KEI Real Time Performance Monitoring

Sentinel Solutions…Turn your data into profit in real time

Why Real Time Performance Monitoring?

- Process Industry return on investment needs to improve above the cost of capital
- $20 billion per year lost to unplanned downtime (ARC)
- Environmental and safety regulations are tighter than ever
- Global competition raises the performance bar
- Operator work force has high turnover
- Operator work methods are moving from operational control to production management
- Decisions need to be made in real time

Sentinel Solutions Reduce Profit Leakage By:

- *Improving* **EFFICIENCY**
- *Improving* **AVAILABILITY**
- *Improving* **ASSET MANAGEMENT**
- *Reducing* **EMISSIONS**
- *Increasing* **CAPACITY**

Why KEI Sentinel Solutions?

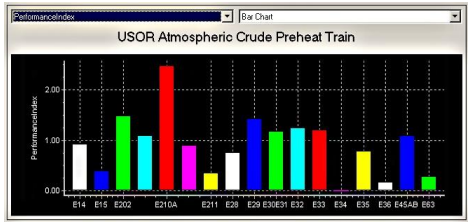
- Tightly integrated with OSI architecture
- Powerful and user friendly data handling and performance calculation engine (Sentinel)
- Process Industry engineering and operational expertise
- Engineering models designed for real time performance monitoring and decision support

KEI Customer Value Promise

- High value, low cost solutions
- Projects completed in weeks
- No major capital investment
- ROI measured in months, not years
- Layered on top of your existing investment in PI

Sentinel RTPM Solution Components

Visualization in OSI Process Book/Ice



Refining | Oil & Gas | Industry Vertical Applications

Asset Management

Energy Management

Emissions Management

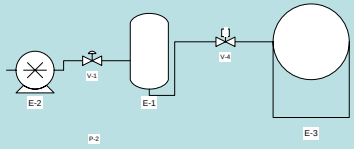
Capacity Management

KPI templates

Design data

Sentinel/PI-ACE On line Calculations

Sentinel Rules Engine



Sentinel RT Models & properties data

PI RT & Historical Data

Sentinel as a KPI Engine

- Users can define their own KPI's for any function.
- Users type their equations into Sentinel.
- Sentinel will find the necessary data in PI and perform all the calculations. Coding is not needed.
- Presentation of KPI's is done in Process Book or ICE (web display).
- Easy to modify rules (maintainable) without coding
- Real Time Excel integration
- Extensible (start small and grow)

***Sentinel* Provides**…

data handling, data checking and reconciliation, equation solvers thermo and physical properties, interactive w/excel, dynamic actions

Existing Packaged Solutions

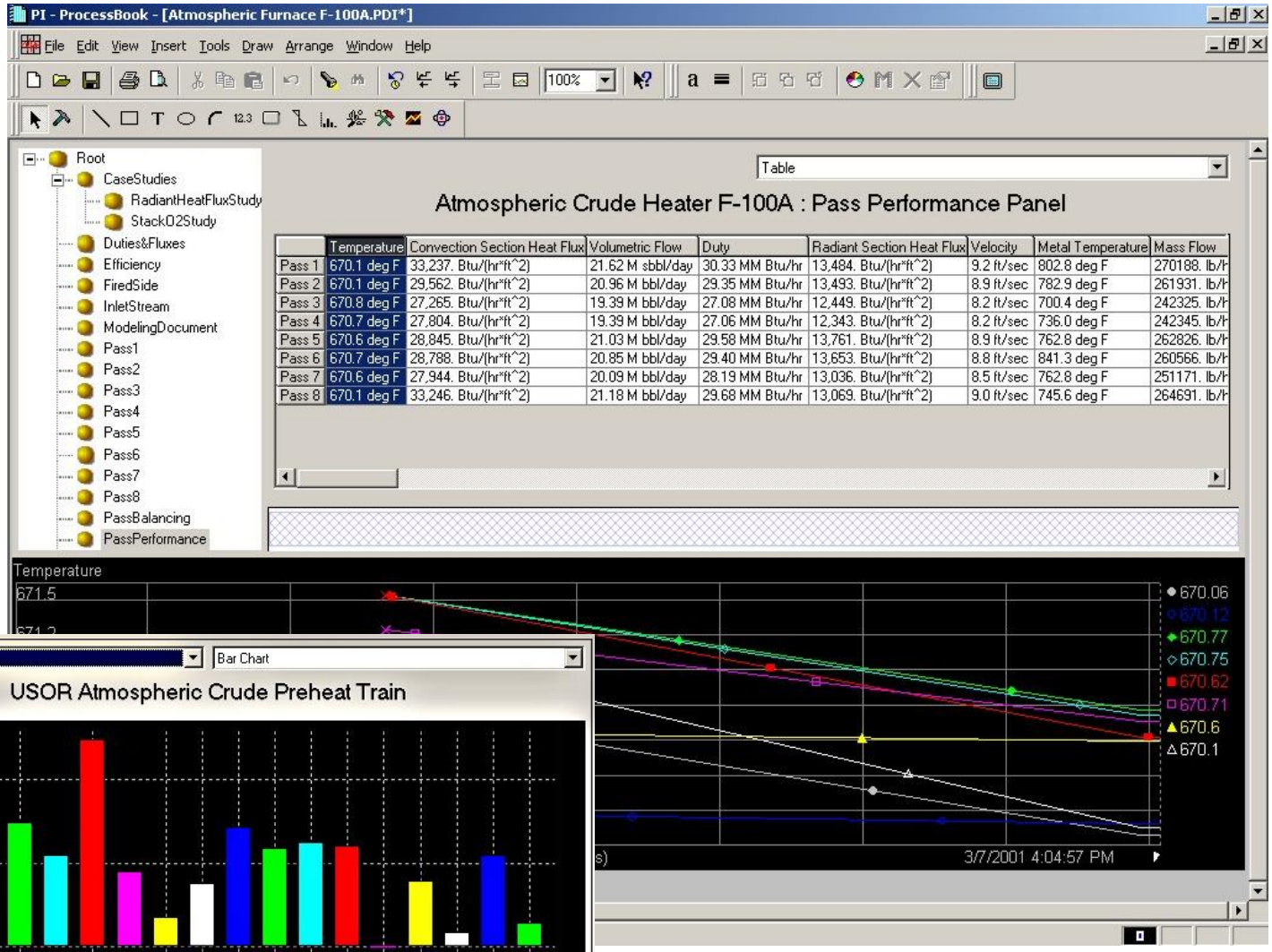
1. **Energy Tracker Sentinel** provides RT calculations to help operators reduce energy consumption in heaters and boilers.
2. **Fired Heater Performance Sentinel** provides RT calculations and recommendations to increase capacity, equipment life and efficiency for hydrocarbon heaters.
3. **Virtual Tower Analyzer Sentinel** helps operators reduce quality giveaway while improving efficiency.
4. **Heat Exchange Network Performance Sentinel** reduces unnecessary maintenance while maximizing exchanger performance.

Energy Tracker Sentinel

- Fired side models of all heaters and boilers
  - Real time analysis of fuel used, heat released, %O2, stack temperature
- Checks accuracy of energy consumption
- Large rotating equipment (release 2)
- Converts energy efficiency to profit
- Compares actual efficiency to theoretical best for different use cases
- Shows operators, engineers and management profit leakage and where to focus improvement opportunities

Applied at US Oil

Energy Tracker

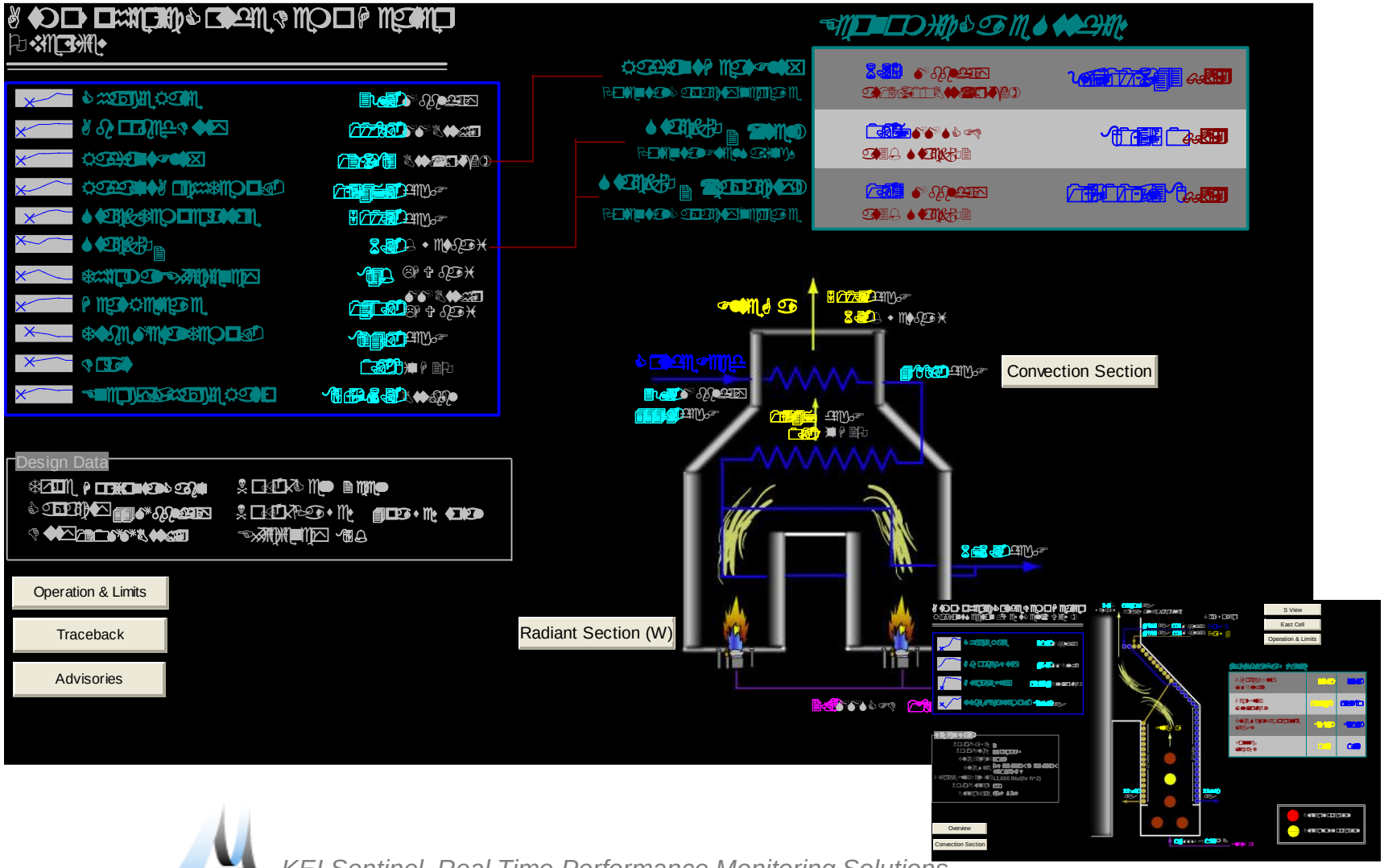


Fired Heater Sentinel

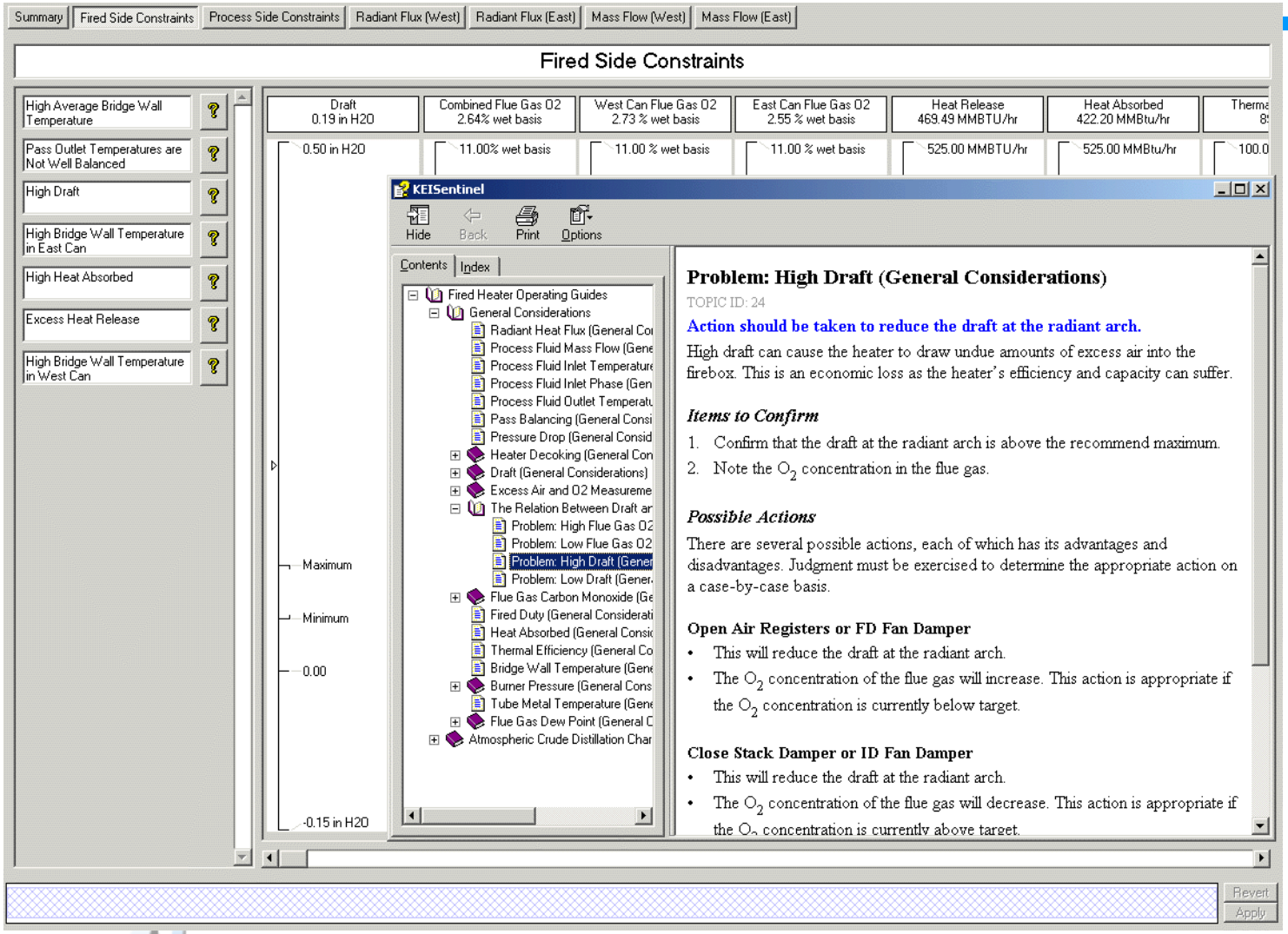
- Retrieves and writes data from/to PI
- Validates and conditions the data
- Calculates
  - fired-side duties and overall heat fluxes of the convection and radiant sections
  - Process-side duties, rates of heat transfer, tube-metal temperatures, and heat fluxes of each pass
  - air preheat performance
  - overall heater efficiency
  - economic incentives to increase efficiencies
- Provides advisories based on events and exceptions

Applied at Citgo Corpus Refinery

Fired Heater Sentinel display



Fired Heater Expert Advisor



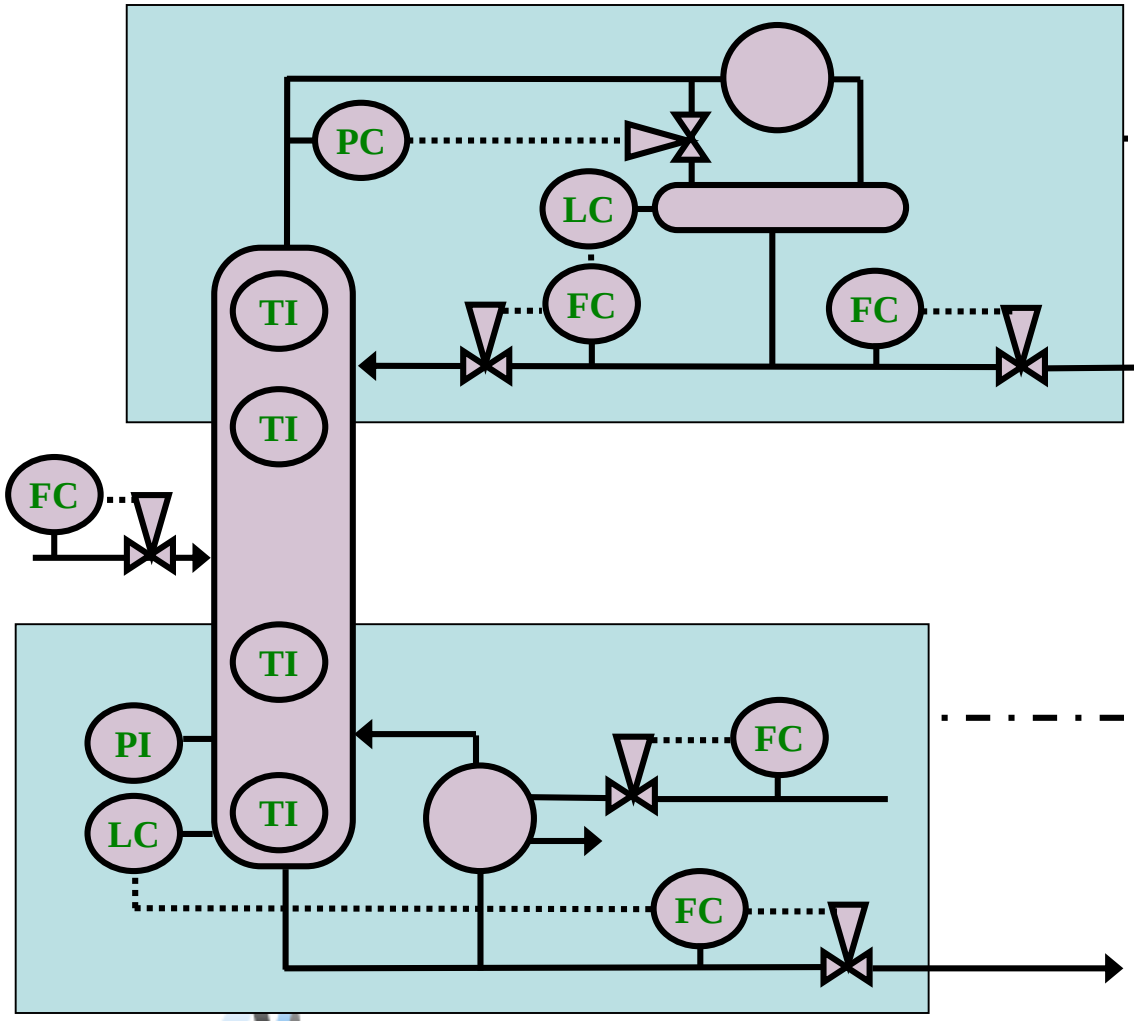
Sentinel Tower Virtual Analyzers

Calculates feed and product composition in real time rather than using expensive on line analyzers

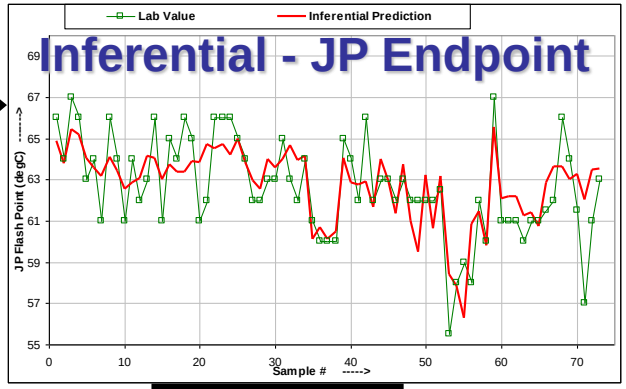
- Uses first principles models
- Allows for tighter operation to reduce quality giveaway and increase capacity
- Reduces energy consumption by reducing excess reflux

Applied at United Refining, Warren Pa.

Tower Virtual Analyzers



TOP INFERENCE MODEL



BOTTOM INFERENCE MODEL

Virtual Analyzers

Crude Oil Switching

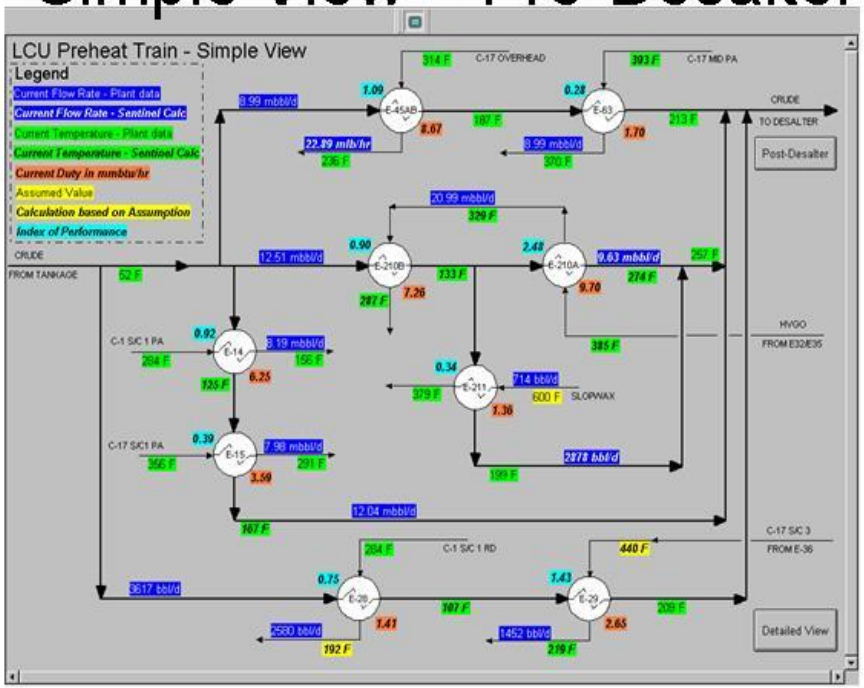
Refiners purchase spot market feedstock. As feed is switched, the refinery can take up to 12 hours to return to optimum operation. During this time throughput is reduced and product quality is given away.

The Sentinel virtual analyzer “calculates” the crude tower product and feed properties from measured data in real time. Operators use the knowledge to tune the tower stabilizing the unit in a few hours. The savings for a typical refinery that changes crude often is over $ 1 million per year. Payback is measured in months. The virtual analyzer has been used with open and closed loop control

Sentinel Heat Exchanger Networks

- Models heat exchanger networks
- Determines when exchangers need to be cleaned avoiding unnecessary shutdowns
- Guides flows to alternate network paths for more efficient heat transfer

Simple View – Pre-Desalter



Applied at US Oil

More Examples of Sentinel

- Asset Management-Life Extension
  - Life extension=f(cycles, operating out of range, time out of range, ramping out of range)
- Real Time Gross Margin
- Energy Trading
- Energy Capacity/Penalty/Spot Price Optimization

Asset Management Template Example

TOTAL PRODUCTIVE MAINTENANCE

Define the equipment that has high replacement value, requires regular maintenance, is a potential safety/emissions problem, can cause outages?

- Asset A
- Asset B

For Asset A, What affects equipment life and repair cost?

- Number of starts and stops?
- Thermal cycles?—how many, how fast
- Operation out of design range? (how far and how long)
- Cleanliness of hydraulic, sealing and lubricating fluids?

Define KPI's and relationships in terms of penalties or dollars, ie,

Asset life KPI=f(# starts, integral of temp out of range over time, speed of thermal cycle)

Define the KPI standard for comparison (design data, vendor standard, use case, best in class, average of other users.

Define design, and RT data needed

Define equations needed

Define any models needed

Define User displays

Sentinel Services

KEI realizes that not all plants have in house engineers to utilize the on line knowledge provided

We provide on line actionable recommendations

We can provide on line analysis from industry experts to supplement your own

Solutions can be implemented on a server in your plant or hosted remotely