PlantTriage Project Execution at Ammonia Plant

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Biography

- Industrial Process Optimization is an engineering consulting company that specializes in process control and control systems engineering applications consulting
- Owner David Leach has over 40 years of industrial experience working previously with five major corporations in the following roles: production supervisor, process engineer, project engineer, project manager, process control engineer, control systems engineer, and technology manager

Abstract

- PlantTriage was used to improve the performance of an ammonia plant in a world class ammonia and urea production facility located in the West Indies area of the Caribbean
- Significant operational improvements were made as a result of evaluating control loop performance, making recommendations, and tuning nearly half of the controllers in the plant

Background

- 1st PlantTriage™ system installed in the largest ammonia plant in this facility in November 2009
- Project conducted in Q1-Q3 2010 to optimize controller and plant performance

Background (Cont’d)

- First major finding ~ 40% of the loops routinely running in a non-Normal (primarily Manual) mode
- Key control valves had stiction and other hardware problems and design limitations causing control loop performance problems
- Initial set of standard and custom-built PlantTriage™ displays and reports created to document perf. baseline

Background (Cont'd)

- Effort launched to get as many loops as possible to run in their Normal mode
- Performance of 70 controllers evaluated and controllers tuned if possible
- Work conducted on an interim basis Jan. 2010 through early Jul. 2010
- Work performed without causing major operational disturbance to the plant & without curtailing production rate

Background (Cont'd)

- Plant shut down for scheduled maintenance and process equipment & instr. upgrades in Aug. 2010
- During shutdown key control valves repaired & 3 key control valves in the Primary Reforming unit upgraded with Digital Valve Controllers (DVC's)
- Plant restarted in Aug. 2010 and has been running continuously since Sept. 2010 at near-record production rates

Project Methodology

- Created and interpreted std. & custom reports and displays in the PlantTriage™ system to identify controller perf. and instrum. problems and find source of control loop oscillations
- Collaborated with operations and technical staff to develop a list of controllers to be evaluated and tuned

Project Methodology (Cont'd)

- Obtained assistance of a dedicated experienced operator who joined project team
- Initiated controller performance evaluation and process response testing phase
- Added monitoring of key process performance indicators in PlantTriage™ system to further quantify benefits of the project results

Project Results

- Reduced variability and increased plant stability by tuning controllers w/o causing sig. plant upsets or trips
- Reduced valve wear and maintenance expenditures by applying “intelligent” PV filtering to the control loops tuned
- Added monitoring of key process performance indicators by configuring indicator-only variables in the PlantTriage™ system

Project Results (Cont'd)

- Put controller in svc. in Auto mode that affects ammonia product conversion efficiency
- ID'ed control valves with H/W problems that had sig. impact on process performance by creating and interpreting custom reports and displays
- Initiated paradigm shift in how Operators' ran plant by running more controllers in their Normal mode

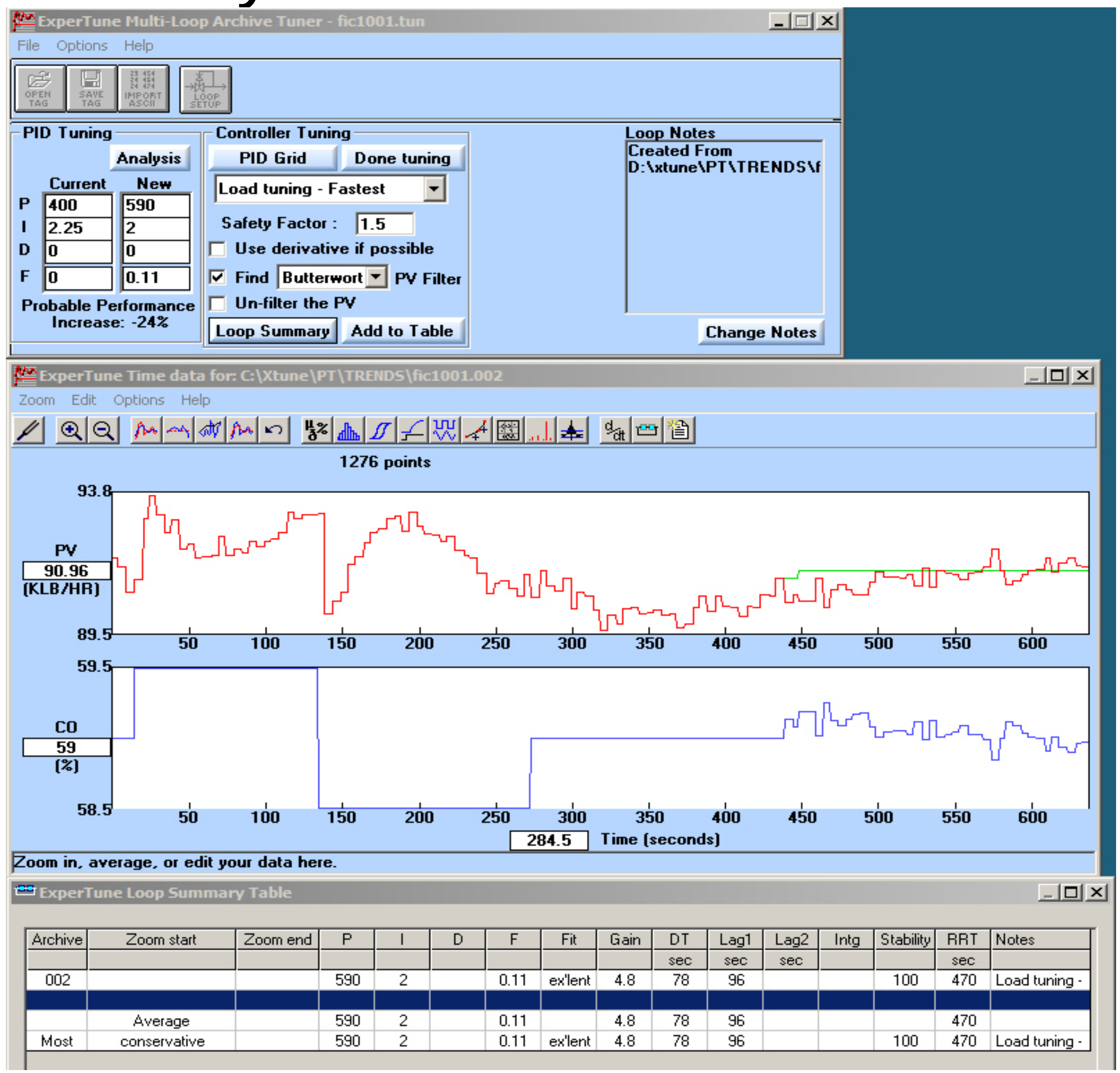
Project Results Doc.

- Process Response Testing and Controller Tuning
  - Mostly open loop process response testing (doublet pulse test type) was conducted for loops in the plant
  - Importance of obtaining agreement on and documenting process control objective(s) on a per control loop basis with the operations and technical staff prior to performing any process response testing or tuning cannot be over-emphasized

Project Results Doc. (Cont'd)

– Example1 Primary Reformer Process Gas Flow Ctlr

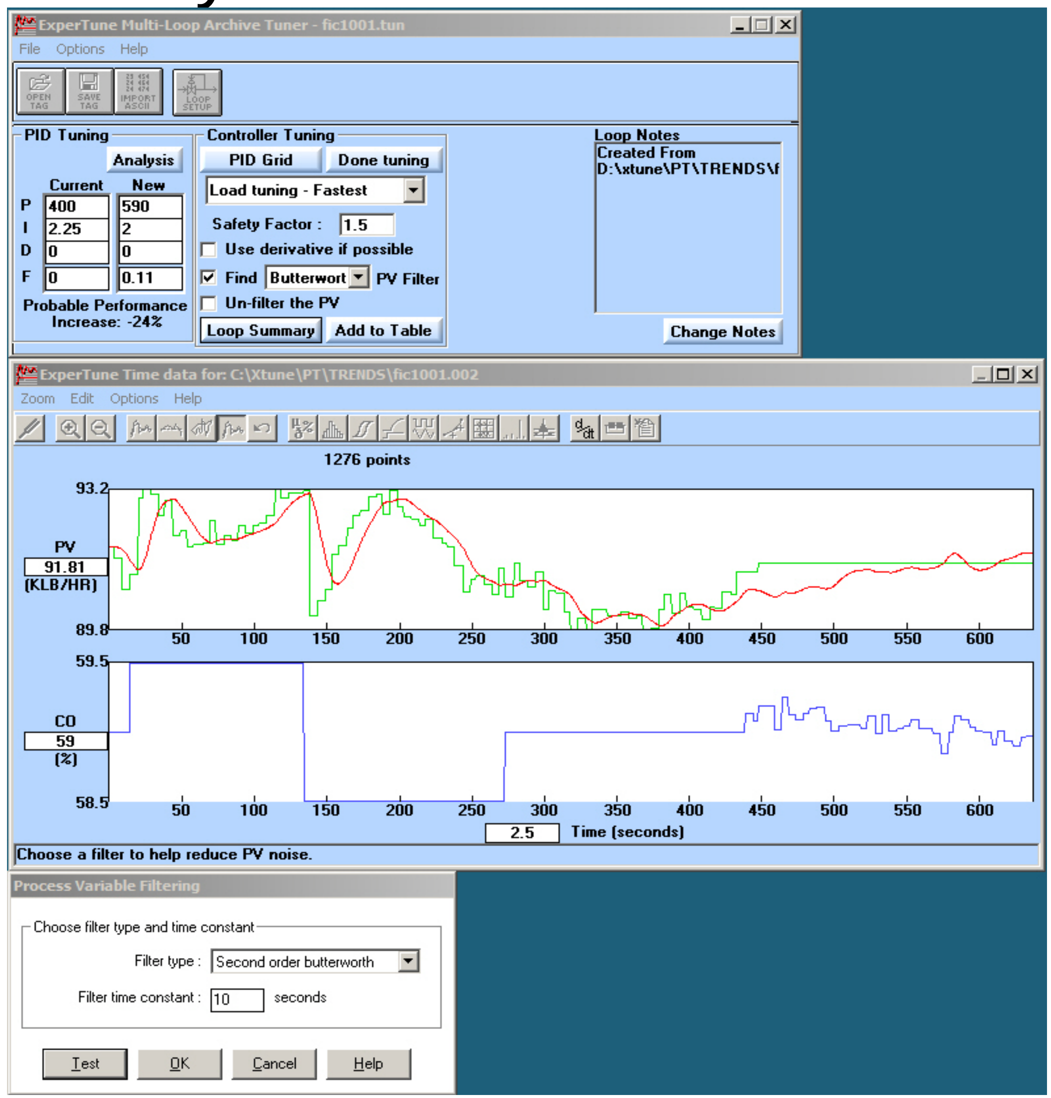
Process control obj. was to reduce valve wear and not necessarily to obtain tighter tuning or reduce control error so Prob. Perf. Incr. is -24%



Project Results Doc. (Cont'd)

– Example1 Primary Reformer Process Gas Flow Ctlr

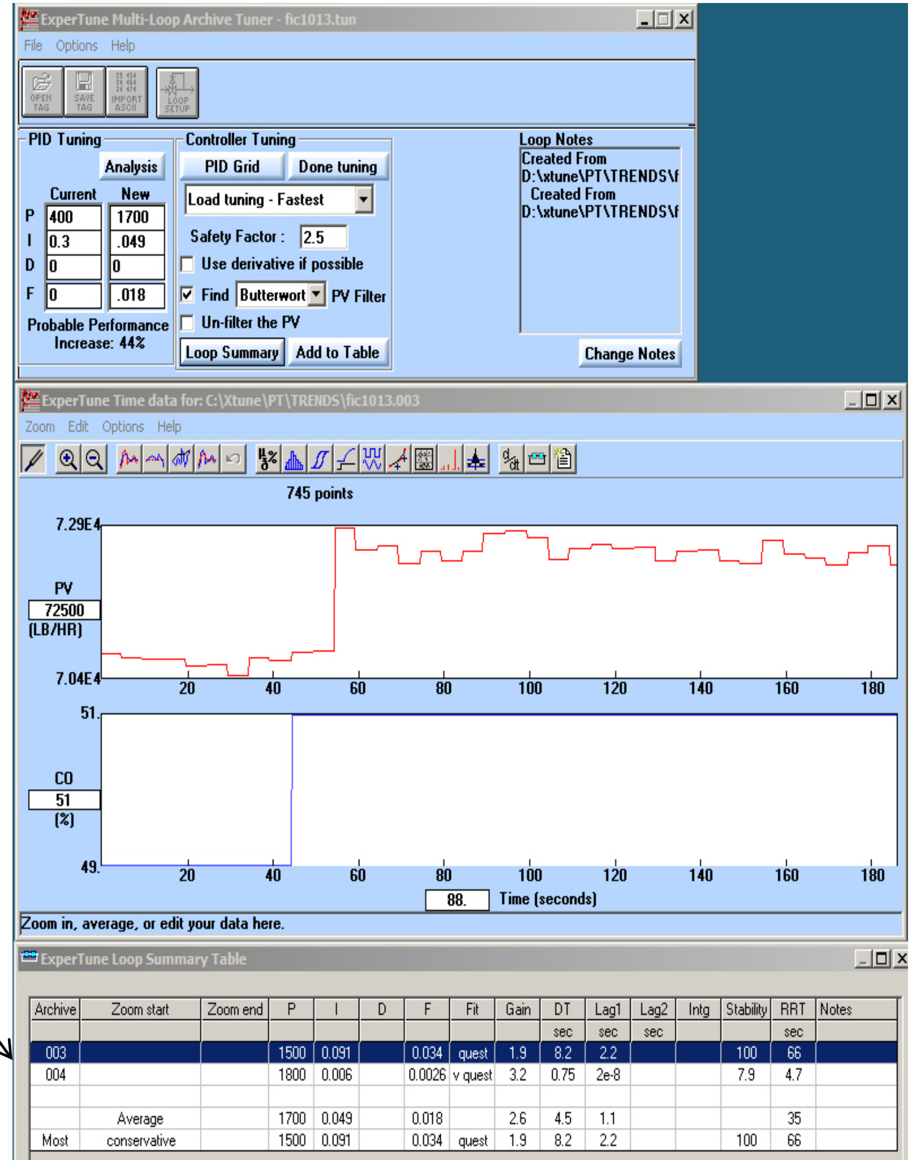
Results of testing a Second Order Butterworth filter value on PV response (green trend line = PV before filtering; red trend line = PV after filtering)



Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E

Even though Qual. Fit for Archive 003 was Quest. Average tuning results from two tests were adequate to be used for closed loop control



Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E

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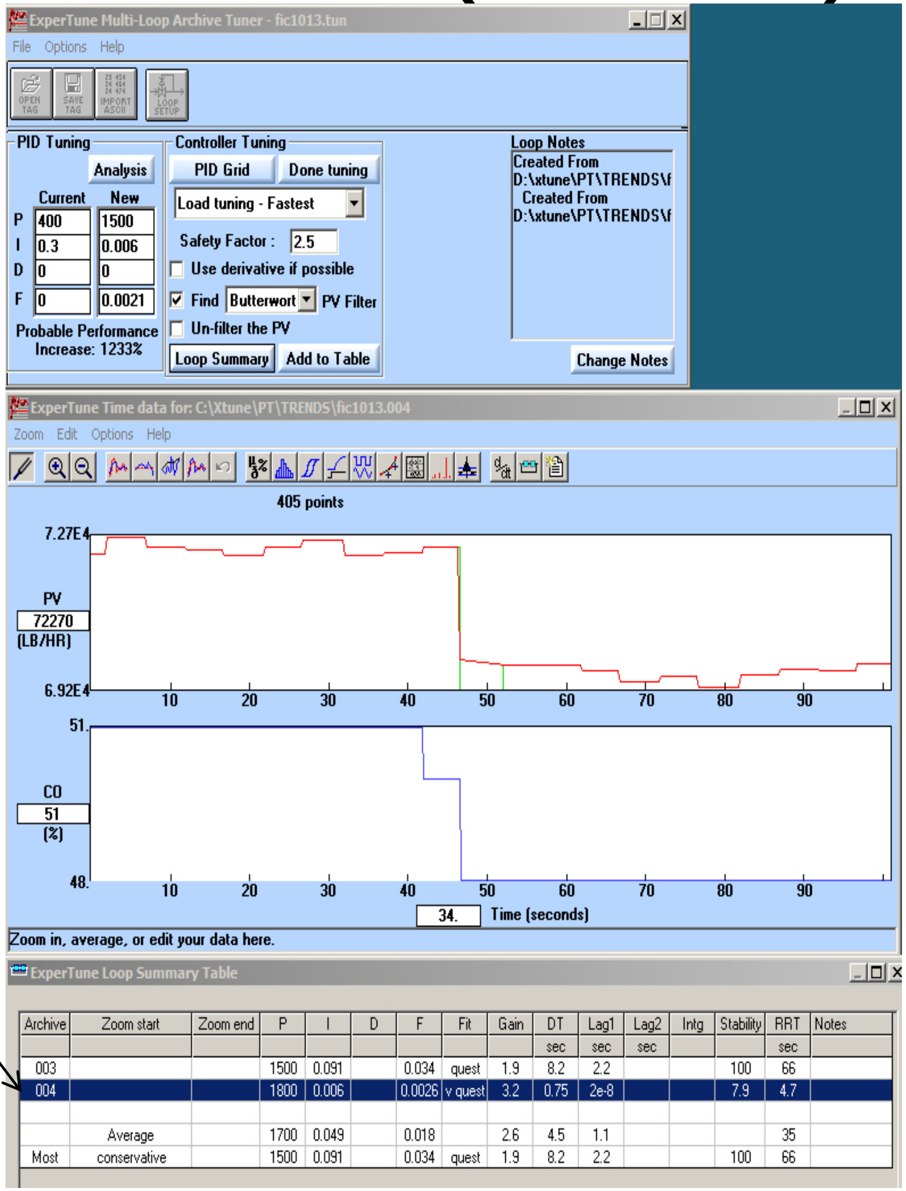
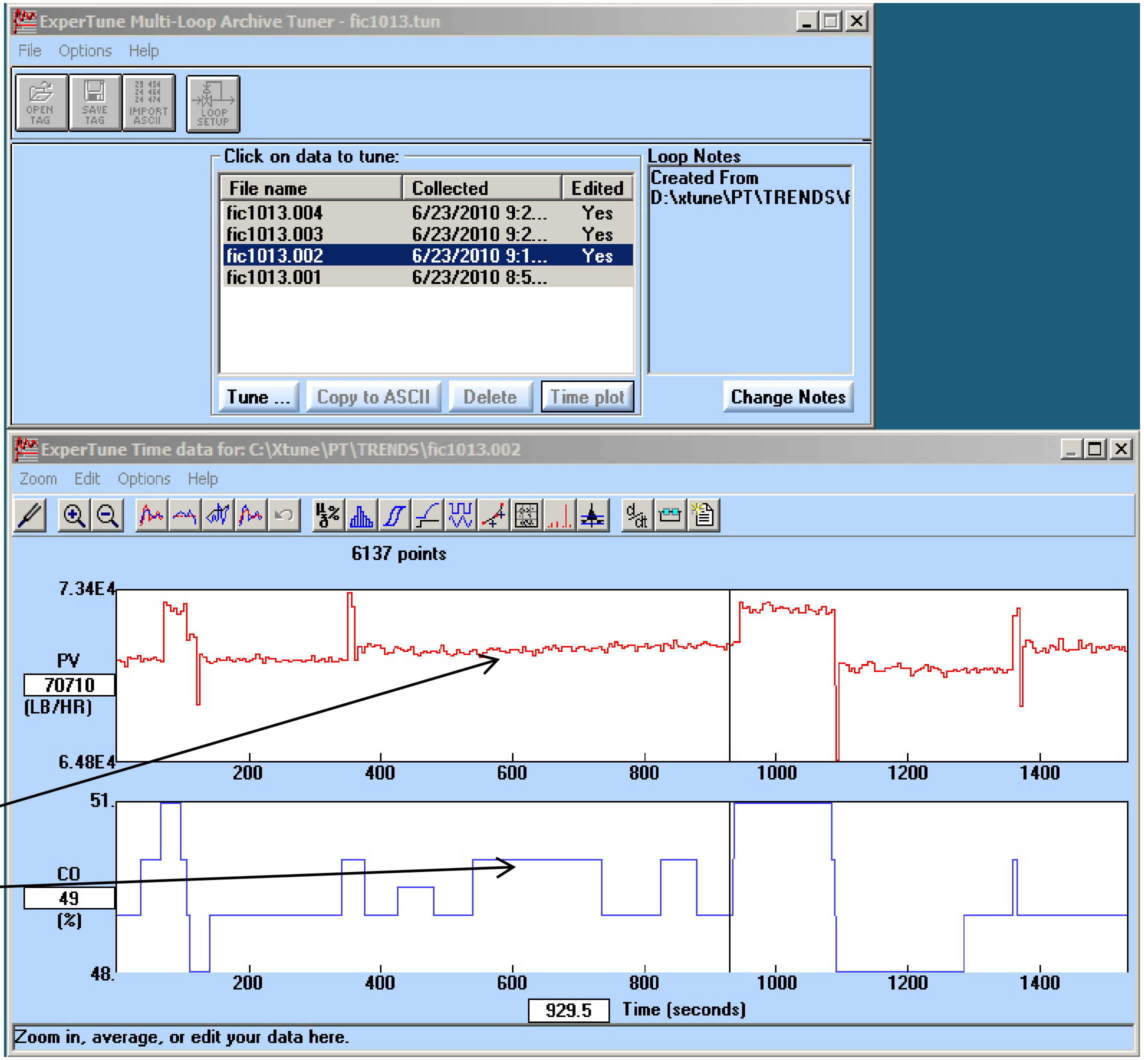


Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E

Series of process response tests conducted reveal control valve stiction--when CO was increased PV failed to respond accordingly



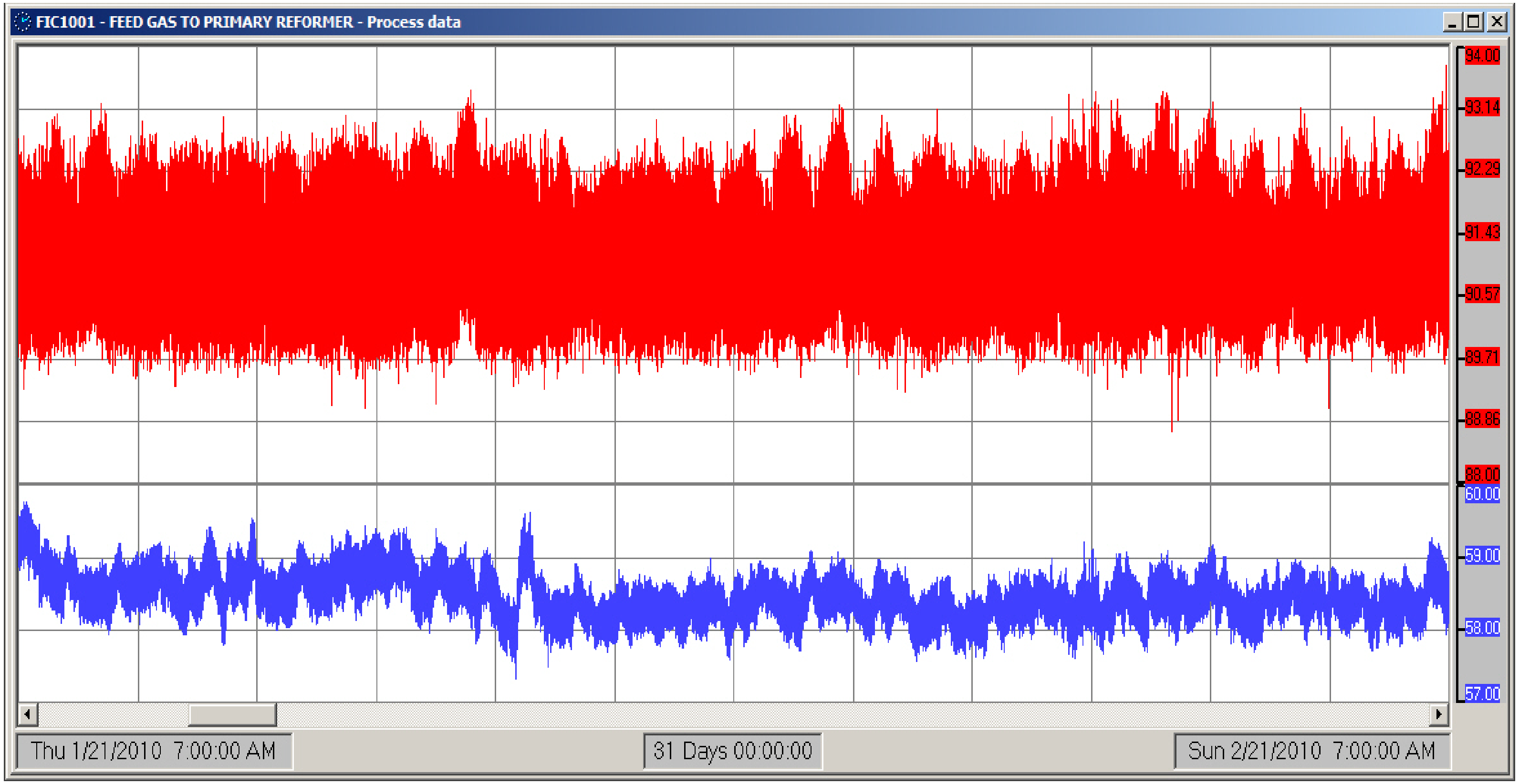
Project Results Doc. (Cont'd)

- Before and After Tuning and Control Valve Repair & Upgrade Results – Process Variable Trend Displays
  - "Before Tuning, Control Valve Repair & Upgrade" 31-day period was Jan. 21, 2010 0700 to Feb. 21, 2010 0700
  - "After Tuning, Control Valve Repair & Upgrade" 31-day period was Nov. 01, 2010 0700 to Dec. 02, 2010 0600

Project Results Doc. (Cont'd)

– Example1 Primary Reformer Process Gas Flow Controller

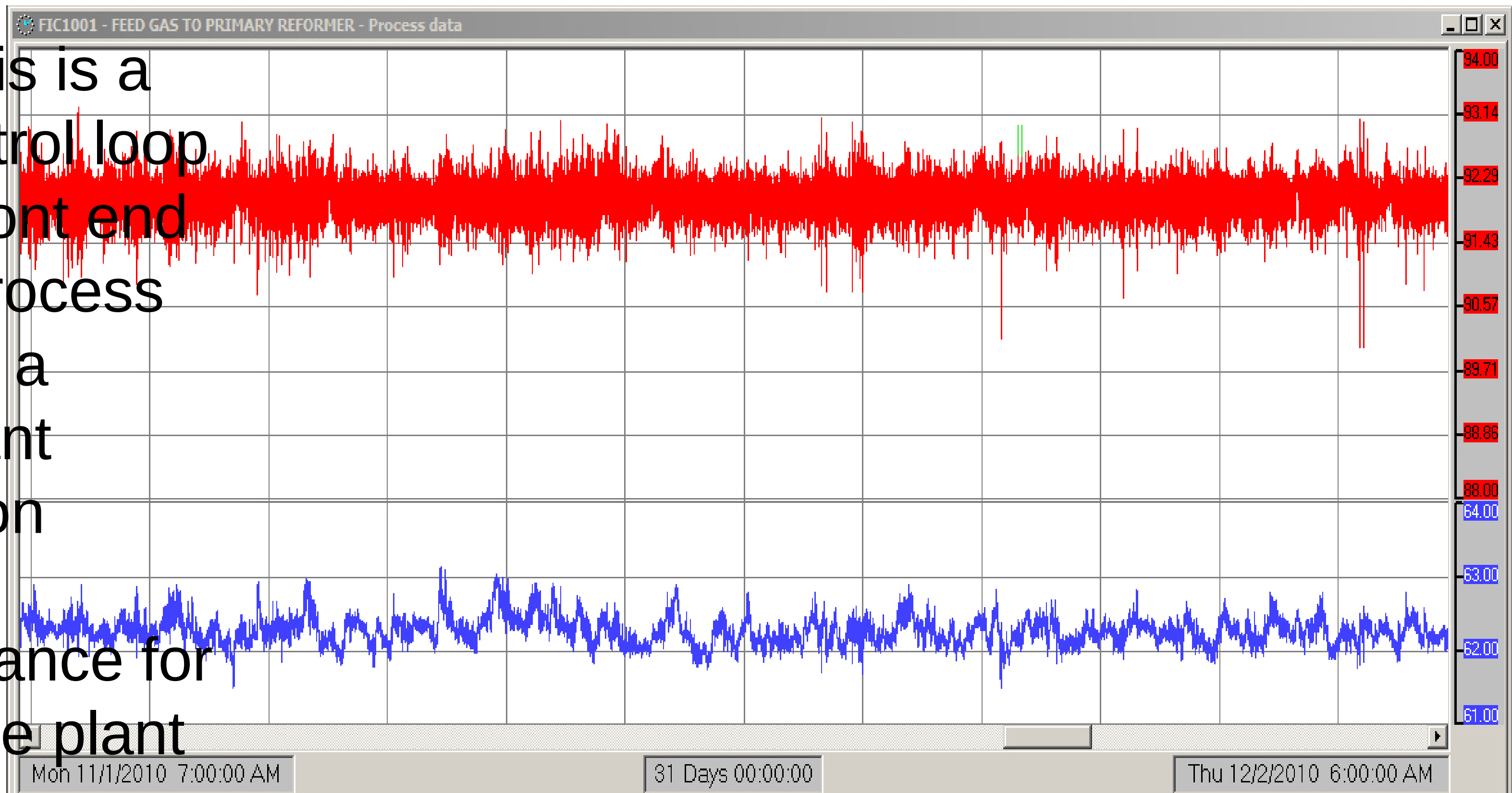
FIC1001 Before Tuning & DVC Upgrade



Project Results Doc. (Cont'd)

– Example1 Primary Reformer Process Gas Flow Controller

FIC1001 After Tuning & DVC Upgrade

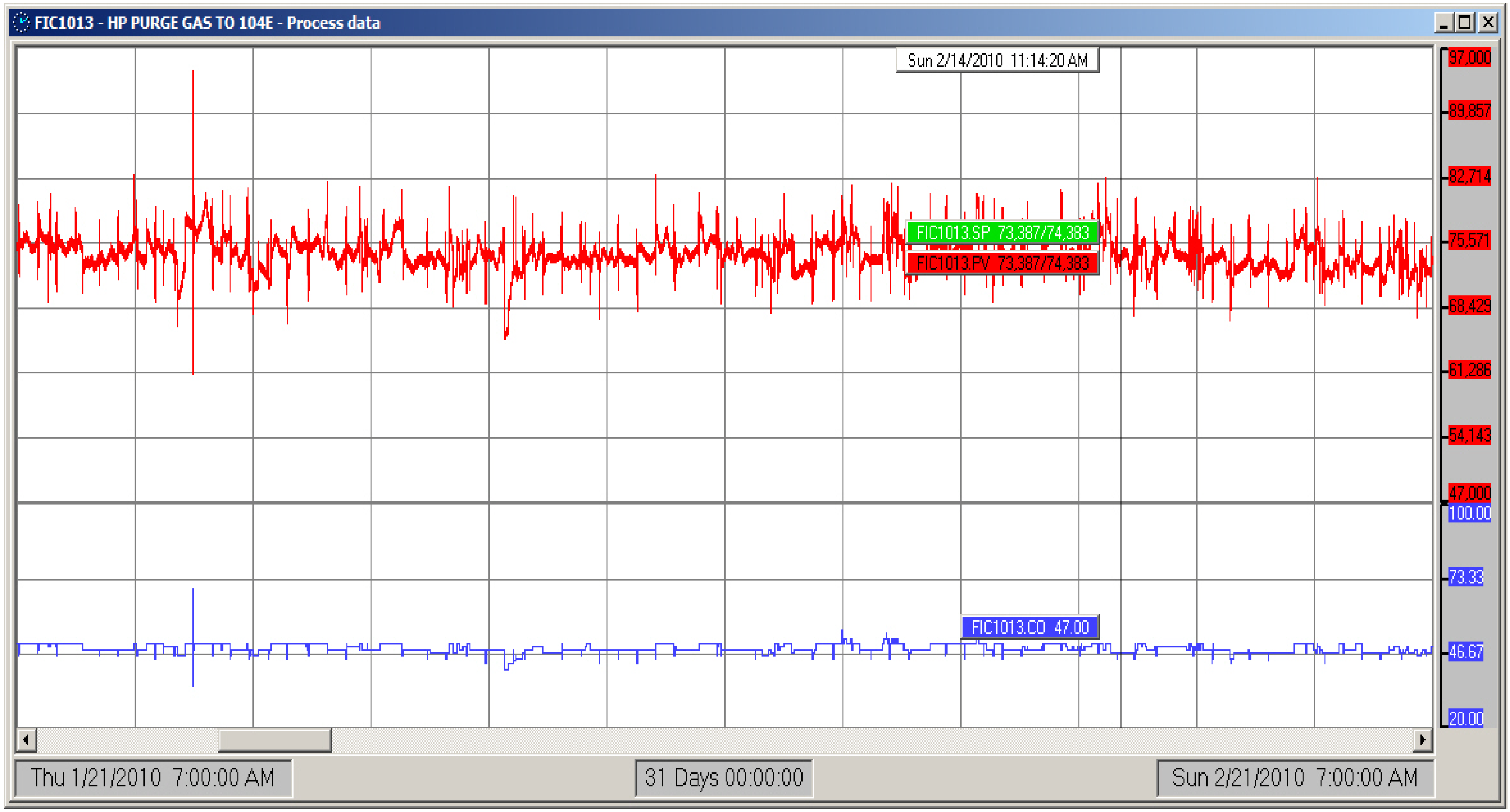


Note: this is a key control loop in the front end of the process that has a significant impact on process performance for the entire plant

Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E Flow Controller

FIC1013 Before Tuning and Running in Manual Mode

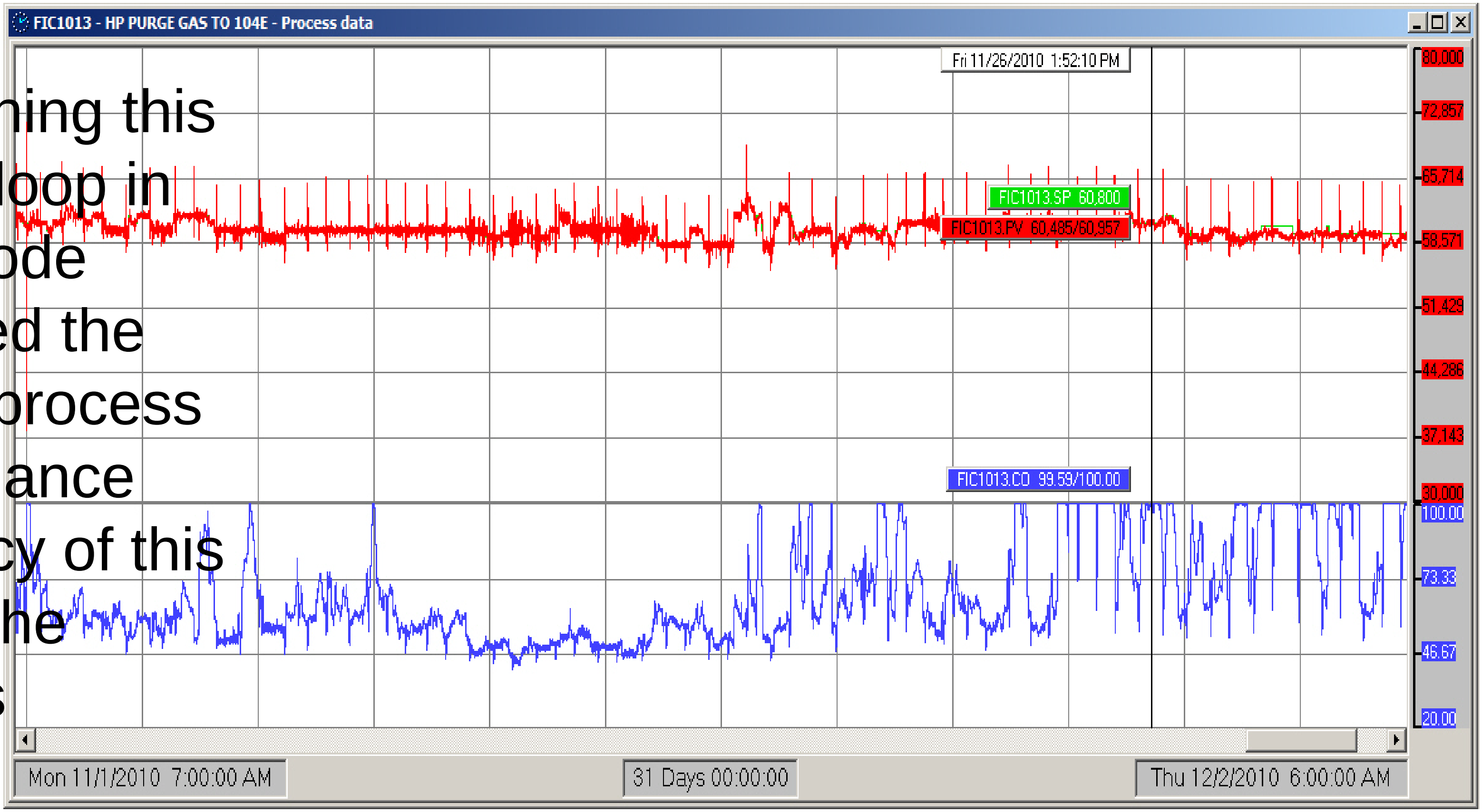


Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E Flow Controller

FIC1013 After Tuning and Running in Auto Mode

Maintaining this control loop in Auto mode improved the overall process performance efficiency of this part of the process

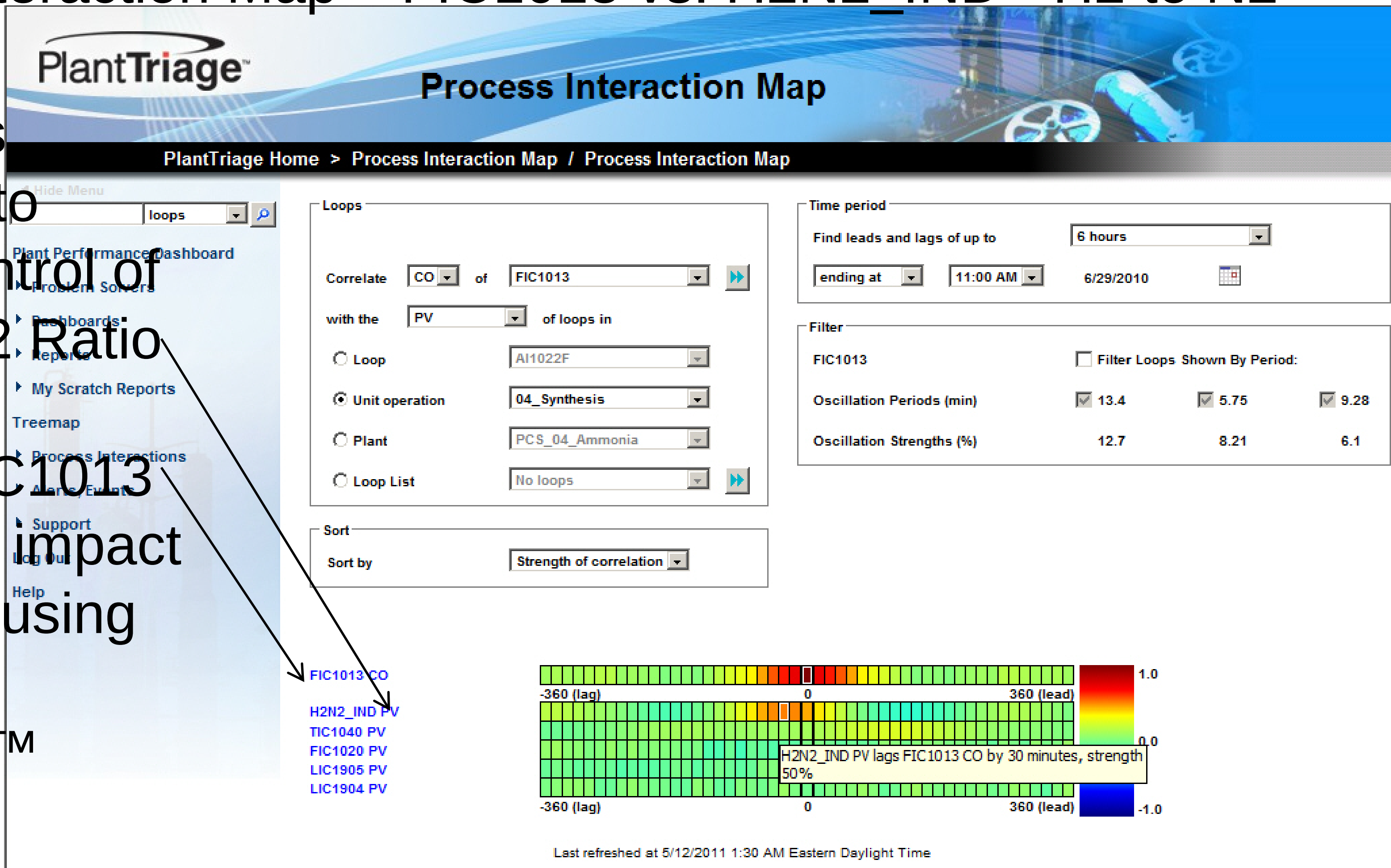


Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E Flow Controller

Process Interaction Map – FIC1013 vs. H2N2_IND - H2 to N2 Ratio

The process objective is to maintain control of the H2 to N2 Ratio as tightly as possible. FIC1013 was det'd to impact this ratio by using this std. PlantTriage™ feature.

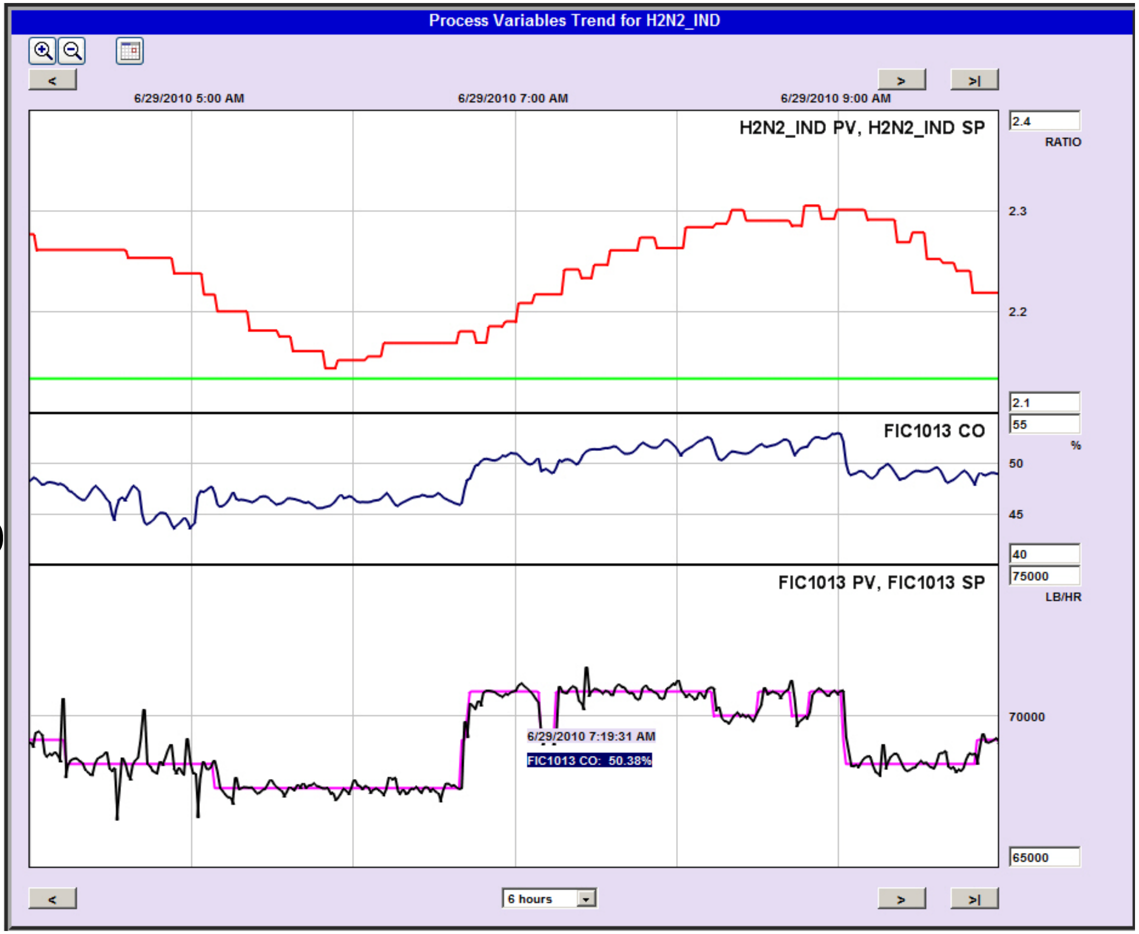


Project Results Doc. (Cont'd)

– Example2 High Pressure Purge Gas to 104E Flow Controller

Process Interaction Map – FIC1013 vs. H2N2_IND - H2 to N2 Ratio

The correlation between FIC1013 CO and H2N2_IND--H2 to N2 Ratio is clearly shown. From results of putting this & other loops in Auto mode a paradigm shift in the way that Operators ran the plant was eventually achieved.

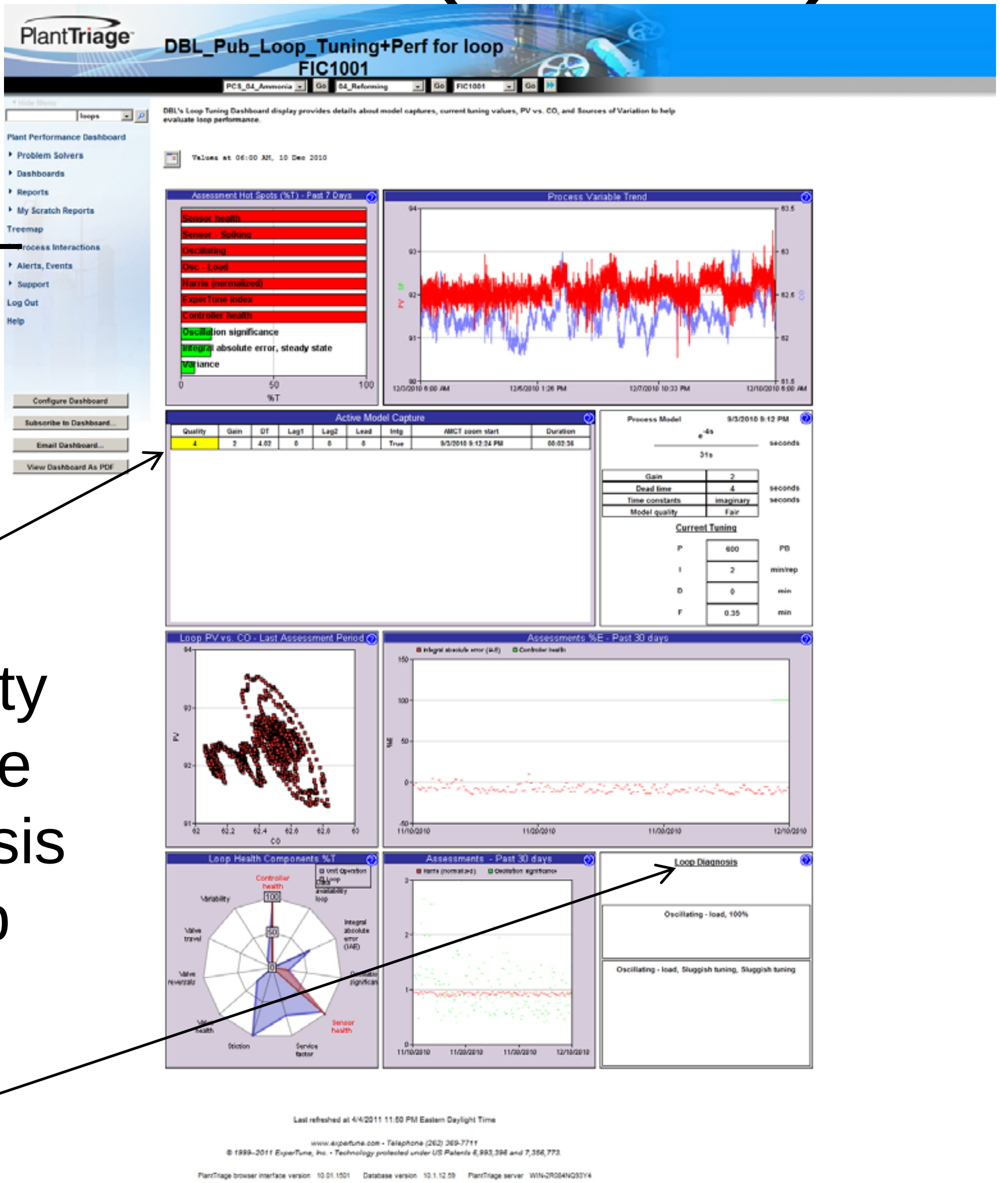


Project Results Doc. (Cont'd)

- Standard and Custom Reports and Displays
  - Example1 Primary Reformer Process Gas Flow Controller – Custom Dashboard Display
    - Customized Dashboard Display that includes a Process Variable Trend display and selected PlantTriage™ Assessments of interest
    - Used by Process Control and Electrical/Instrumentation Engineers to track results after performing control loop tuning

Project Results Doc. (Cont'd)

– Example1 Primary Reformer Process Gas Flow Controller – Custom Dashboard Display



Note: AMCT captured one model for this loop with a Quality of Fit =4 (lowest quality so this model was not useable for tuning). The Loop Diagnosis excerpt reported that the loop was oscillating due to load & that was an accurate perf. assessment at that time.

Project Results Doc. (Cont'd)

– Example2 Primary Reformer Process Gas Flow Controller – Before & After Tuning and Control Valve Upgrade Assessment Report

Loop	Avg abs error (%) Before	Avg abs error (%) After	Avg abs error (%) Change	IAE Before	IAE After	IAE Change	Osc. Sig. Before	Osc. Sig. After	Osc. Sig. Change	Variability (%) Before	Variability (%) After	Variability (%) Change
FIC1001	0.3926	0.1646	-0.228	33920	14220	-19700	2.515	1.172	-1.343	1.079	0.4573	-0.6221

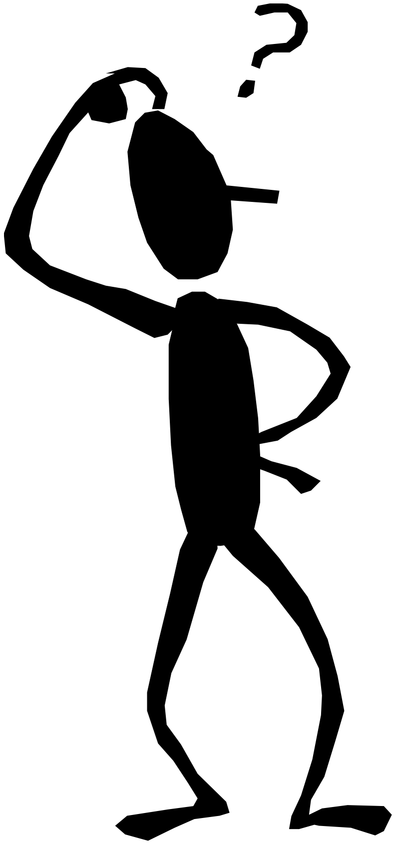
Loop	Variance Before	Variance After	Variance Change	Valve travel Before	Valve travel After	Valve travel Change	Valve reversals Before	Valve reversals After	Valve reversals Change
FIC1001	0.2483	0.04741	-0.2009	529.1	24.68	-504.5	2646	112.2	-2533

This customized Before and After Assessment results report clearly shows that the combination of controller tuning, overhauling the control valve and adding a DVC significantly improved controller performance

Results & Conclusions

- Business Benefits
  - Largest ammonia plant operation stabilized & performance efficiency improved in parts of the process
- Technical Benefits
  - Std. & custom PlantTriage™ reports created to monitor plant & ctlr performance & aid in troubleshooting instrumentation problems
- “Soft” Benefits
  - Longer term: control valve maintenance costs reduced through less valve wear

Questions?



- What’s on your mind?