FCCU Advanced Control at Chevron Pembroke Refinery

ERTC
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Petrocontrol

FCC at Pembroke Refinery

- Initial Hydro skim refinery commissioned in 1967
- Cracking facilities commissioned in 1983 (Texaco side by side Rx/Rg unit, with a main fractionator and gas concentration section)
- Can process over 35% resid of total throughput of over 100,000 BPSD (600m3/hr - One of the Biggest FCC in Europe)
- Feed mix variation is in the region of 0.908 to 0.92 SG
- Last major turn around is during 2003

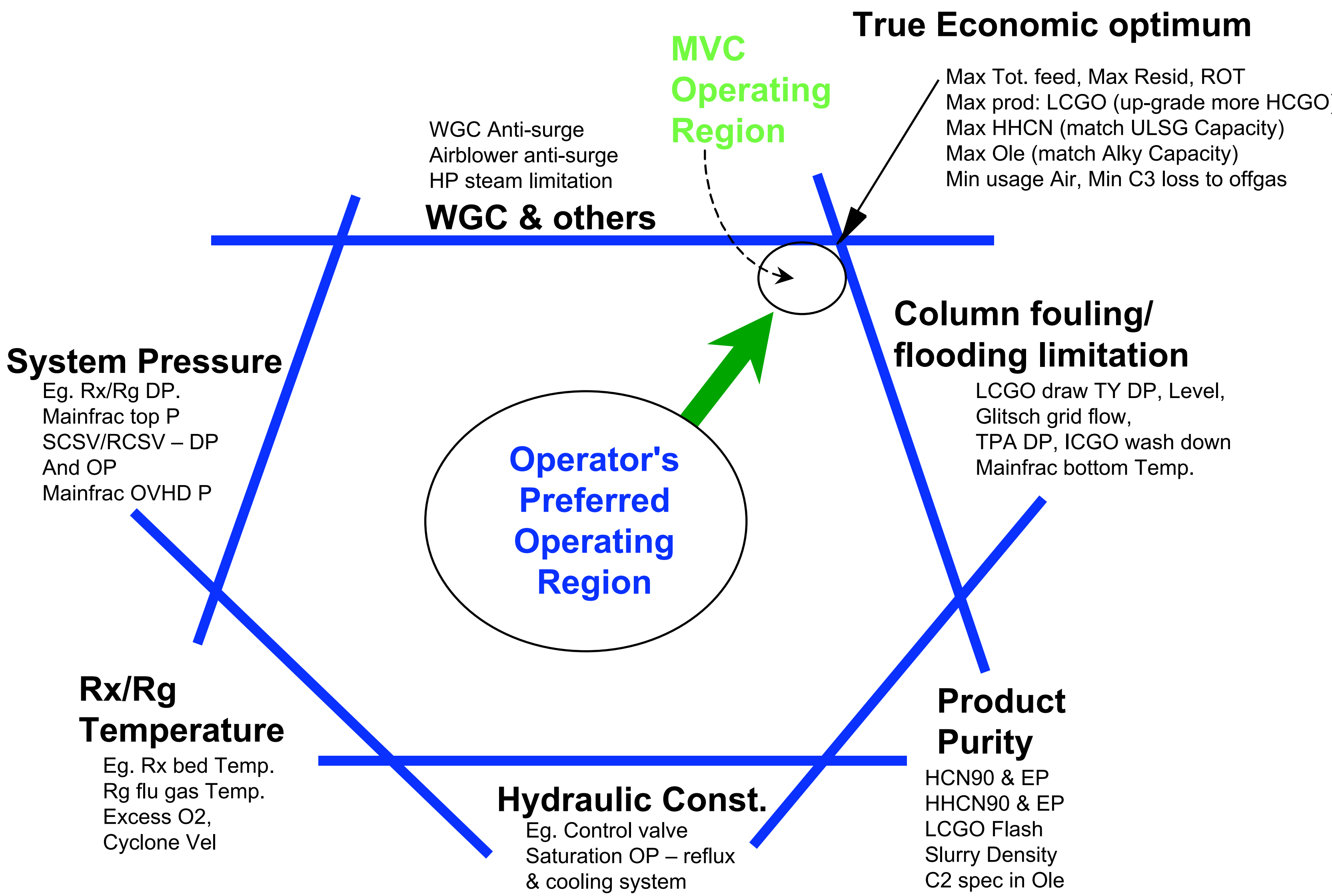
History of APC at Pembroke

- Pembroke Refinery has a long history of APC since 1987
- First MVC controller on FCC – 1988 (DMC) – with separate cotnroller for Rx/Rg, and Mainfrac
- 2001, RMPCT replaced DMC, retained original structure, and added deeth, debut, napsplit
- Very limited success at each time (mainfrac didn't work, lack of co-ordination between applications, tray damage)
- First Principle Inferentials first used in early 1990's and have been deployed across most refinery units

FCCU APC Reengineering

- Potentially US$ 4millions/yr yet to be captured (carried a study on FCC APC during 2004) - Need to completely revamp FCC APC
- Scope of the revamp to cover reactor, regenerator, mainfrac, deeth, debut
- Main focus of the application and this paper is the Fractionator section due to major difficulties in managing this section of the unit
- Major feed limiting constraints are mainly in the Fractionator section
- RMPCT is the control technology used
- New FCCU application commissioned in July 2005

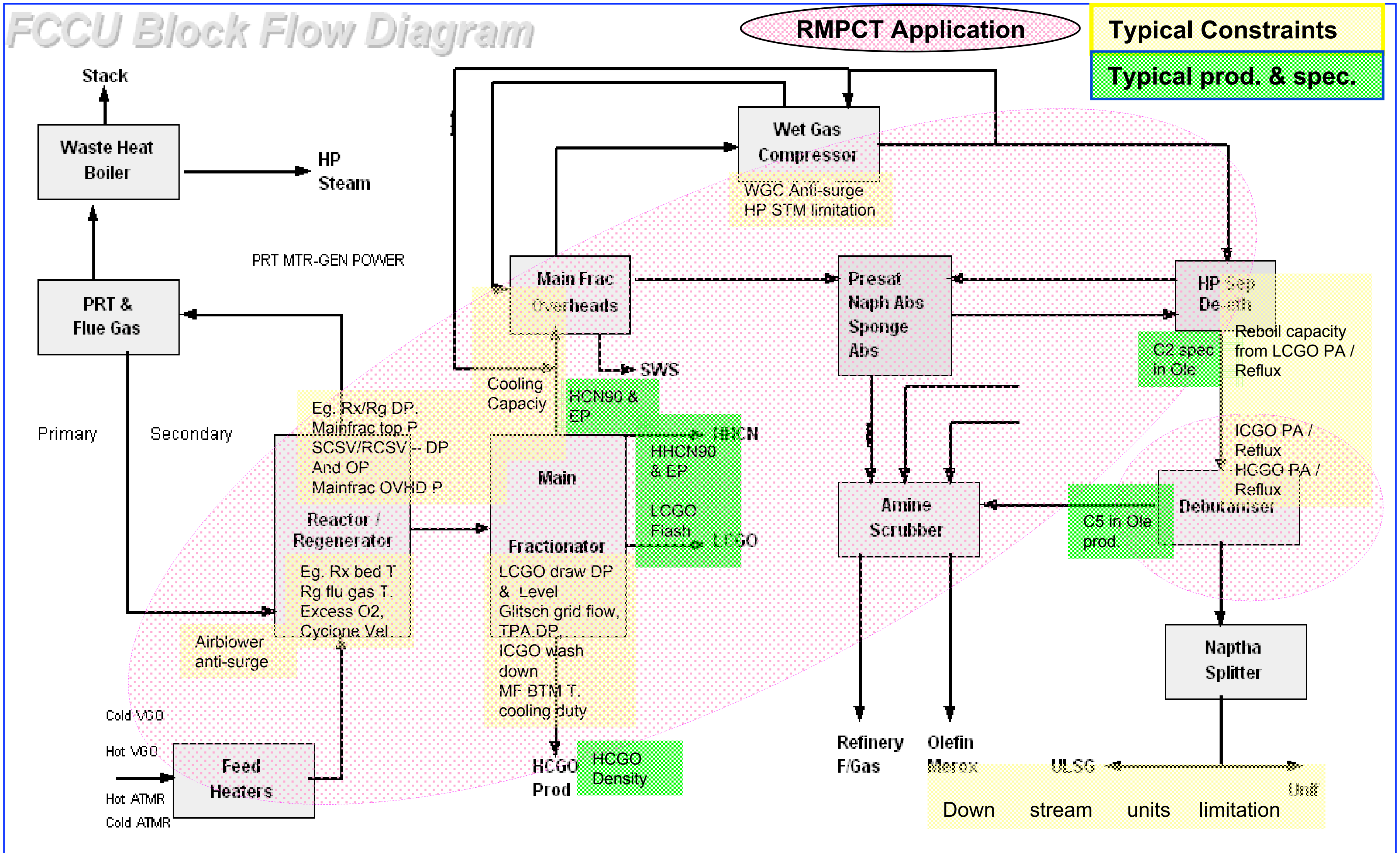
Operating within Constraints



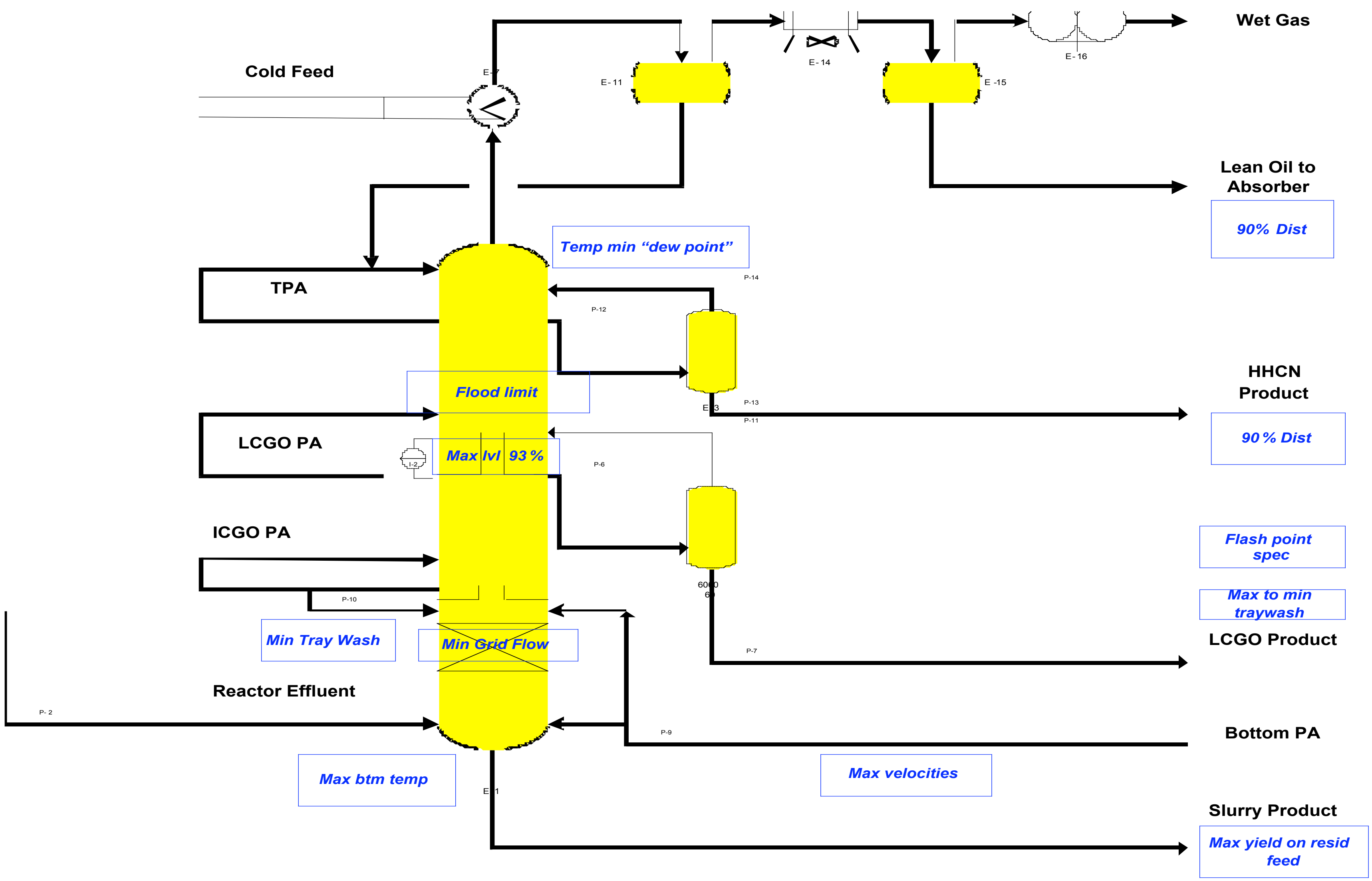
FCCU application overview

- Applications are as follows:
  - Rx_Rg/mainFrac/Deeth (better integration and optimisation) – 55CVs,22MVs,11DVs
  - Single application to cover Debutaniser (8CVs,4MVs,6DVs)
- Large scope application with sub controllers deployed for ease of maintenance and operator intervention. *(Sub controller switch AM/CL code supplied by AMT)*
- Customised Operator displays developed by CVX and AMT
  - Easy monitoring and operated upon (by panel operators)
  - Accommodation for switching access
- First principle Inferential model based on GCC (PetroControl)

Overview of Revamp Design



Schematic of Main fractionator



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Project details Schedule and contract

- Project was completed in a 8 month window.
- Inferential model provided by PetroControl, and implemented and subsequent re-calibrated by CVX (VBA-model for easy maintaining and calibration)
- APC model jointly developed and implemented by CVX and AMT (one engineer each)
- Operator training package jointly developed by CVX and AMT (computer based self-learning, interactive)
- Project completed under budget with benefits higher than expected

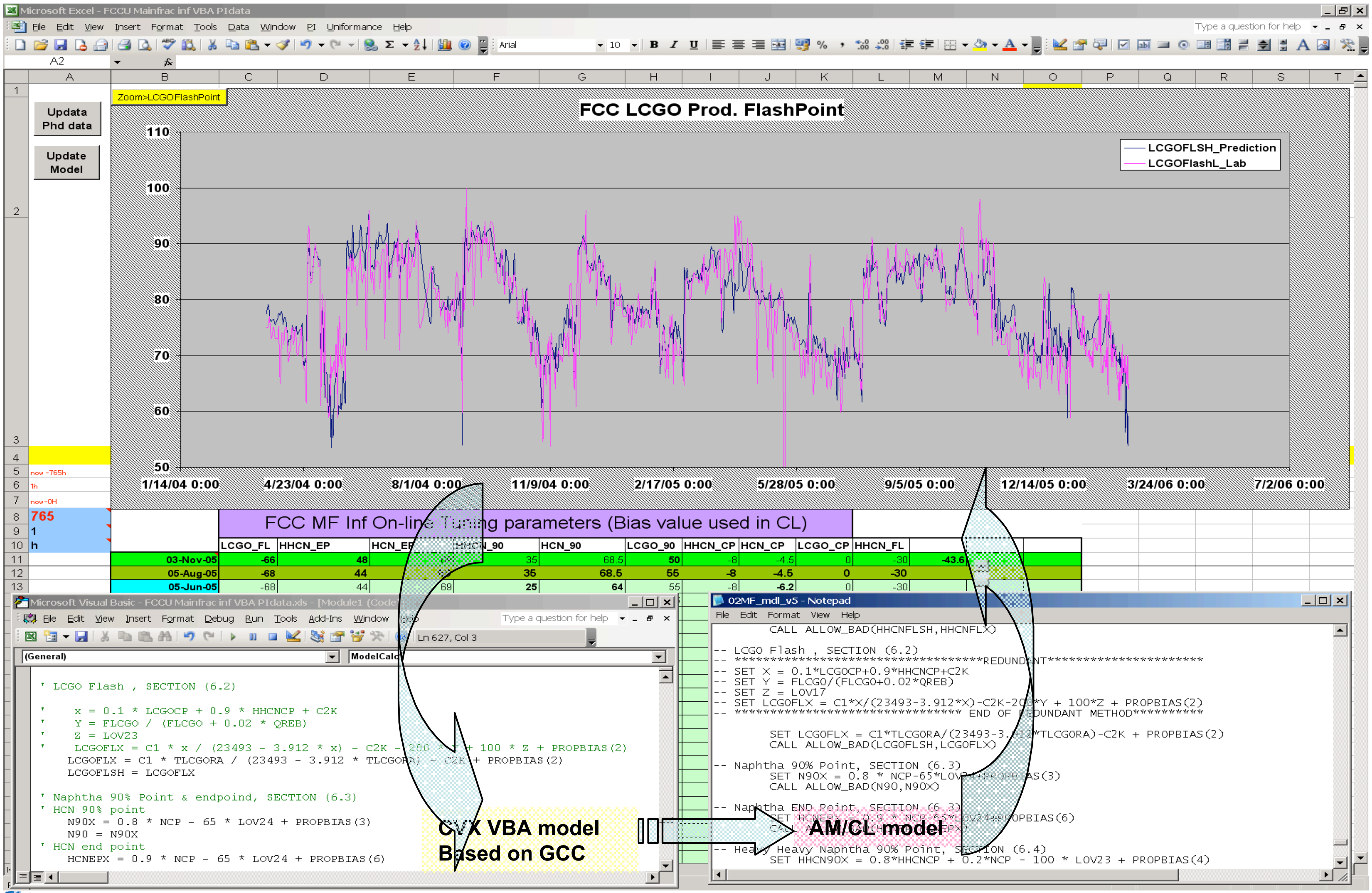
FCCU APC Application Success Factors

- New FCCU application commissioned in mid-June 2005
- High operator acceptance
- Good average controller uptime (>95% when process available)
- Fractionator control now much improved, this is a key issue for the FCCU unit operations.
- Payback achieved within a month

Feature – inferentials/Specs Control

- Fractionator:
  - LCGO Flash Point
  - HHCN ASTM 90% & End point
  - HCN ASTM 90% & End point
- Gas Plant
  - Deeth bottom % C2 slippage
  - Olefin % C5
  - LCN RVP
- ***Note: no analyser or lab updates used for biasing inferences***

Highlight - Inferential models



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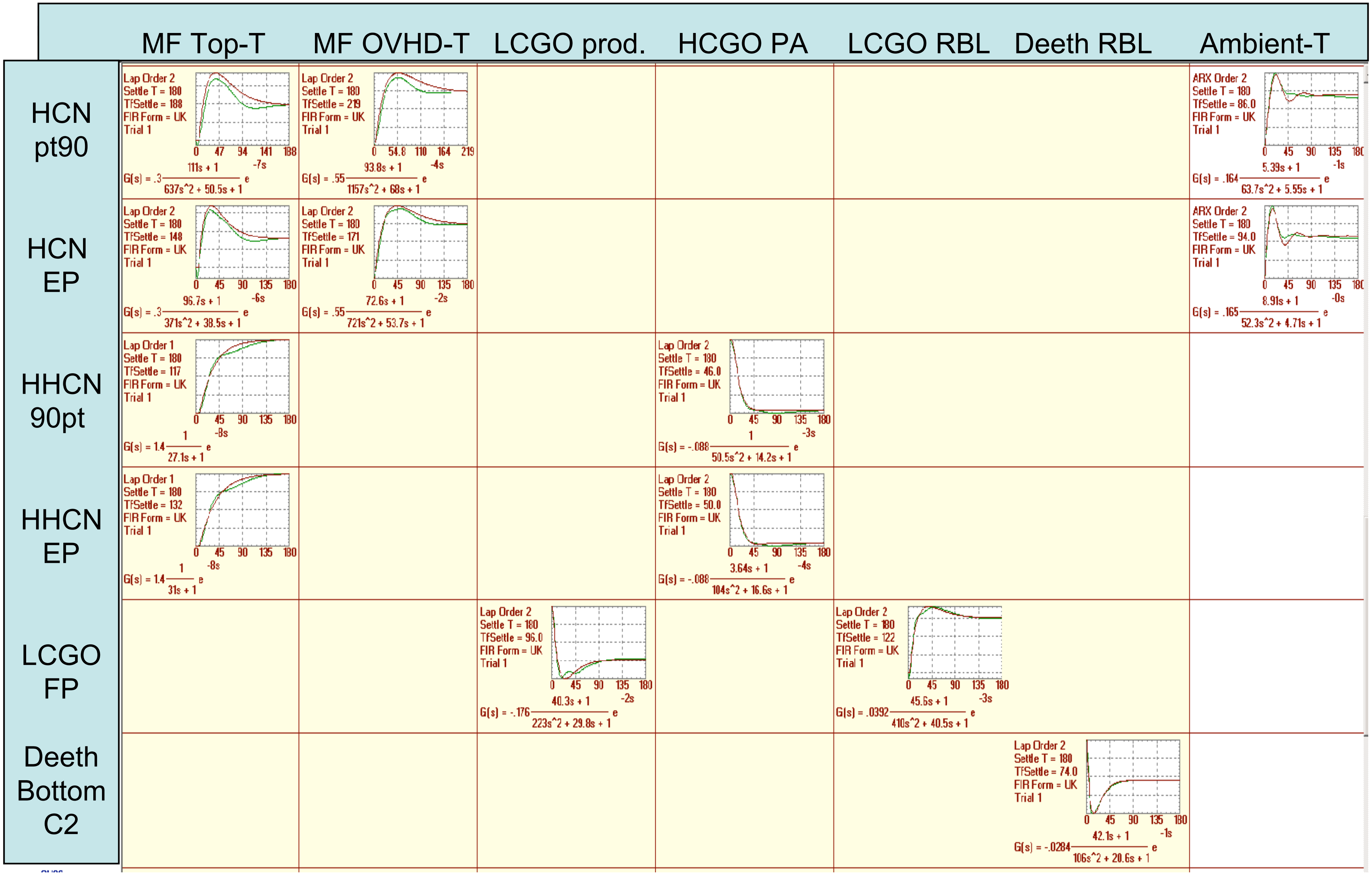
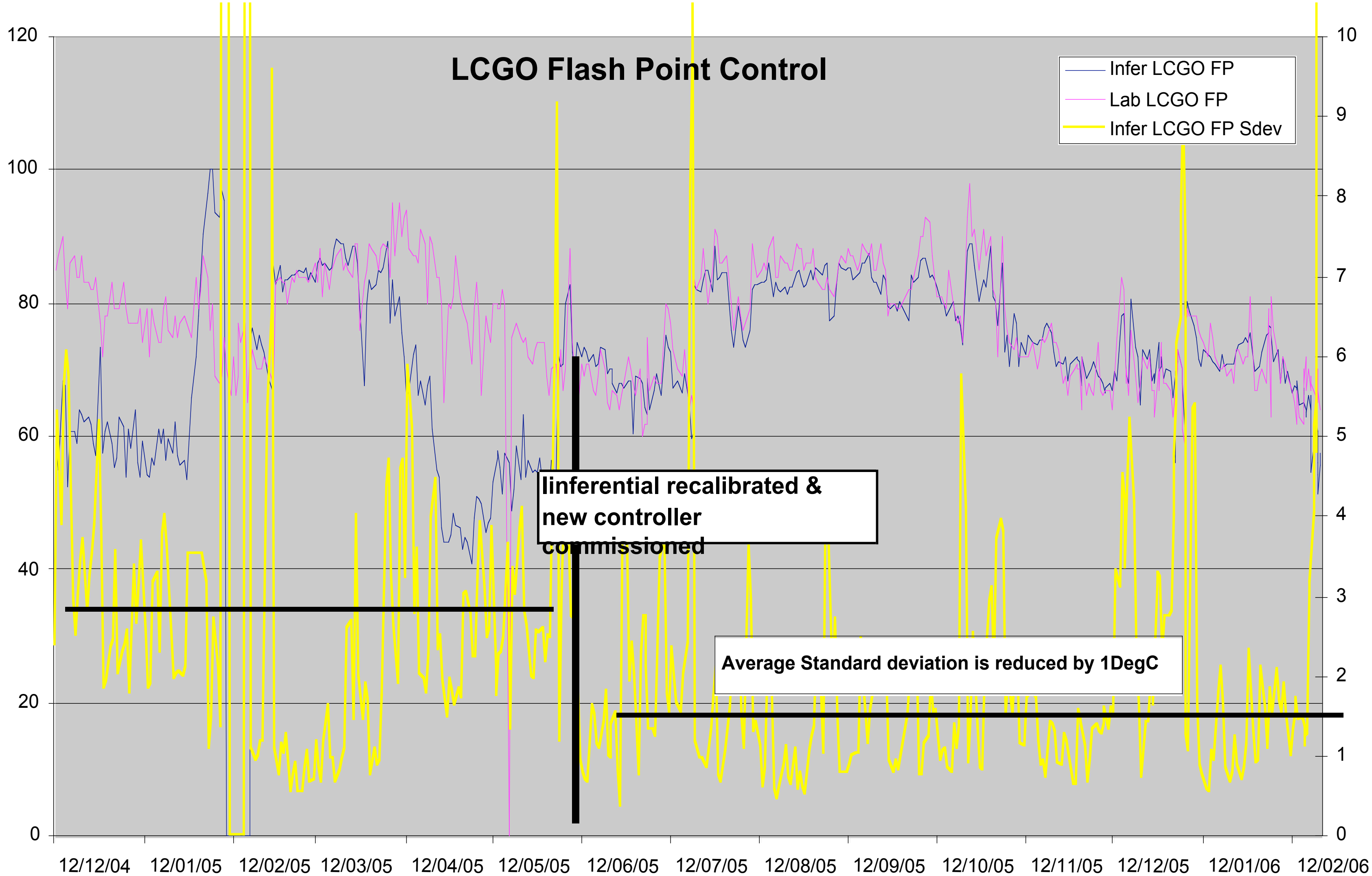
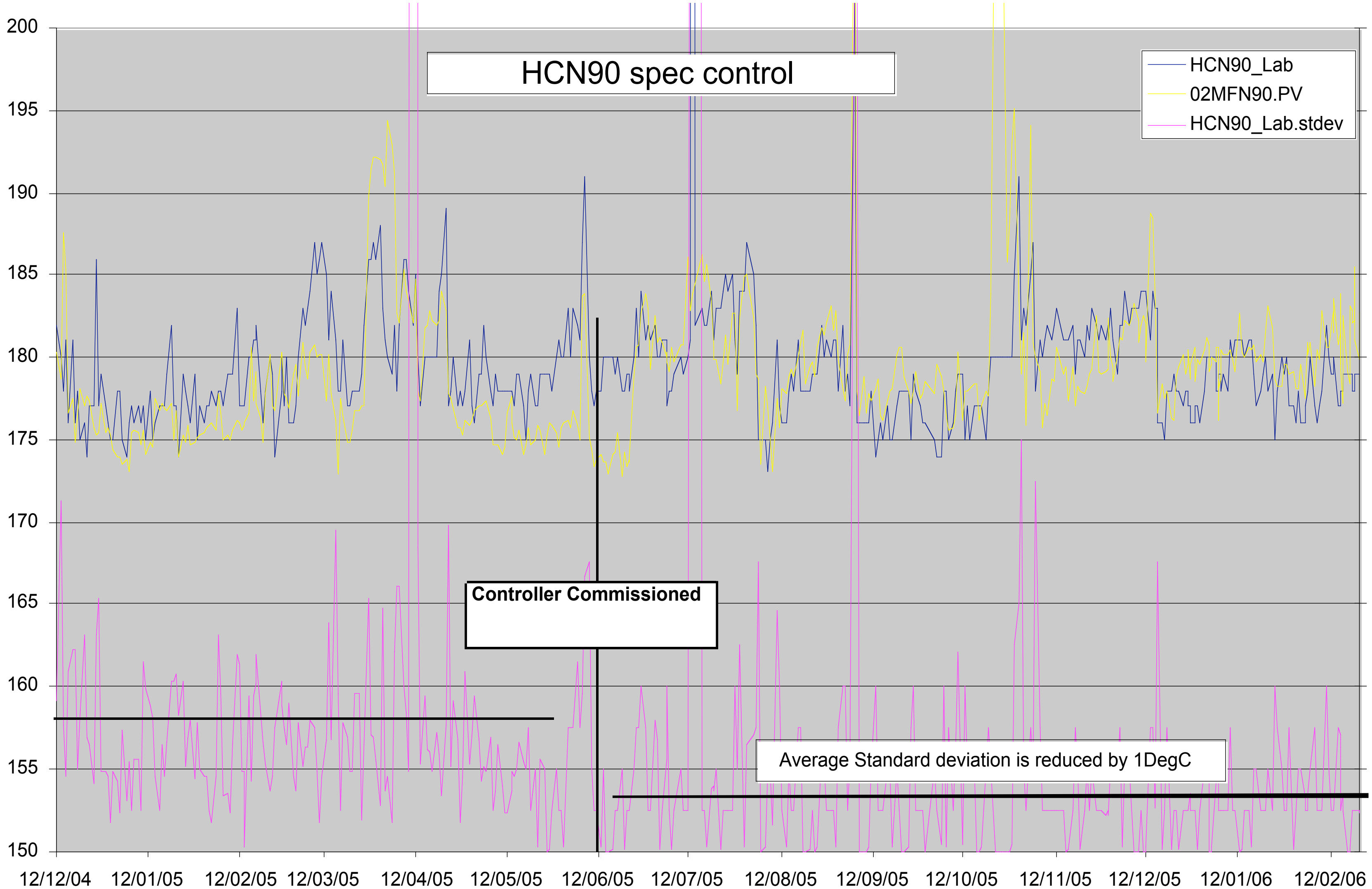
Sample Model – Spec Control



Highlight - LCGO Flash Point control



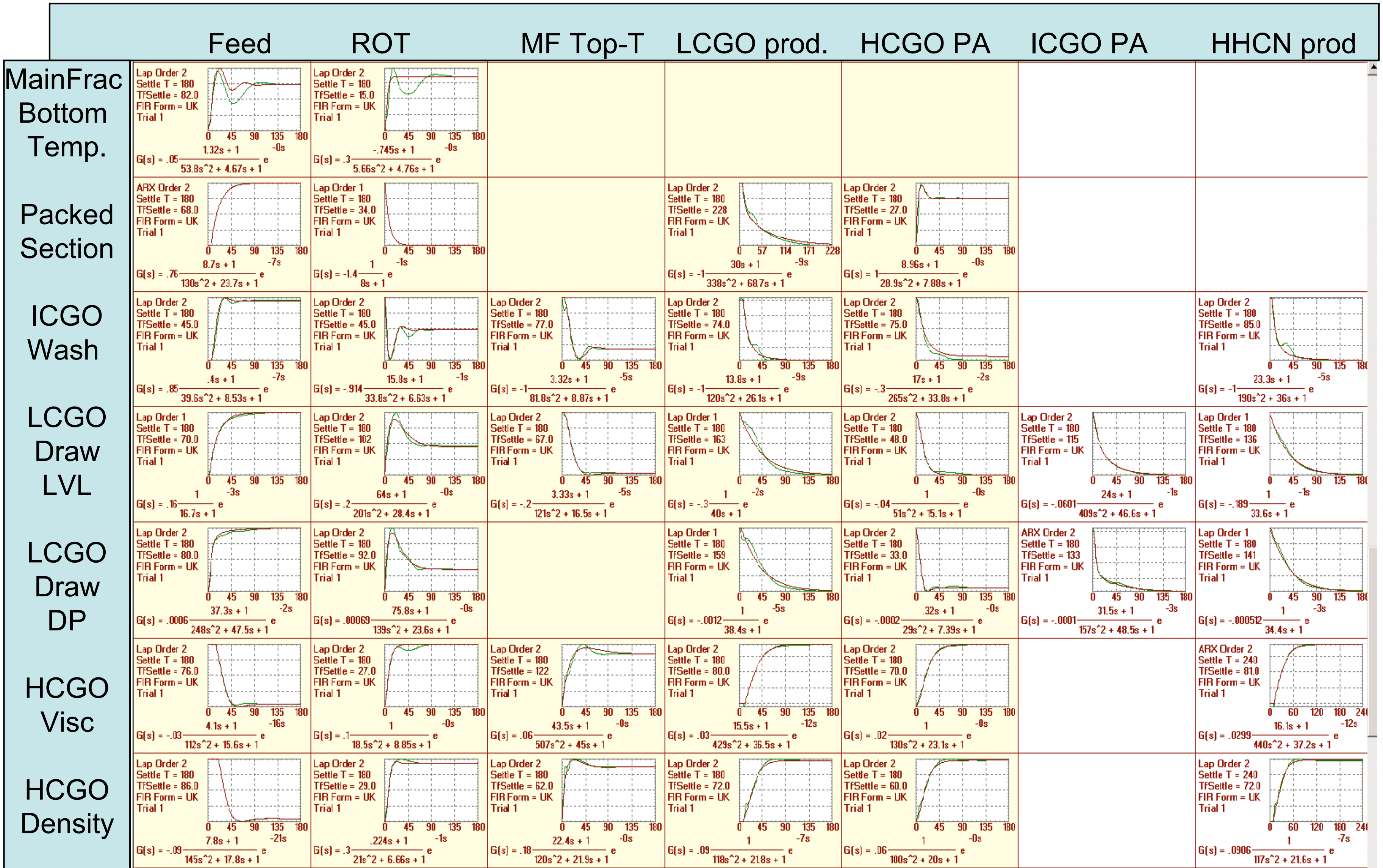
Highlight – HCN90 spec control



Feature – mainfrac control

- Optimise where possible the Fract bottoms heat removal Control Fractionator bottom temperature
- Prevent Fractionator flooding
- Maximise heat removal and balance duty around the column
- Ensure column packed sections are kept wet
- Ensure Slurry oil density remain on control within tight limits
- Minimise fouling probabilities in Slurry system
- Sustains Debutaniser on control even though reboiler (HCGO) exchanger fouling occurs

Sample Model – Main Frac control



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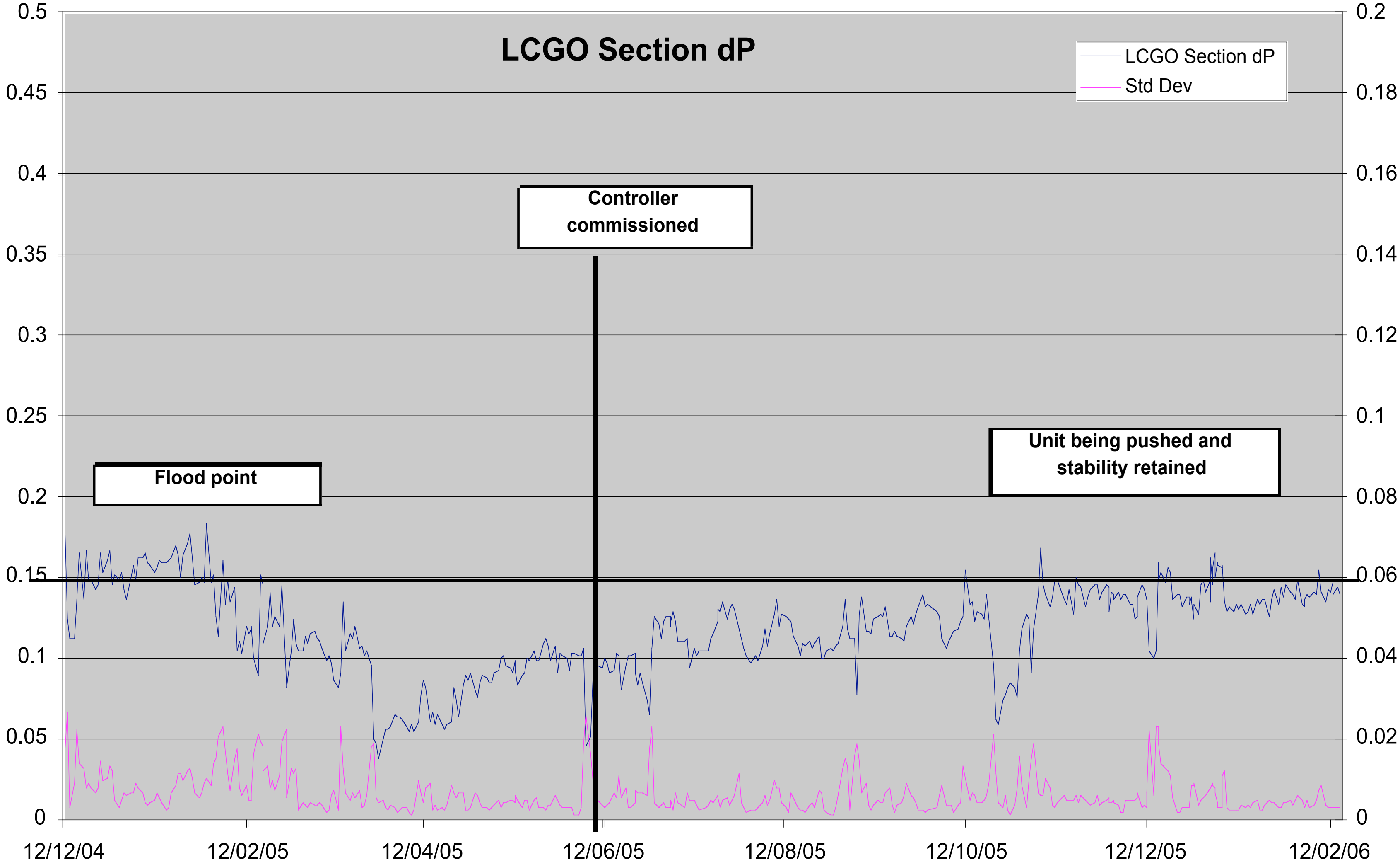
Highlight - LCGO Section dP Sensitivity to Flood



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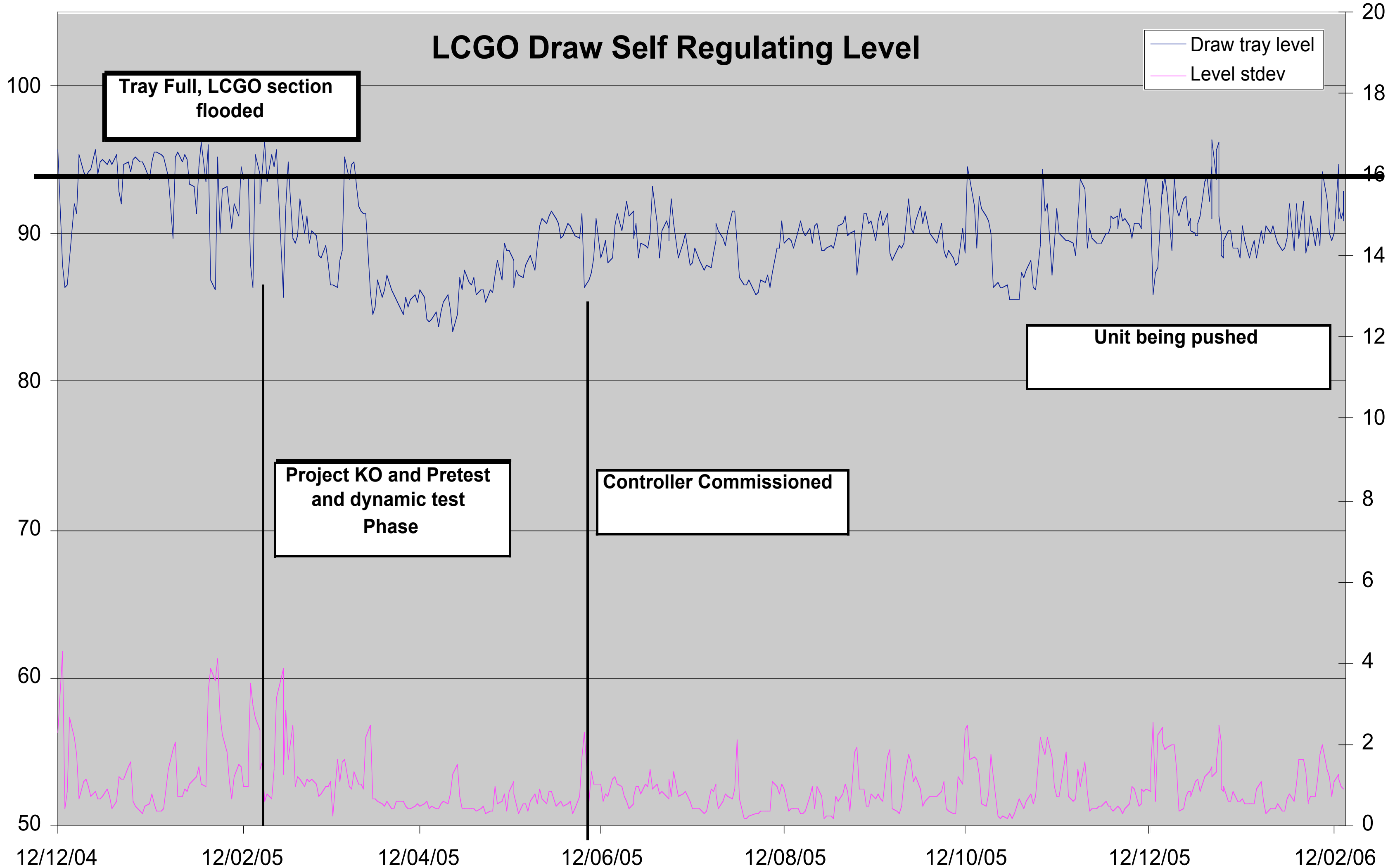
Highlight - LCGO Draw Tray Level



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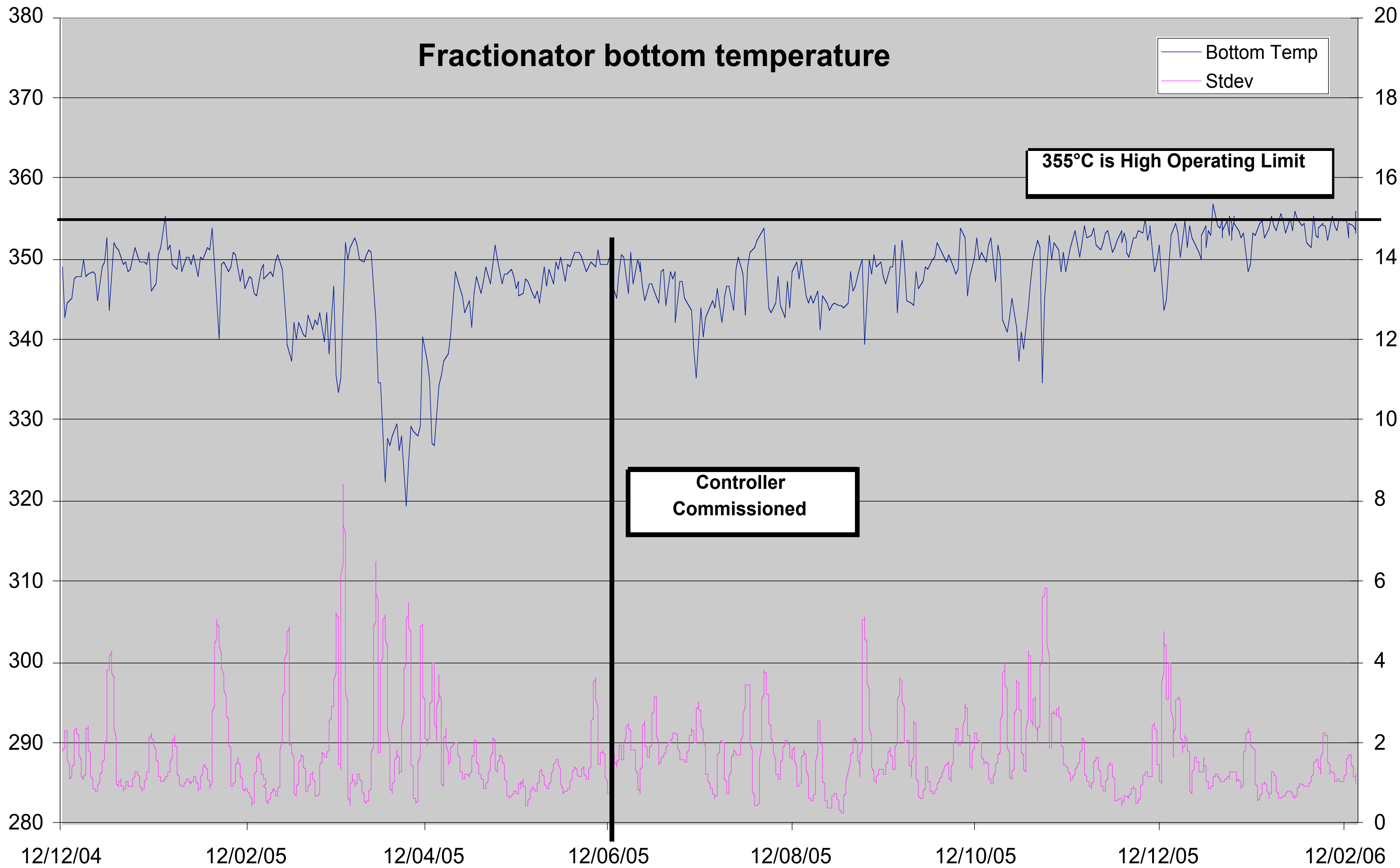
Highlight - Fractionator BTM T Critical Unit imitation



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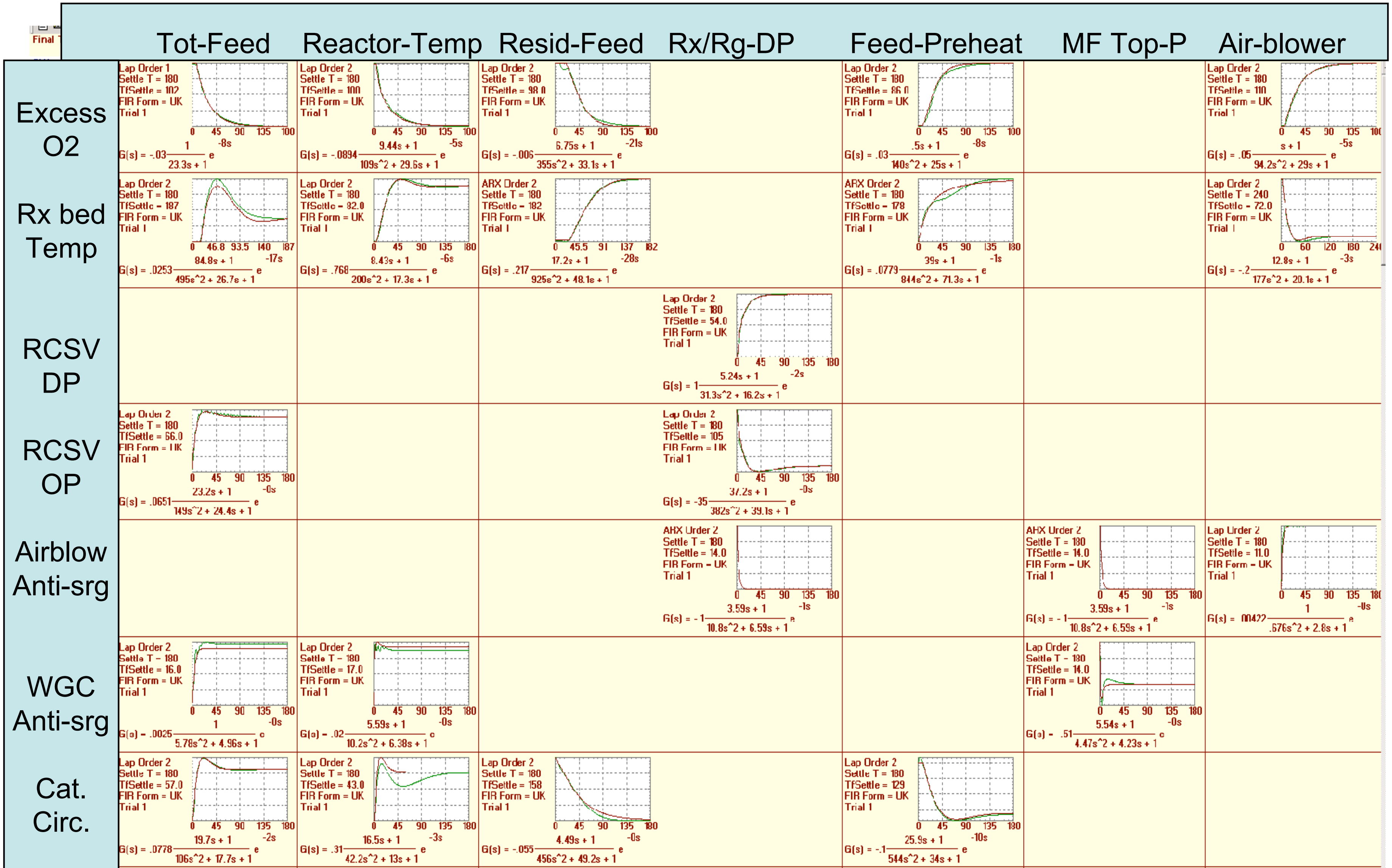
Feature – Optimisation direction

- Maximise Total Feed (match scheduling)
- Max Resid processing to Regen limitations
- Minimise load on Blower and expander
- Stay in safe system delta P range (slide valves) – max cat circulation
- Maximise Conversion
- Run to minimum Regen excess O2 (>1%)
- Max LCGO draw against MIN internal reflux
  - Significant operator issue
- Minimises the Deethaniser C3's loss to offgas subject to C2 content at bottom (ole prod)

Sample Model – Rx/Rg optimisation



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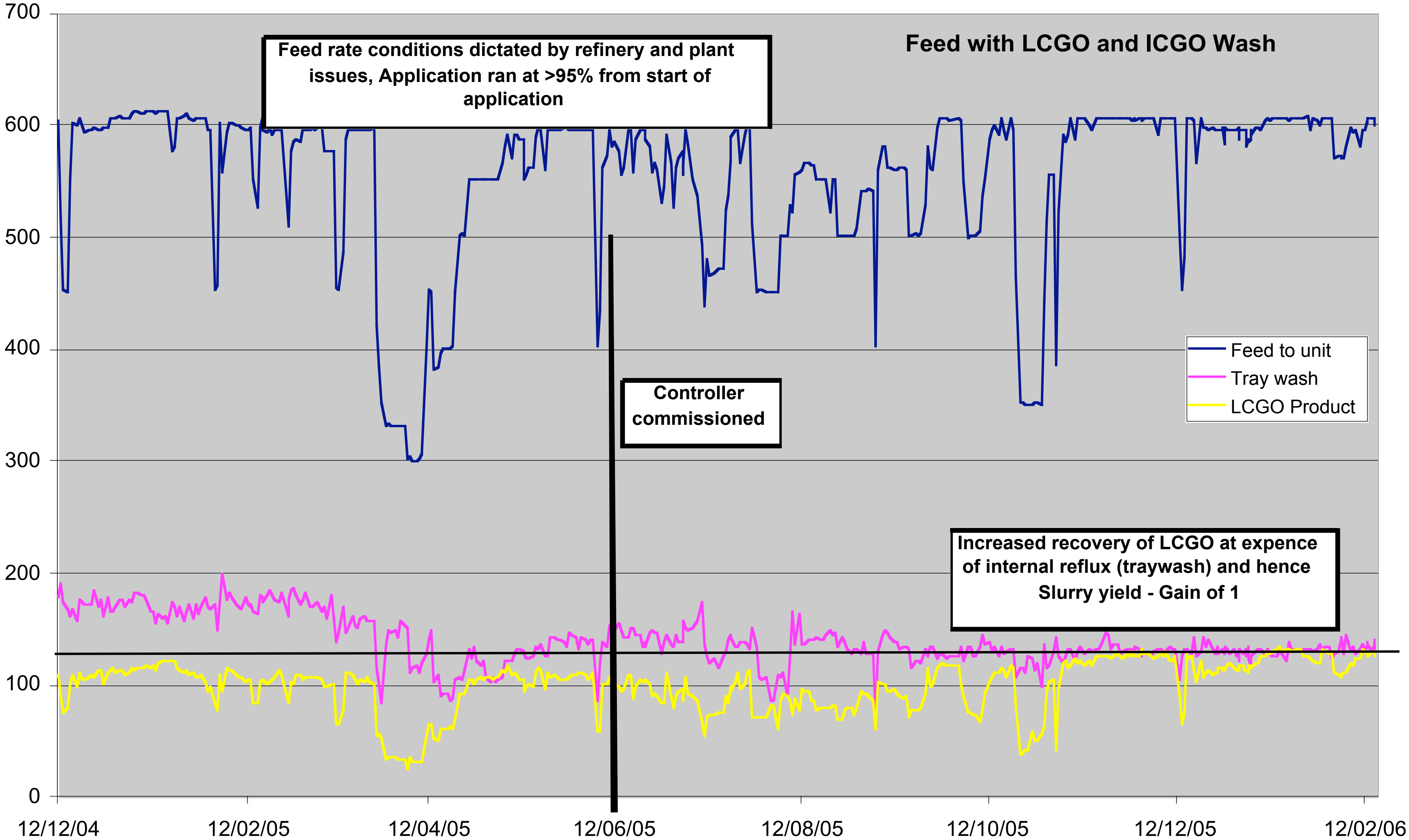
Unit Feed and Yields in M3/HR
Shows increase in recovery of LCGO whilst sustaining bottom conditions



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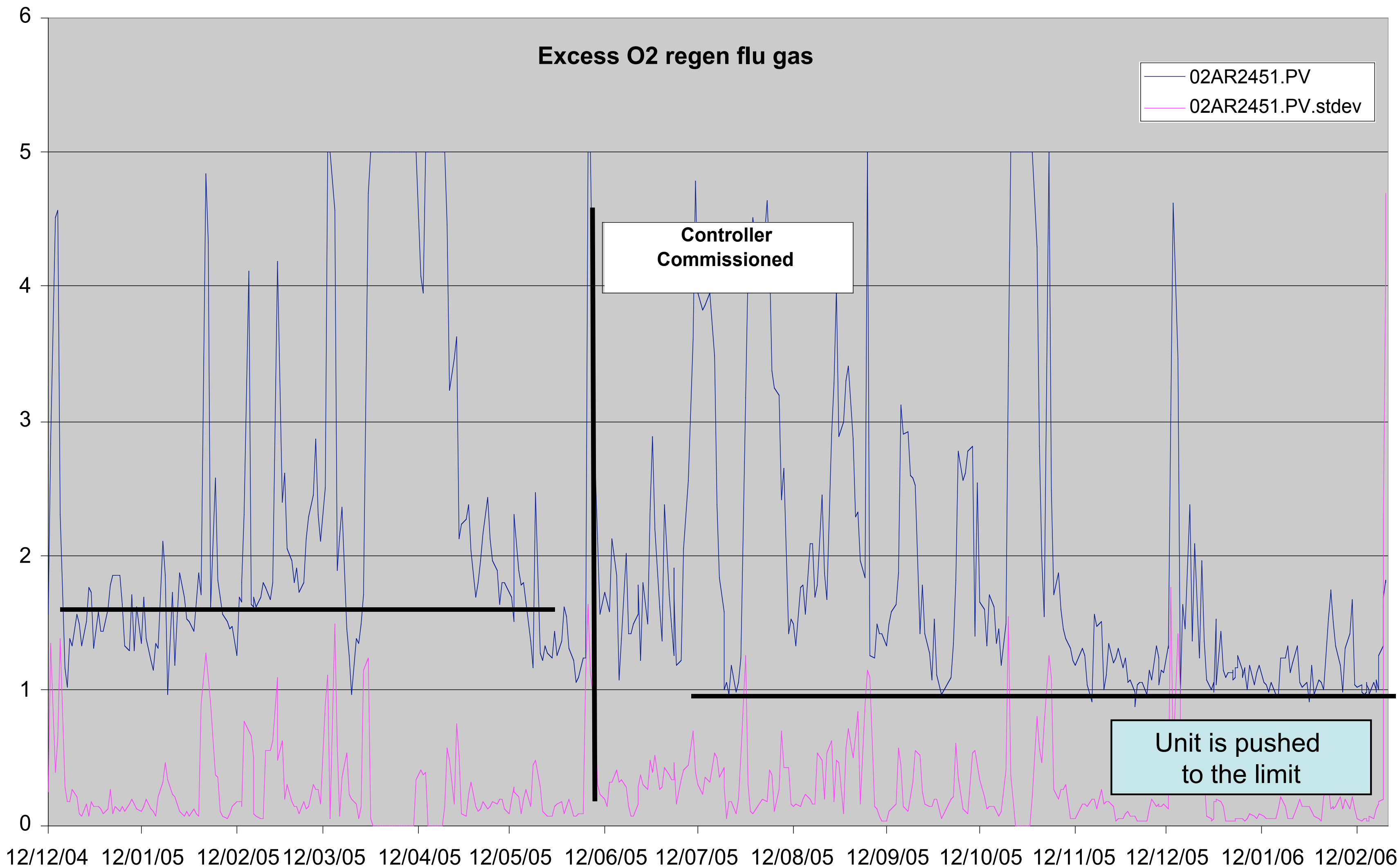
Highlight – Excess O2 optimisation



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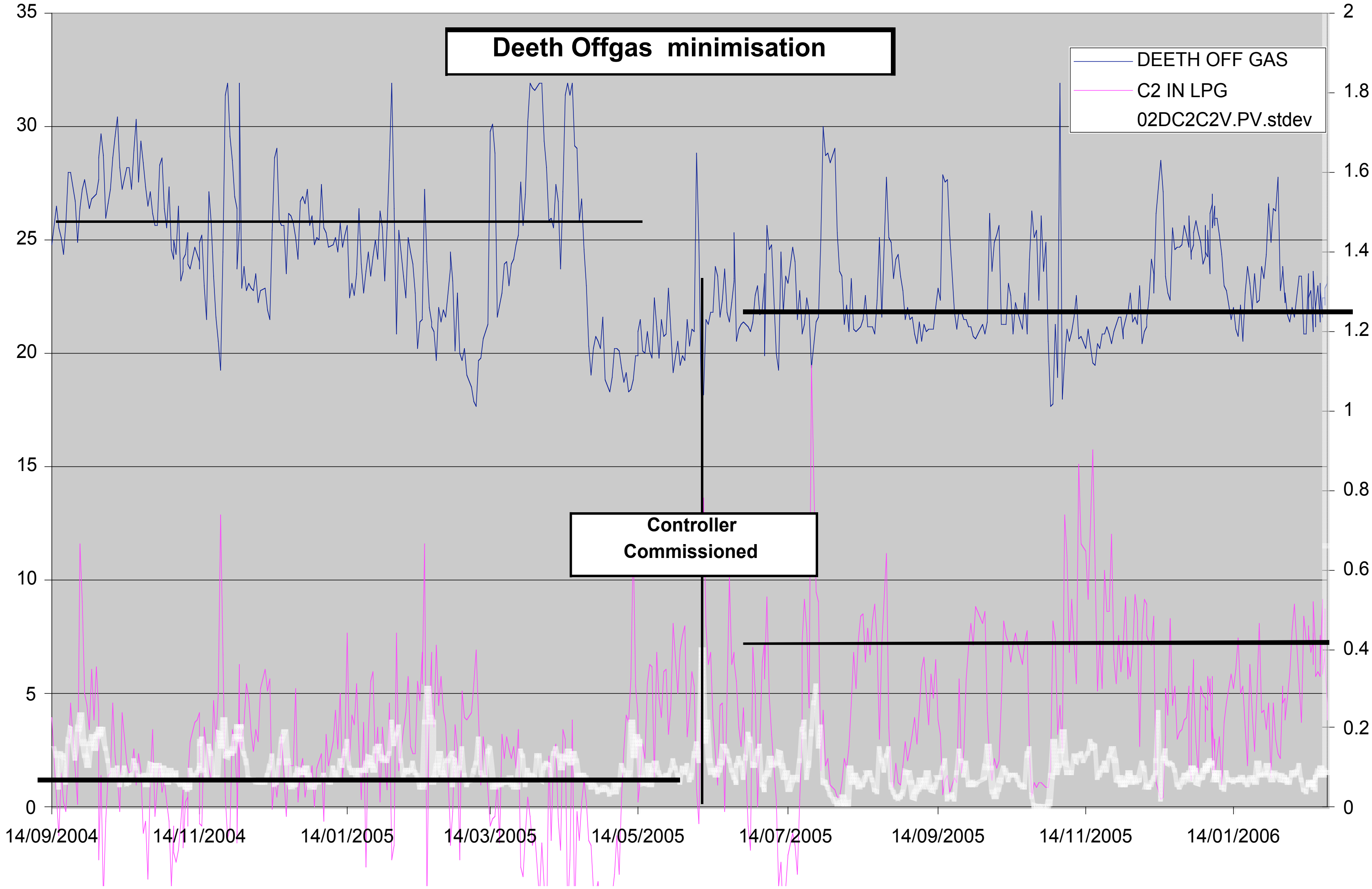
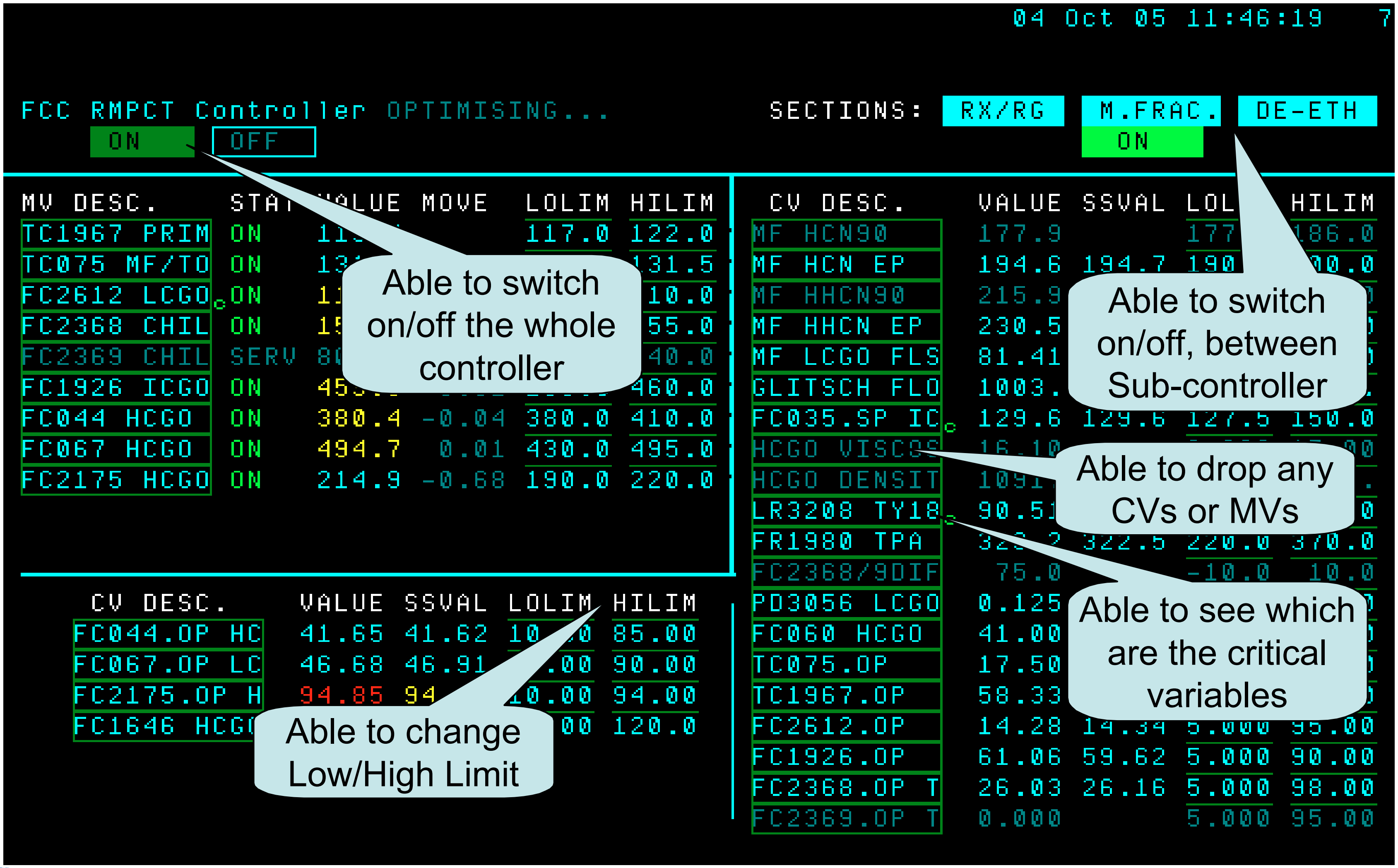
Highlight – Deeth Optimisation



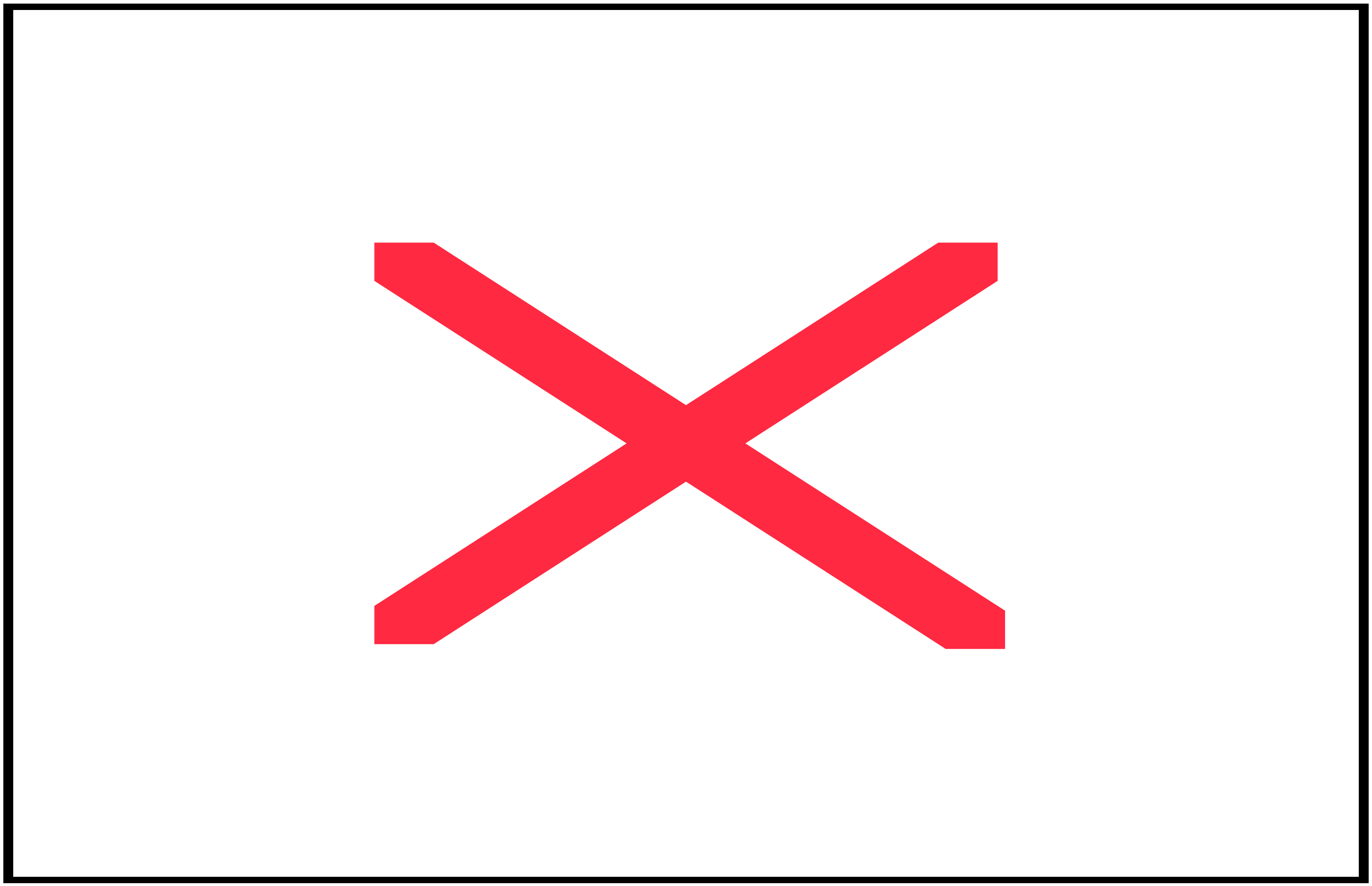
Feature – operator Acceptance

- Easy & user friendly APC monitoring display
- Comprehensive operator's training

Highlight – Custimised Operator Display



Highlight – sample training slide



Thank you

Questions