
- Digital Upgrades

DECOMMISSION SERVICES
- Assessment/ Readiness
- Procedures
- 10 CFR 72 Compliance
- License Termination

CONSULTING
- Nuclear Operations
- Program Compliance
- Performance Analysis
- Work Management
- Corrective Actions
- License & Regulatory
- Design for Inspectability

STAFFING
- Staff Augmentation
- Schedule/Plan Estimates
- Project Management
- Procedure Development

THERMAL PERFORMANCE
- Assessment Modeling
- Heat Balance Analysis
- Megawatt Improvement
- Online Monitoring
- Training Courses
- Thermal Performance Software

ENGINEERING PROGRAMS
- ASME OM Code
- In-Service Inspect/Test
- Appendix J
- Balance of Plant
- Engineering Programs Software
- Training Courses

SIMULATION
- Virtual Commissioning
- Advanced Modeling
- System Design
- Generic Simulation
- Full-Scope Custom Simulation
- On-Demand Platform
- Engineering Simulators

CONSULTING
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Data Validation & Reconciliation (DVR)
Importance of Process Measurements

• Measured process data in power plants is used as input for operational, maintenance, business, and regulatory decisions

• There is always error associated with any measurement, and often the amount if error exceeds ....

• What could bad data be costing you?
Improving Fleet-wide Monitoring & Reliability

Data Validation and Reconciliation (DVR)
Improving the system coherency, reliability and availability of the utility’s fleet of generating facilities (nuclear, fossil and combined cycle).

**DETECT**
Detect faulty sensors – Reduce maintenance costs by focusing on components that need it

**IDENTIFY**
Identify errors - Optimize output in existing instruments and correct that indication

**SOLVE**
Compute pseudo measurements and their uncertainty to compensate for missing instruments to facilitate robust analysis

**REPORT**
Report findings - more accurate than traditional component monitoring systems; can identify losses typically not found by component monitoring which allows recovery of losses

DO MORE WITH LESS

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Power Recovery Using DVR

• Venturi fouling causes a higher-than-actual feedwater flow rate measurement, which causes indicated reactor thermal power to be falsely high

• The reconciled feedwater flow rates from the DVR model allow for correction factors to be implemented at the plant

• Feedwater flow rate correction factors from DVR reconciled output have been implemented in multiple nuclear plants in the US, as well as Europe.

• No change to plant calorimetric calculation or license limit

• One case of severe venturi fouling resulted in approximately 13 MWe gain once correction factors were implemented

~2.5 million dollars per year in additional revenue + carbon credit benefit
Progress of DVR in the US

2015 First EPRI Study for power recovery
2016 Developed EPRI Guidance for Using DVR
2017-18 Various EPRI & Power Station Studies Performed
2019 Fleet wide implementation of DVR – Exelon
2020 Fleet wide implementation of DVR – Duke
2021 Completed EPRI Topical Report for DVR Established ASME Committee for DVR
Use of DVR Methods for Measurement Uncertainty Recapture: Topical Report (3002018337)

- EPRI submitted the Topical Report to the NRC for review in January 2021.

- Current timeline indicates Request for Additional Information (RAI) is expected late spring and issuance of the Topical Report – A version and Review Letter in early 2024. NEI is supporting the interface with the NRC.

  **Meeting was held in October at GSE Engineering, Programs & Performance (formerly True North) offices to review RAIs.**

- Utilities have expressed a high level of interest in using DVR technology for MUR.

- GSE P&P is currently supporting an investigation (with Constellation) to perform MUR using DVR for one of the sites where DVR is already well established.
Nuclear Plants with DVR

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**DVR Installed**

- **Exelon**
  - Braidwood 1 & 2
  - Byron 1 & 2
  - Calvert Cliffs 1 & 2
  - Dresden 2 & 3
  - Fitzpatrick
  - Ginna
  - LaSalle 1 & 2
  - Limerick 1 & 2
  - Nine Mile Point 1 & 2
  - Peach Bottom 2 & 3
  - Quad Cities 1 & 2

- **Duke**
  - Brunswick 1 & 2
  - Catawba 1 & 2
  - Harris
  - McGuire 1 & 2
  - Oconee 1, 2, & 3
  - Robinson

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**DVR In Development**

- **Arizona Public Services (APS)**
  - Palo Verde 1, 2, & 3

- **Energy Northwest**
  - Columbia

- **China National Native Products (CNNP)**
  - Changjiang
The Fleet-wide Monitoring & Optimization Software Product and Services offer a comprehensive suite of features designed to enhance operational efficiency and performance. Key components include:

- **Real-time, Remote Monitoring**
- **Advanced Statistical Analysis**
- **What-If Dynamic Analysis**

**Software Modules** include:

- **DVR Model Dev**
- **Troubleshooter Configuration and Smart Alarm Dev**
- **Custom Report Dev (MOR, INPO, etc.)**
- **CIM Model Dev & Leakage Reporting**
- **Custom integration with 3rd party systems**

**Software Platform** provides a comprehensive solution:

- **DVR**
- **Advanced Monitoring: Alarming & Troubleshooting**
- **Plant Performance (De-rate) Reporting**
- **Cycle Isolation**
- **Workflow**

**Service offerings** are designed for diverse user needs:

- **Asset Management System**
- **Custom IT System**
- **Internal/External Data Sensors, Historians, Files**

**Engineers, Managers** can access the system via (web access), while **Engineers/Operators** can use tablet access (online and offline) to walk-through the plant.

**Real-Time Online Monitoring, Alerts, Recommendations** support real-time insights and decision-making.

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Functional View of the TSM Solution

**Real-Time Dashboards (web)**
Dashboards to monitor plant status, alerts, recommendations

Drill down to solve specific problems

**Drill-down Reports (web)**
Explore detailed automated reports

**DETAILED REPORTS**
- Plant Loss Summary – MW Accounting
- Performance Alert Summary and Notifications
- Core Thermal Power Predictor
- Steam Turbine Report
- Condenser Performance Report
- Feedwater Heater Performance Report
- Primary Pump Performance Reports
- Moisture Separator and Reheater Report
- Cooling Tower Report
- Core Thermal Power Evaluation Report and Trend
- Thermal Performance Issues Reporting
- Customized business reporting – e.g. Capacity Factor Predictor, Generation Predictor
- Data analysis Tools
- Interface to EPRI Troubleshooting Software
- Baseline Comparison Report
- PJM testing & reporting tool
- INPO/WANO Derate Reporting tool

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TSM Enterprise Software (Thermal System Monitoring)

- Fleet dashboard
- Drill down on plant views
- Account for losses
- Model troubleshooting actions
- Create cost benefit analyses
- Reduce maintenance cycle
Constellation Energy
Peach Bottom
Core Display Hardware Replacement

Background
Given the issues with obsolescence and hardware failures of the GE Core displays, GSE solved the problem with an innovative solution of replacing all the core display modules, indicators, and associated IO with one 8K thin bezel large display.

Solution
• Replace failing hardware
• Update obsolete hardware
• Easily upgraded to match any changes in the control room
• Reduce maintenance and downtime
Bruce Power
(CANDU)

Objective:
• GSE upgraded Bruce A Units 2,3 in 2014
• Technology: JTopMeret, RELAP5-HD, REMARK

Scope
• Upgrade Bruce A to the latest version of SimExec, JADE and RELAP5-HD
• Upgrade Bruce B Units 6, 0, and 7 to same technology with plant specific changes
• Collaborative effort between GSE simulation engineers and Bruce engineers in model development using JADE
Tokai Unit 2  
(Japan)

Objective: Regulatory safety systems upgrades

Scope
• Add new safety-related process models
• Modify existing process systems with additional interfaces
• Modify existing electrical system to reflect backup power supply
• Enhance PSA-HD Severe Accident Model
• Modify I/O system for new hard-panel
• Additional Soft Panels
• Support computer equipment upgrade

Challenges
• Conforming severe accident model needs with regulatory standards with additional safety process systems by enhancing existing MAAP
• Adding I/O and interface with new hard panel without modifying existing IO system
• Maintaining full power initial condition while adding/modifying process and logic/control systems
KHNP-CRI Digital Twin
(South Korea)

**Objective:** Develop the Plant Simulation Models and Interfaces to support Digital Twin Project Initiatives in optimizing plant operation, maintenance, and diagnostics

**Scope**
- Deliver High Fidelity Simulation JADE Software Tools
- Develop APR1400 Simulator model and platform for supporting Digital Twin Initiatives
- Develop the specification for interfaces between simulation models and plant components, sensors and real-time data snapshots

**Challenges**
- Data security constraints that only available at the KHNP sites
- Remote access is not available due to KHNP regulations
- Digital Twin functionality to be defined in the subsequent phases of the project related to real-time plant performance interfaces
Summary

• GSE Solutions has integrated our broad capabilities in Simulation, Design & Analysis, and Engineering Programs & Performance

• Data Validation & Reconciliation (DVR) + Integration with TSM Enterprise

• Models Informed Analysis for developing new insights and solving engineering & operational challenges
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