OPTIMIZE™ | 2019

Sustain Operation Excellence by Upgrading OTS for FCC Unit

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SUSTAIN REFINERY OPERATIONAL EXCELLENCE WITH EDUCATIONAL TOOLS AND PROGRAMS

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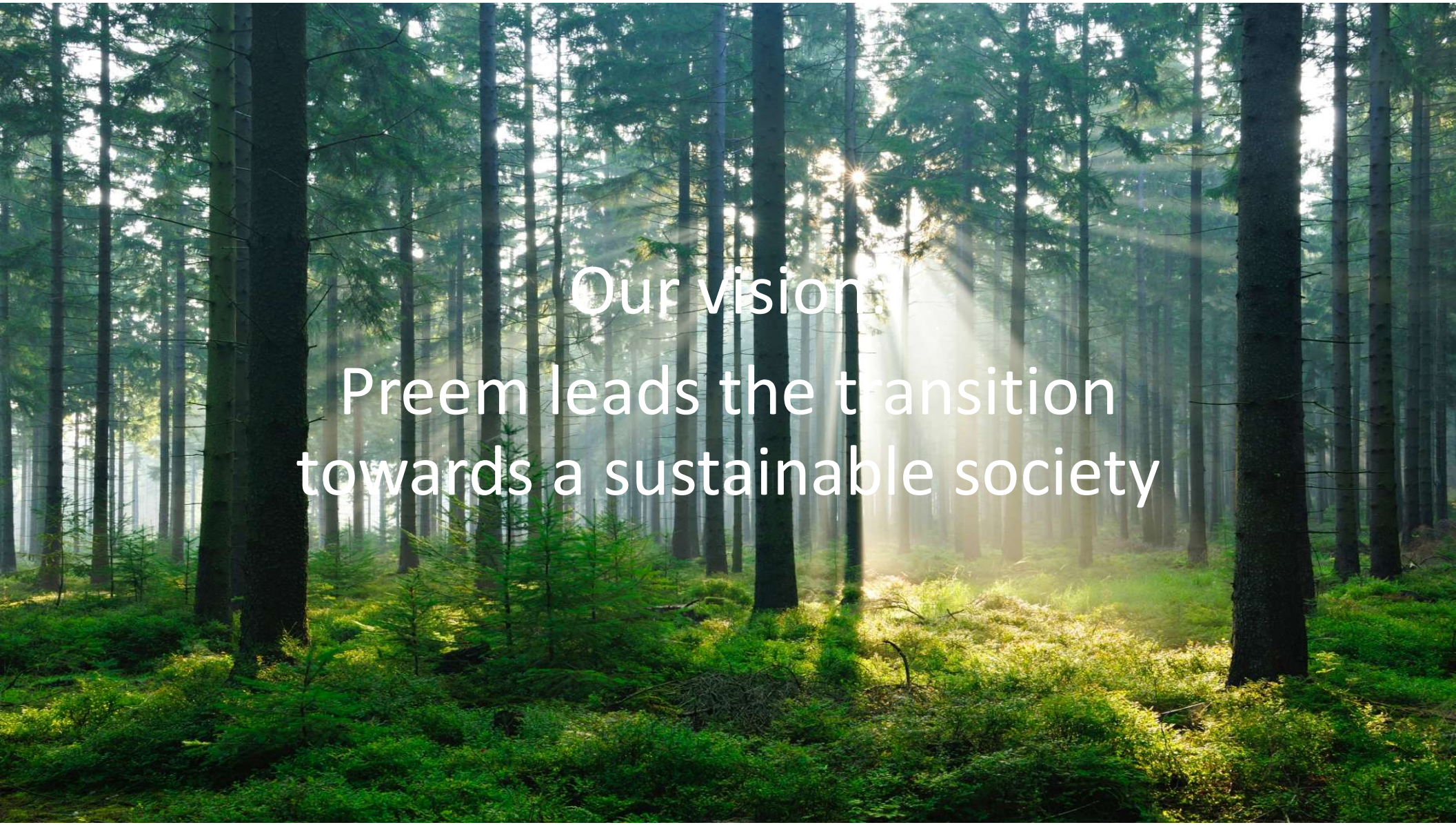
Agenda

- Preem at a glance
- Inprocess at a glance

- Project background
- OTS scope
- OTS virtualization
- OTS management
- Conclusions


Our vision:
Preem leads the transition
towards a sustainable society

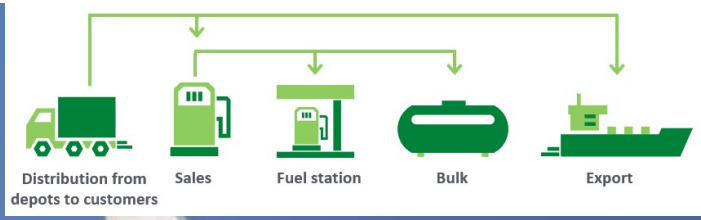
Supply & Trading

Purchasing and trading of raw materials → Planning and optimization of product flow → Raw materials transportation

Refining

Refining
Products
Storage and distribution
Transport to depots or for export

Marketing & Sales



The Lysekil refinery

- Largest refinery in the Nordics
- Capacity:
  11.4 million tons crude oil per year
  (equivalent to 220,000 barrels/day)
- Brofjorden – Sweden's second largest port
- Almost 700 employees

700
employees

The Gothenburg refinery

- Biorefinery – refines crude oil and renewable raw materials
- Capacity:
  6 million tons crude oil per year
  (equivalent to 125,000 barrels/day)
- 280 employees

280
employees

Inprocess at a glance

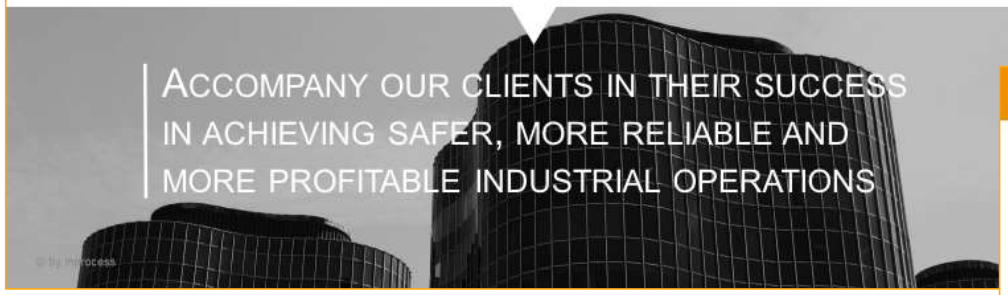
ESTABLISHED **2006** BY FORMER ASPEN EXPERTS

250+ MAN-YEAR **EXPERIENCE**

PROCESS SIMULATION SERVICES

60+ EMPLOYEES

35+ SIMULATION **ENGINEERS**



What we do

Knowledge Transfer / Training Courses

- **Process Simulation Training**: Steady State; Dynamics; O&G; LNG; Refining
- **Technology Courses**: Heat Transfer; Process Control; NG Processing Handling
- **KIP** - Knowledge Improvement Programs, linked to client project
- **Operations Training:** Simulator-based Customized Educational Programs

Engineering Simulation Projects

- **Steady State Simulations**: What-If studies; KPIs; APC gains and inferentials; Optimization; PSV Sizing and Flare Revalidations, Refinery Reactor Modelling
- **Dynamic Process Modelling**: Batch processes; Compressors; Flare Load Estimations; HIPPS; APC; Flow Assurance
- **Software Extensibility:** VB and VC programming of custom objects.

Operator Training Systems

- **Commercial Process Simulation Software:** Aspen HYSYS et al.
- **Emulated or Stimulated types**
- **DCS independent:** several DCS and SIS technologies already implemented
- **Proprietary Instructor Station:** communication hub and instruction environment

Proprietary Applications

- **ITOP:** generic OTS for unit operations fundamentals
- **IIS – Inprocess Instructor Station:** for OTS projects
- **IPSV:** Inprocess Database to manage Pressure Safety Valves information
- **H2 Network Management Tool:** RTO based for H_2 Network
- **PSA Simulator:** dynamic simulator of H2 purifying units
- **IFLOW:** link Dynamic Process Simulators and OLGA®

Project Introduction

- The objective of the project was to add 2 additional refinery units (Hydrogen Production Unit and IsoCracker unit) to the training program to reach a total of 3 units in OTS (Operator Training Simulator) format

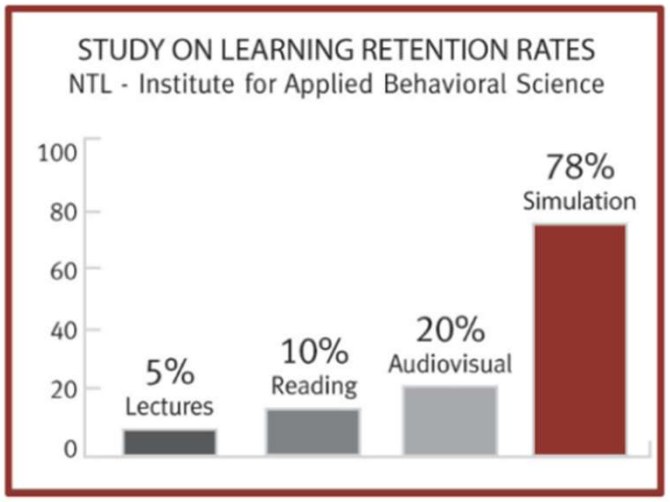
- Additionally, an upgrade of the existing OTS was included, preserving Preem's original investment in the Aspen HYSYS. This speaks about the value of using a standard process simulator, like Aspen HYSYS, for OTS. You are not tight to one DCS vendor, not even to one OTS vendor

- The success of the project led to the integration of a fourth refinery unit in the same structure

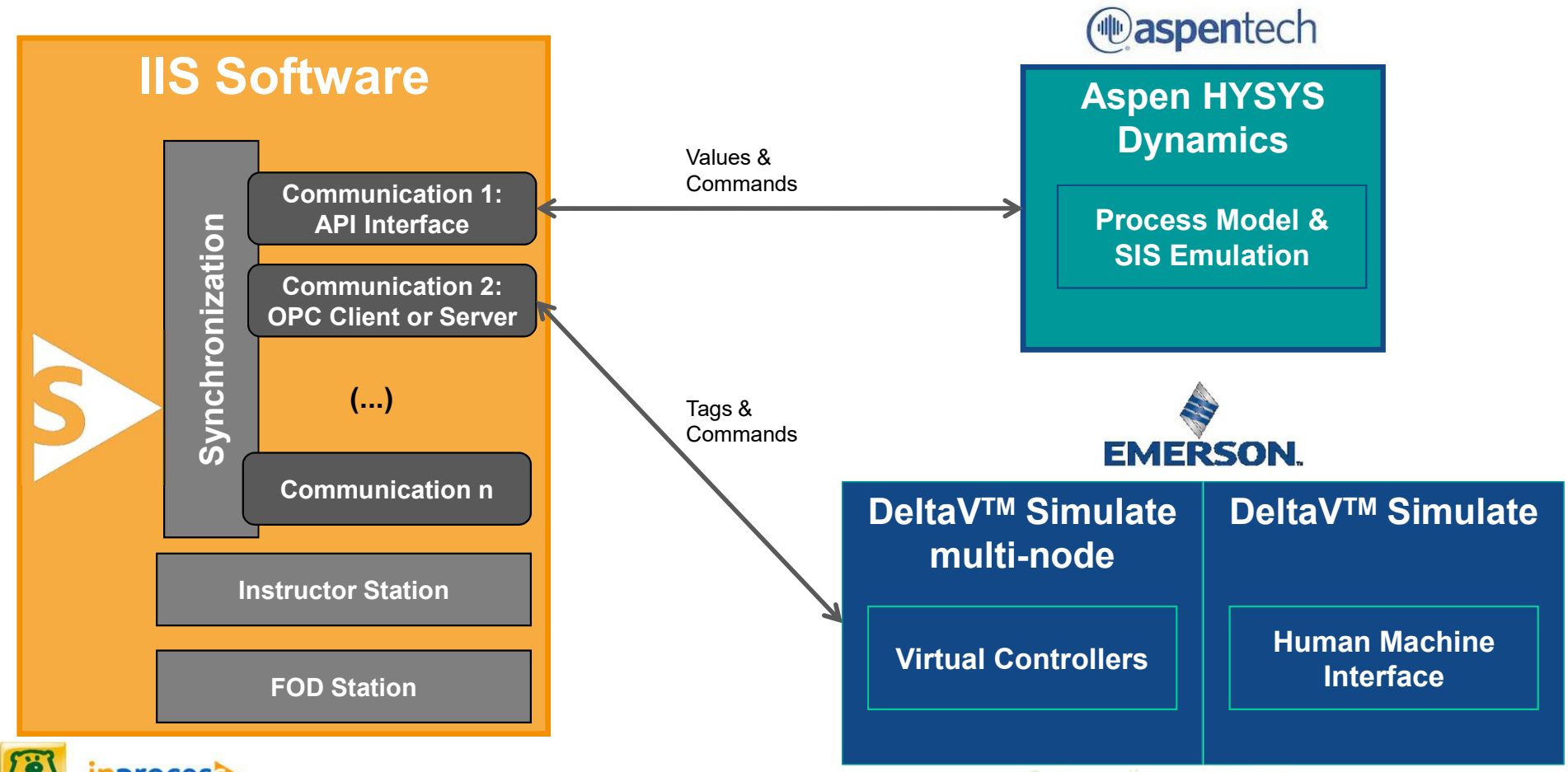
Driving Forces for the Project

- Driving forces for already working units (ICR, HPU, FCC)
  - Demographics (workforce retiring; millennials joining; etc.)
  - Efficient training (“Involve me and I will remember”…)
  - Confident operators (well trained staff is (and feels) safer)

- Additional driving force for the new unit (VDU)
  - Support during Commissioning stage

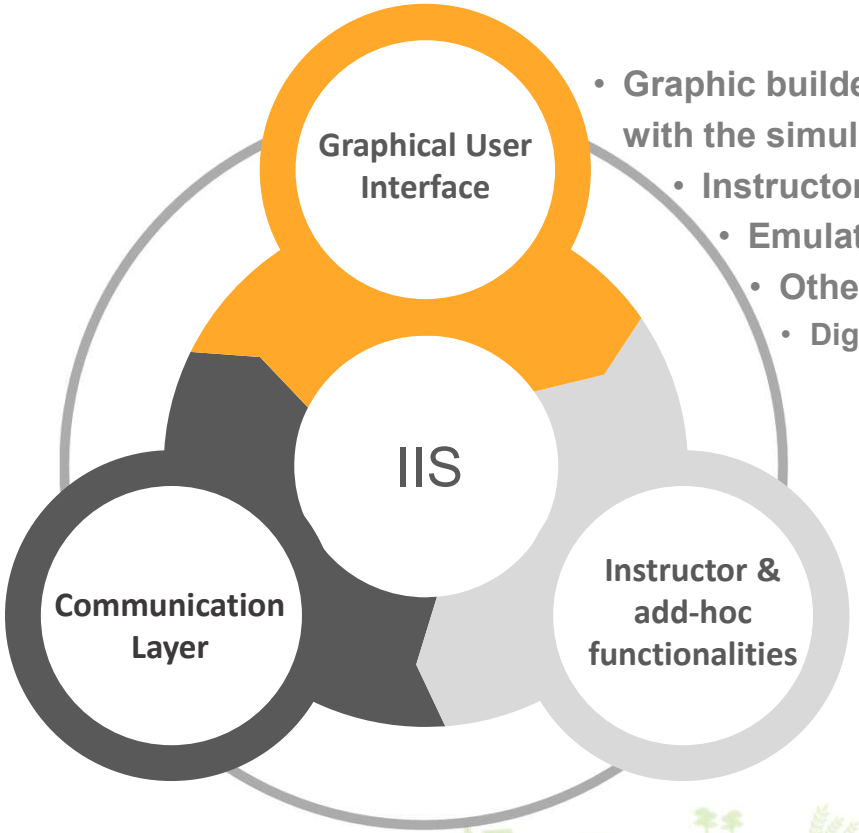


Software Architecture for a Direct-Connect OTS



IIS: Inprocess Instructor Station

- Proprietary software created from scratch to be flexible for multiple applications
- First mission: create OTS framework



- Graphic builder that allows user interaction with the simulation model:
  - Instructor Station
    - Emulated OTS
    - Other dedicated applications:
      - Digital Twin Plant, Bad Actor Detector, etc.

- Handles multiplatform communications

- Accessible from the Instructor Station of and OTS
- Allows to manage training sessions

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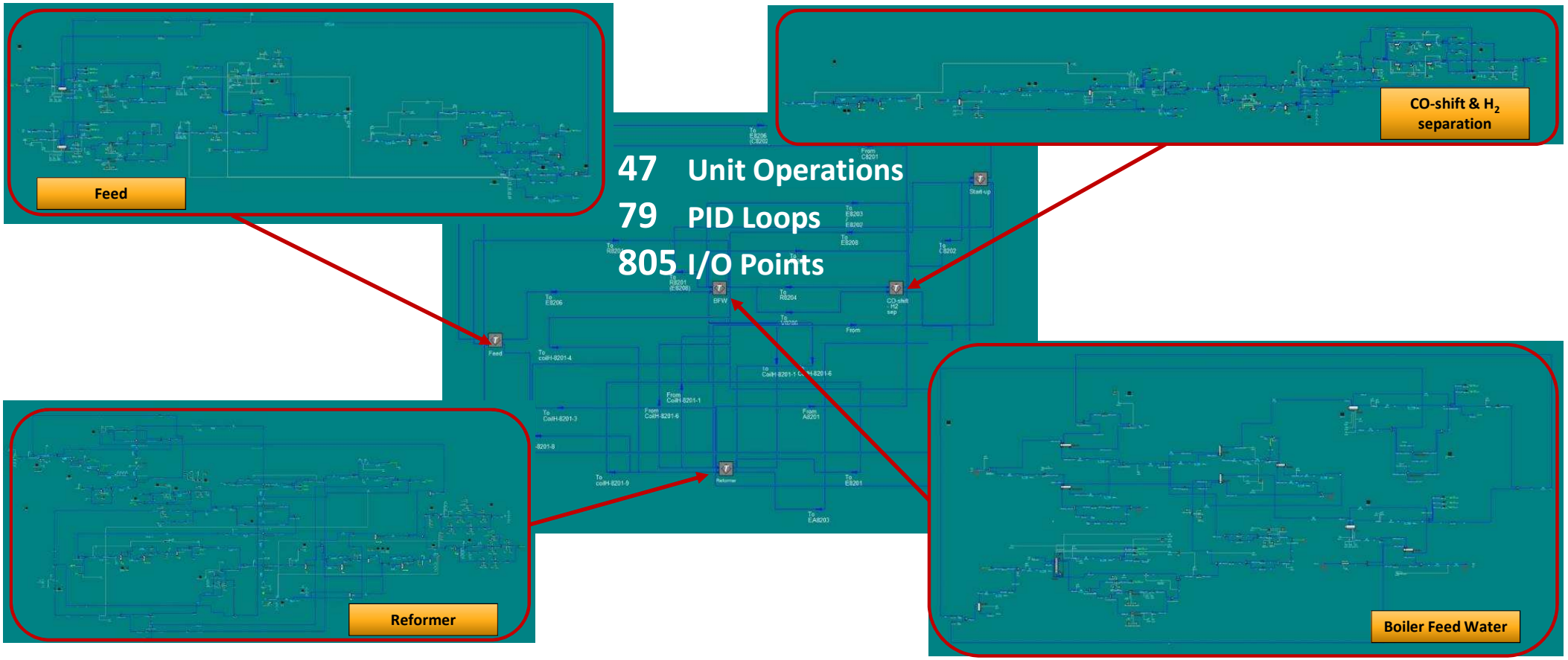
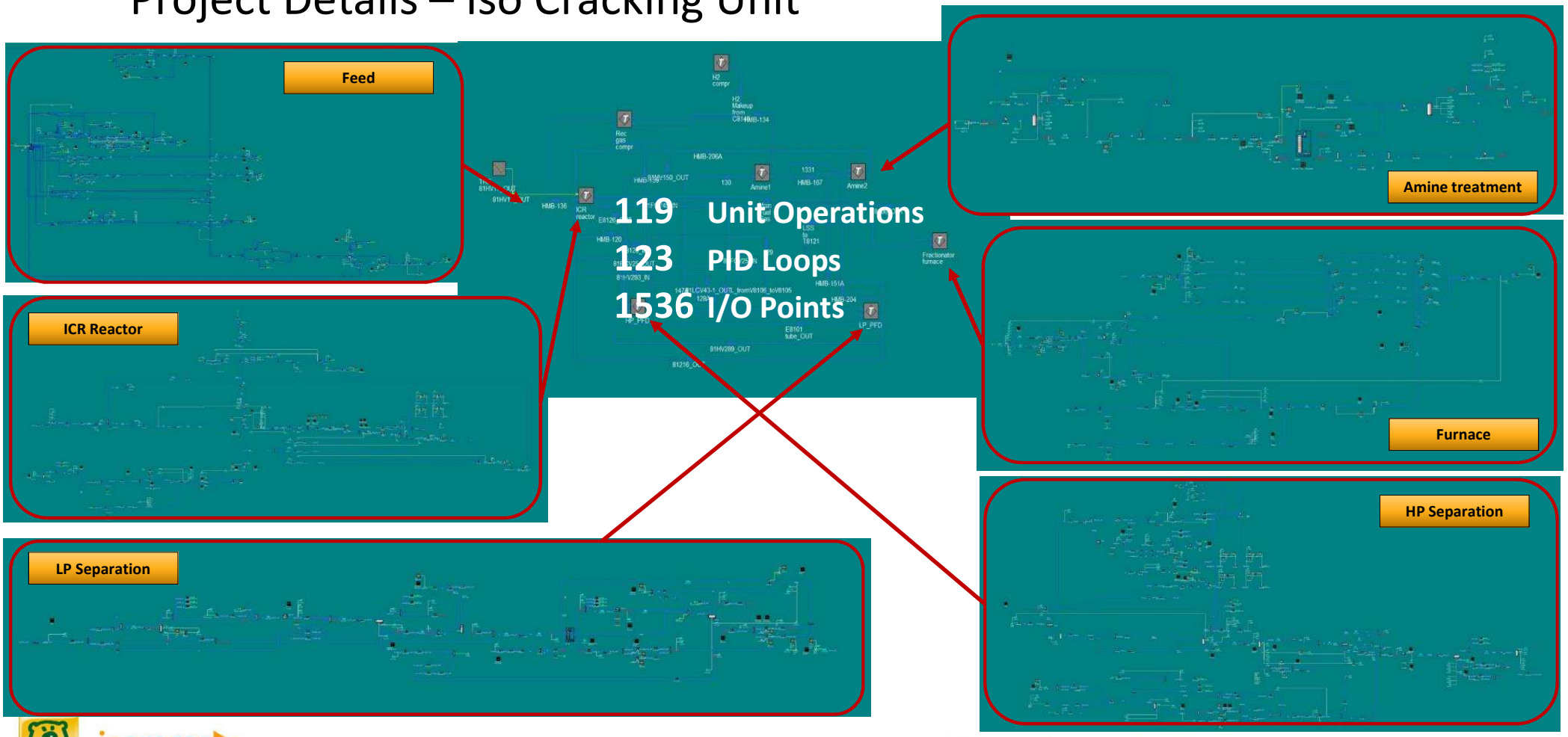
Project Details – Hydrogen Production Unit



Project Details – Iso Cracking Unit



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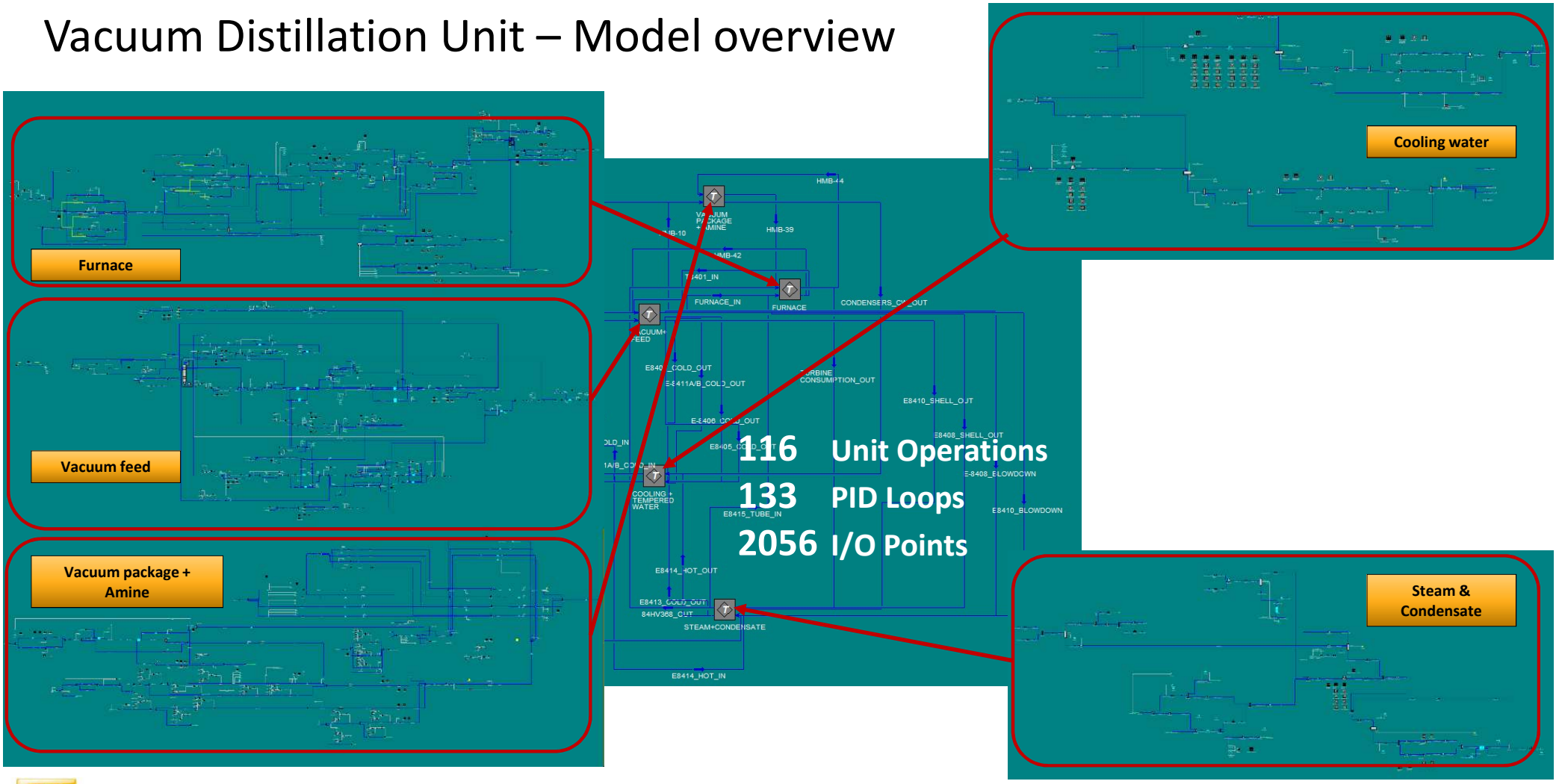
Vacuum Distillation Unit – Model overview



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Vacuum Distillation Unit - Scenarios

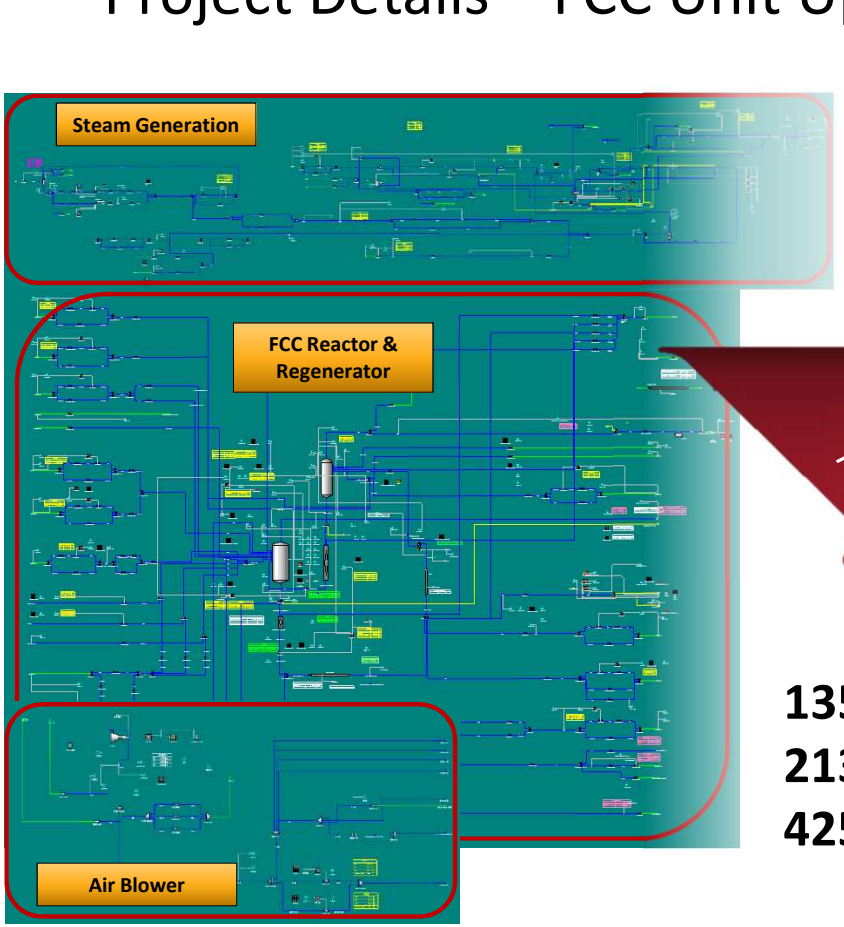
#	Scenarios	Description
1	Planned unit shutdown	NSD of the VDU unit, running at stable condition, as defined in HMB and control narratives.
2	Emergency shutdown	ESD of the VDU unit, running at stable condition, as defined in HMB and control narratives.
3	Unit Start-up / Cold start	CSU after a long shutdown
4	Warm start-up	WSU after a short shutdown
5	Feedstock changes	Change in the percentage of the hot/cold feedstock depending on the oil quality

#	Malfunctions	Unit / Equipment	Description
1	Heat Exchangers	Performance Deterioration	When the 'Performance Deterioration' malfunction becomes active, the overall heat transfer coefficient U deteriorates to the specified 'Failed Performance'
		Shell Fouling	'Shell Fouling' malfunction models fouling on the shell. When this malfunction becomes active the shell side heat transfer coefficient ( ) decreases and the shell side pressure drop increases.
		Tube Fouling	'Tube Fouling' malfunction models fouling on the Tube. When this malfunction becomes active the tube side heat transfer coefficient (ht) decreases and the tube side pressure drop increases.
		Tube Leakage	Tube Leakage k is used in the tube leakage flow pressure relationship which determines the lumped leakage flow across the shell and tube when the Tube Leakage malfunction is enabled.
2	Valves	Actuator Failure	Actuator Failure malfunction models actuator failure to a selected failed position.
		Positioner Offset	Positioner Offset malfunction models offset in the valve position due to inaccurate actuator calibration. The specified offset (percentage) adds to the Actuator offset on the Actuator page of the Dynamic tab of the valve.
		Leakage	Leakage malfunction models leakage (percentage) in the valve. The leakage by passes the valve operating characteristics - linear, quick opening, equal percentage etc. For example if a valve is closed and 10% leakage is specified, then flow across the valve will be same if it were a linear or equal percentage valve.
		Plugging Factor	Plugging Factor malfunction models plugging (percentage) in the valve which restricts flow through the valve by reducing the Cv. The plugging by passes the valve operating characteristics - linear, quick opening, equal percentage etc.
		Stem Inertia	Stem Inertia malfunction models the actuator inertia.
		Sticky Stem	Sticky stem malfunction models the valve stickiness. The specified time constant adds to the valve stickiness time constant on the Actuator page of the Dynamic tab of the valve.
		Positioner Hunting	Positioner Hunting malfunction models damping in the actuator second order response.
3	Pumps	Total Failure	The Total Failure setting is used to simulate a mechanical pump failure. In the plant environment, this failure may result from the following conditions: bearing failure; gear seizure; coupling/impeller fragmentation.
		Pump Overheating	In the plant environment, flows below minimum safe settings will cause pump overheating and eventually total pump failure. The Pump Overheating setting is used to simulate this form of pump malfunction.
		Performance Deterioration	The pump performance deterioration setting is used to simulate plant conditions involving performance loss due to fouling or suction loss.
4	Control Ops	Drift	When the 'Drift' malfunction becomes active, the transmitter output drifts to the configured 'Fail Offset'. PV' = PV + Fail Offset
		Fail Status	Fail Status Malfunction When the 'Fail Status' malfunction becomes active, the transmitter outputs a 'Fail Value'. PV' = Fail Value
		Noise	When 'Noise' malfunction fails, noise is added to the transmitter output. The amount of noise added to the measured value is generated as a 'Random Number' in the range +/- (Amplitude/2). PV' = PV + 1/2 Amplitude x Random Number

Project Details – FCC Unit Upgrading

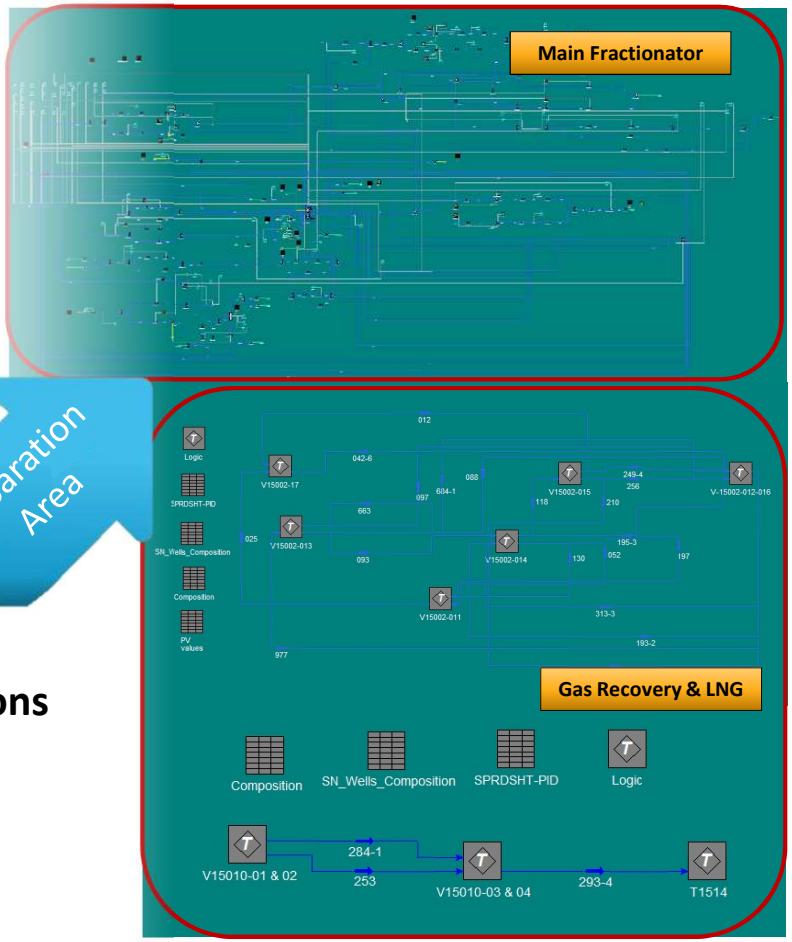
- Technology Migration
  - Change of the OTS platform from SimSci Sim4me to Inprocess Instructor Station. Aspen HYSYS original model was reused
- ESD Logic Implementation
  - Replication of PLC and ESD logics in Aspen HYSYS
- HMI for Instructor Station
  - High fidelity DCS HMI replication for OTS Instructor
- Scenario Recovery
  - Scenarios of Start-Up and Shut-Down for the new Platform

Project Details – FCC Unit Upgrading



Reaction Area

Separation Area



135 **Unit Operations**

213 **PID Loops**

4250 **I/O Points**

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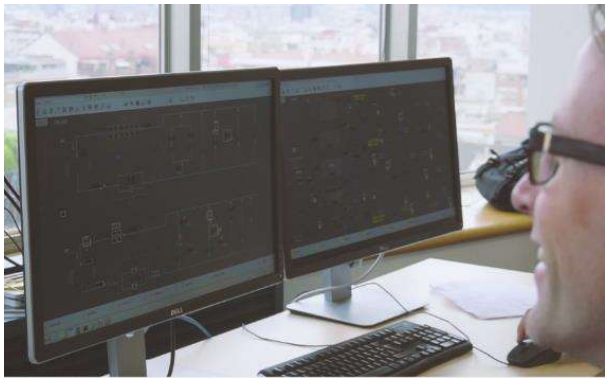
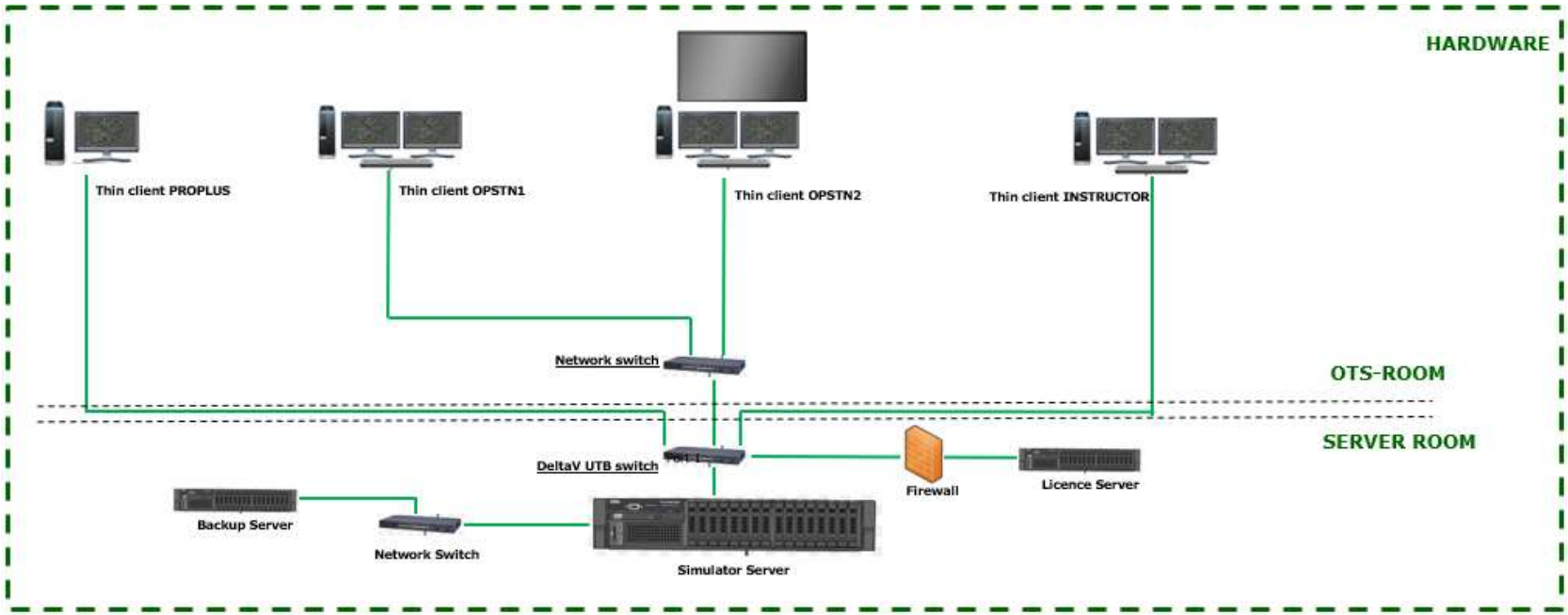
Project Details – Virtualized OTS

- The solution adopted to integrate the existing OTS with the new units being developed in the same training room was a virtualized architecture in which the different groups of Virtual Machines needed for each of the units can be launched on demand.

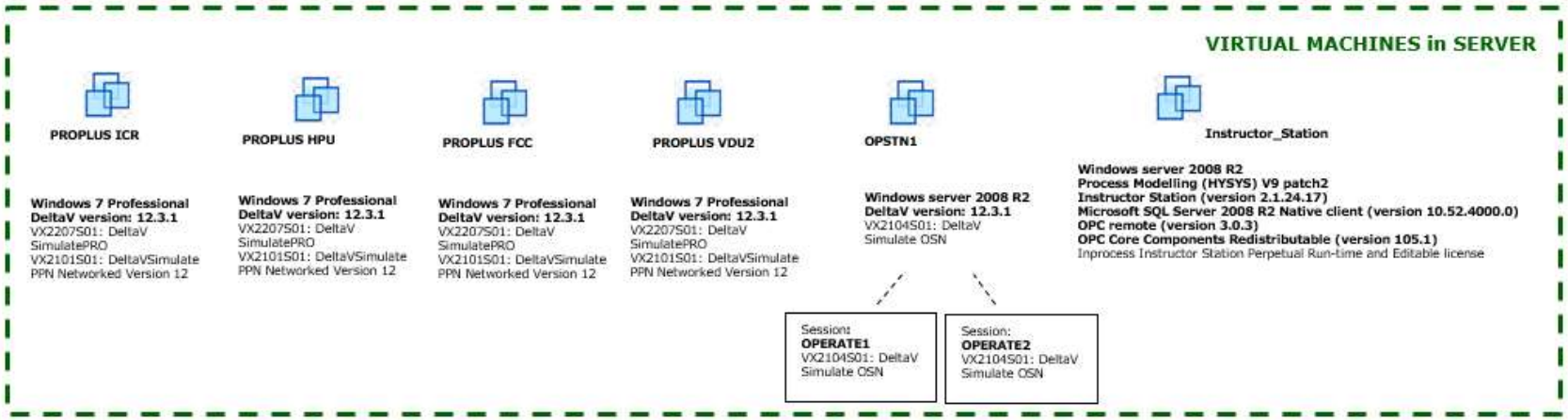
- The OTS infrastructure was built in a separate subnet

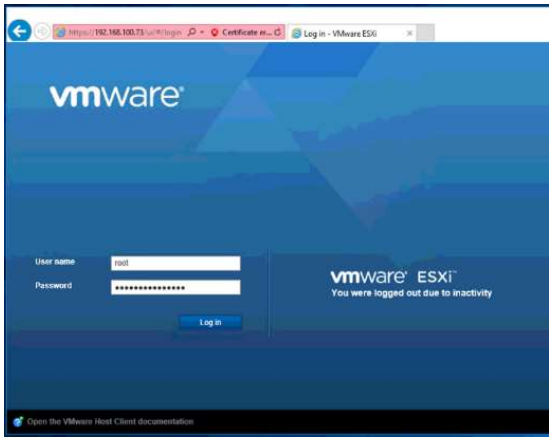


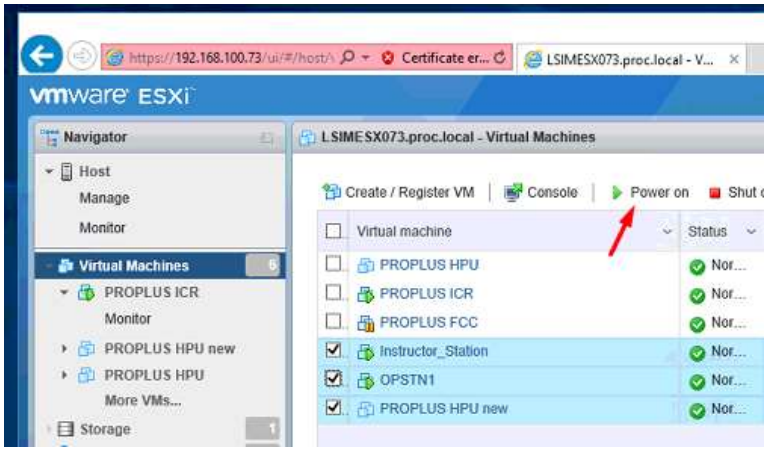
Project Details – Virtualized OTS



Project Details – Virtualized OTS







Project Details – Virtualized OTS

- Virtualization allowed for:
  - Shared training room and resources for all OTS
  - A fast and easy switch between training sessions of different units (<5 min)
  - Saving training status between different training crews, and recovering later on
  - Scalability, allowing for increasing number of units, Operator Stations, or changing screens configuration.
  - Virtualization environment, backup strategies… defined by customer IT – happy!
- Successful results led to the deployment of another OTS for a 4th unit in the same infrastructure

Project Details – Using Aspen HYSYS® Dynamics

- **Flexible:** robust and reliable dynamic process simulator for the oil refinery markets
- **Scalable:** It was possible to upgrade the existing model
- **Standard:** It was possible to reuse the original model developed by other vendor
- **Fast mathematical integrator:** It was possible to simulate, with high enough rigor for operator training purposes, highly complex refinery units and plants at real time or higher

Training program

Organization of training

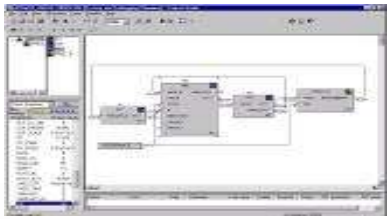
- 10 experienced operators working as instructors.
- Mandatory 16 hours a year of OTS training.
- 70-75 CCH operators result in 60-80 sessions yearly.

Availability

- Next to CCH open for everyone

Keep it alive

Control strategy updates



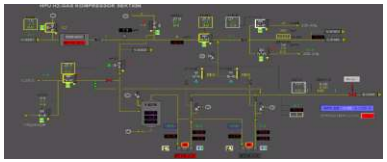
Support

Supportärenden

Nytt objekt eller redigera denna lista

Ärende-ID	Rubrik	Tilldelad	Ärendestatus	Prioritet	Förfallodatum
2	ICR pilotfel	...	Aktiv	(2) Normal	
3	GOP-simulatorn	...	Aktiv	(2) Normal	

Graphic updates



FCC, HPU, ICR, VDU2

Preem Process Control engineer → Inprocess (service agreement)

New projects

Date: Last Week		
G[redacted]	PI01434 Uppdatera och modifie...	fr 2018-09-21 08:59
H[redacted]	Konfigureringsunderlag – Konf...	on 2018-09-19 11:03
E[redacted]	SV: GI00622: BB2 mek	on 2018-09-19 08:28
L[redacted]an	R19-Byggbeskrivning – BB2 – M...	on 2018-09-19 07:58
W[redacted]an	GI00622: BB2 mek	må 2018-09-17 10:51

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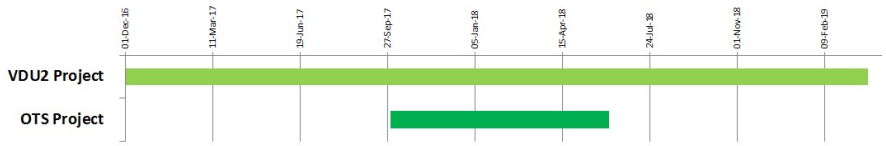
Project conclusion

- Requirements for a succesful OTS program
  - Quick support
  - Easy to use and maintain
  - Commitment

- Support in Vacuum distillation unit, april 2019
  - Validation of instructions
  - Validation of graphics
  - Prepared operators



"A really good way to improve the understanding of a new unit. The best tool we ever had."

–Plant operator

"I got really suprised of the behavior of the ejector recycle valve and capacity of the liquid ring pumps – this cannot be true I thought! Now, after startup I know it is"

–Startup up engineer


Thank you!
preem