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VALERO

GDOT Applications at Valero's Pembroke Refinery

An Rigden, Process Control Manager, Valero Pembroke Refinery

Presentation Overview

- Introduction to Valero Pembroke Refinery
- GDOT Program at Valero Pembroke Refinery
- ULSD Maximization Case Study
- CDU Heat Balance Optimization Case Study

Valero Pembroke Introduction

- Pembroke refinery opened in 1964
- Crude capacity of 220,000 BPD
- Approximately 600 employees and 400 term contractors
- Valero acquired the Pembroke Refinery in southwest Wales in 2011

GDOT Optimiser Program at Pembroke Refinery

- ULSD_OPT (2006)
  - CDU, VDU, VBU, HTU1, HTU2 and part of FCCU
- NAP_OPT (2009)
  - CDU, Unifiner, CCR, Benzene column, ISOM (added 2010)
  - Partial gasoline blending to be added
- UTIL_OPT (2010)
  - Fuel gas/oil system, 7 boilers, LP MP and HP steam.
- HYDROISOM_OPT, (2011)
  - Small nonlinear reactor optimiser
- FCCU_OPT, (2013)
  - Main fractionator commissioned first, feed optimisation ready after DCS migration
- ALKY_OPT (2014)
  - Model completed, to be commissioned after DCS migration
- H2_OPT
  - Feasibility study completed

Pembroke ULSD Optimization Project

Valero Pembroke ULSD Project Objective

- Consistently maintain high ULSD (and gasoil) production rates.
- Reduce off spec diesel production
- Minimize giveaway
- Optimize towards HVP from the crude oil
- HDS unit/catalyst optimization
- Improve energy efficiency

Published Benefits Case Study

Petroleum Technology Quarterly 2011 Q2

Modelling for ULSD optimisation

On-line coordination and optimisation of refinery process units led to a 10% increase in middle distillate production

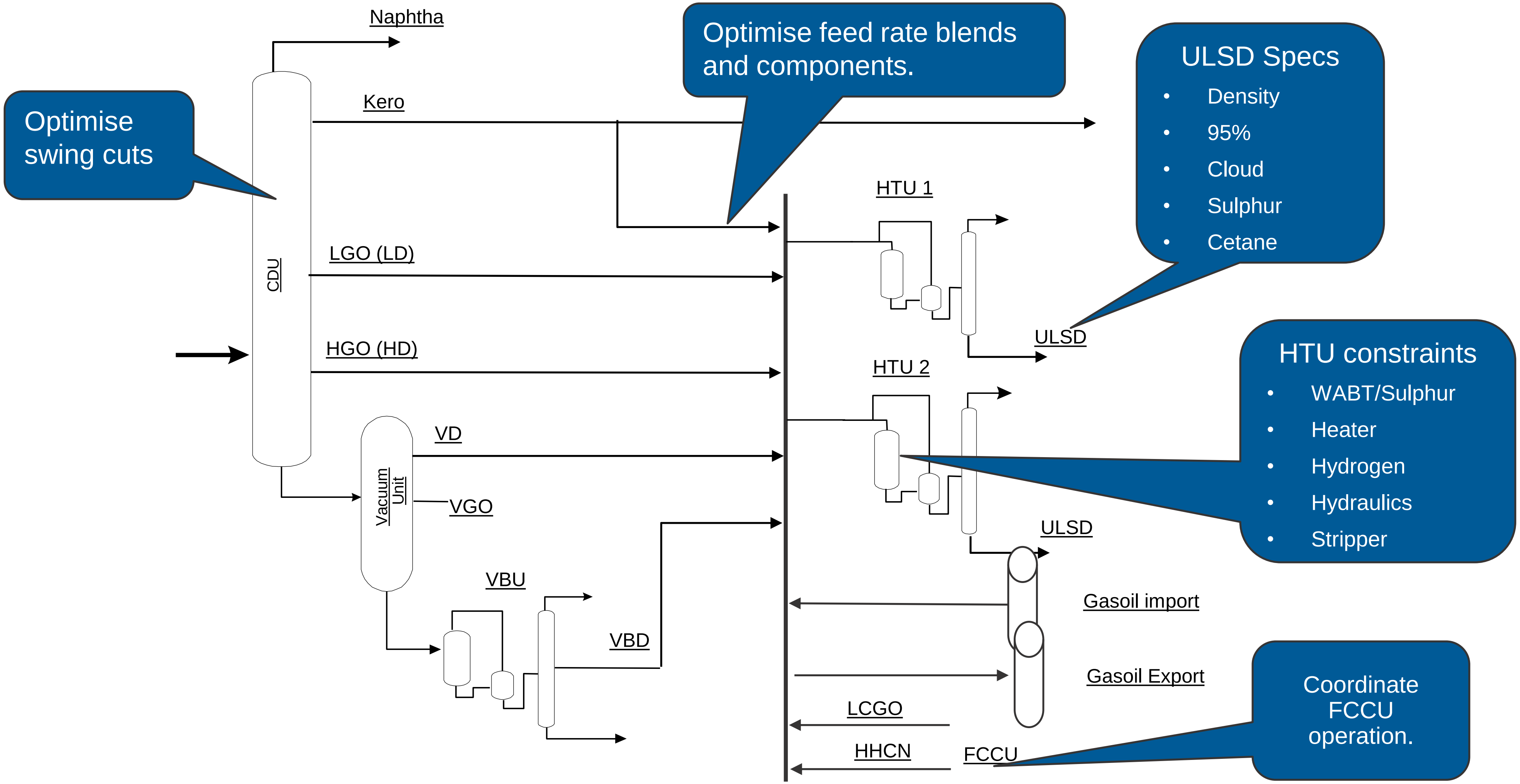
KLAS DAHLGREN *Apex Optimisation/Dynaproc*
AN RIGDEN *Chevron* HENRIK TERNDRUP *Apex Optimisation*

The Chevron Pembroke oil refinery is a complex and large (220 000 b/d) processing site. This case study examines the improvements achieved by a project with a high return on investment, which resulted in better operation of the process units involved in middle distillate production and

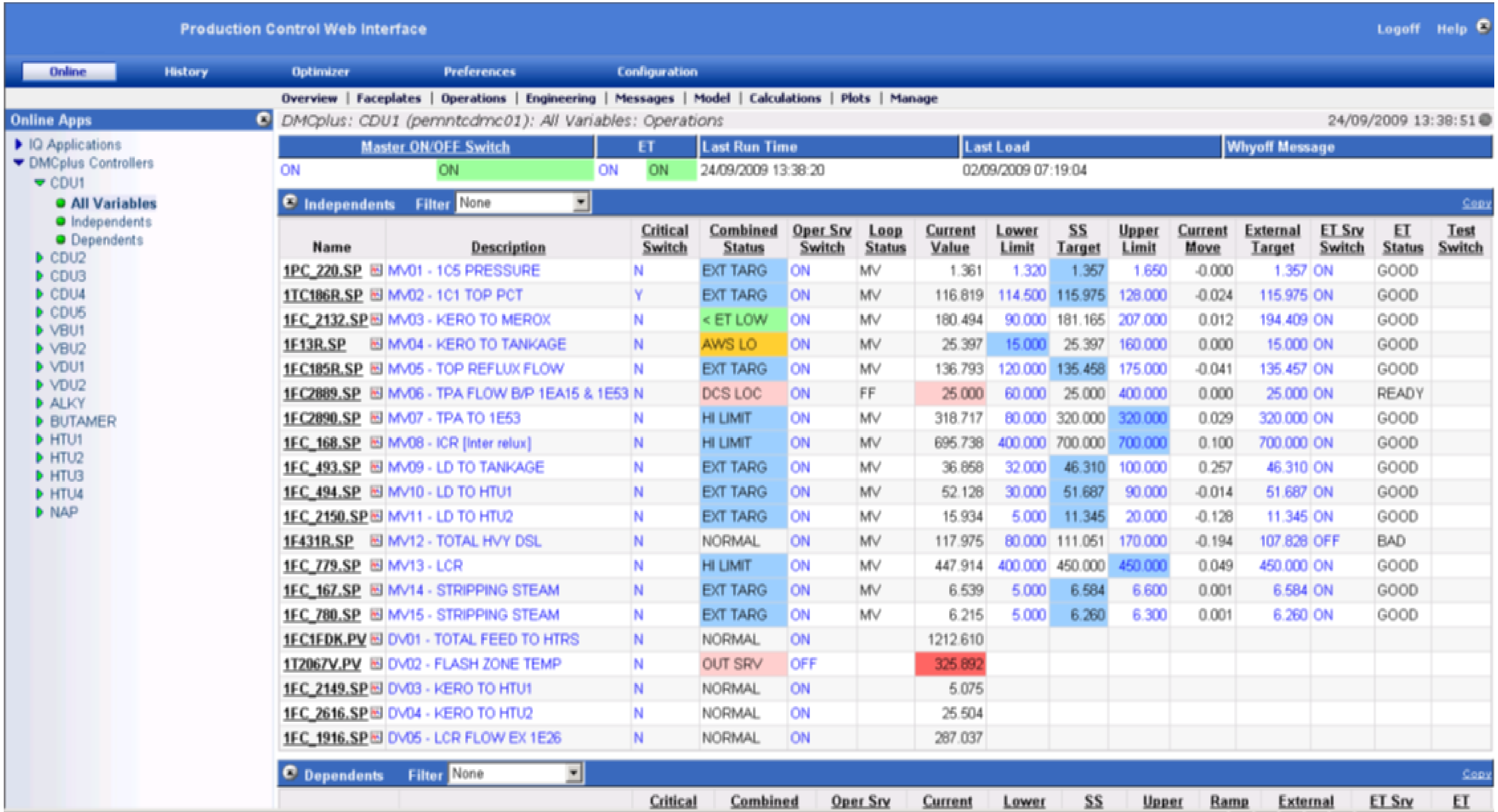
components, which include kerosene, several straight-run gas oil streams and FCC product streams such as HHCN and light cycle gas oil (LCGO). The decision-making process for these blends involves several refinery areas and console operators in different control rooms across the site.

Like many other ULSD-producing refineries, the Pembroke site blends middle distillates directly from the process unit rundown lines prior to hydrotreating. The main advantages of this approach, compared to a conventional batch blending system, are lower tank storage and manpower requirements, and the

Pembroke Diesel System



DMCplus with GDOT for Operators



Production Control Web Interface   Logoff   Help

Online | History | Optimizer | Preferences | Configuration

Overview | Faceplates | Operations | Engineering | Messages | Model | Calculations | Plots | Manage

Online Apps
- IQ Applications
- DMCplus Controllers
  - CDU1
    - All Variables
    - Independents
    - Dependents
  - CDU2
  - CDU3
  - CDU4
  - CDU5
  - VBU1
  - VBU2
  - VDU1
  - VDU2
  - ALKY
  - BUTAMER
  - HTU1
  - HTU2
  - HTU3
  - HTU4
  - NAP

DMCplus: CDU1 (pemntcdmc01): All Variables: Operations   24/09/2009 13:38:51

Master ON/OFF Switch		ET		Last Run Time	Last Load	Whyoff Message
ON	ON	ON	ON	24/09/2009 13:38:20	02/09/2009 07:19:04	

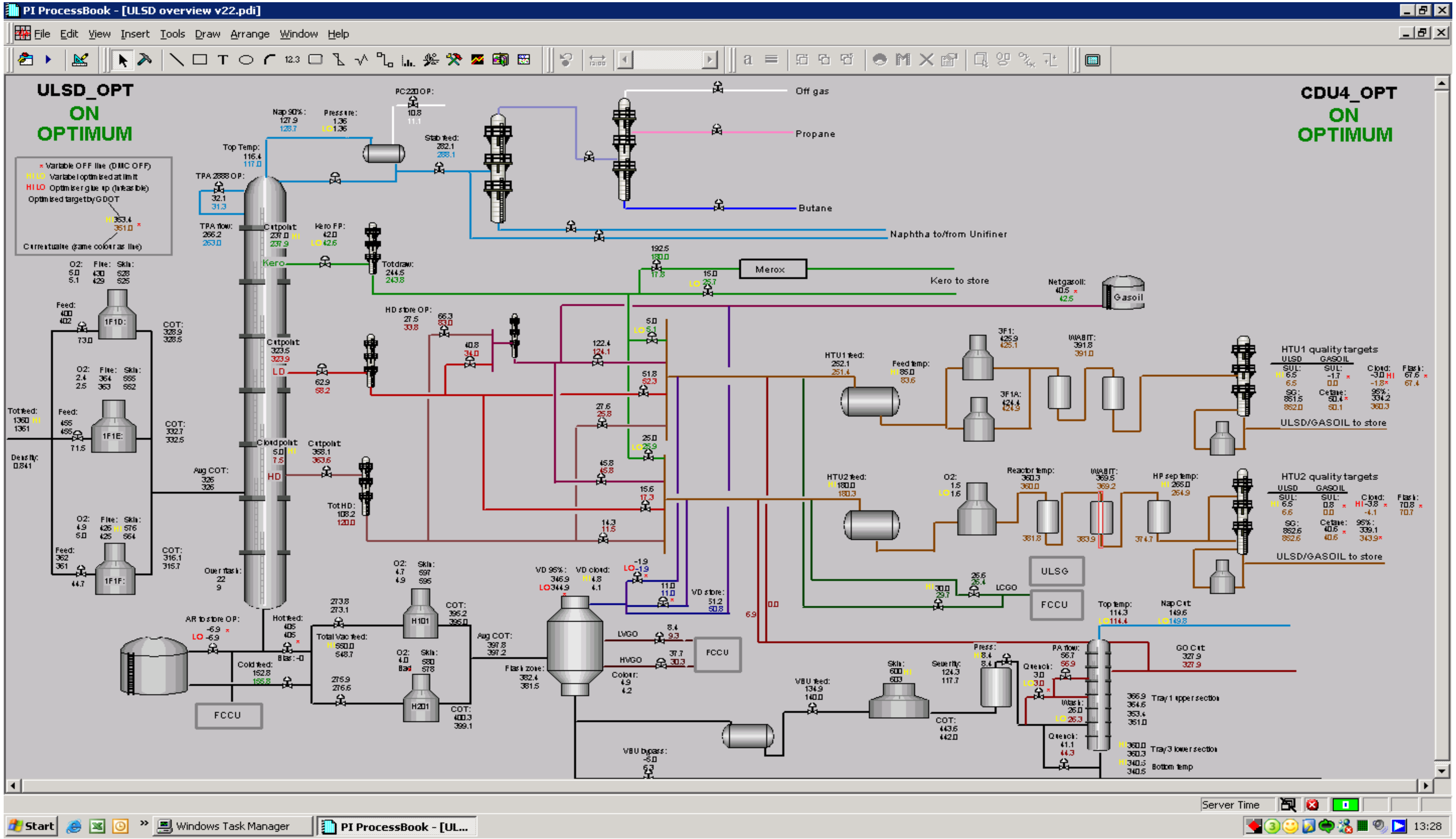
Independents Filter None Copy

Name	Description	Critical Switch	Combined Status	Oper Srv Switch	Loop Status	Current Value	Lower Limit	SS Target	Upper Limit	Current Move	External Target	ET Srv Switch	ET Status	Test Switch
1PC_220.SP	MV01 - 1C5 PRESSURE	N	EXT TARG	ON	MV	1.361	1.320	1.357	1.650	-0.000	1.357	ON	GOOD	
1TC186R.SP	MV02 - 1C1 TOP PCT	Y	EXT TARG	ON	MV	116.819	114.500	115.975	128.000	-0.024	115.975	ON	GOOD	
1FC_2132.SP	MV03 - KERO TO MEROX	N	< ET LOW	ON	MV	180.494	90.000	181.165	207.000	0.012	194.409	ON	GOOD	
1F13R.SP	MV04 - KERO TO TANKAGE	N	AWS LO	ON	MV	25.397	15.000	25.397	160.000	0.000	15.000	ON	GOOD	
1FC185R.SP	MV05 - TOP REFLUX FLOW	N	EXT TARG	ON	MV	136.793	120.000	135.458	175.000	-0.041	135.457	ON	GOOD	
1FC2889.SP	MV06 - TPA FLOW B/P 1EA15 & 1E53	N	DCS LOC	ON	FF	25.000	60.000	25.000	400.000	0.000	25.000	ON	READY	
1FC2890.SP	MV07 - TPA TO 1E53	N	HI LIMIT	ON	MV	318.717	80.000	320.000	320.000	0.029	320.000	ON	GOOD	
1FC_168.SP	MV08 - ICR [Inter relux]	N	HI LIMIT	ON	MV	695.738	400.000	700.000	700.000	0.100	700.000	ON	GOOD	
1FC_493.SP	MV09 - LD TO TANKAGE	N	EXT TARG	ON	MV	36.858	32.000	46.310	100.000	0.257	46.310	ON	GOOD	
1FC_494.SP	MV10 - LD TO HTU1	N	EXT TARG	ON	MV	52.128	30.000	51.687	90.000	-0.014	51.687	ON	GOOD	
1FC_2150.SP	MV11 - LD TO HTU2	N	EXT TARG	ON	MV	15.934	5.000	11.345	20.000	-0.128	11.345	ON	GOOD	
1F431R.SP	MV12 - TOTAL HVY DSL	N	NORMAL	ON	MV	117.975	80.000	111.051	170.000	-0.194	107.828	OFF	BAD	
1FC_779.SP	MV13 - LCR	N	HI LIMIT	ON	MV	447.914	400.000	450.000	450.000	0.049	450.000	ON	GOOD	
1FC_167.SP	MV14 - STRIPPING STEAM	N	EXT TARG	ON	MV	6.539	5.000	6.584	6.600	0.001	6.584	ON	GOOD	
1FC_780.SP	MV15 - STRIPPING STEAM	N	EXT TARG	ON	MV	6.215	5.000	6.260	6.300	0.001	6.260	ON	GOOD	
1FC1FDK.PV	DV01 - TOTAL FEED TO HTRS	N	NORMAL	ON		1212.610								
1T2067V.PV	DV02 - FLASH ZONE TEMP	N	OUT SRV	OFF		325.892								
1FC_2149.SP	DV03 - KERO TO HTU1	N	NORMAL	ON		5.075								
1FC_2616.SP	DV04 - KERO TO HTU2	N	NORMAL	ON		25.504								
1FC_1916.SP	DV05 - LCR FLOW EX 1E26	N	NORMAL	ON		287.037								

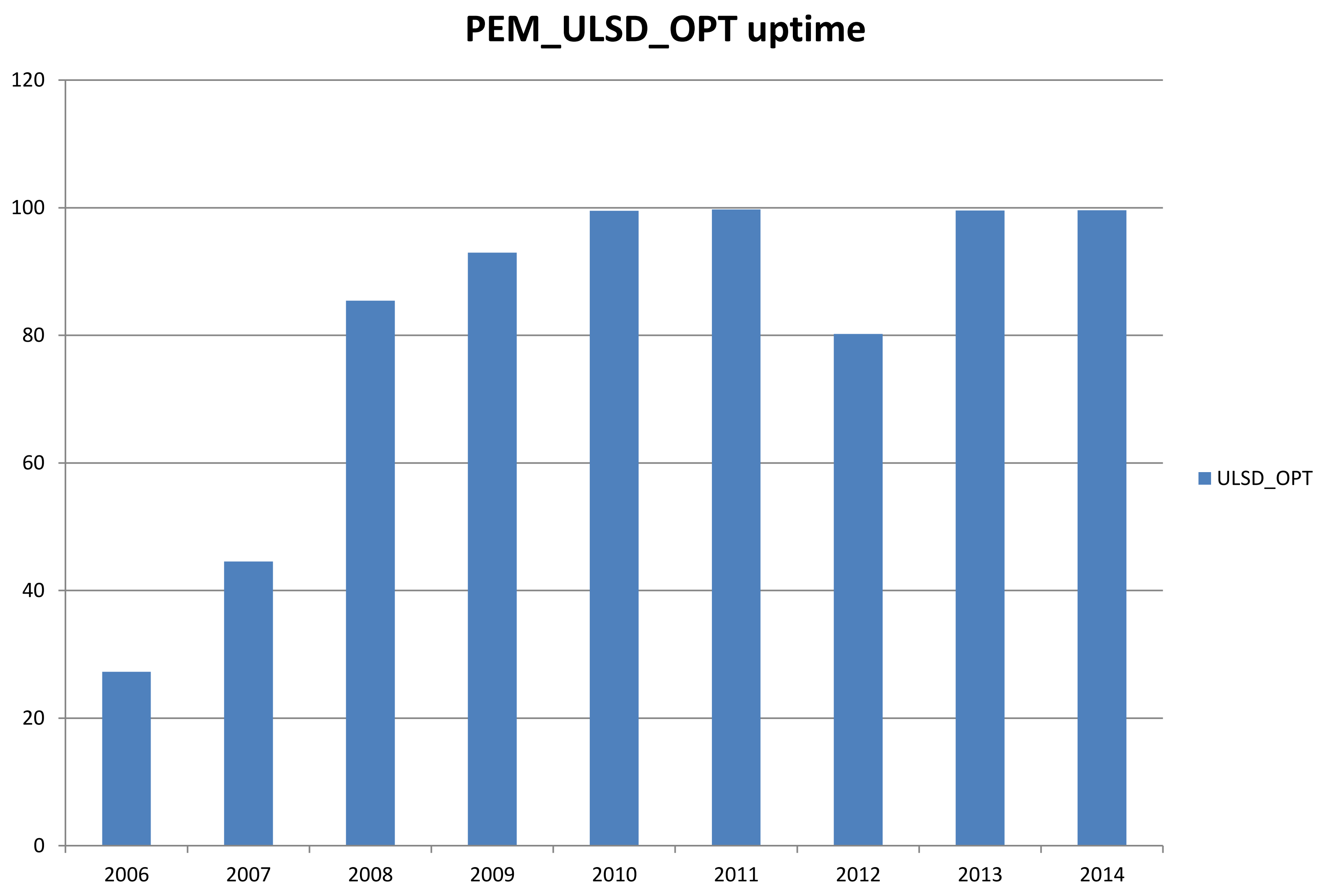
Dependents Filter None Copy

Critical	Combined	Oper Srv	Current	Lower	SS	Upper	Ramp	External	ET Srv	ET

Operations Overview Interface



ULSD Optimization System Uptime From 2006 to 2014



Pembroke CDU Heat Balance Optimization

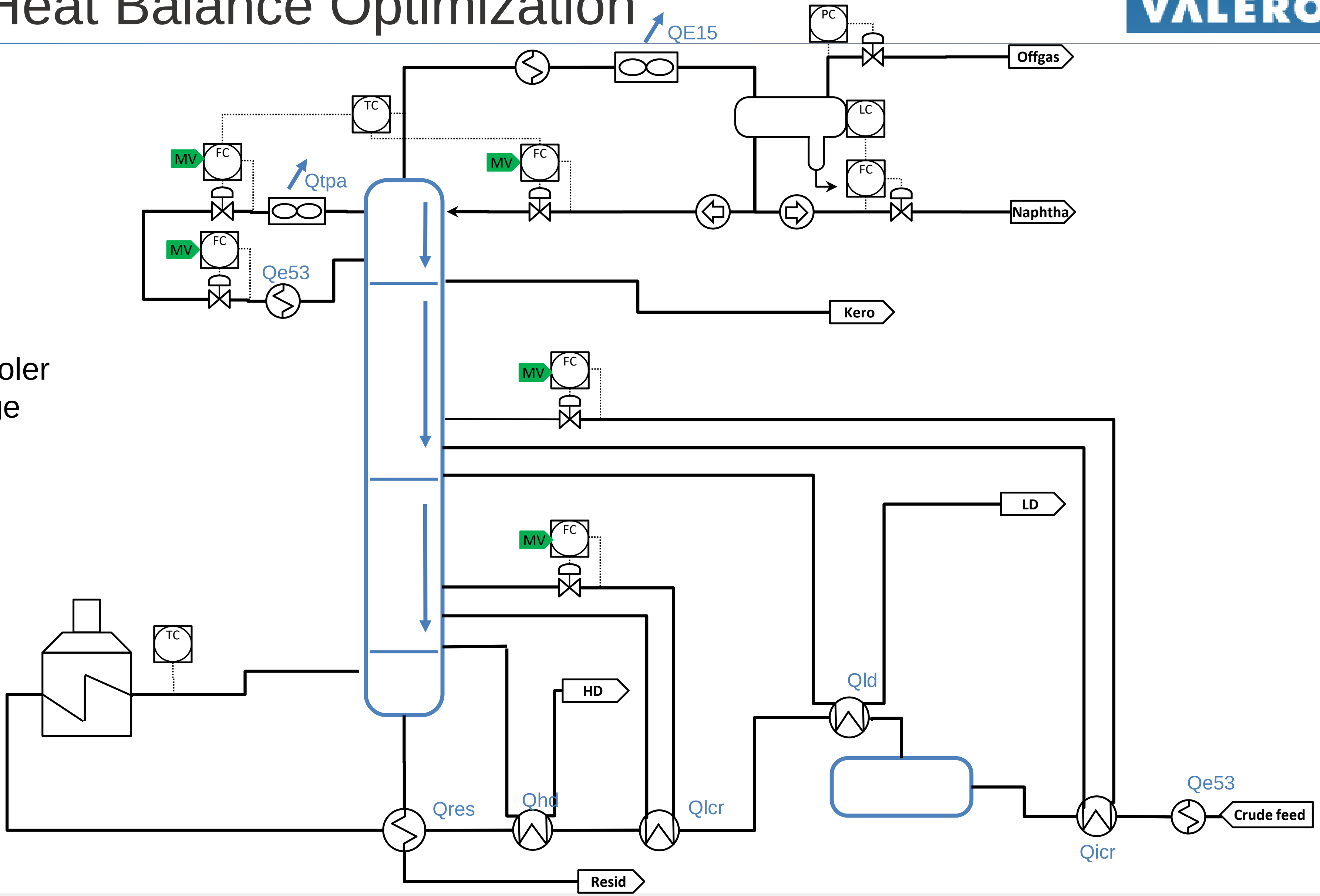
GDOT CDU heat balance Optimization Project Oct 2012

- Refinery focus on heat recovery
- New APC/Opt approach using a GDOT heat balance model
- ULSD Optimiser extended with around 40 new variables for the CDU heat exchanger network
- Modelling Objectives:
  - Maintain and shift duty accurately and fast
  - Deal with nonlinearity's
  - Delta T variations resulting in flow gains to change significantly
  - Long term fouling
- No step testing, all mathematically derived!
- No changes to the DMCplus model and operator interface!

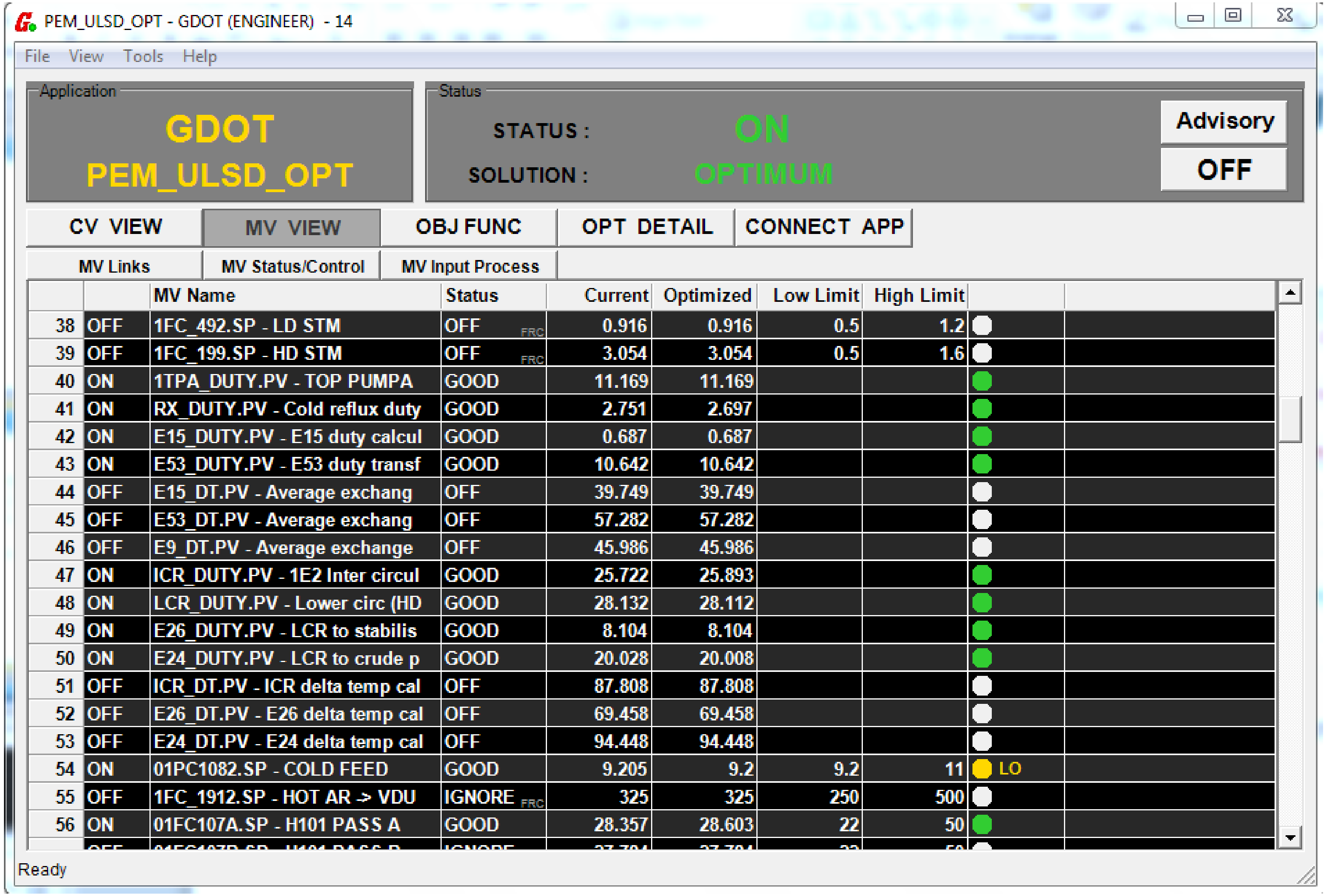
Pembroke CDU Heat Balance Optimization

Application Objectives:

- Maximise heater inlet
- Minimise heat loses in air cooler
- Desalter temperature in range
- Maintain cutpoints
- Bottoms overflash and dP constraints



Heat Balance Variables added to GDOT

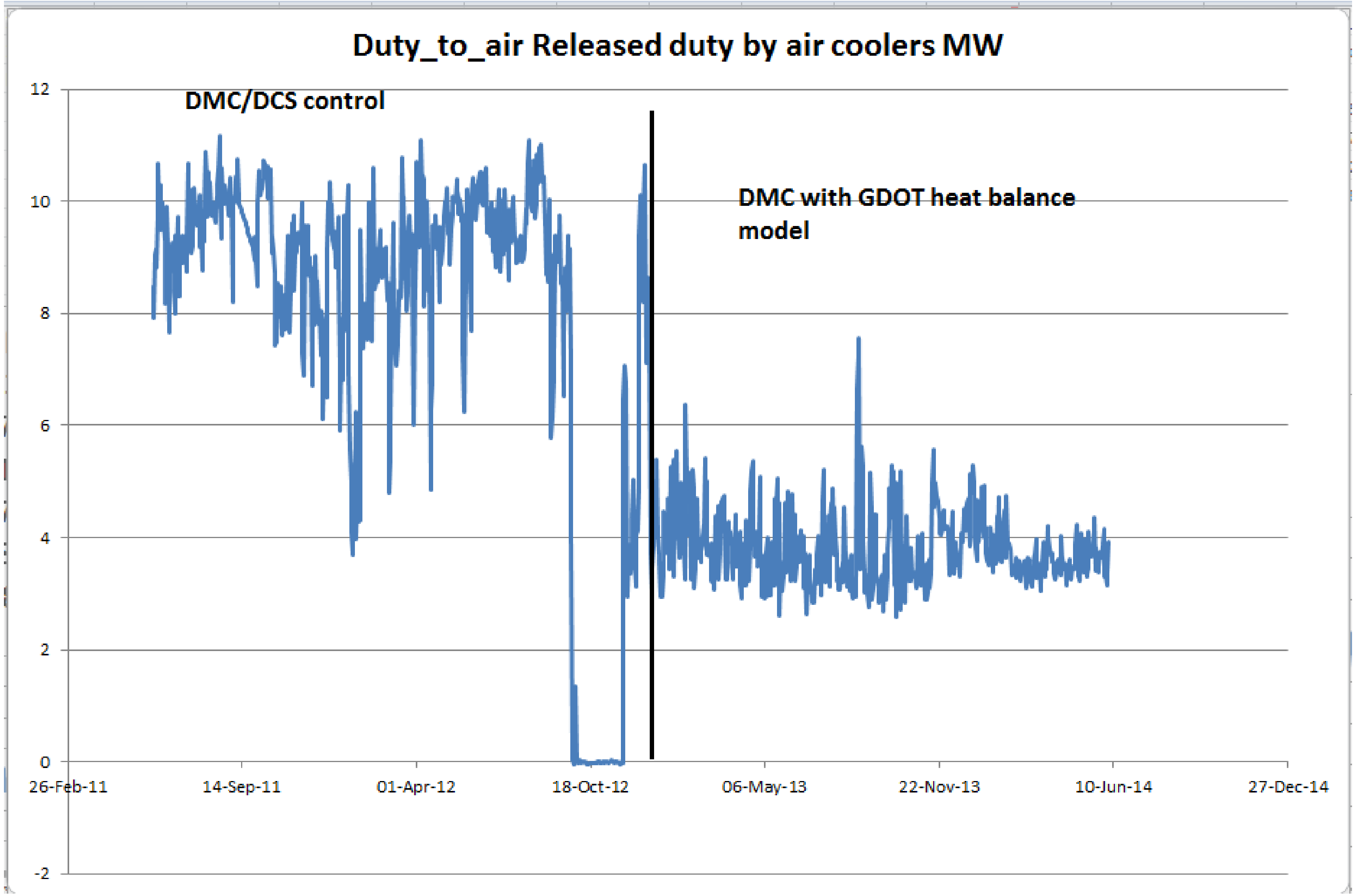


		MV Name	Status	Current	Optimized	Low Limit	High Limit	
38	OFF	1FC_492.SP - LD STM	OFF FRC	0.916	0.916	0.5	1.2	
39	OFF	1FC_199.SP - HD STM	OFF FRC	3.054	3.054	0.5	1.6	
40	ON	1TPA_DUTY.PV - TOP PUMPA	GOOD	11.169	11.169			
41	ON	RX_DUTY.PV - Cold reflux duty	GOOD	2.751	2.697			
42	ON	E15_DUTY.PV - E15 duty calcul	GOOD	0.687	0.687			
43	ON	E53_DUTY.PV - E53 duty transf	GOOD	10.642	10.642			
44	OFF	E15_DT.PV - Average exchang	OFF	39.749	39.749			
45	OFF	E53_DT.PV - Average exchang	OFF	57.282	57.282			
46	OFF	E9_DT.PV - Average exchange	OFF	45.986	45.986			
47	ON	ICR_DUTY.PV - 1E2 Inter circul	GOOD	25.722	25.893			
48	ON	LCR_DUTY.PV - Lower circ (HD	GOOD	28.132	28.112			
49	ON	E26_DUTY.PV - LCR to stabilis	GOOD	8.104	8.104			
50	ON	E24_DUTY.PV - LCR to crude p	GOOD	20.028	20.008			
51	OFF	ICR_DT.PV - ICR delta temp cal	OFF	87.808	87.808			
52	OFF	E26_DT.PV - E26 delta temp cal	OFF	69.458	69.458			
53	OFF	E24_DT.PV - E24 delta temp cal	OFF	94.448	94.448			
54	ON	01PC1082.SP - COLD FEED	GOOD	9.205	9.2	9.2	11	LO
55	OFF	1FC_1912.SP - HOT AR -> VDU	IGNORE FRC	325	325	250	500	
56	ON	01FC107A.SP - H101 PASS A	GOOD	28.357	28.603	22	50	

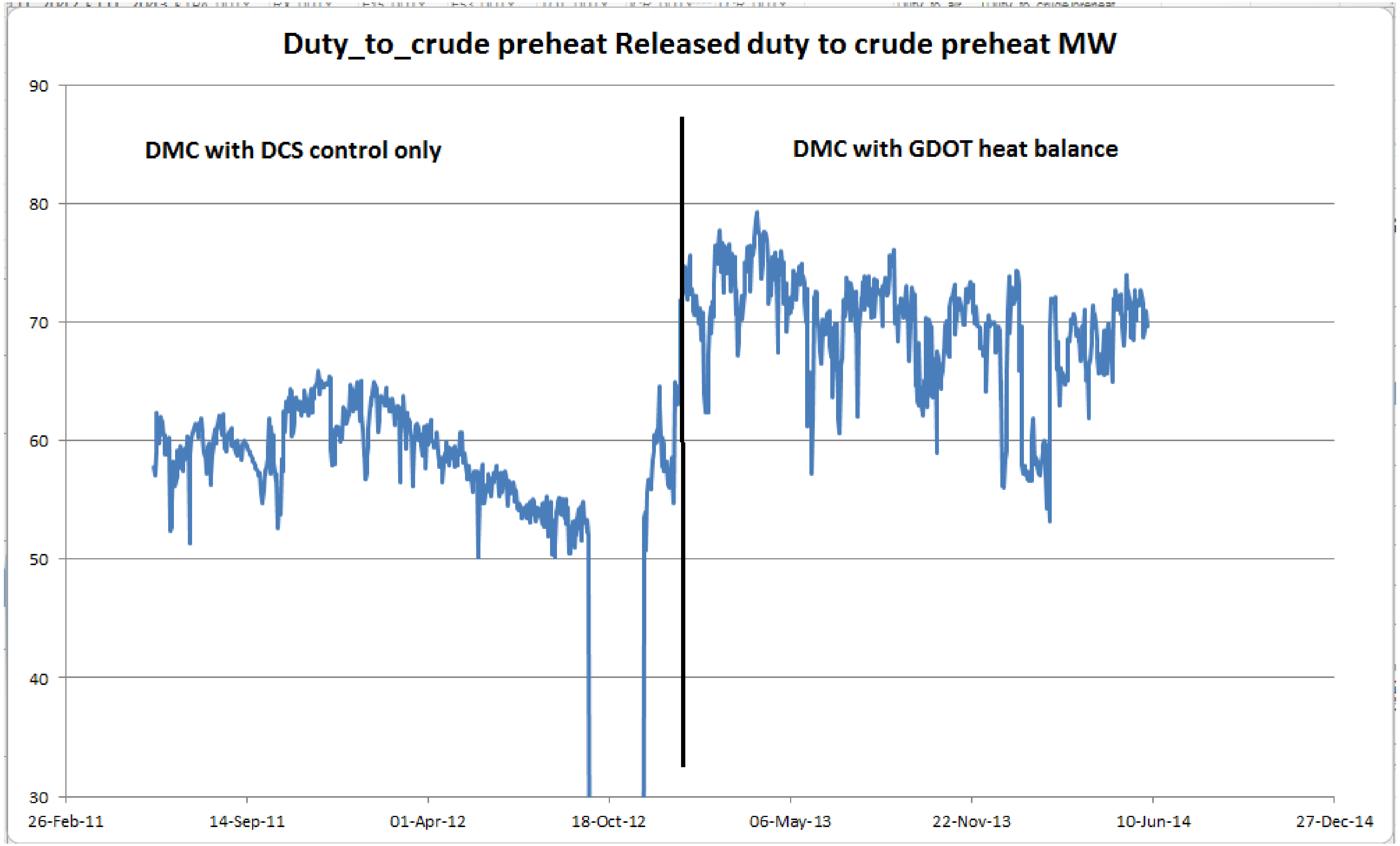
GDOT Model based on simple heat duty transfer equation derivatives:

$$Q=Cp*Flow*DeltaT$$

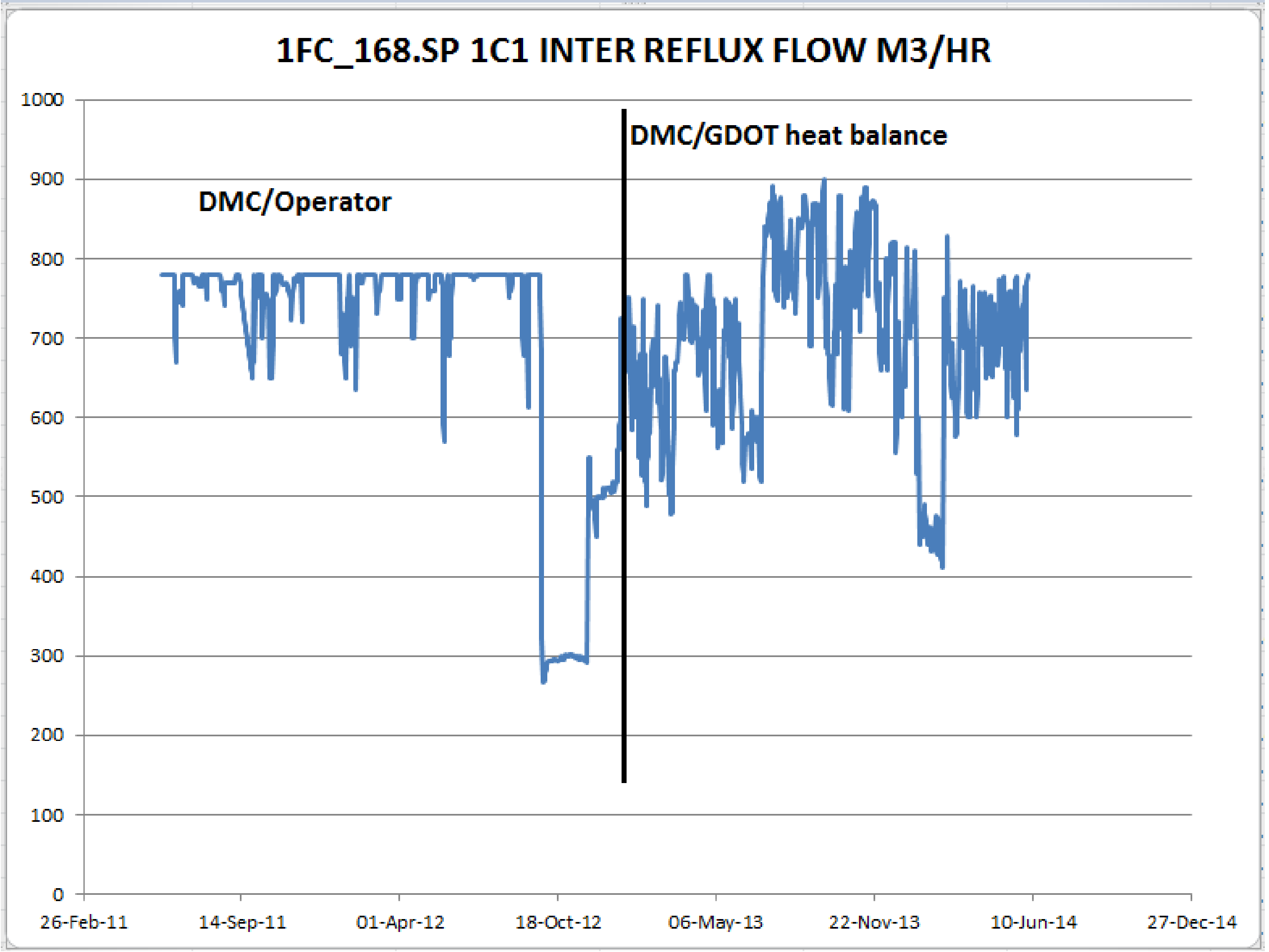
Post Audit Results - Cooling Duty lost to Ambient



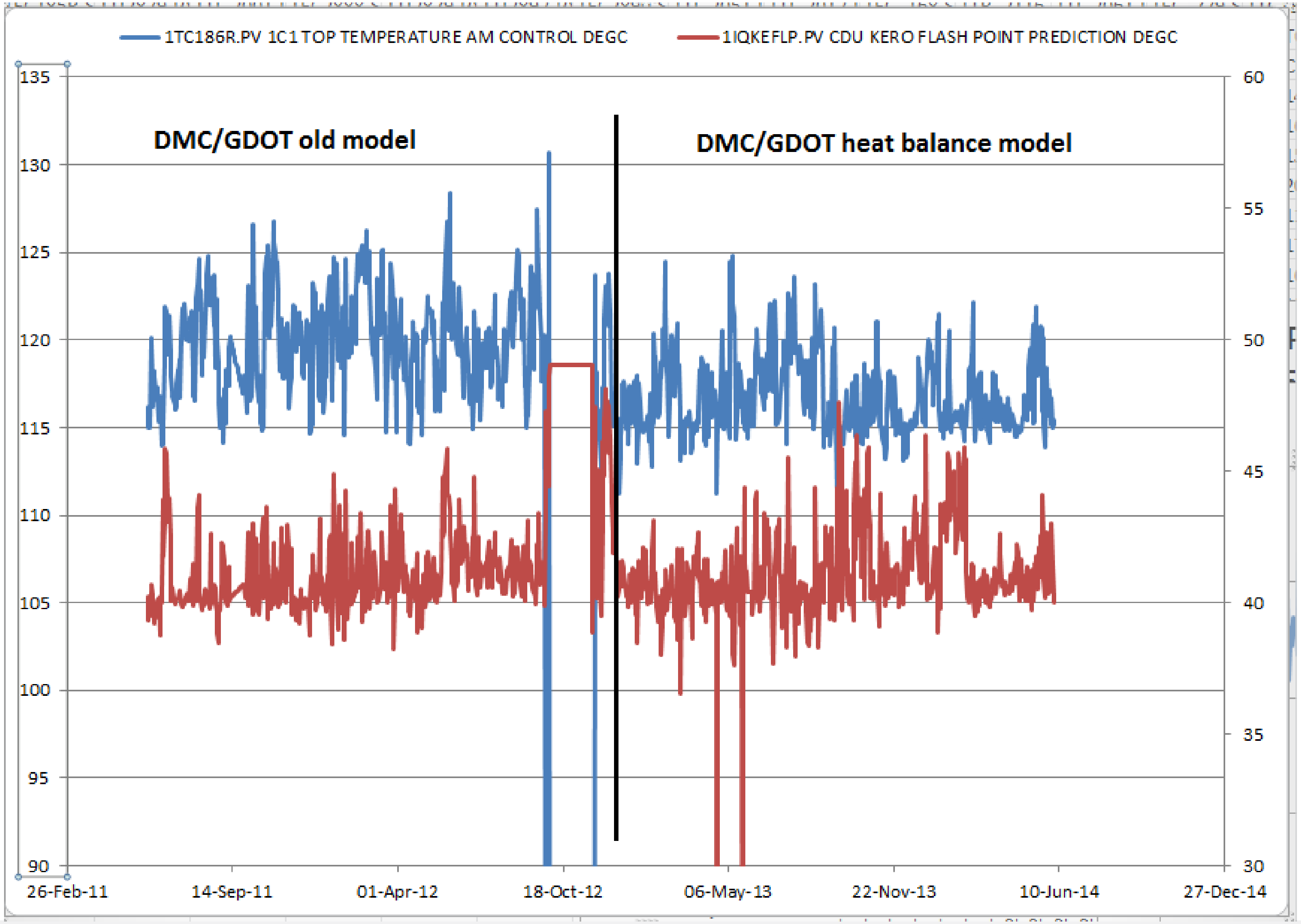
Post Audit Results – Duty to Preheat



Post Audit Results – Inter Reflux Movements



Post Audit Results –Naptha Cutpoint vs Kero Flash



Q&A

Thank You