

**EXCHANGING IDEAS.
CREATING SOLUTIONS.**

2011 Emerson Global Users Exchange



Recovery from a Process Saturation Condition

Benefits of Using DeltaV PIDPlus

Presenters

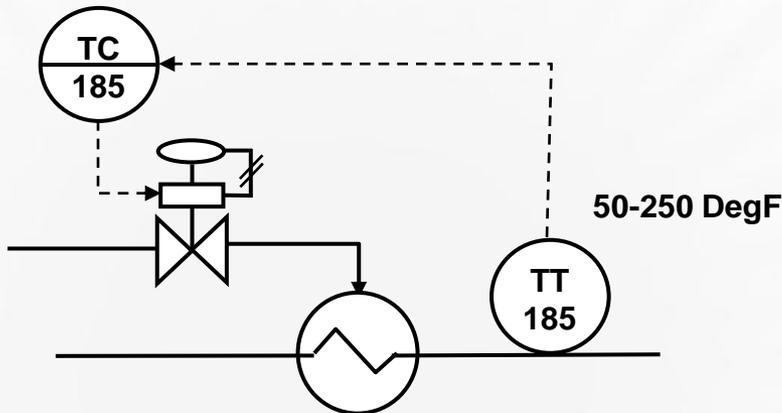
- Daniel Coyne
- Terry Blevins



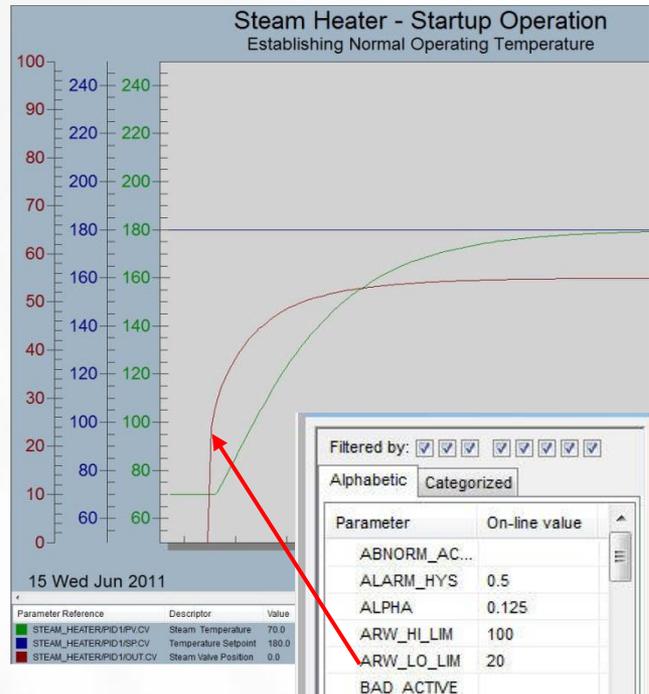
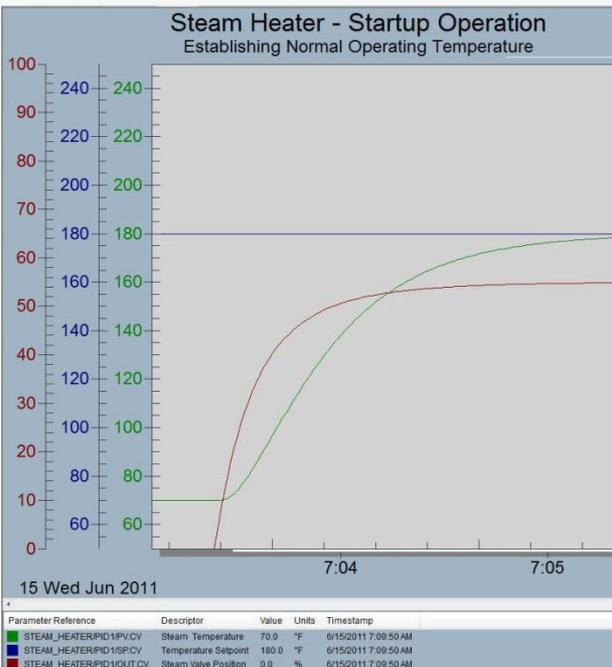
Introduction

- The PIDPlus option in DeltaV v11 provides improved the control response for recovery from process saturation. In this session we address:
 - Examples of processes that commonly operate under process saturation conditions.
 - PIDPlus option added in DeltaV v11.3 to improve control response for recovery from process saturation.
 - Application of PIDPlus in Surge Control will be examined in detail based on “typical” centrifugal air compressor used in Petrochemical industry.
- The benefit of enabling the PIDPlus option will be shown using several process examples.

Normal Process Operation



- The PID can achieve setpoint within the PID output (OUT) operating range.
- During process startup, the time required to establish normal operating conditions may be reduced by setting ARW limits inside OUT limits



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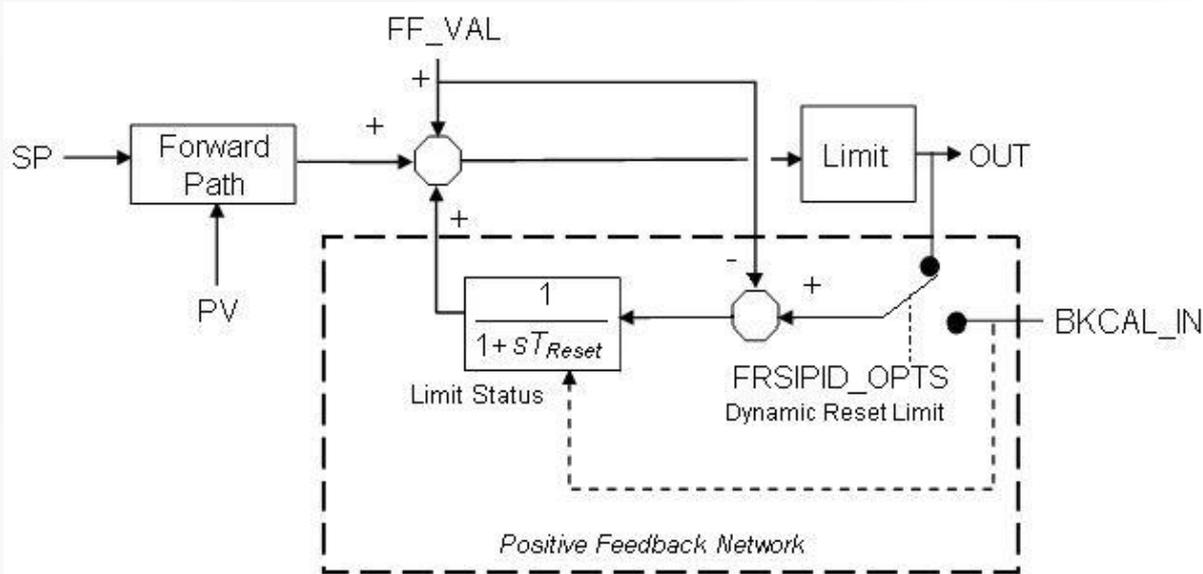
Alphabetic Categorized

| Parameter | On-line value |
|--------------|---------------|
| ABNORM_AC... | |
| ALARM_HYS | 0.5 |
| ALPHA | 0.125 |
| ARW_HI_LIM | 100 |
| ARW_LO_LIM | 20 |
| BAD_ACTIVE | |

Process Saturation

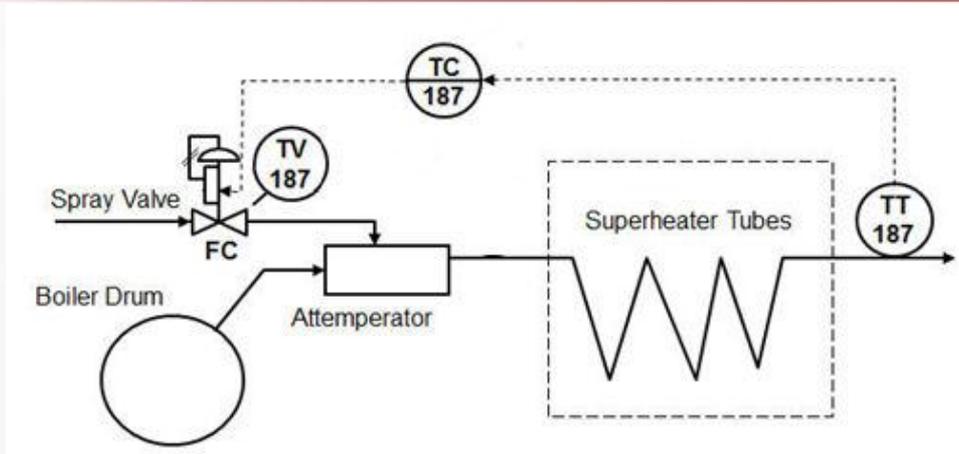
- A process saturation condition exists when the setpoint of a PID can not be maintained and the PID output is limited.
- Three examples will be used to illustrate process saturation conditions :
 - Steam header pressure control
 - Boiler outlet steam temperature control.
 - Compressor surge Control
- When operating conditions change that allow the process to recover from a process saturation condition, then improved response is provided by enabling the FRSIPID_OPTS option for PIDPlus

DeltaV PID Reset Implementation



- The reset component of the PID block is implemented with a positive feedback network.
- Reset windup is automatically prevented under limit conditions associated with process saturation conditions.

Example – Steam Temperature Control using PIDPlus

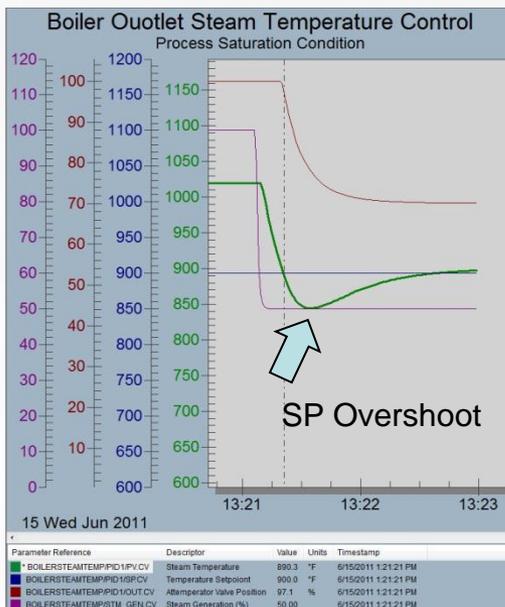


- If steam generation exceeds the attenuator capacity then the boiler outlet steam temperature will exceed the outlet setpoint with the spray valve fully open.

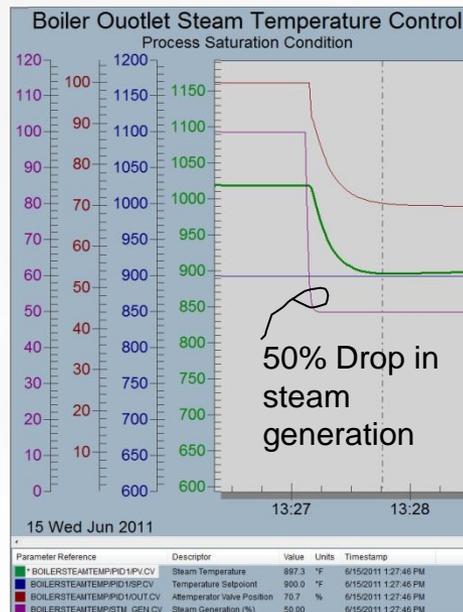
- When boiler firing rate is reduced, then the spray value should be cut back as the outlet temperature drops.

- When the FRSIPID_OPTS for PIDPlus is enabled then the valve moves before PV reached SP – providing improved response.

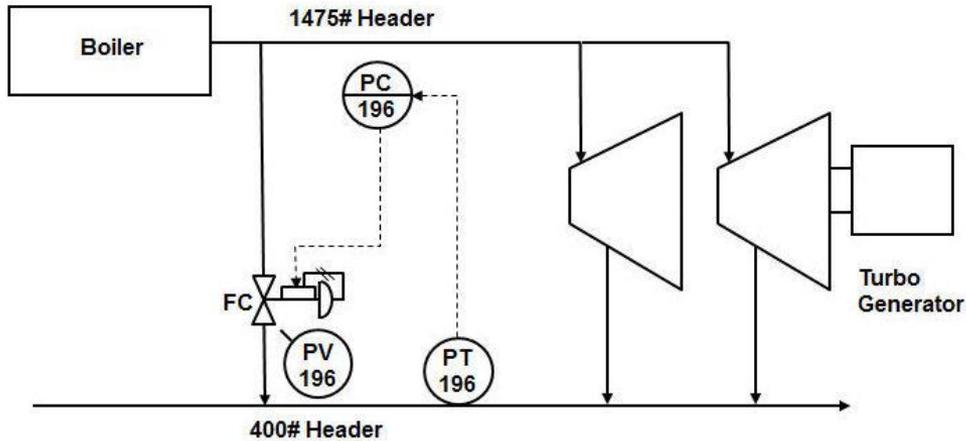
Standard PID



DeltaV PIDPlus

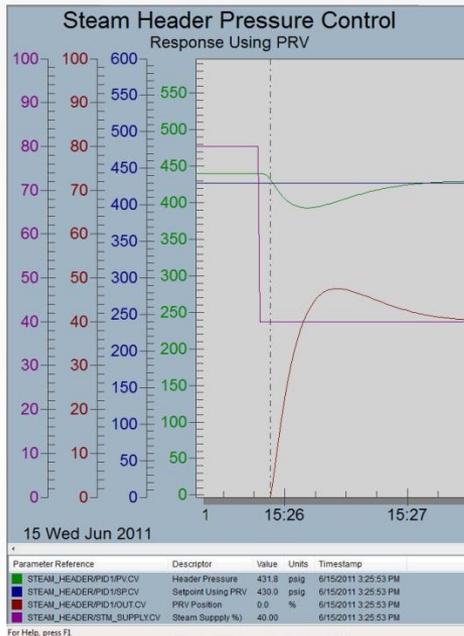


Example - Header Pressure Control

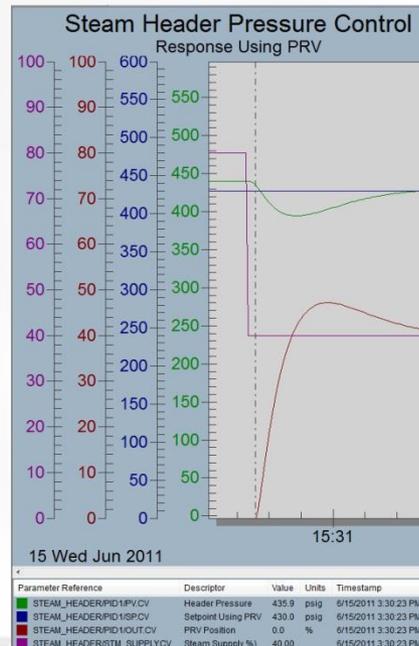


- Under normal operating conditions the pressure reducing valve, PV196, remains close and the 400# header pressure is maintained by the steam turbine extraction.
- If the turbine extraction can not meet 400# steam demand or the turbine trips off-line then the PRV valve must open to maintain header pressure.
- A very small improvement in response for a 40% drop in turbine extraction is seen since for this example the PV normally operates close to SP.

Standard PID



DeltaV PIDPlus



DeltaV PID Response to Process Recovery From a Saturation Condition

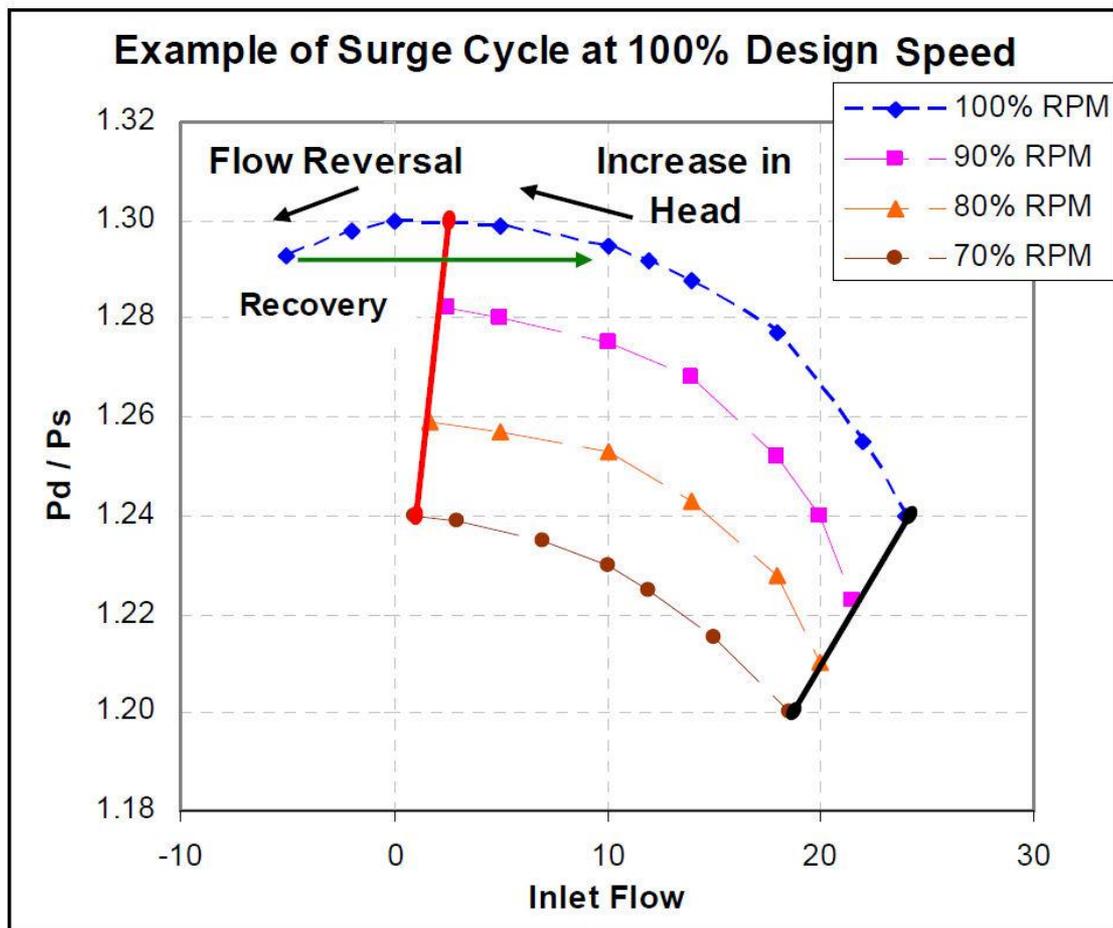
- DeltaV v8.3 or earlier – Only if rate action is utilized in the PID will the valve move from the limit before the PV transitions through setpoint
- DeltaV v9.3 and later – Valve will come off limit before PV transitions through PID setpoint if ARW limits are inside or equal to OUT limits. However, this anticipation action is very conservative (small contribution) and is not adjustable.
- DeltaV v11.3 with PIDPlus enabled – Anticipation action can be adjusted using the PID parameter RECOVERY_FILTR. Value of 1 = v9.3 behavior, Value of 0 = full anticipation utilized to avoid SP overshoot when recovering from process saturation.

Compressor Surge Control



- Single-shaft centrifugal compressors with horizontally split casings are commonly used in the process industry
- Are preferred for applications requiring medium pressures and large volume e. g. cracked gas, coker gas, process air or carbon dioxide.
- Electric or steam turbine drive design.

Compressor Surge



Typical Compressor Surge Line on Performance Map

- Surge* is the point at which the compressor peak head capability and minimum flow limit are reached. If the operating point approaches the surge line, the impeller and diffuser begin to operate in stall and flow recirculation occurs.
- The flow separation will eventually cause a decrease in the discharge pressure and flow from suction to discharge will resume. This surge cycle will repeat itself unless control system brings the compressor out of the surge cycle.
- Any surge event can cause severe damage to the thrust bearings, seals, and the impeller.

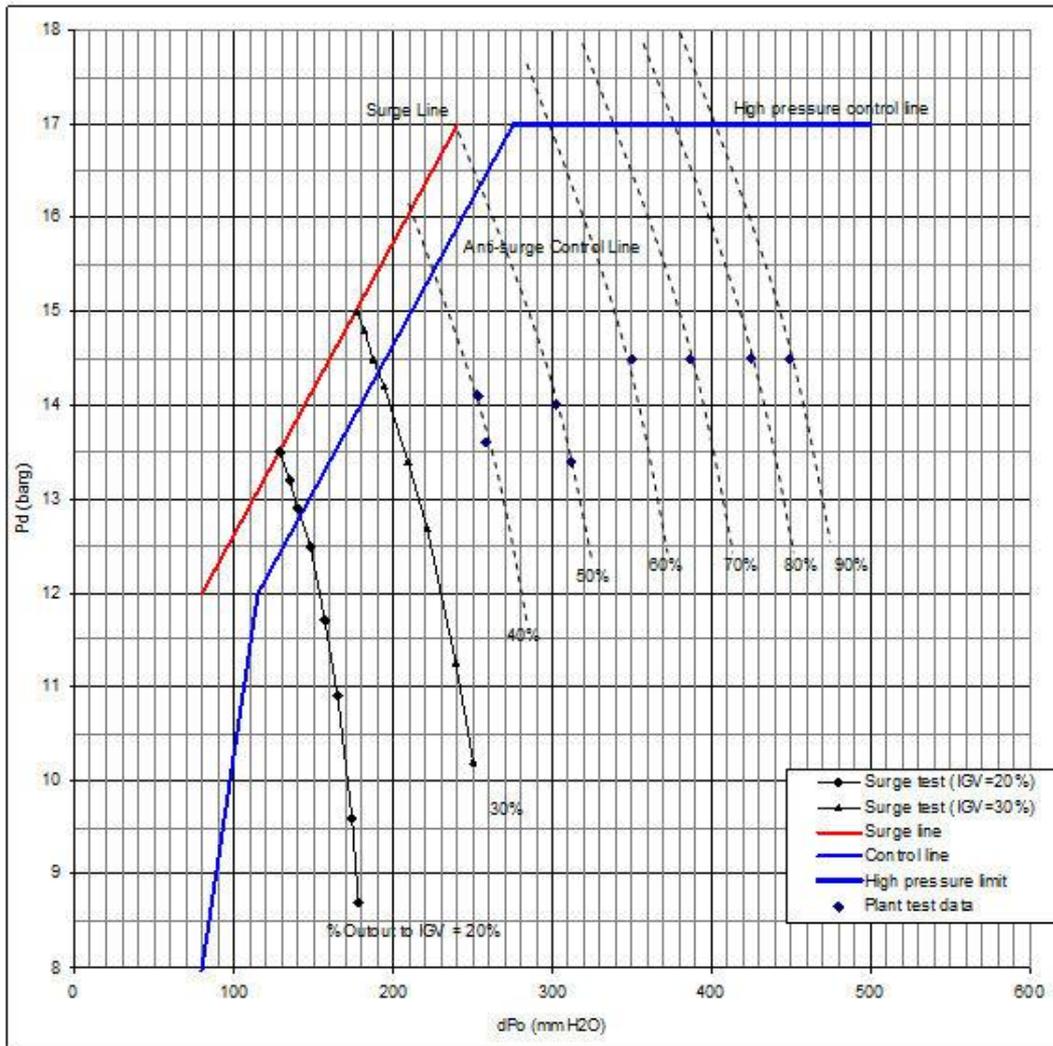
Control Requirements

The primary objective of a surge control system is to prevent the occurrence of surge so as to reduce possible damage to the compressor. The three primary operating environments for the surge control system are:

- **Start-up Environment** - In a typical start-up mode, gas is continually recycled to bring the compressor online. The recycle valve is fully opened upon start-up. As the compressor begins to gain speed and flow is increased, the recycle valve is gradually closed.
- **Normal Process Control Environment** –The surge control system must provide for smooth operation of the compressor over the entire operating range. The shape of the surge control line will determine the response characteristics of the surge control system. Precision in recycle valve position control and minimizing overshoot are required.
- **Emergency Shutdown Environment** - The surge control system must function quickly to open the recycle valve fully

In this presentation we address the normal process control environment.

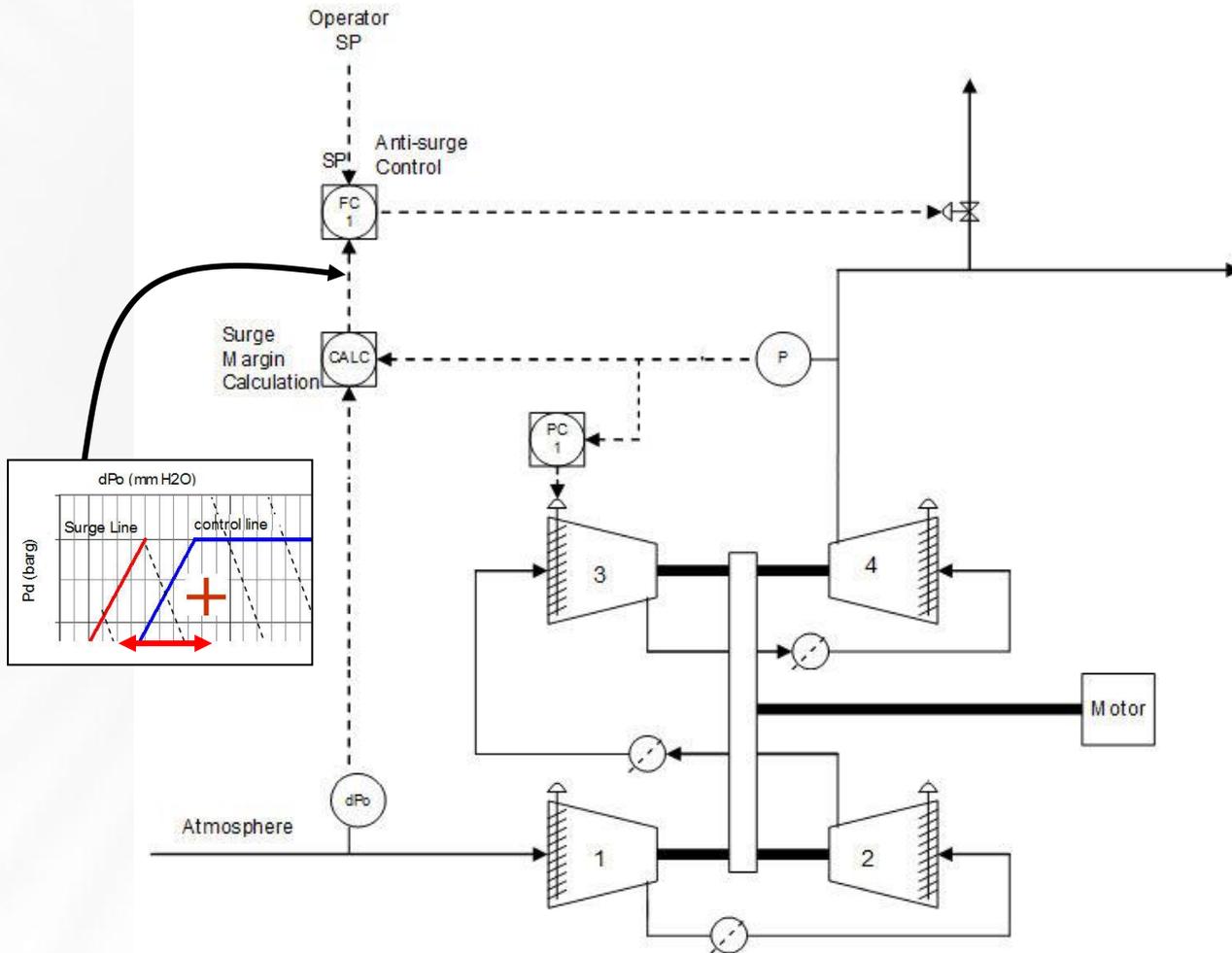
Typical Air Compressor



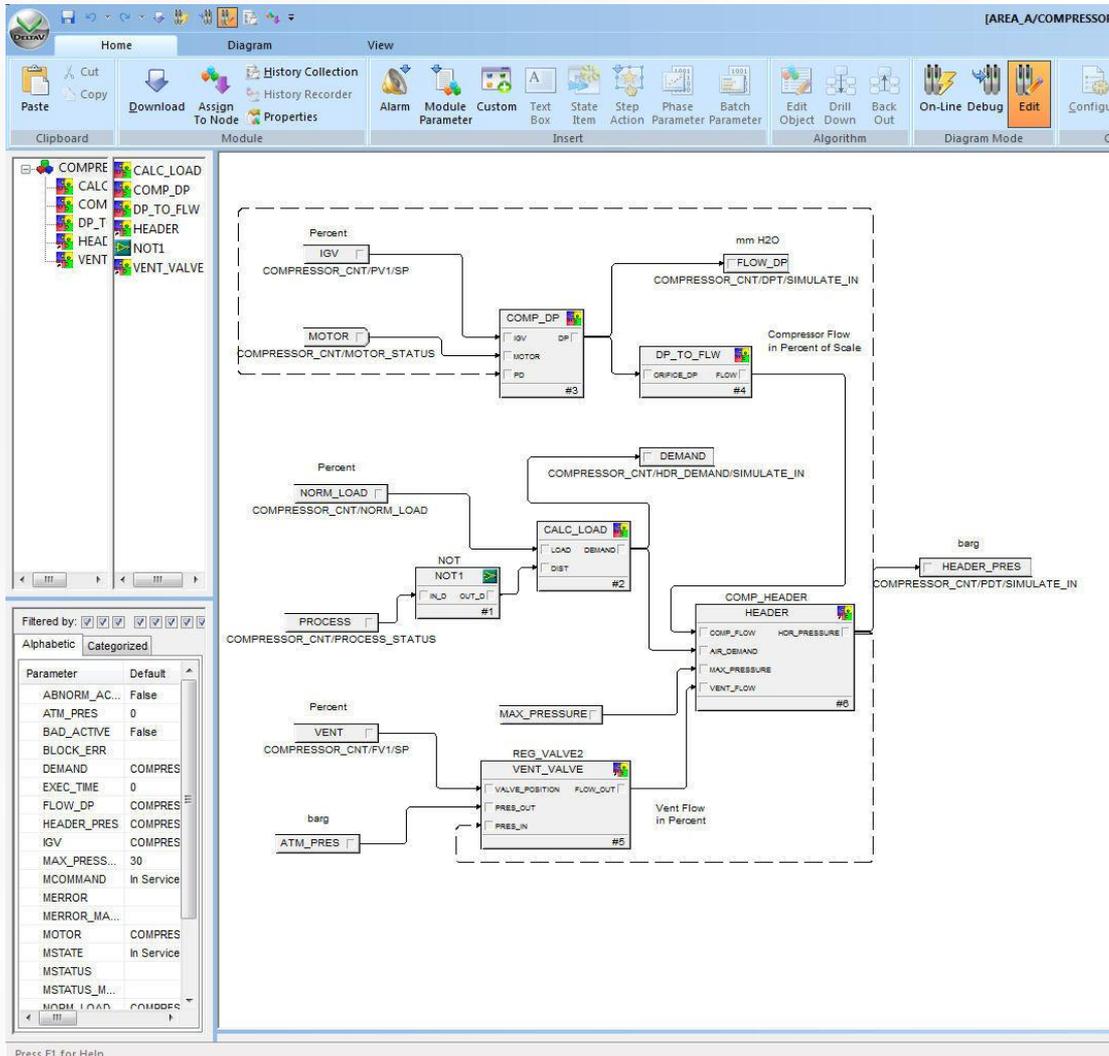
- The surge control system acts as an integral part of the compressor station controls.
- The recommended margin allowed between the actual surge line and the surge control line is 6-10 percent of the actual flow surge limit.

Air Compressor – Normal Operations

- The function of the surge control system is to detect the approach to surge and provide more flow to the compressor through opening the recycle valve to avoid surge.
- Opening of the vent valve provides more flow and reduces compressor head, to move the compressor away from its surge point.

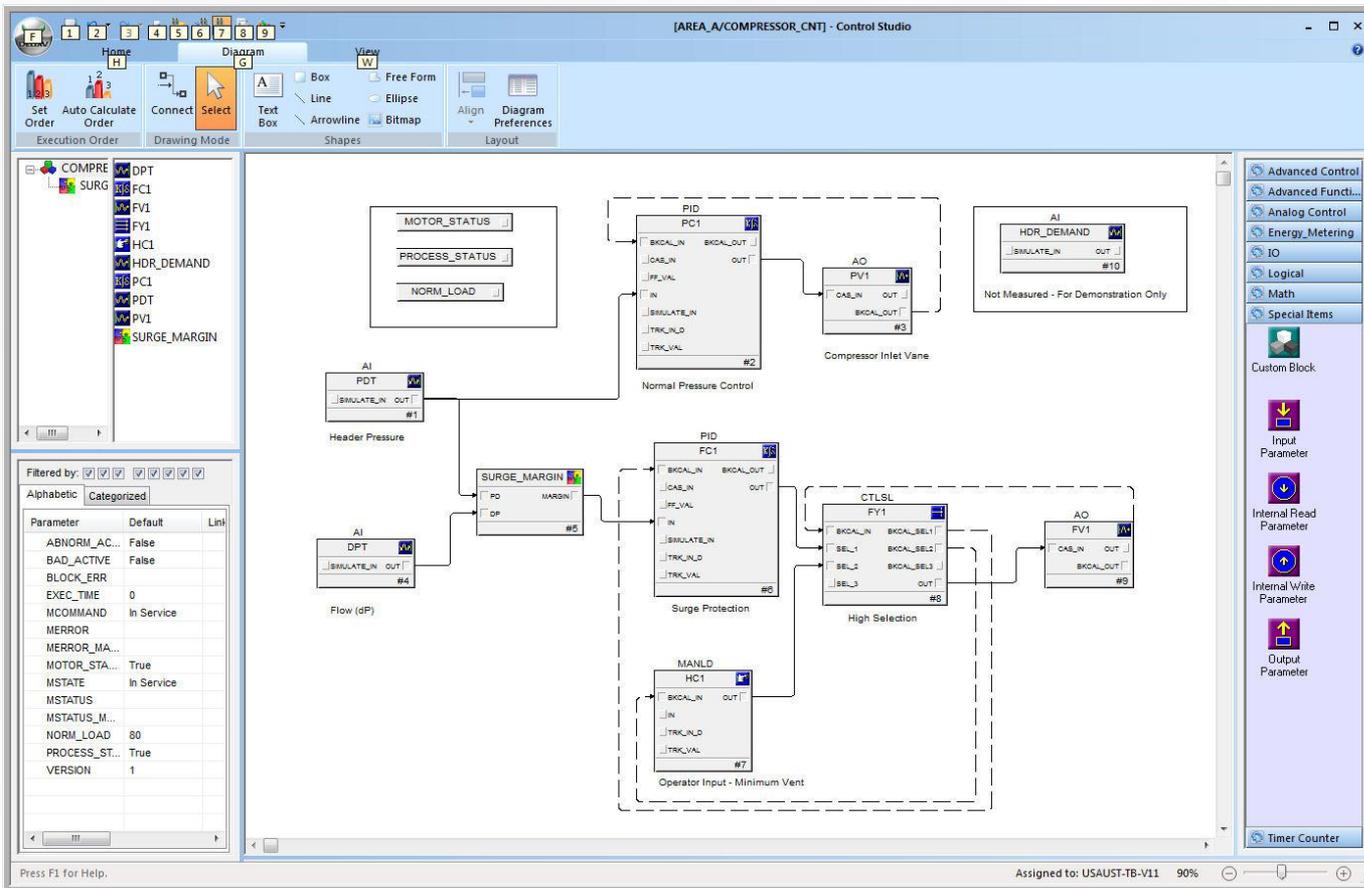


Dynamic Compressor Simulation



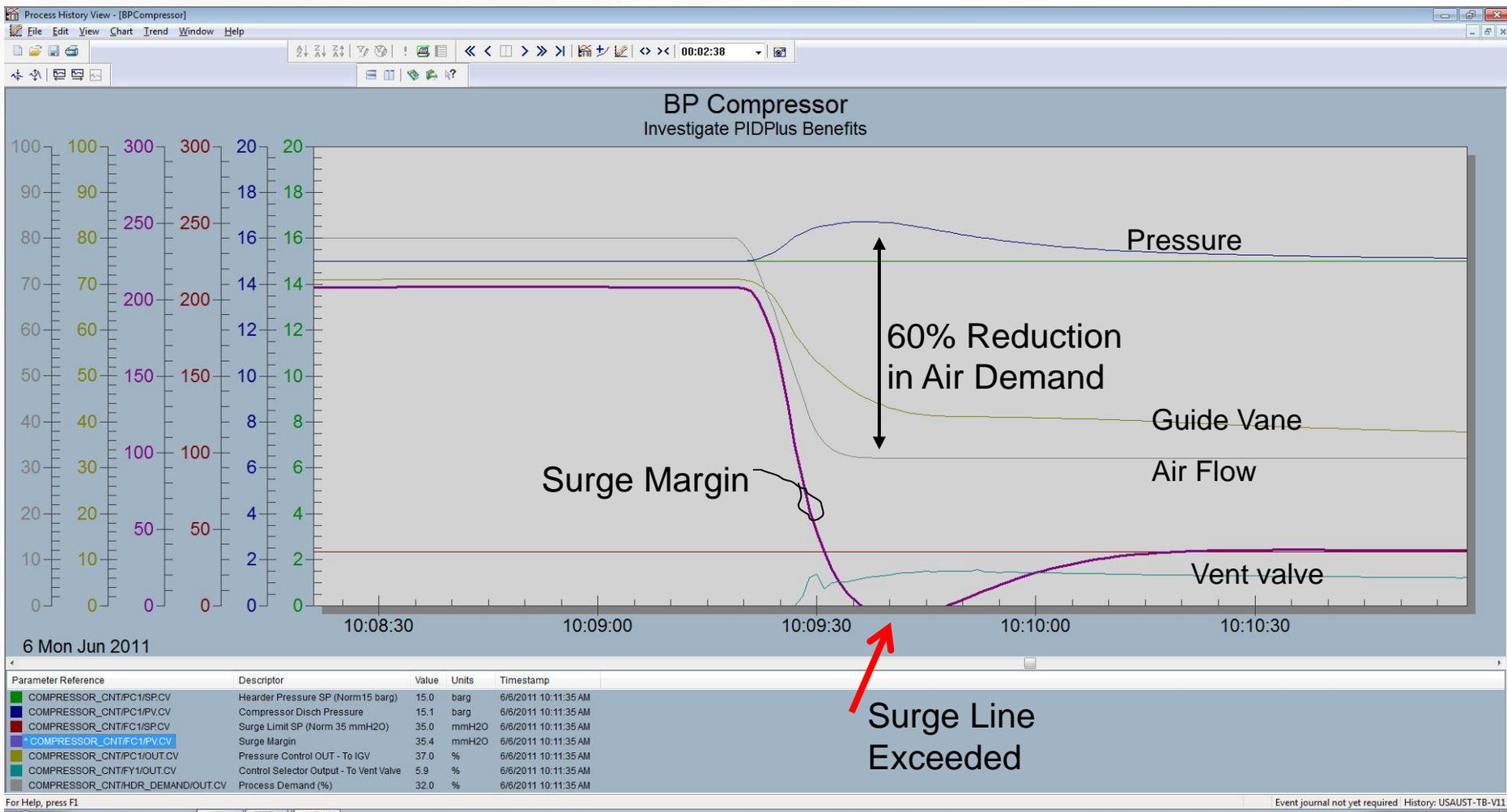
- A dynamic compressor simulation that matches typical BP air compressor data was developed to support testing of the compressor controls.
- The simulation was tied to the control strategy used for normal operation.

Air Compressor Control – Normal Operations

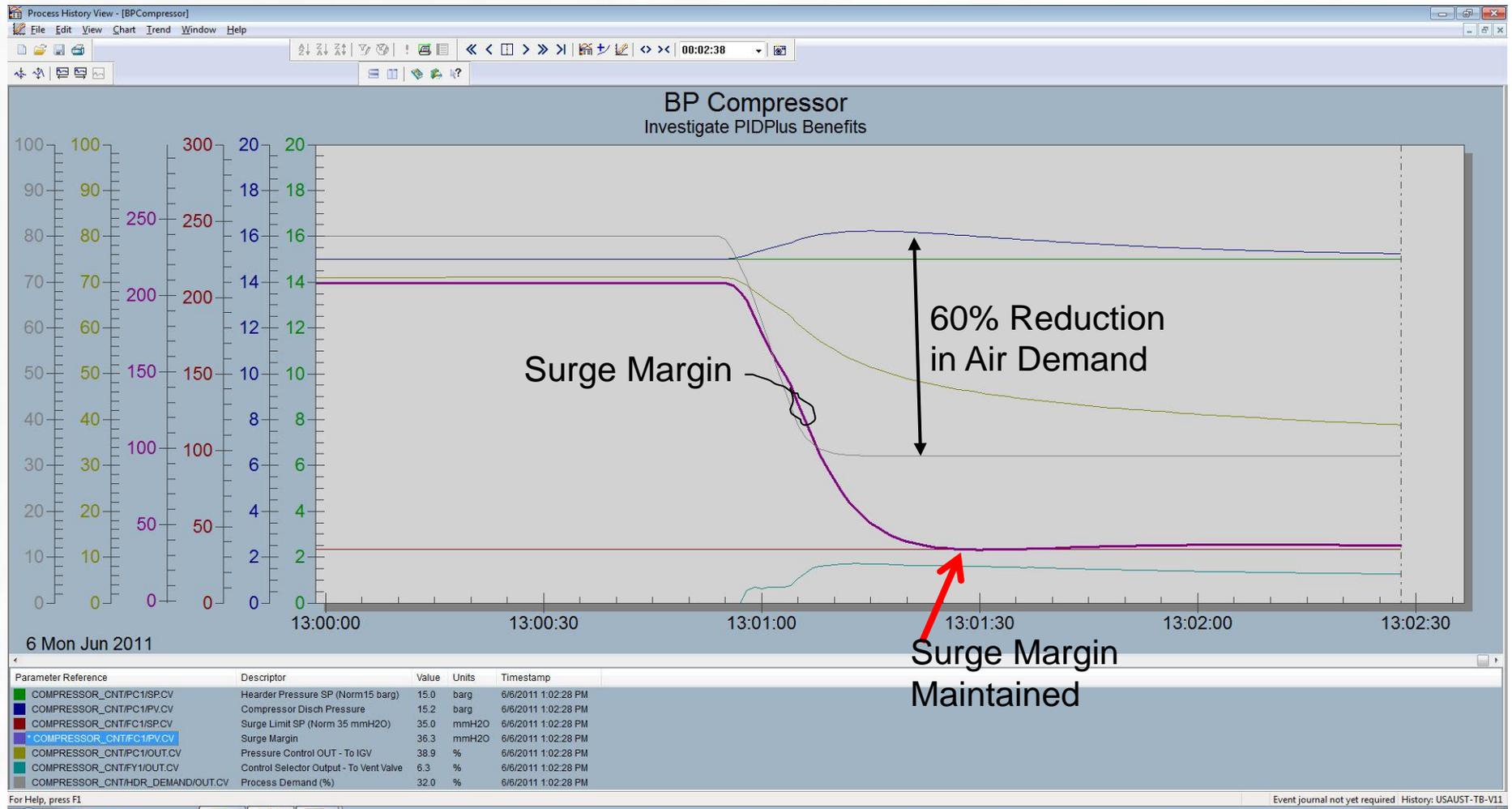


- Parameters were added to support testing
 - Normal Load Demand
 - Process status
 - Motor status
- BP Tuning for typical compressor was utilized

Control Response – PIDPlus Disabled



Control Response – PIDPlus Enabled



Business Results Achieved

- Improved response for recovery from a process saturation condition may be achieved by enabling the PIDPlus option in DeltaV v11.3.
- Setpoint overshoot is minimized during recovery from a process saturation condition. This control improvement allows process operating conditions to be better maintained and can be used to help avoid process upsets that could impact plant operation and key quality parameter.
- For applications such as compressor surge control the improved control performance provided by the PIDPlus option provides an added layer of equipment protection.

Summary

- An improvement in PID response for recovery from process saturation using the PIDPlus option was shown using three process examples.
- This capability allows process operating conditions to be more closely maintained and thus could help avoid process upsets that impact plant operation and key quality parameter.
- For applications such as compressor surge control this capability provides an added layer of equipment protection

Where To Get More Information

- The theoretical basis for the DeltaV PID block PIDPlus capability will be presented early next year at: **IFAC Conference on Advances in PID Control 2012**, March 28 - 30, 2012, Brescia, Italy.
- Documentation on the PIDPlus features for recovery from process saturation is targeted for DeltaV v12 books on-line.