Current Research and Future Needs in Power Generation

NETL Sensors and Controls Workshop

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Robert Frank

EPRI I&C Center

865-717-2001

rfrank@tva.gov

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Current Research and Future Needs in Power Generation

- Background
- Current Research
- Future Needs

Background

- Electric Power Research Institute (EPRI)
  - Headquartered in Palo Alto, CA
  - Research Arm of the Electric Power Industry
    - Various Research Initiatives in all phases of the industry
  - Several Technical Centers
    - I&C Center - near Knoxville, TN

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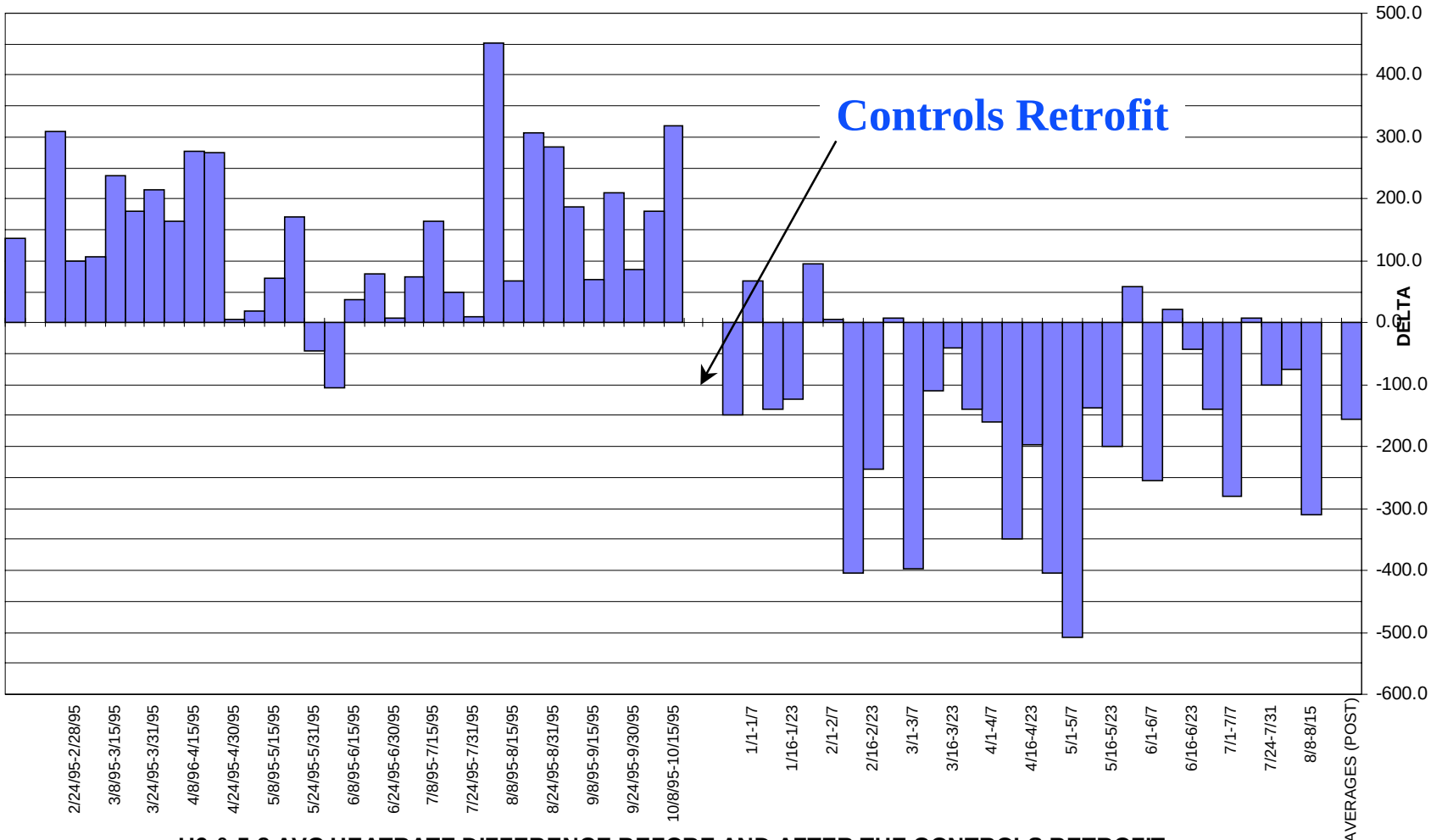
Kingston Fossil Plant

History of the I&C Center

- Unit 9 DCS Retrofit created the opportunity for the I&C Center.
- Mission: To provide advanced process control and instrumentation solutions that improve plant competitiveness and profitability
- Facility dedicated February 29, 1996

I&C Center Activities

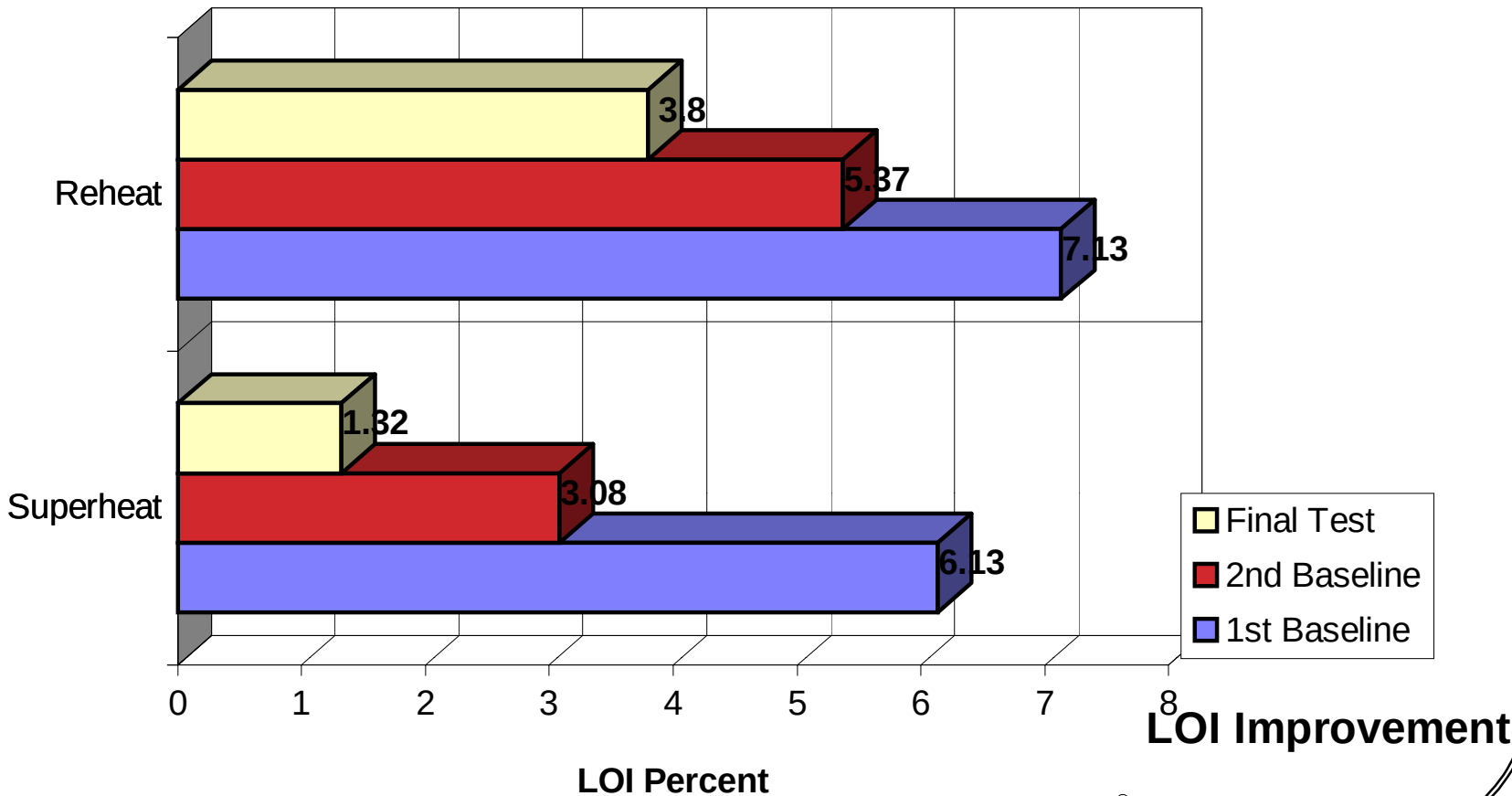
Kingston Unit 9 control retrofit benefits: Reduced Heat Rate

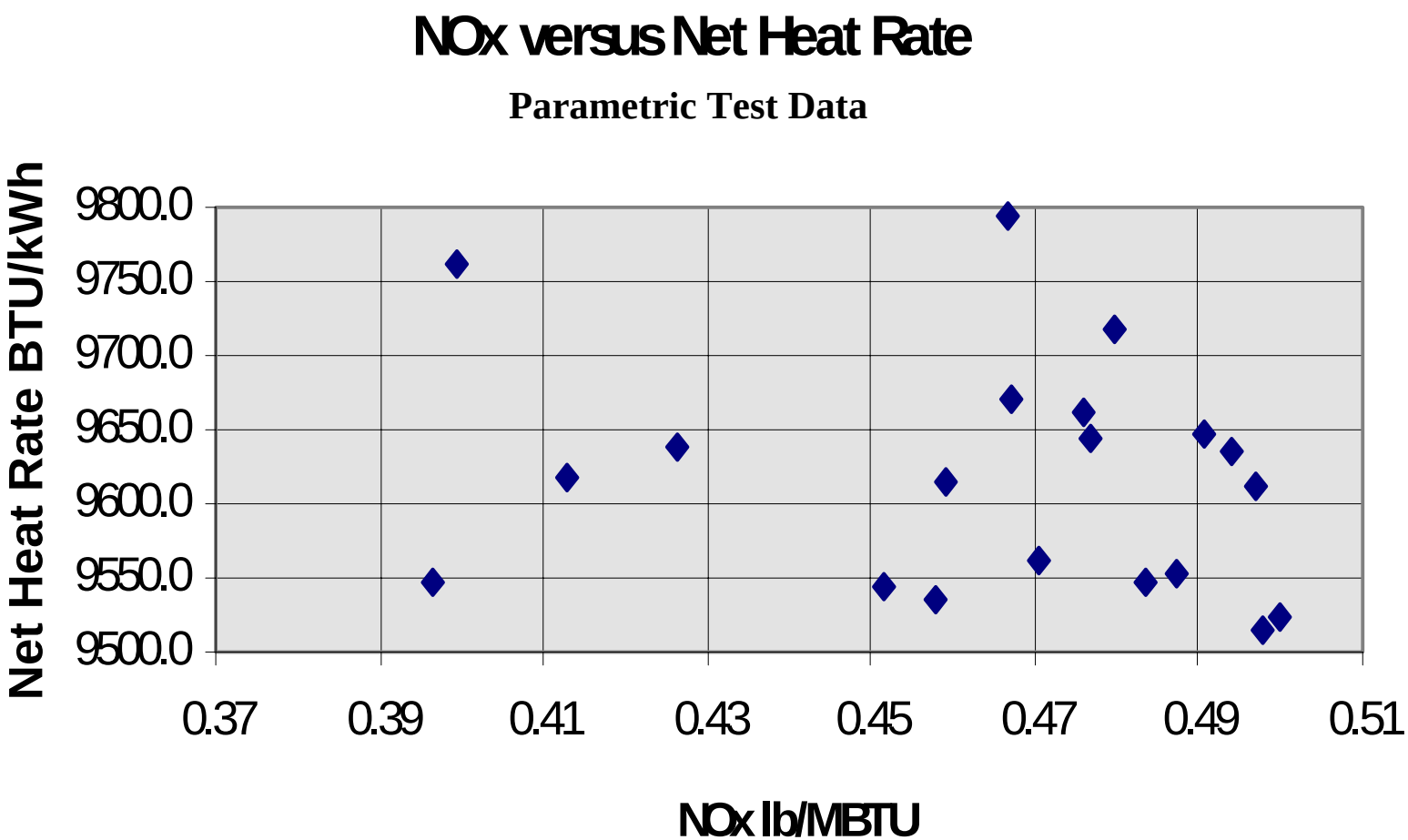


U9 & 5-8 AVG HEATRATE DIFFERENCE BEFORE AND AFTER THE CONTROLS RETROFIT

BUNKER PERIOD

I&C Center Activities
Unit 9 LOI Improvement





Baseline NOx before Controls
Retrofit: .62 lbs./10e6 BTUs

NOx Data obtained by varying:

- **O2**
- **Fuel Bias**
- **Air Bias**
- **Burner Tilts**

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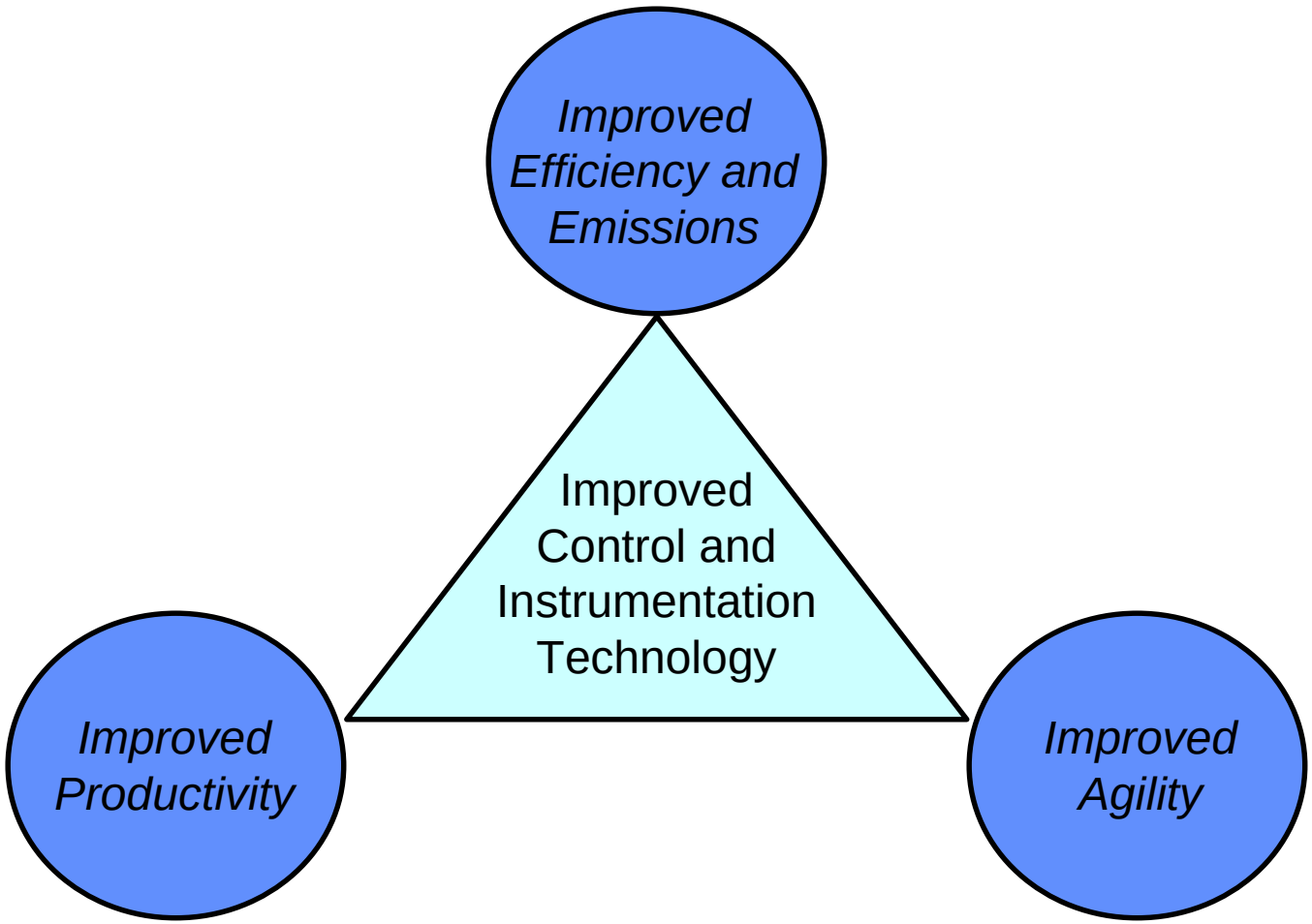
I&C Issues and Opportunities



Improved Productivity

Improved productivity consists of better decisions due to better information available and more efficient use of staff. Examples of EPRI tools to enhance productivity include CMW and ICCP.

Improved Agility

Improved agility is the ability to respond to the new demands of dispatch as well as fuel quality. In the competitive world, the unit which can:

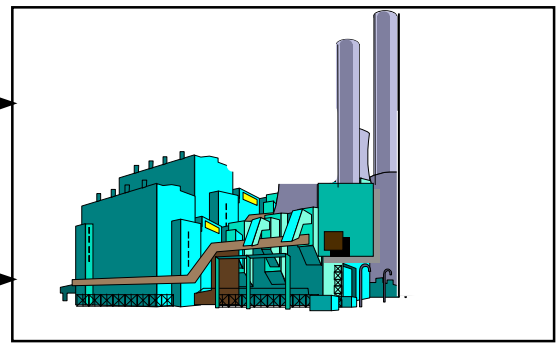
- reach target load faster and
- provide quality ancillary services such as
  - voltage regulation,
  - VARs, and
  - frequency control

is going to be much more profitable than one does not. Advanced I&C provides the platform and ability to provide this capability.

Improved Efficiency and Emissions

FUEL COSTS
$39,000,000/Year @
9,500 BTU/kw-hr,
$1.25/million BTU's

Non Fuel O&M COSTS
$5,850,000/Year
(10 - 20% of total costs)



Gaseous emissions

POWER

3,285,000,000 kw-hr/yr
@75% Capacity Factor

Solid wastes

Total Fuel + O&M Budget
$44,850,000 for "Avg. 500 Mw Unit"

- **A 1% improvement in EFFICIENCY yields $390,000 savings in fuel costs.**
- **For the entire installed fossil capacity, this yields $409,439,000.**
- **Additional benefits include 1% REDUCTION in greenhouse gases and solid wastes.**

- **A 1% increase in availability equals and additional 32,850,000 kw-hr/yr for the 500Mw plant($1,971,000 in additional sales @$60/1000kw-hr)**
- **At a retail price of $60/1000 kw-hr, this yields a $1,461,825 increase in gross profit for this plant at $15.5/Mw-hr production costs.**
- **This equals an additional 5,000 Mw of capacity for total installed fossil power plants**

Current I&C Center Projects

- Advanced Multivariable Boiler Control
- Combustion Optimization
  - GNOCIS Neural Network (KIF 5-9)
  - Forney OptiFlame (JFP 7)
  - MK Engineering LOI & CO Measurements (KIF 9)
- Improved Sootblowing
  - Intelligent Sootblowing
  - Heat Flux Sensors
  - Bergemann Water Cannon
- Heat Rate Monitoring
- Plant Monitoring Workstation Implementation & NT Conversion
- Heat Rate Monitoring Systems Assessment
- Cost of Generation Monitor Development

Current I&C Center Projects

Water Chemistry Expert System Implementation (KIF)

Assessment of On-line Coal Analyzers (PAF & CUF)

On-Line Pulverized Coal Flow Measurement (TVA BRF,)

Combustion Products Sensor Assessment (CO, NOx, etc.)

Advanced Pulverizer Control

Controls Maintenance Workstation Implementation

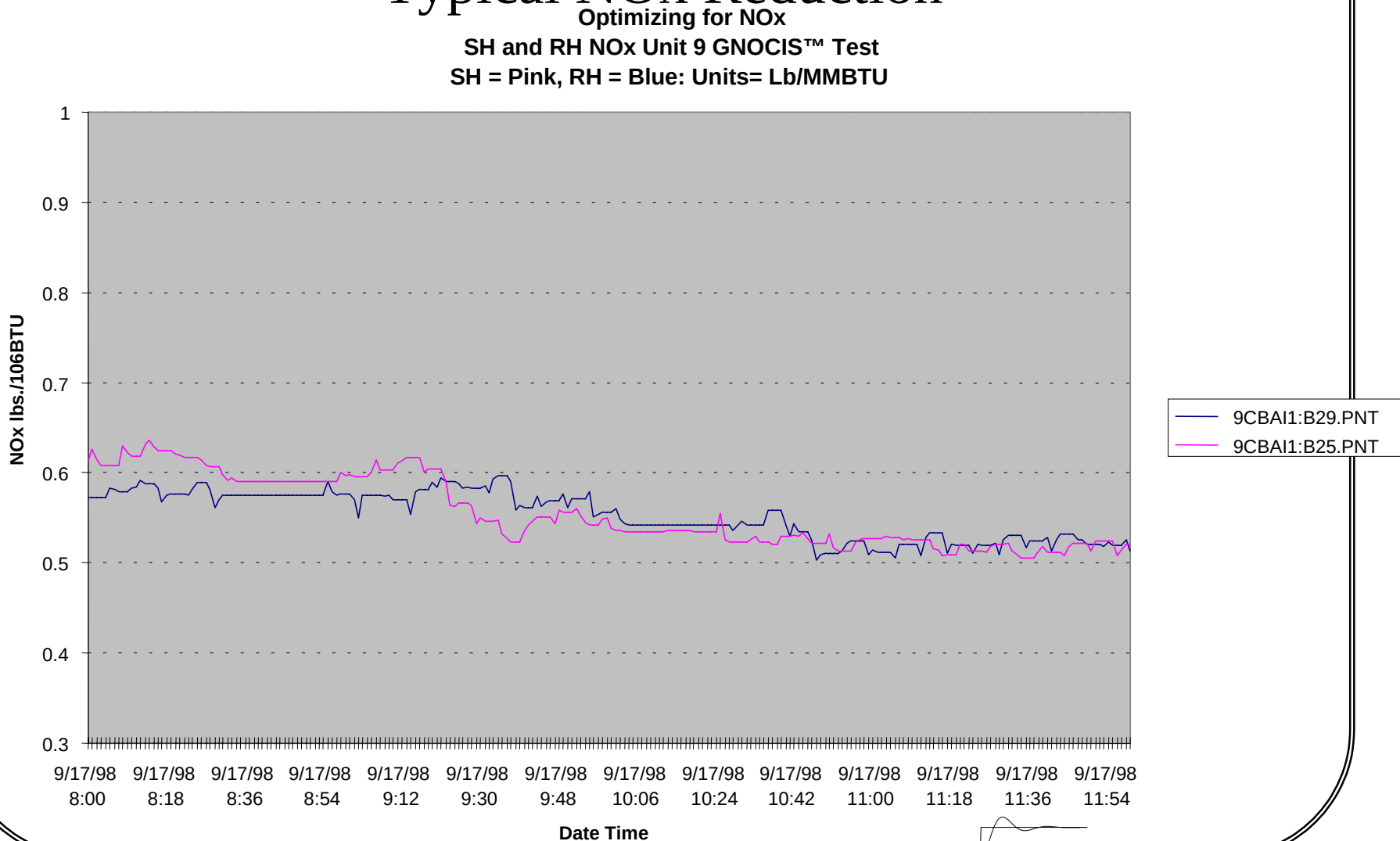
Ultrasonic Feedwater Flow Measurement

Boiler Inspection Robot Development

Sensor Validation

GNOCIS Neural Network

Typical NOx Reduction



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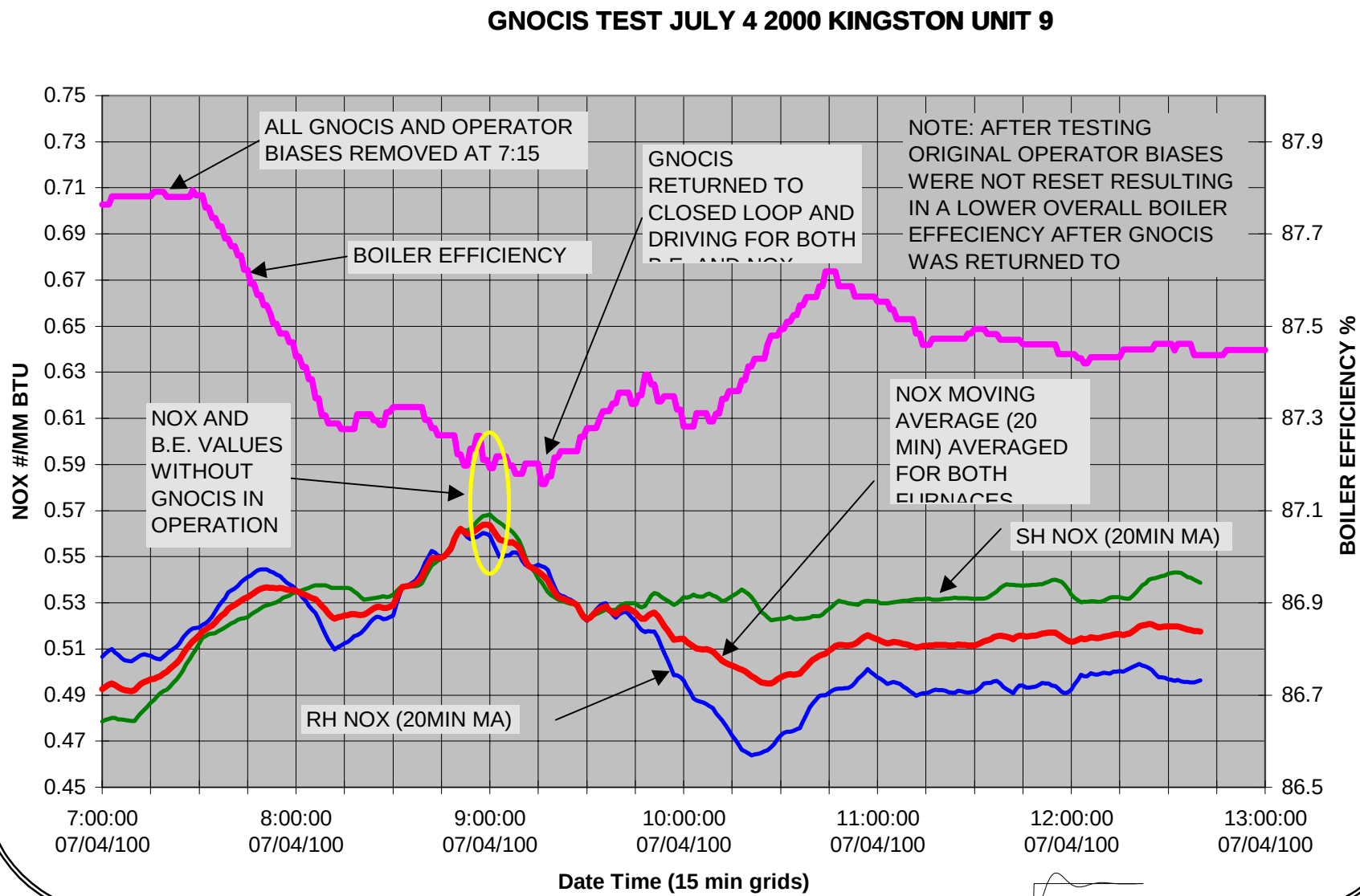
Typical NOx and Boiler Efficiency Results from GNOCIS



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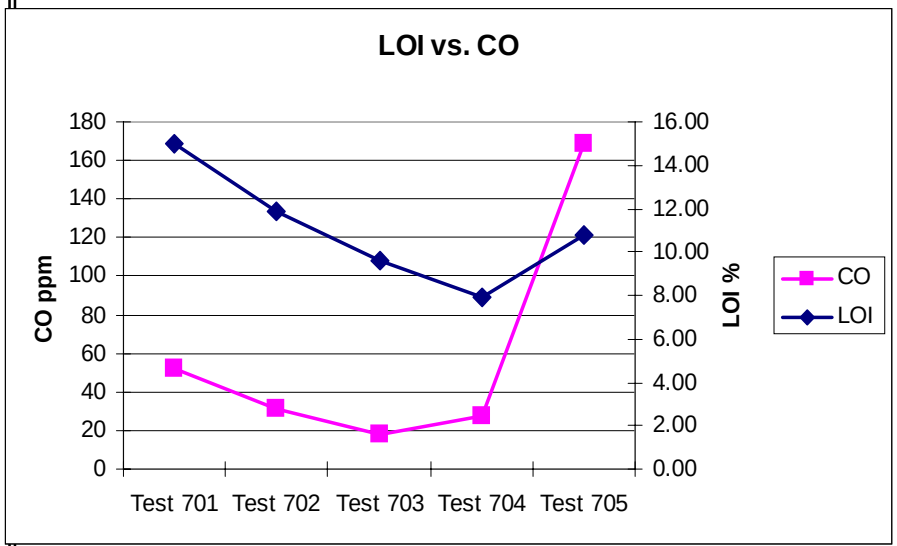
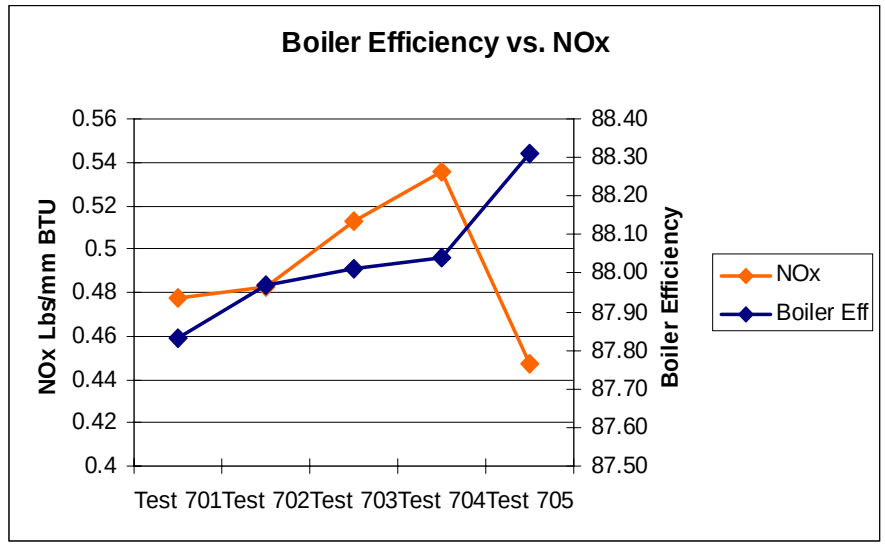
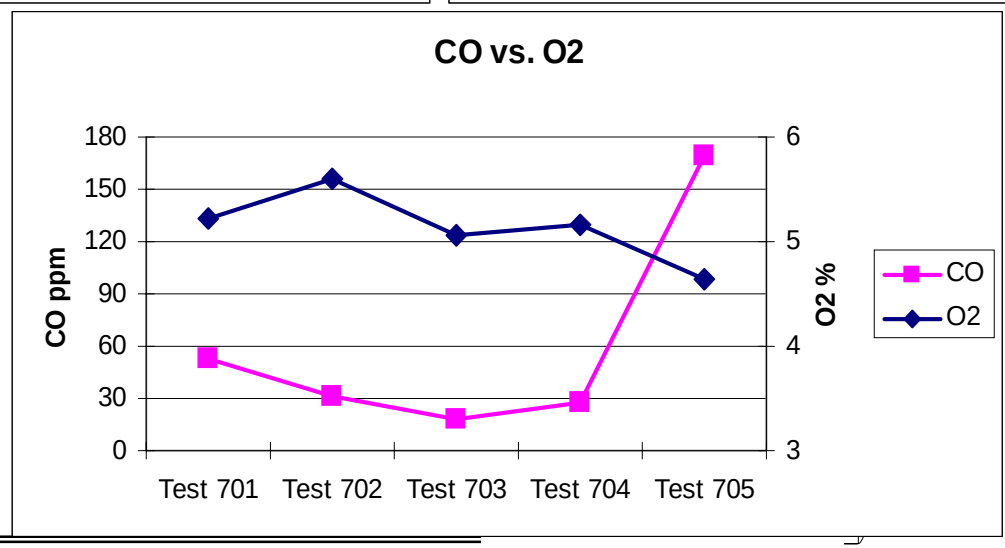
Johnsonville Optiflame Summary







EPRI I&C Center/TVA/TTU
Boiler Inspection Robot

Goal: Develop a low cost mobile platform for inspection of fireside boiler surfaces

Benefits: Reduced costs and time to inspect boiler tube surfaces

Long-term goal: Investigate the development of automated tube leak location, preparation, and repair.

Boiler Inspection Robot

- Dr. Steven Canfield (TTU) has developed such a platform and tested it at TVA Kingston
- It uses magnetic tracks to drive along water wall surfaces
- Current inspection device is a CCD camera
- Current project focuses on applying other NDE inspection methods onboard

Future Needs

- Individual burner tuning with active control
- Improved combustion measurements
  - NH_3, CO, NO_x, etc.
  - Flame quality
- Real time cost-of-generation linked with economic and environmental dispatch
- Improved plug and play software
- Adaptive control modes for changing market demands

Possible New Opportunities

- Generation Plant Challenges
  - Reduced staffing
  - Pressure to improve profitability
  - Push to reduce emissions
  - New emissions regulations
- R&D Opportunities/Challenges
  - Teaming to leverage funding
  - Short term goals
  - Long term vision