Automation Applications Inc, LLC

*together with*

JMP Engineering

# Optimization of Steam Generation Assets

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**Technical Focus Group**

# Discussion Items

- AAI-JMP Profile
- Power House Operating Challenges
- Advanced Control Strategies
- Implementation Approach
- Benefits

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# AAI-JMP Profile

- Automation Applications Inc, LLC (AAI) has joined

**JMP Engineering, Inc.**

- AAI is operating as AAI-JMP Engineering, Philadelphia
- 9 North America Branches
- 100+ employees
- Additional Engineering Capabilities as a Function of JMP Integration
  - Energy Management and Monitoring Solutions
  - Water and Waste Treatment

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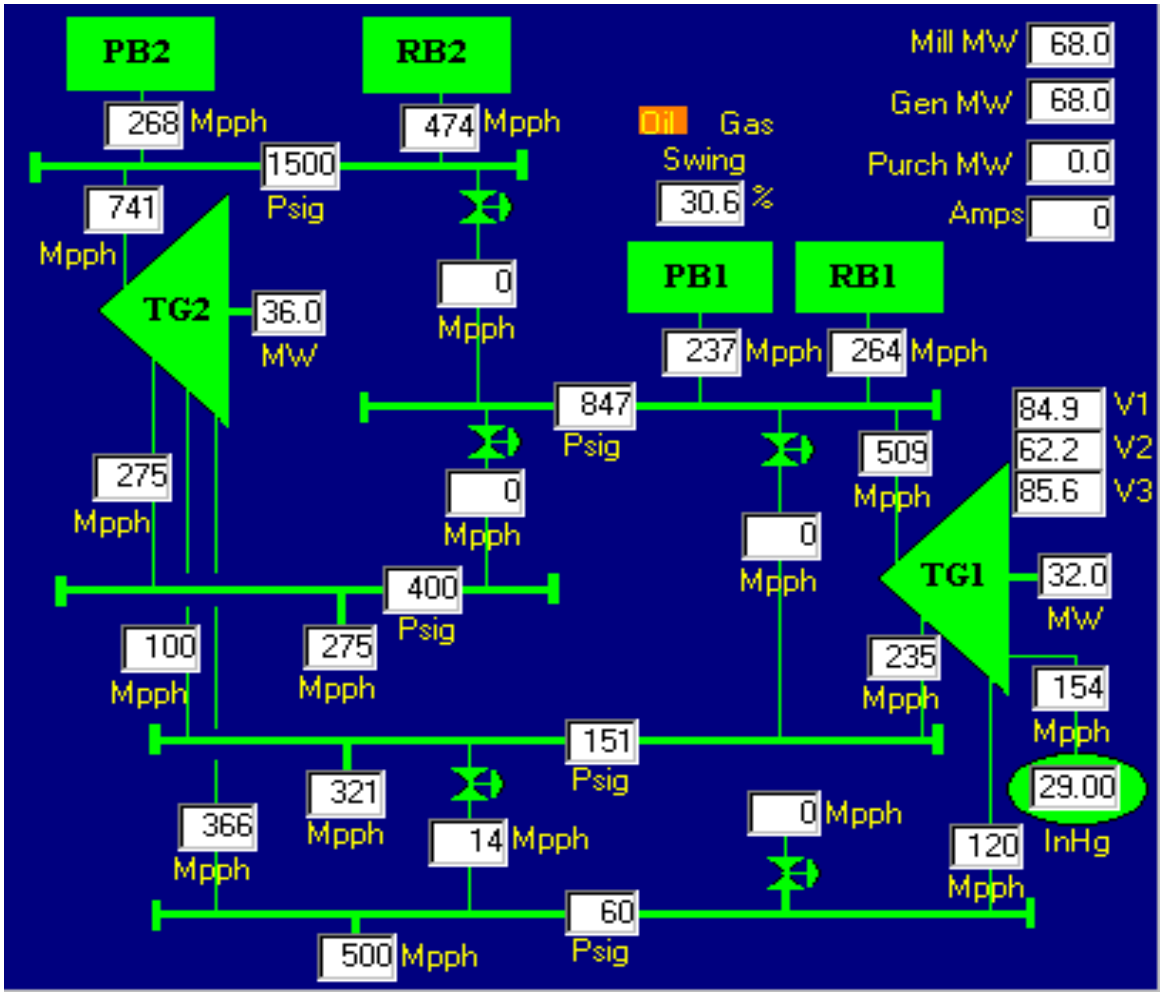
# Philadelphia Profile

- Independent Full Service Turnkey Solutions Provider in Process Control, Manufacturing & Information Systems
- Consumer Products, Energy, Food & Beverage, Petrochemical, Pharmaceutical, and Pulp & Paper Market Solutions
- Boiler Combustion Controls and Industrial Energy Management is Core Application Expertise
- Successfully Completed over 300 Powerhouse Projects
- Industrial Energy Solutions Team Comprised of Individuals with Hands-On Background in Boiler Control Design, Start-Up and Operation

# Industrial Utilities Operating Challenge

- Meet Steam & Electrical Demands
  - @ Lowest Possible Cost
  - While Operating Smoothly, Reliably, Consistently, Safely
  - And, Meeting Environmental Constraints

# Powerhouse Overview

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# Operating Priorities

- Meet steam demand among fuels/boilers based on minimum costs while adhering to fuel, boiler, operational & environmental constraints
- Maximize steam supplied on a prioritized fuel(s) basis, e.g. NG, biomass, or coal
- Distribute steam economically among your turbines and PRVs to maximize total power generated and minimize the use of PRVs
- Manage generated emissions
- Manage purchased energy costs

# An Approach

- Rule-based supervisory control system utilizing multi-variable, prioritized constraint control strategies
- Process equipment, operational constraints, environmental constraints define the operating envelope
- The applications finds the most optimized point within the defined envelope

<u>The Objective:</u> Run the powerhouse as well or better than your best operators on their best day!!

# AAI-JMP Solutions

- Energy Management Solution
  - Boiler Load Allocation
  - Turbine Load allocation
  - Coordinated Header Pressure/Predictive Header Pressure Control
  - TieLine Control
  - Economic Load Shed
- Multi-Fuel Boiler Optimization
  - Independent Fuel Masters, e.g. BioMass, NG, Coal
  - Flexibility to Tune Each Master for Specific Fuel
  - Inferred Btu Control by Consumed Air
  - Coordinated Load Changes
    - Auto Air Distribution Control
    - Excess Air Control

# Advanced Boiler Load Allocation

- Generate Steam at the possible the lowest possible impact to emissions and operating costs
- Allocates the total steam demand among multiple fuels/boilers based on defined fuels, emissions and cost constraints
- Incremental emissions and costs for the next unit of steam
- Fuels & Boilers with lower incremental emissions and steam costs are favored more than boilers & fuels that produce higher resulting emissions and costs
  - Lowest impact boilers & fuels take most of the load

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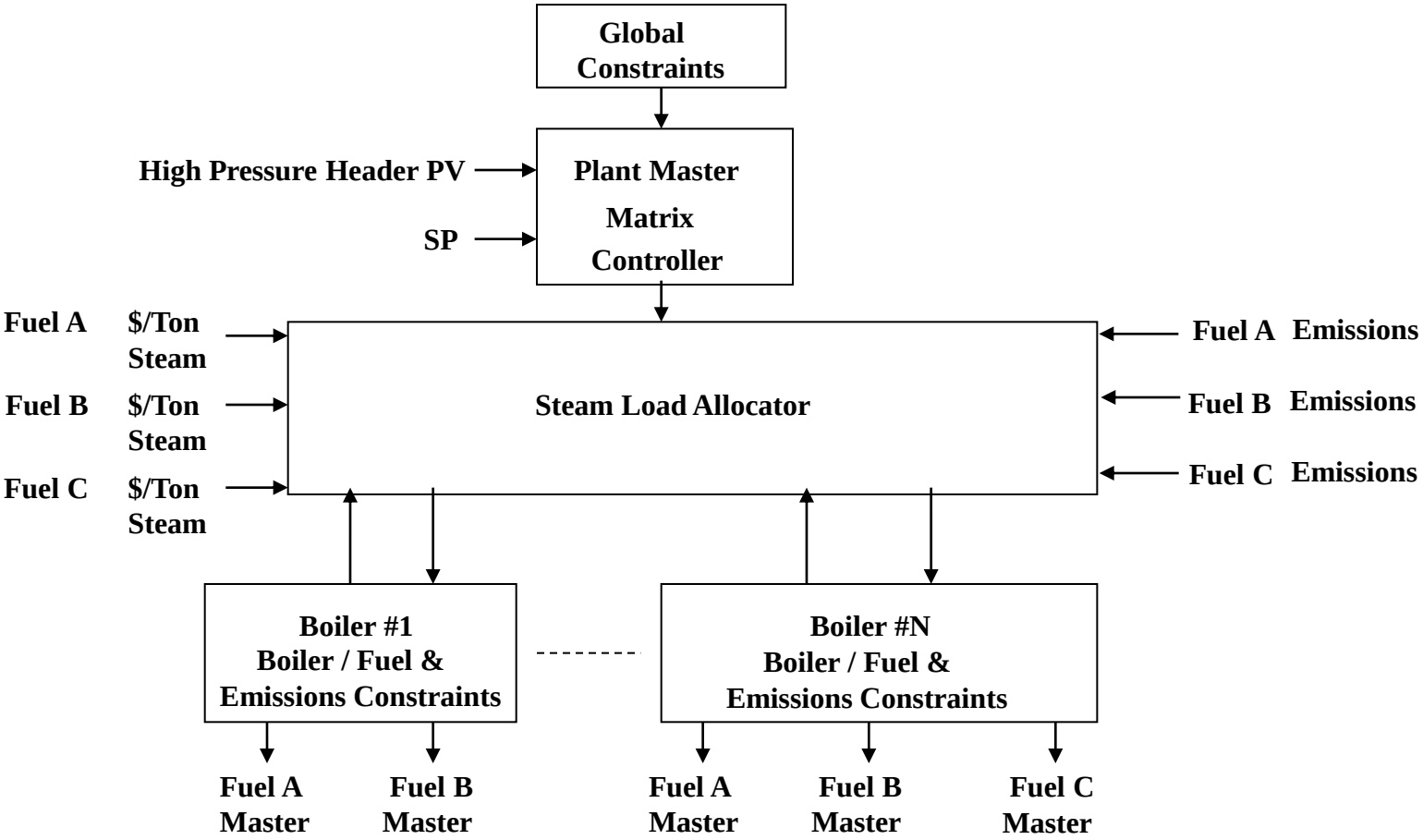
# Advanced Boiler Load Allocation

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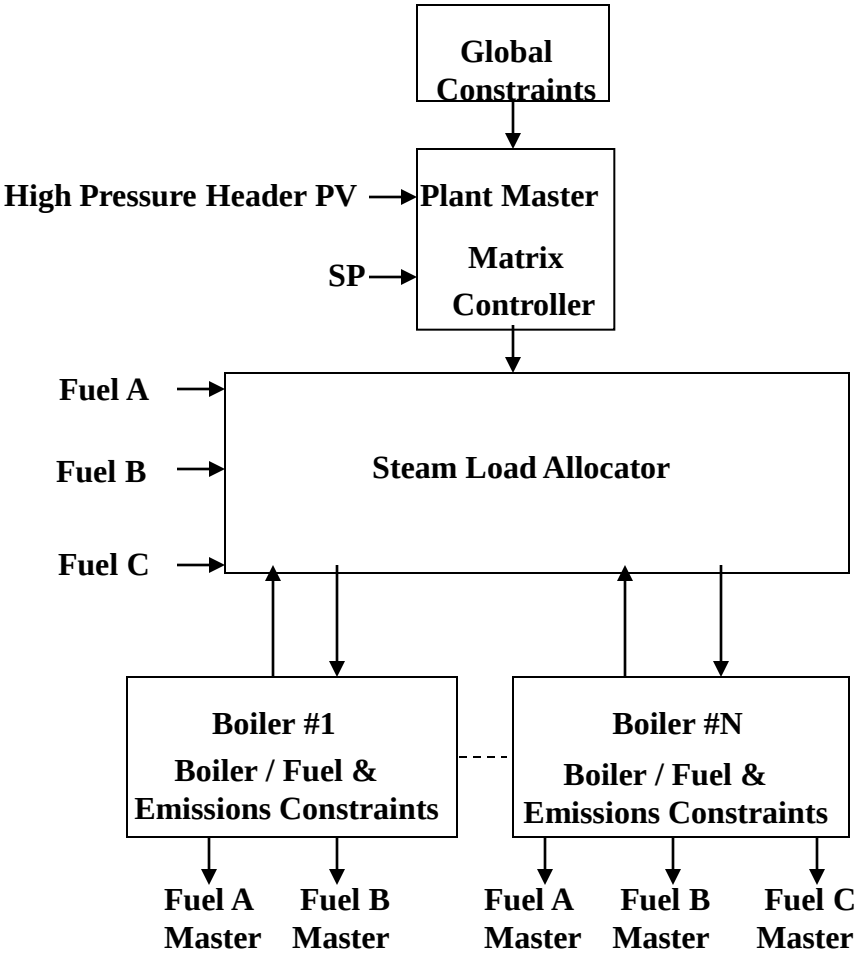
# Advanced Boiler Load Allocation




- Boiler Fuel Optimizer
  - Maximizes lower cost fuels and minimizes more expensive fuels
  - Works with constraints to minimize the emissions and cost of steam/electrical power
- Constraint Controllers
  - Create an operating/environmental (process envelope)
  - Constraints prioritized on order of importance
  - Global constraints have precedence
  - Operating & Emissions Constraints have priority over cost decisions

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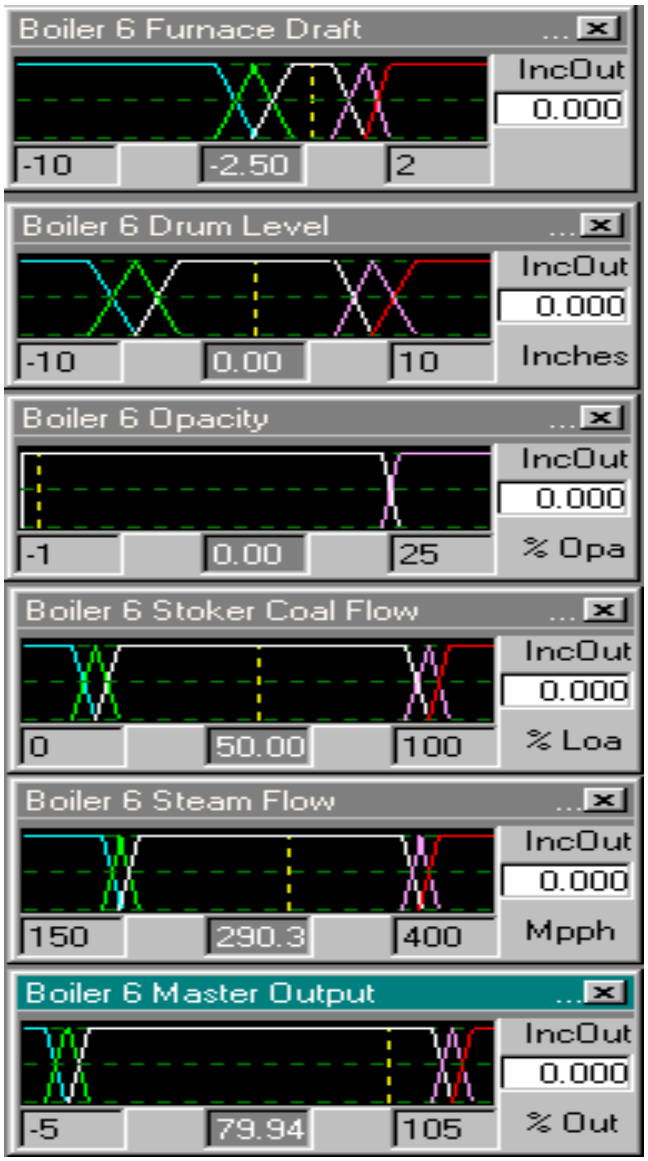
# Boiler Constraints

## Rule Based Constraints

- Furnace Draft
- Drum Level
- O2, CO, NOx, Opacity
- Fuel Flow Limits
- Steaming Limits
- Boiler Master Limits
- Others as required

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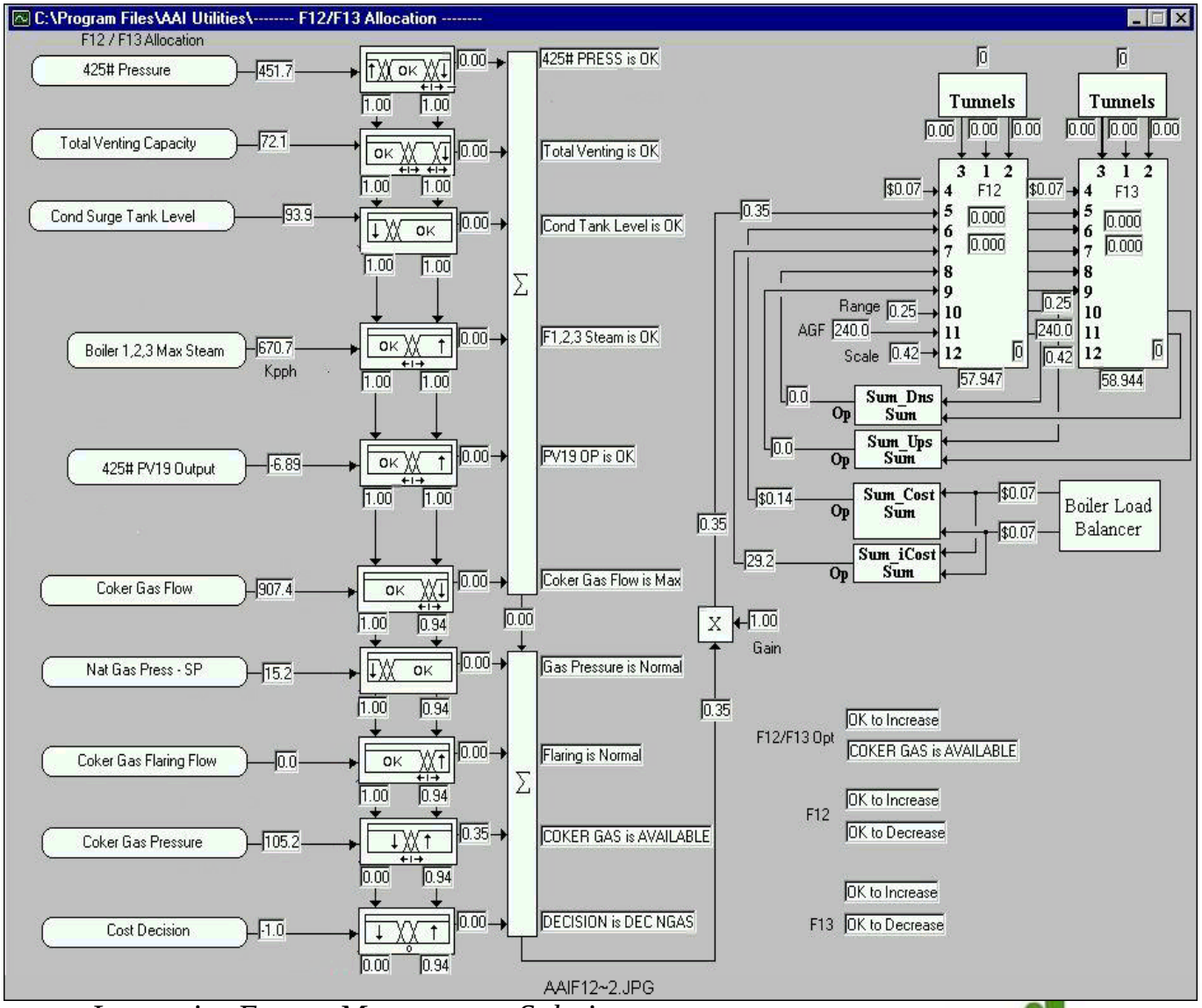
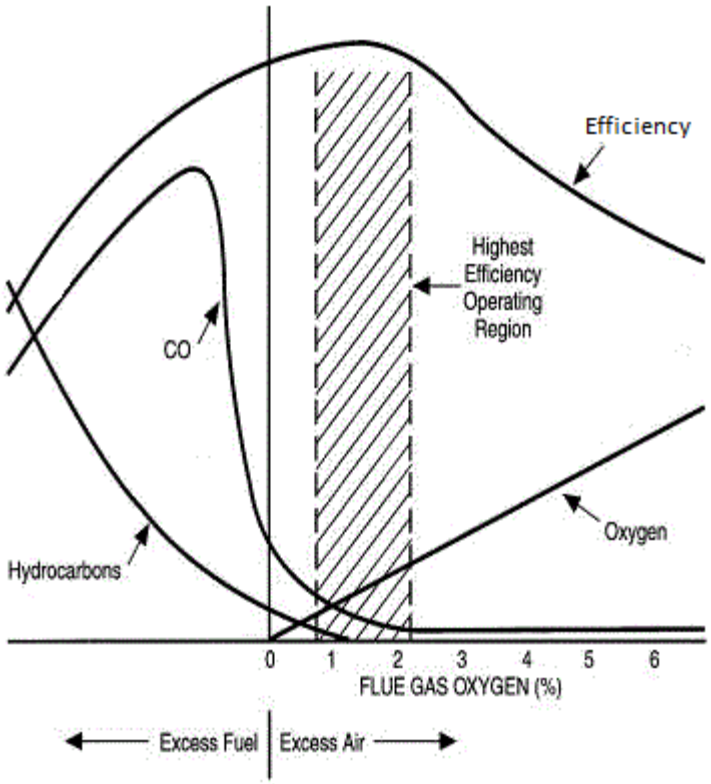
# Global Constraints



# O2 and Air Distribution

- Reduce O2 until the point where you start to make CO, however…
- ***The Relationship between Excess Air and CO Is Not Fixed!***
- Increase the effectiveness of mixing, and the CO line slides to the left.
- Narrow the controllability range with tight responsive coordinated control, and Excess O2 Setpoint can be lowered.
- **But What Happens to NOX**



# Where are we & what does it all mean

- Restriction of Manual Operation:

  With the addition of sophisticated fuel burning equipment, post combustion emissions control units and their associated control requirements, it's expected that Operator (Manual) Control and Intervention into the control strategies will be greatly restricted.
- This will require control and automation that anticipate and correct for situations, where previously accepted practice was operator manual control
- The ability to dynamically "fine tune" the indexed O2 & air distribution curves based on current emissions will be essential.

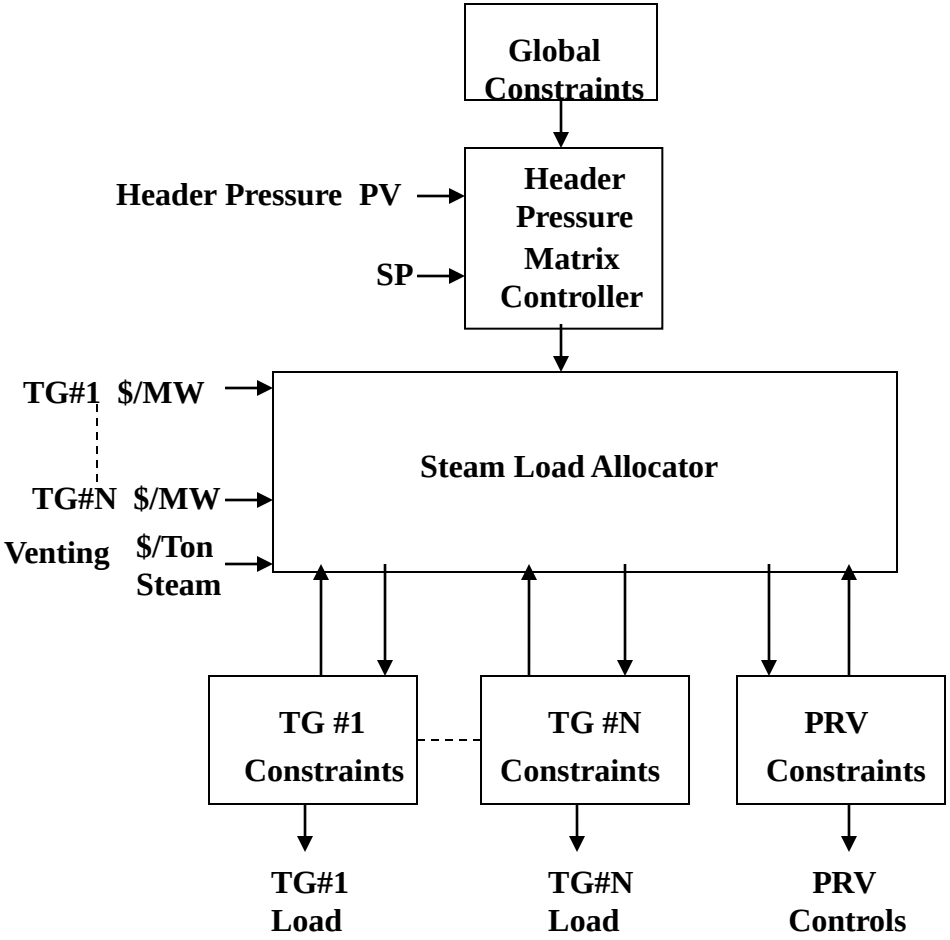
# Control Approach

- Extend Rules based process constraint control to emissions
- These include;
  - Opacity
  - CO
  - NOx
  - Others as measurements are available
- These constraints and potentially others will be used as continuous control measurements to define an operating envelope and “fine tune” boiler emissions within permitted levels

# Advanced Boiler Load Allocation

- Benefits
  - Managed/Optimized Fuel Usage
  - Managed/Optimized Emissions
  - Improved Demand Side Operations Through Improved Quality & Reliability of Steam Generation
  - Greater Operating Stability & Reliability of Steam Generating Assets.

# Advanced Turbine Load Allocation




- Allocates steam among turbines and PRVs while adhering to constraints to minimize:
  - The cost of producing electricity
  - Steam venting
- Benefits
  - Minimum cost of self generated electricity
  - Cost savings from reduced steam venting & condensing

# Operational Benefits

- Improved Demand Side Operations
- Greater Operating Stability & Reliability
- Reduced Steam Venting & Condensing
- Prioritized Fuel Use
- Identification of Bottlenecks for Improved Efficiency
- Maximum Asset Utilization
- Minimized Emissions and Operating Costs

# Implementation

- Based on Proven Technology
- Rule-Based supervisory control system utilizing multi-variable, priority constraint control strategies
- Process equipment & operational constraints, as well as environmental constraints, define a safe operating envelope
- Power House usually operates on the boundary of constraints

# Integration with Existing Controls

- Client/Server Based or Imbedded Application
- Works in Concert w/Major Control System Platforms
  - DCS, Hybrid, PLC, Turbine Controllers
- Utilizes Industry Data Interface Standards
  - OPC, DDE, Modbus
- Database Open to Third Parties
- Standard Operating & Engineering Displays
- Tailored to Specific Steam Generation Functions

# Application of the Controls

- Quick & Easy to Implement
  - Function Blocks Configured to Form Tailored Solution
    - **No Programming Required**
    - **No Models to be Developed & Maintained**
- Easy to Maintain, Modify, Expand

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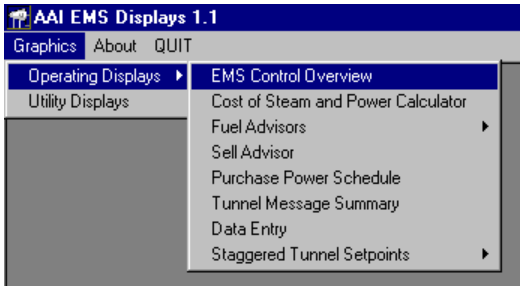
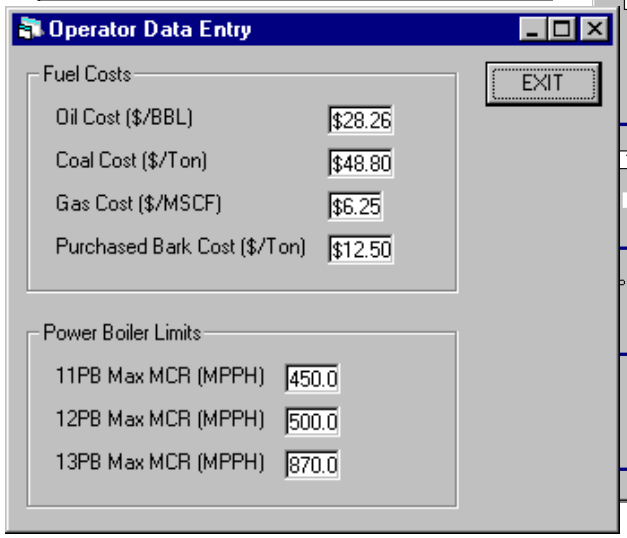
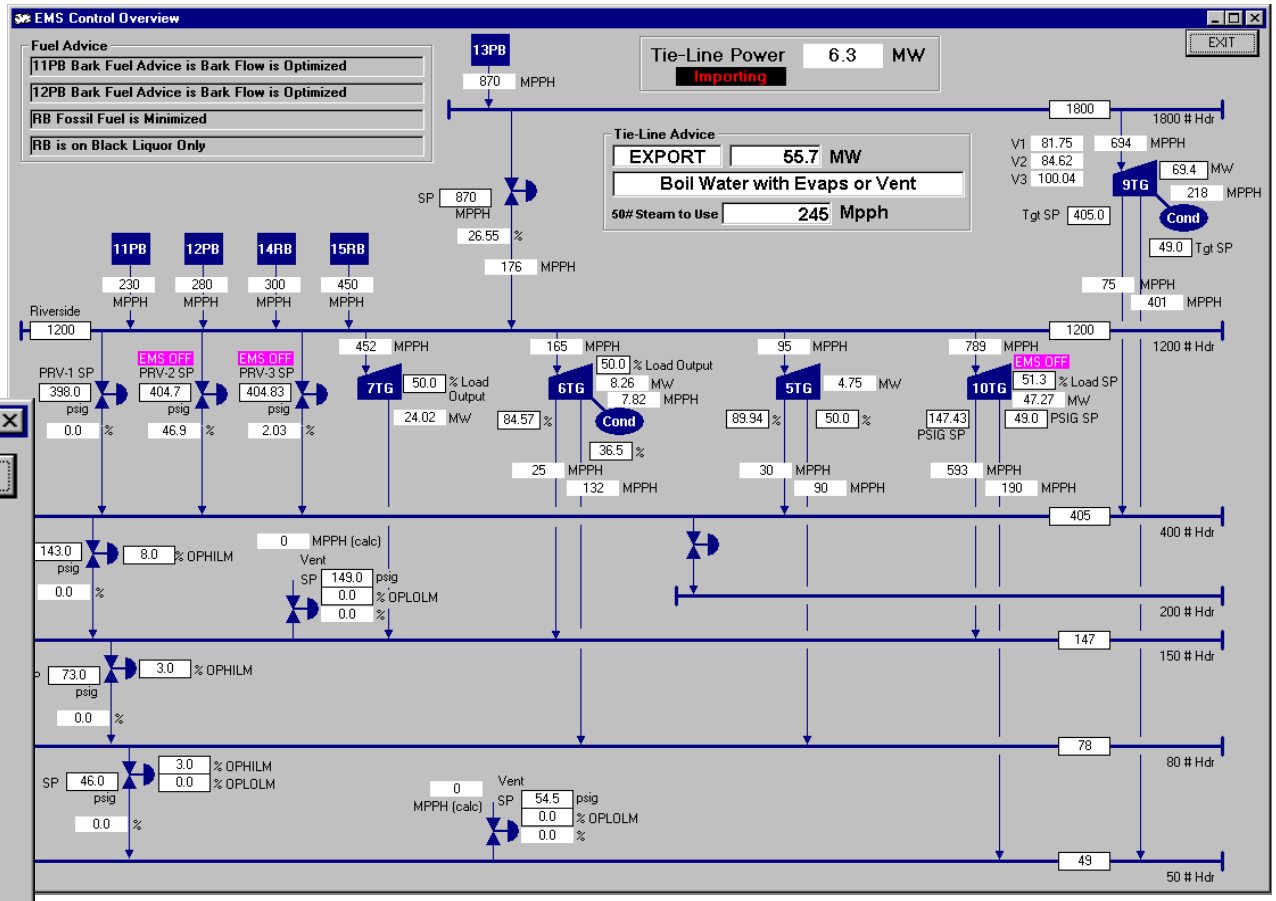
# Intuitive Look & Feel

## Easy for Operating Personnel to Understand & Use

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# Some Typical Installations

Peace River, Alberta – Multi-fuel Boiler Control, Coordinated Header Pressure Control, Demand & RTP Tie Line, Load Shedding, Power Factor Control

Orange, Texas - Multi-fuel Boiler Control, Coordinated Header Pressure Control, Boiler Load Allocation Demand Tie Line and Power Factor control

Prattville, Alabama - Demand & RTP Tie Line

Ft. McMurray, Alberta – Multi-fuel Boiler Control, Coordinated Header Pressure Control, Demand and RTP Tie Line Control, Load Shedding, Boiler Load Allocation

Prince George, BC – Multi-fuel Boiler Control, Coordinated Header Pressure Control, Boiler Load Allocation

Cedar Springs, GA – Multi-fuel Control, Coordinated Header Pressure Control, Boiler Load Allocation

Columbus, MS – Multi-fuel Control, Coordinated Header Pressure Control, Boiler Load Allocation

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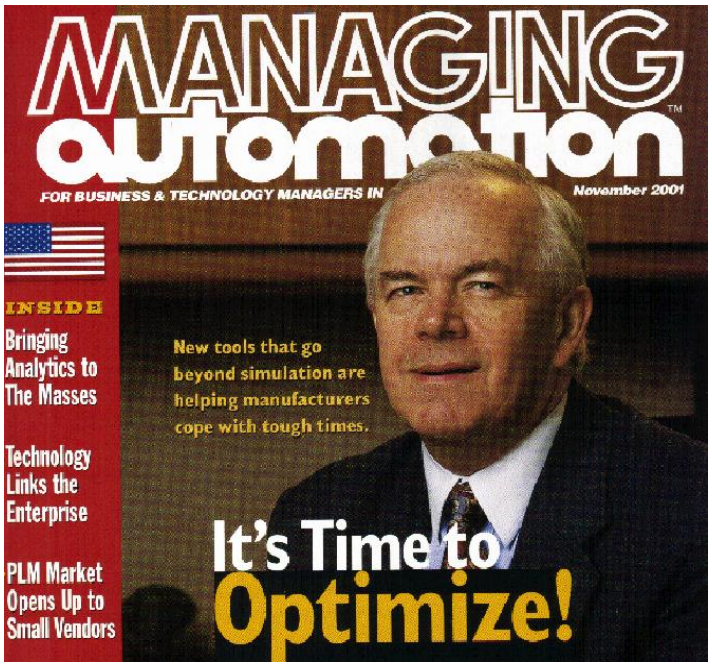
# It's Time to Optimize

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