YPF

inprocess

simulation · knowledge · profit

FCC Unit's Operator Training System (OTS) built using Aspen HYSYS helps refinery in its path to operational excellence

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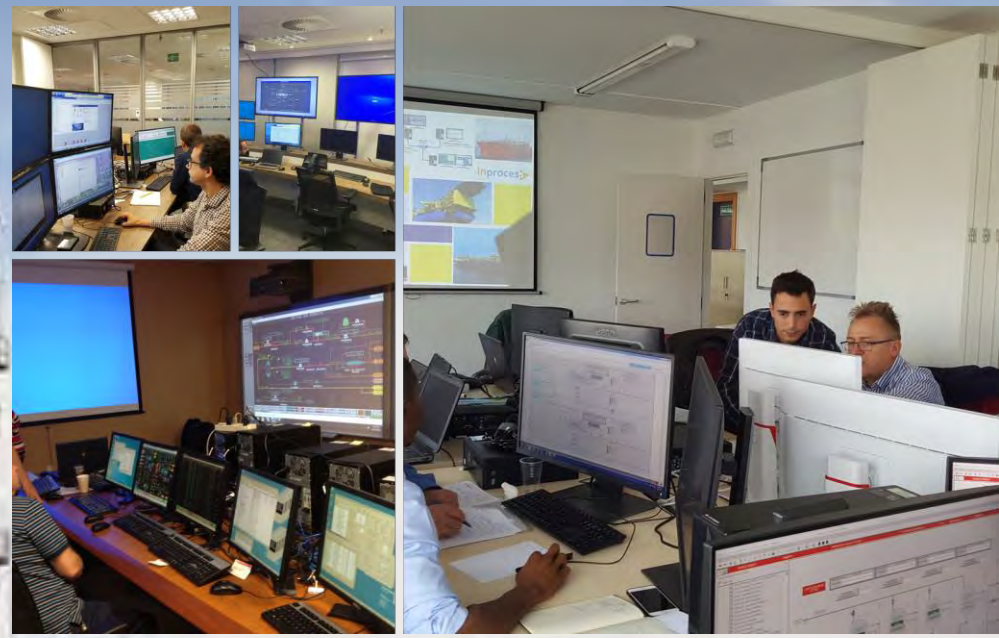
May 2021

Summary

- Introduction
- Process Overview
- OTS Solution
  - First Principle Model
  - OTS Architecture
- Operators Training
  - Procedures Verification
  - OTS Supporting Operation
  - Training Program
- Benefits



Inprocess in brief

independent from any ICSS or simulation software provider

our **core business** is Process Simulation

keen to **share its knowledge** with clients

2006

founded in Barcelona by domain experts

48 countries

worldwide presence

50+

simulation engineers

250+

years experience

400+

executed projects

320+

training courses

Mission: accompany our clients in their success in achieving safer, greener, more reliable and more profitable industrial operations

Lifecycle Modelling and OTS projects

Simulation Lifecycle	Feasibility Studies	Dynamic Simulation Studies (DSS) Validation of Control	Operational Procedures Early OTS	DCS check-out	OTS Operator Training System	Plant start-up support	Operations & Maintenance support with the Digital Twin
Plant Lifecycle	Conceptual Design, Basic Engineering (FEED) and Detailed Engineering (EPC)					Commissioning & start-up	Operations & Maintenance

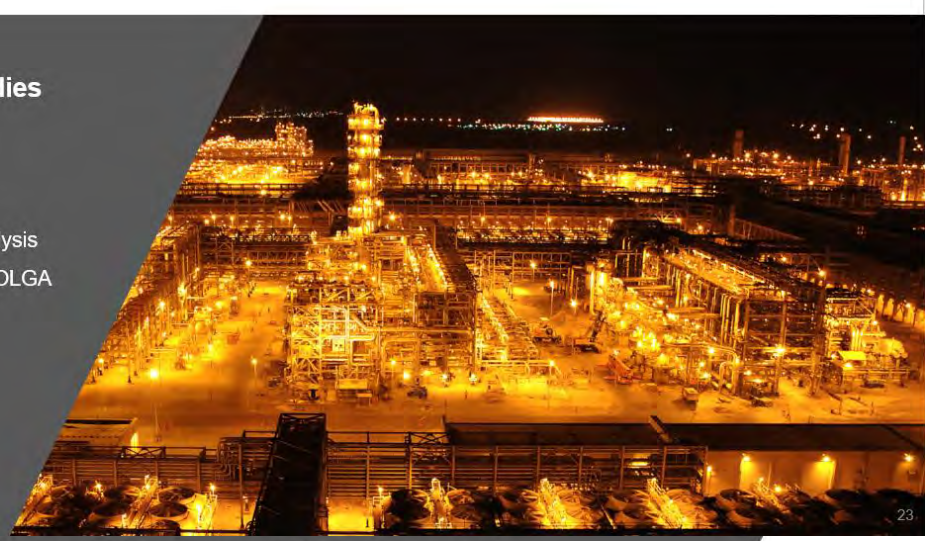
Lifecycle Modelling

- Feasibility studies. Selection of alternatives
- Dynamic simulation studies before plant construction
- Validation of control philosophy
- Operational procedures development/enhancement
- Process trainer - Emulated OTS - Early OTS
- DCS check-out
- OTS for operators' initial and continuous training
- Support during commissioning and start-up
- Operations & Maintenance support (Digital Twin)

Process Simulation projects

Process Simulation Studies

- Steady State Analysis
- Dynamic Simulation Studies
- Integrated Flare Systems Analysis
- Flow Assurance Studies with OLGA
- Utilities Network Models
- On-line models
- Operations Staff Training
- O&M Support



Training & Knowledge Transfer

Training / Knowledge Transfer

- Process simulation courses
- Technology courses
- Knowledge Improvement Program – KIP
- Training for plant operators / technicians

Applications & Software Development

Applications / Software Development

- **IIS**: Inprocess Infrastructure Suite
- **IPSV**: PSVs database
- **ITOP**: Inprocess Training for OPerators
- **ICOM**: Inprocess Competence Management System
- **IFLOW**: to link process simulators with OLGA®
- **IPSA**: Pressure Swing Adsorption simulator
- **OTS Web Access:** e-learning options
- Extensions for process simulators

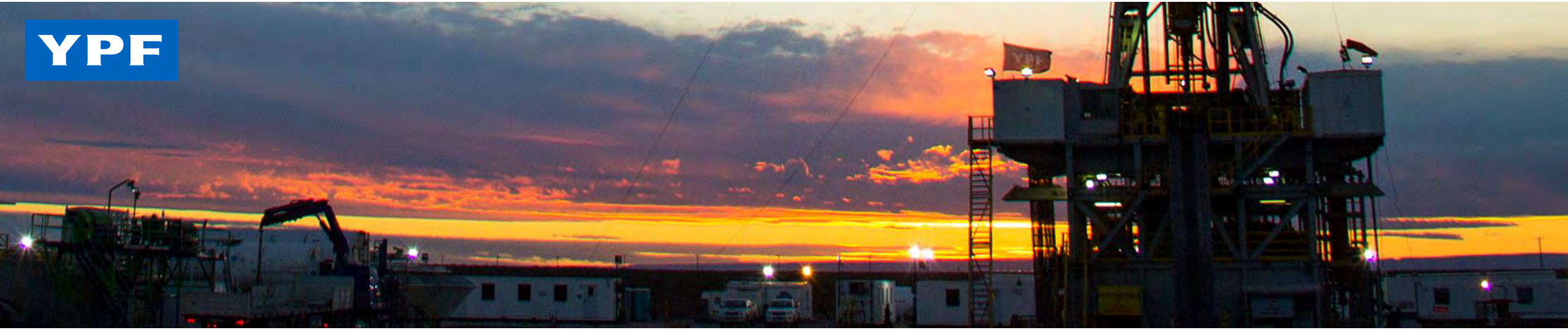
YPF

YPF works to generate efficient and reliable energy by developing and producing oil and gas from conventional, unconventional and renewable sources such as wind, solar, geothermal and hydropower.

YPF produce fuels, petrochemicals and lubricants at three industrial complexes

- **La Plata**
- **Luján de Cuyo**
- **Plaza Huincul**

Strong business presence in the retail, agriculture, industrial and LPG market sectors.



FCC Process Overview

YPF FCC Process

The FCC feed is a low-value product

The load is mainly made up of heavy gas oil (GOP) from topping, vacuum and cokes.

The FCC product

- High level of conversion to products of high demand and commercial value.
- This naphtha contributes the highest number of octanes to the naphtha pool.
- Higher LPG production.

YPF

OPERATIONAL EXCELLENCE POLICY

We want to be a modern energy company, committed to our community, employees, customers, suppliers and shareholders. For this reason, at YPF we have adopted operational excellence as an essential value to:

. Ensure people's health and safety
. Preserve the environment.
. Warrant the reliability and integrity of our assets and operations.
. Boost resource use efficiency, maximizing the company's worth.
. Consistently meet the needs of both internal and external customers.

And we are committed to:

- Effectively planning our activities based on clear, measurable and challenging management objectives aligned within our corporate strategy, integrate operating and support processes, allocating appropriate resources and ensuring optimum working conditions.
- Guaranteeing comprehensive management of the risks associated with our assets, processes, businesses and projects, integrating, at all stages of their life cycle, criteria and preventive actions for environmental protection, safety, health, quality, integrity and reliability.
- Operating in strict compliance with policies, rules and procedures, within Argentina's current legal and regulatory framework, acting proactively and adopting reference standards in the absence of legislation.
- Making decisions taking into account stakeholder requirements, and fulfilling any and all agreements made.
- Designing and executing efficient processes and rules to produce results of value for the organization in a safe, healthy way and at the lowest cost, maximizing stakeholder benefits.
- Taking care of the assets that YPF has assigned to us for process, business and projects development, adopting criteria and preventive actions for asset protection and integrity.
- Developing and maintaining emergency preparedness plans for responding to incidents or contingencies that may affect the safety of people and the environment, the reliability and integrity of our facilities and processes, and the fulfillment of stakeholder commitments.
- Ensuring the reliability, transparency and protection of the information we report and manage, sharing it in a safe and responsible manner.
- Working exclusively with suppliers of goods and services, and business partners who adhere to, comply with and maintain operational excellence criteria in accordance with the standards set by this policy.
- Constantly improving, based on the control, recording and analysis of relevant data on processes and management systems, and the analysis of incidents or contingencies, integrating new technologies and innovative criteria for quality management, environment, safety, health, resource efficiency, reliability and any other applicable and relevant management discipline.

Daniel González
CEO
May 2018

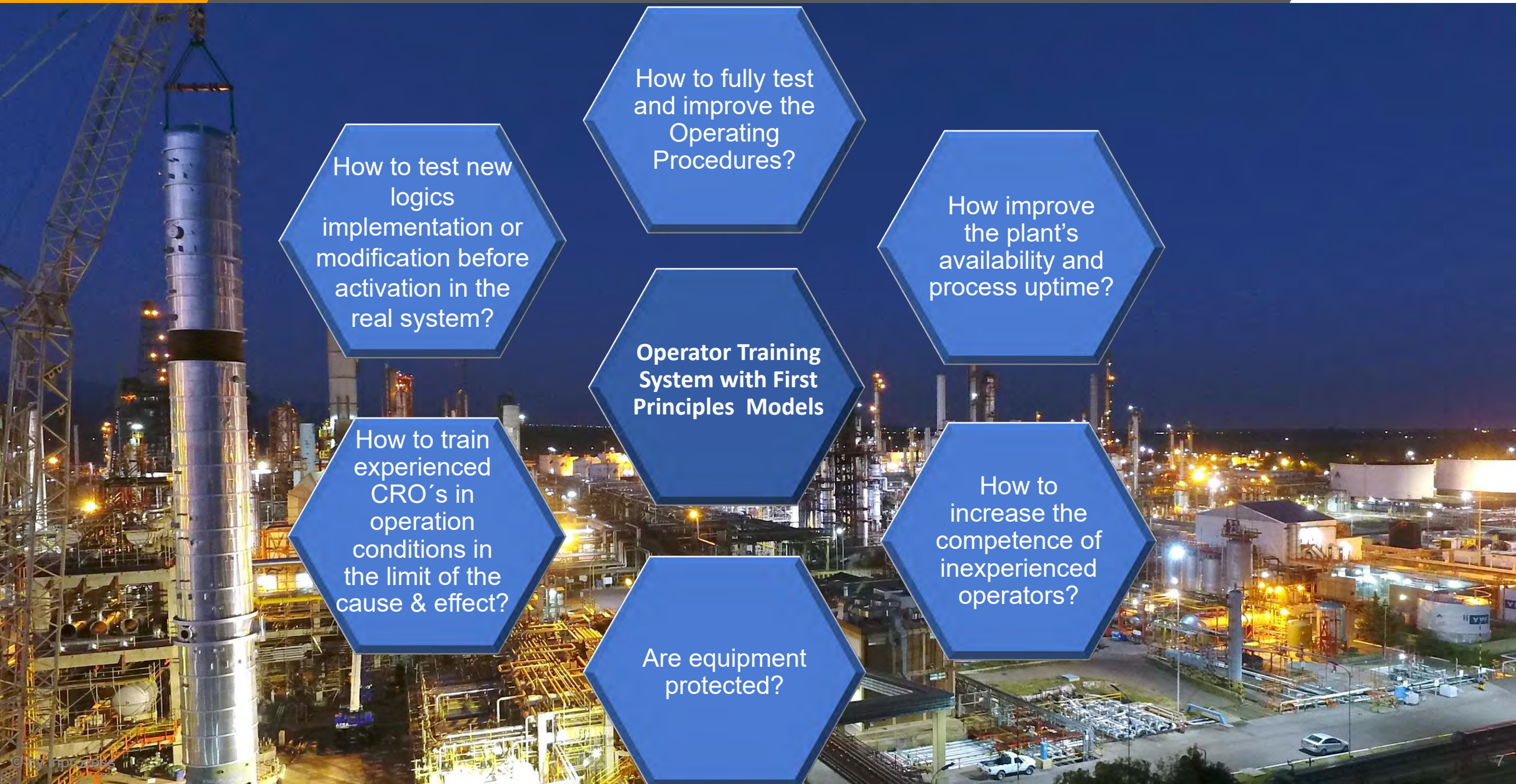
- Guaranteeing comprehensive management of the risks associated with our assets, processes, businesses and projects, integrating, at all stages of their life cycle, criteria and preventive actions for environmental protection, safety, health, quality, integrity and reliability.

- Constantly improving, based on the control, recording and analysis of relevant data on processes and management systems, and the analysis of incidents or contingencies, integrating new technologies and innovative criteria for quality management, environment, safety, health, resource efficiency, reliability and any other applicable and relevant management discipline.

YPF FCC OTS Objective

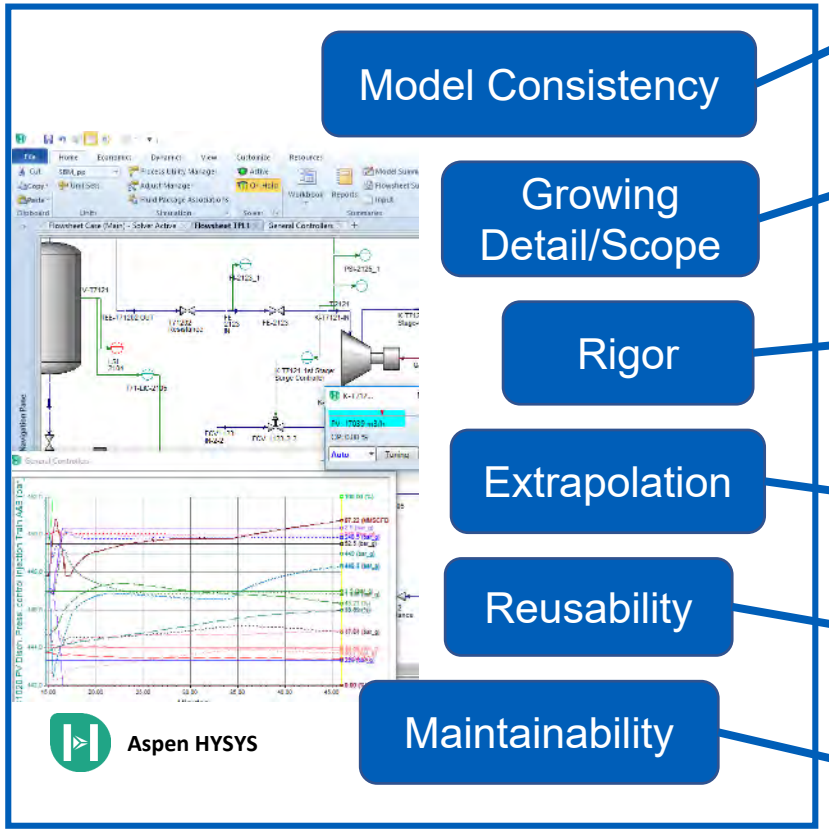
The original objective of this application was limited to the training of operators, while after the completion of the OTS based on first principles dynamic model the application expanded to include helping process Engineering department and Optimization and Control department in analysis for process improvements and diagnoses.

Challenges



Usage of a First-Principles Dynamic Model

First-principles (FP) models use understanding of the system underlying chemical and physics to derive its mathematical representation. The value and advantage of this approach are:



- **Model Consistency** → Thermo Packages are consistent with the Steady-Sate Design models. Data is introduced once and the model is used along the phases of the lifecycle
- **Growing Detail/Scope** → Detailed Equipment data is available and refined as the project evolves. Additional process units can be incorporated as needed in the application
- **Rigor** → Control Room Operator ´s (CRO) will expect realistic process responses. This is the key to replicate/verify/ improve operating procedures, pre-tune controllers and define alarms limits
- **Extrapolation** → Extrapolate process conditions far from nominal. Model will help to determine the settings to maximize production, reduce flaring and improve its controls
- **Reusability** → The dynamic model can be re-used with minor modifications for other purposes
- **Maintainability** → Model update workflow is defined to keep the model alive and synchronized with the process, control and procedure changes

FCC OTS Objective

Purpose:

Develop OTS application using first principles dynamic model of the FCC unit

- Training new and experience operators
- Improve the plant operation
- Validate the effectiveness of the control system
- Verify the operating procedures after a control update and process modification

Focus:

Operators training in not frequent operations, detect possible system instabilities, potential overload conditions, validate the operating procedures.

Typical Scenarios

- ✓ Emergency shutdown scenario
- ✓ Start-Up
- ✓ Typical Upsets
- ✓ Ramp-Up /Ramp-down
- ✓ Change operating mode

Areas of Interest:

- Retain process knowledge
- CRO* generational change
- Overall Operability
- Max/Min Pressures & Temperatures
- Control Valves behaviour
- Pressure Controllers behaviour
- Driver Overload protection
- Slide Valve Behaviour
- Post Combustion Detection

*CRO- Control Room Operator

Operational Excellence

In process industry, Operational Excellence is the operation of the plant in efficient, reliable and agile manner to achieve optimal profitability of the plant operations over the full lifecycle.

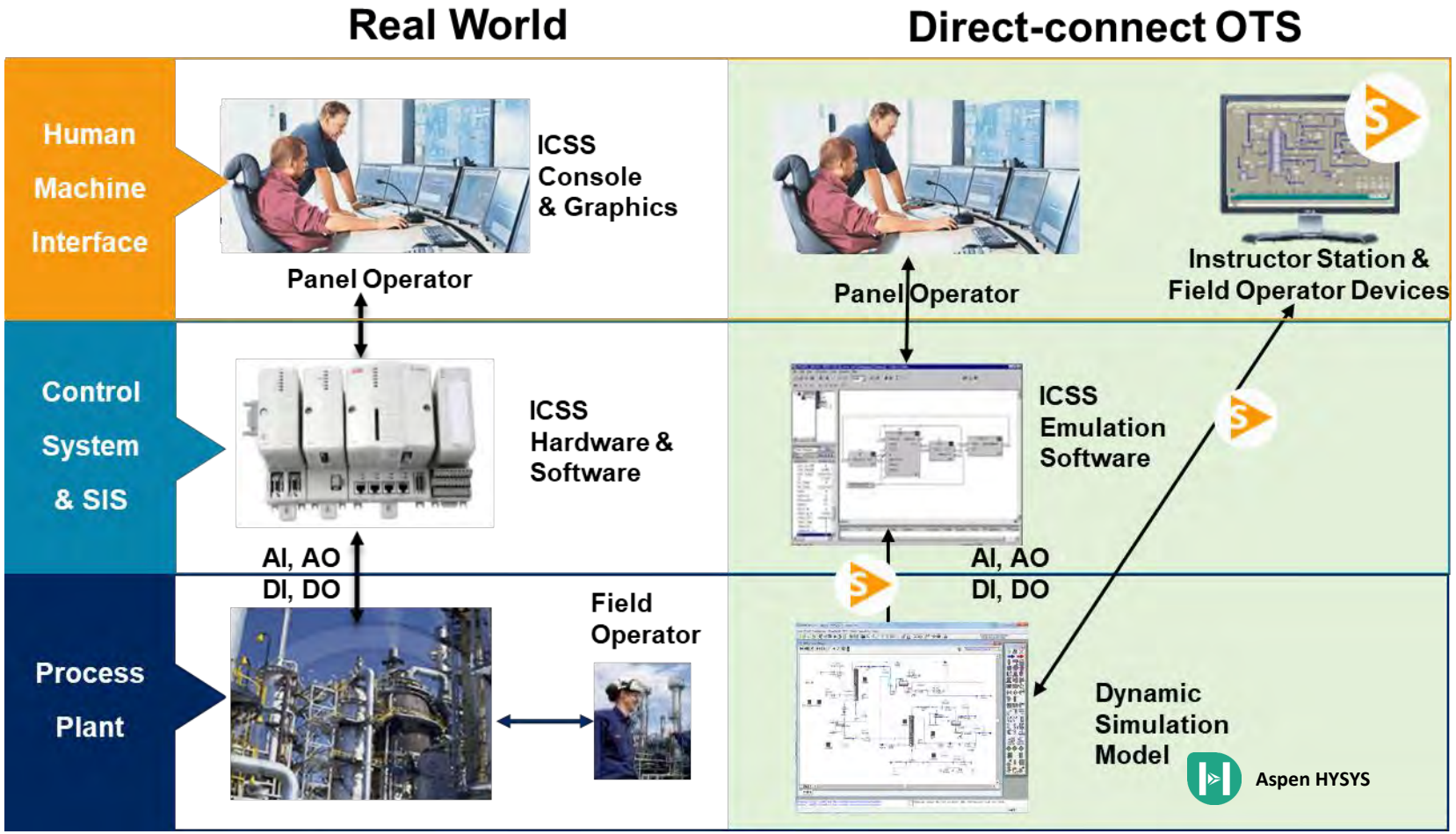
- **Process Optimization** Optimizing yield, energy and throughput
- **Improve Decision Support** enable and speed-up the decision making with right time information
- **Enhance Process Operation** Integrate data and process knowledge to operators interface
- **Operation Knowledge Management** Improve the knowledge retention and increase operators competence and risk control by training programs based on lessons learned

OTS and Operational Excellence

The Operators training system based on first principle simulation is an enabling technology in the way to achieve the Operational Excellence.

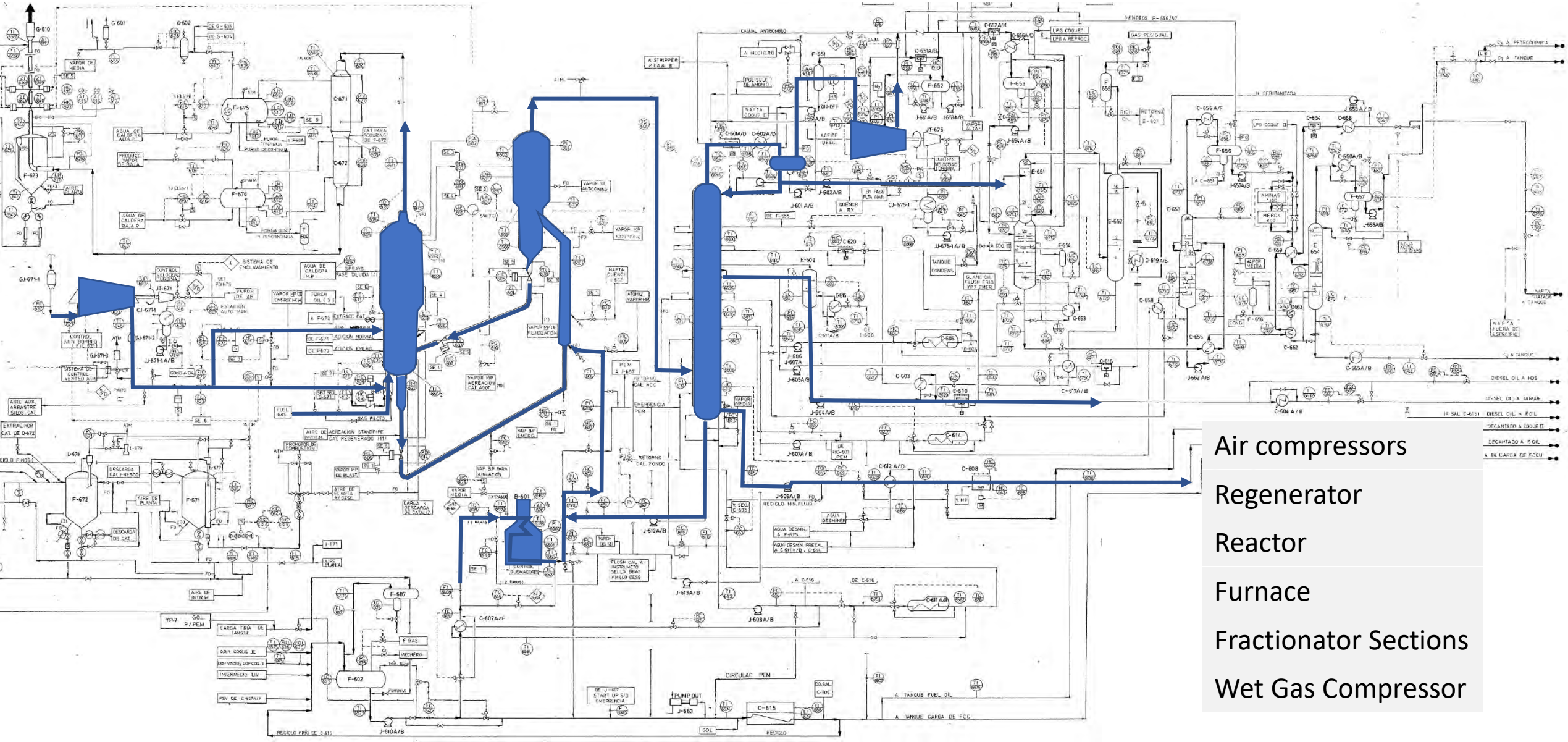
- Learn from events through learning by doing.
- Easy way to apply lessons learned initiatives with the purpose of ***analyzing, developing and implementing robust solutions to improve operations***.
- Improve the implementation of process safety management in operation procedures
- ***Investigate/Root Cause Analysis in virtual environment***
- ***Implement training programs*** *using learn by doing approach to increase operator competence and knowledge retention in the company*

Operator Training System



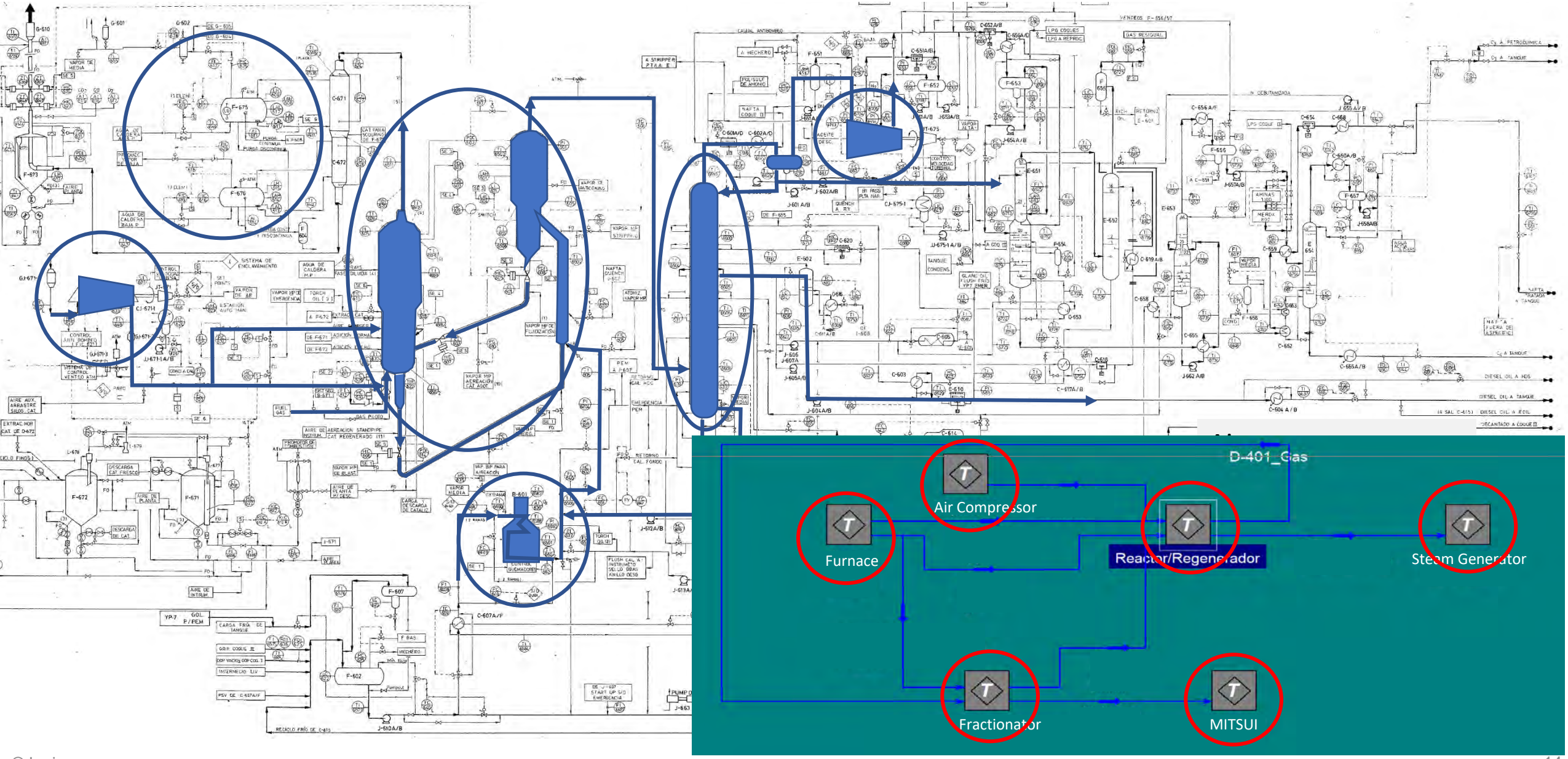
Inprocess Instructor Station connects all these items, and fills some gaps in certain architectures.

FCC Process Layout

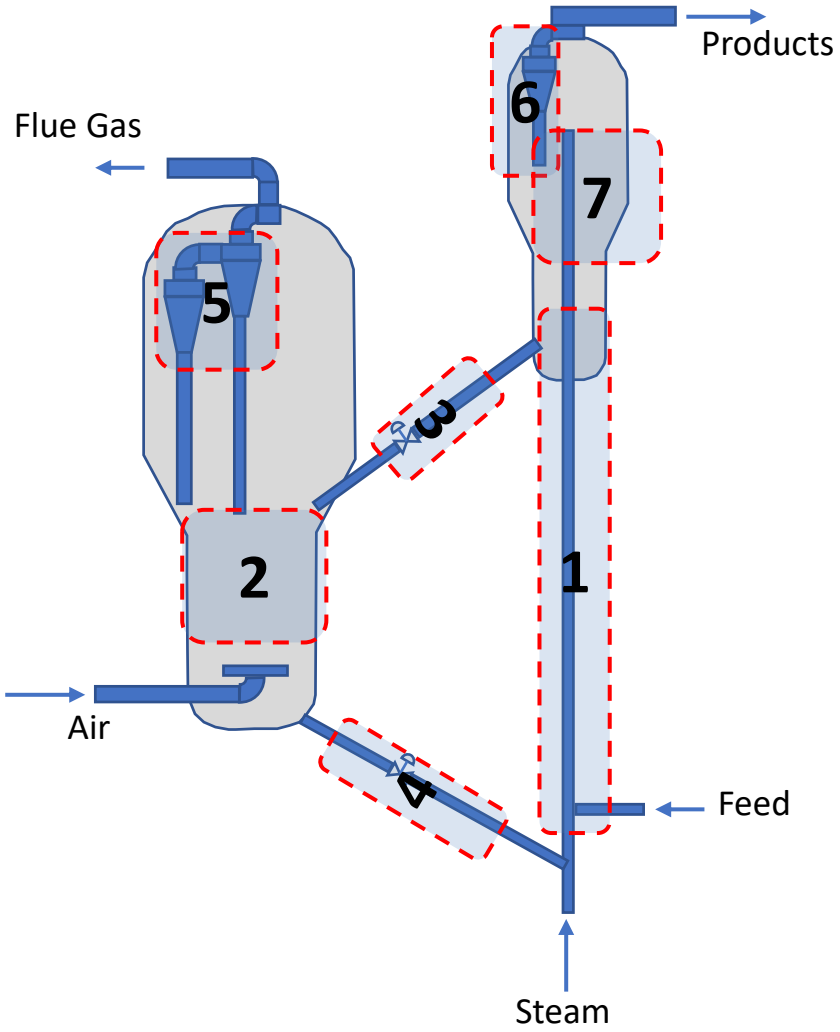


- Air compressors
- Regenerator
- Reactor
- Furnace
- Fractionator Sections
- Wet Gas Compressor

FCC Model

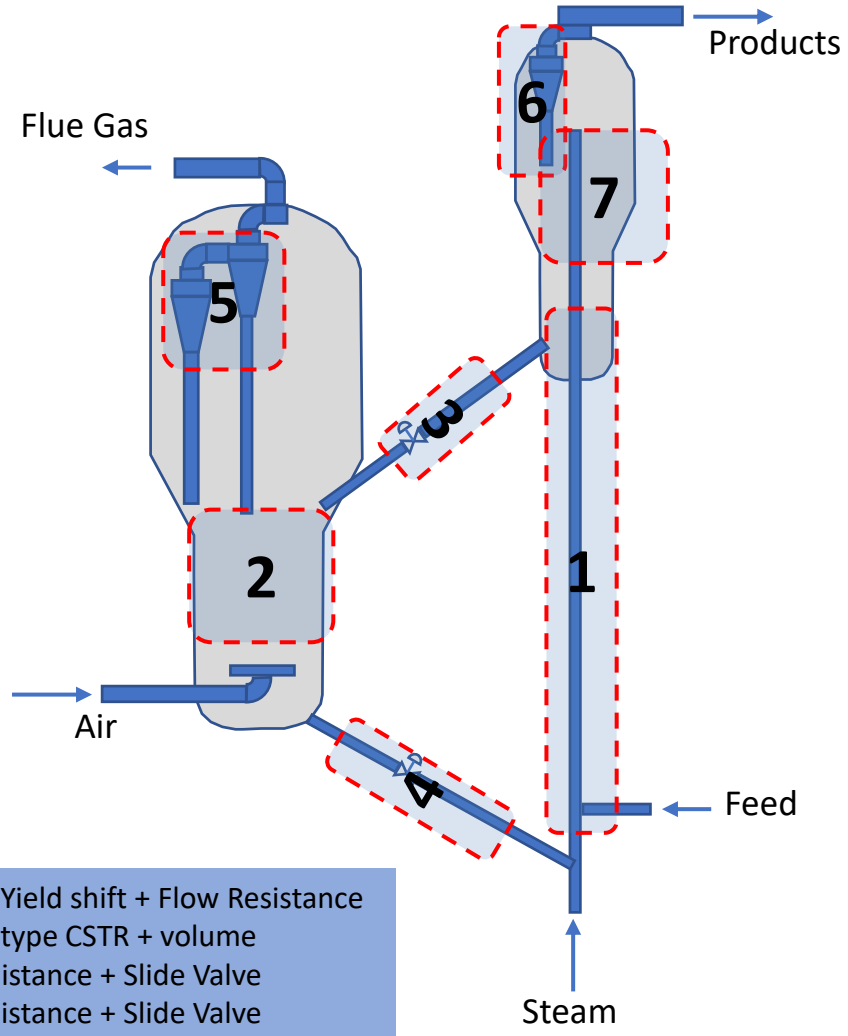


Reactor and Regenerator

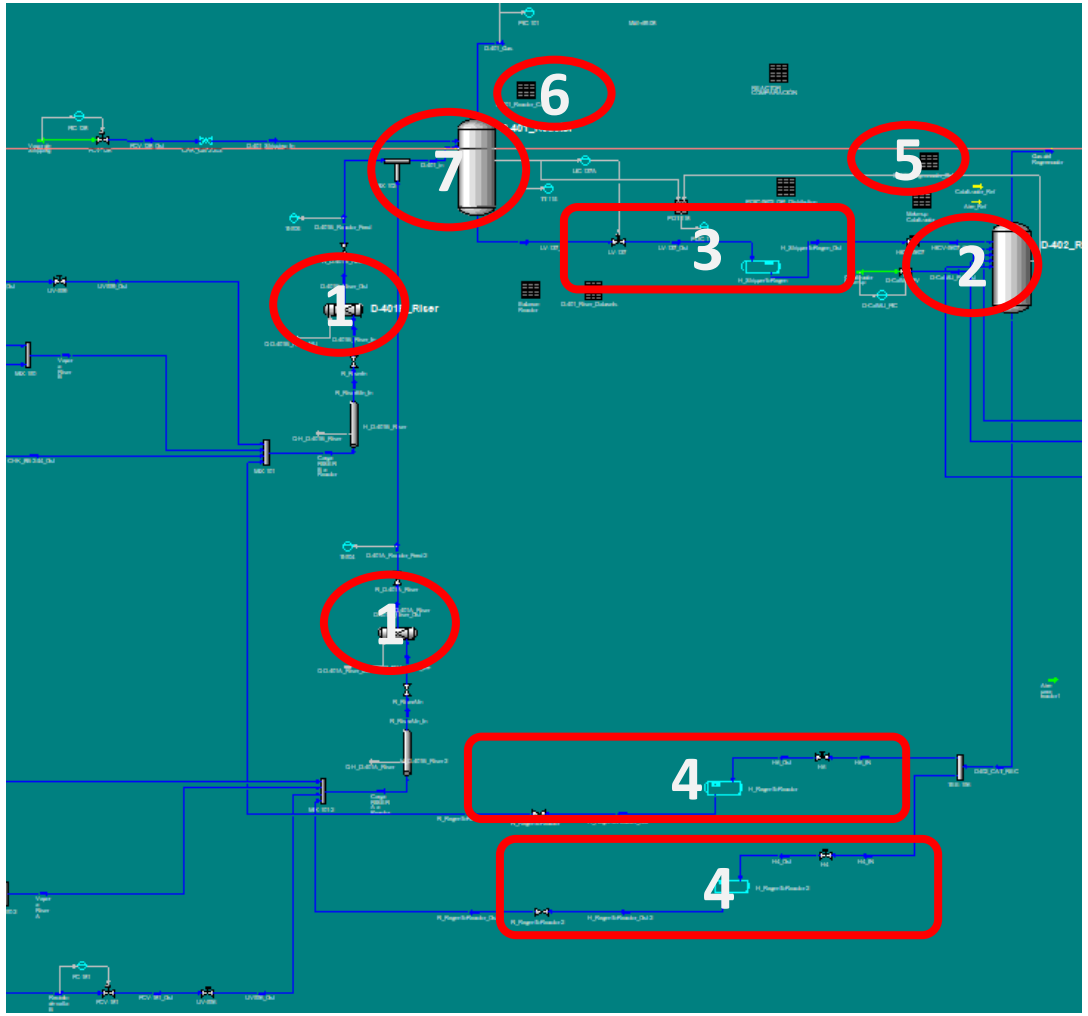


- Chemical reaction in the riser
- Reaction in the regenerator
- Hydraulics in the riser and its interaction with the pressures in the reactor (split section) and the regenerator
- Gas dynamics

Reactor and Regenerator

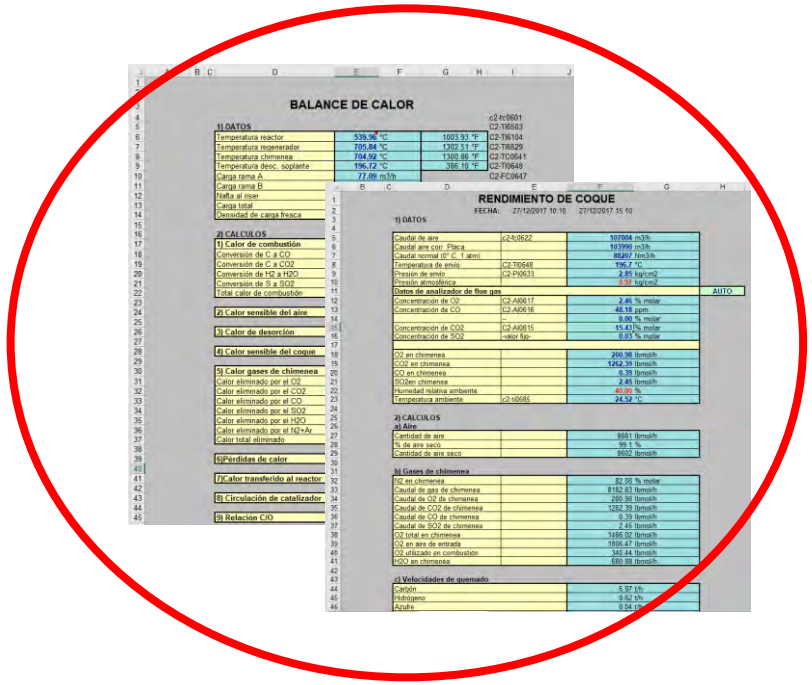


1. Reactor Yield shift + Flow Resistance
2. Reactor type CSTR + volume
3. Flow resistance + Slide Valve
4. Flow resistance + Slide Valve
5. Cyclone calculation block
6. Cyclone Calculation block
7. Volume



Dynamic Model Rating

The dynamic model has been rated based on the heat balance calculated using plant data.



Reactor Heat balance based on plant data

Equipment Datasheet
Thermodynamic properties
Geometrical data

Reactor Model

Model Calibration

?

Operator Training System –Architecture

Hypervisor Server
- Domain Server
- Aspect Server
- AC 800M Connectivity Servers
- AC 800M Softcontrollers

DS AS CS

Operator Station-1:
- *ABB 800xA DCS Consoles*

Ethernet Network

DCS / Process Simulation interface
OPC Protocol
ABB Simulator Link Interface

- *Aspen Hysys License Server*

Aspen HYSYS

- *Gateway computer*

YPF Corporate Network

- *Remote Connection Server*

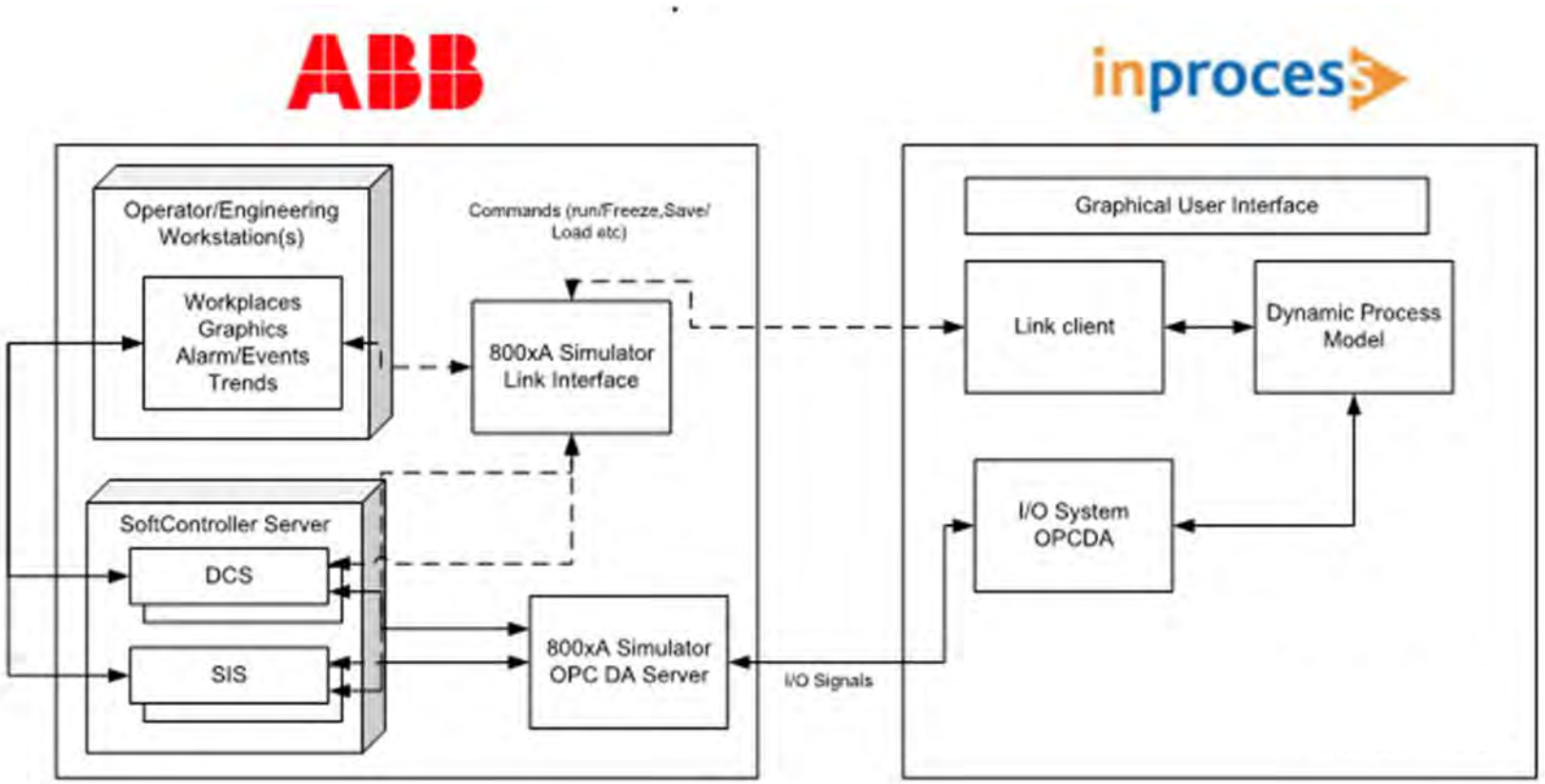
Internet

- *Remote Connection Client*

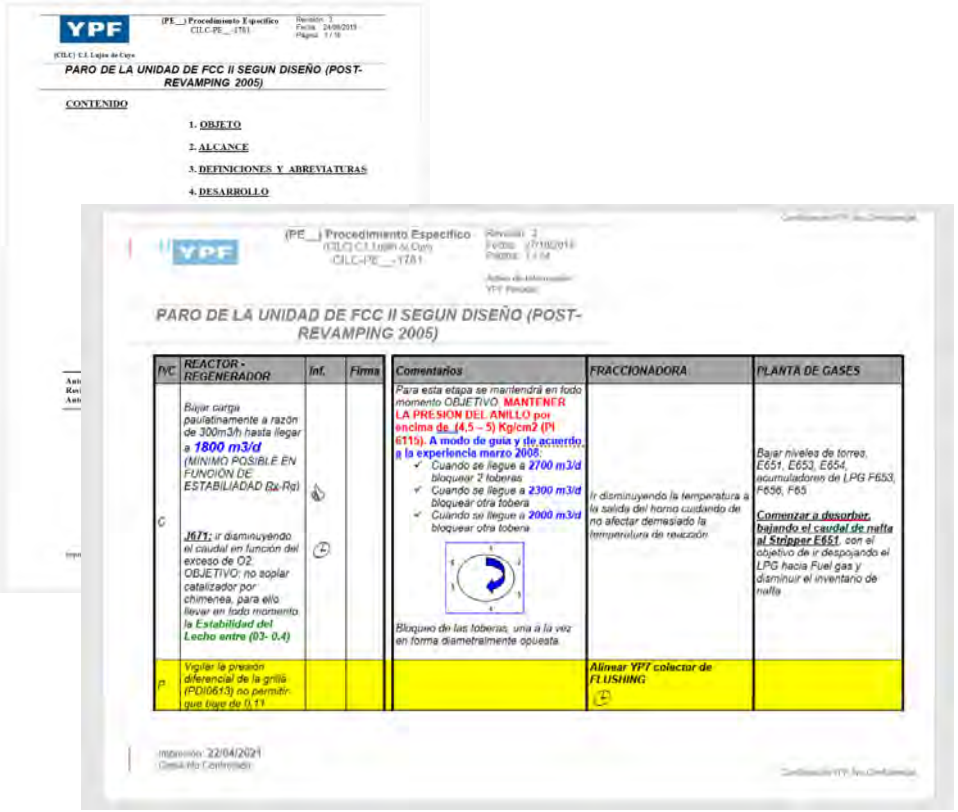
Aspen HYSYS

Instructor and Simulation Station:
- *Inprocess Instructor station*
- *HYSYS® Dynamics*

Operator Training System – Architecture



Training Program Development



YPF

(PE__) Procedimiento Específico

PARO DE LA UNIDAD DE FCC II SEGUN DISEÑO (POST-REVAMPING 2005)

CONTENIDO

1. OBJETO
2. ALCANCE
3. DEFINICIONES Y ABREVIATURAS
4. DESARROLLO

(PE__) Procedimiento Específico

PARO DE LA UNIDAD DE FCC II SEGUN DISEÑO (POST-REVAMPING 2005)

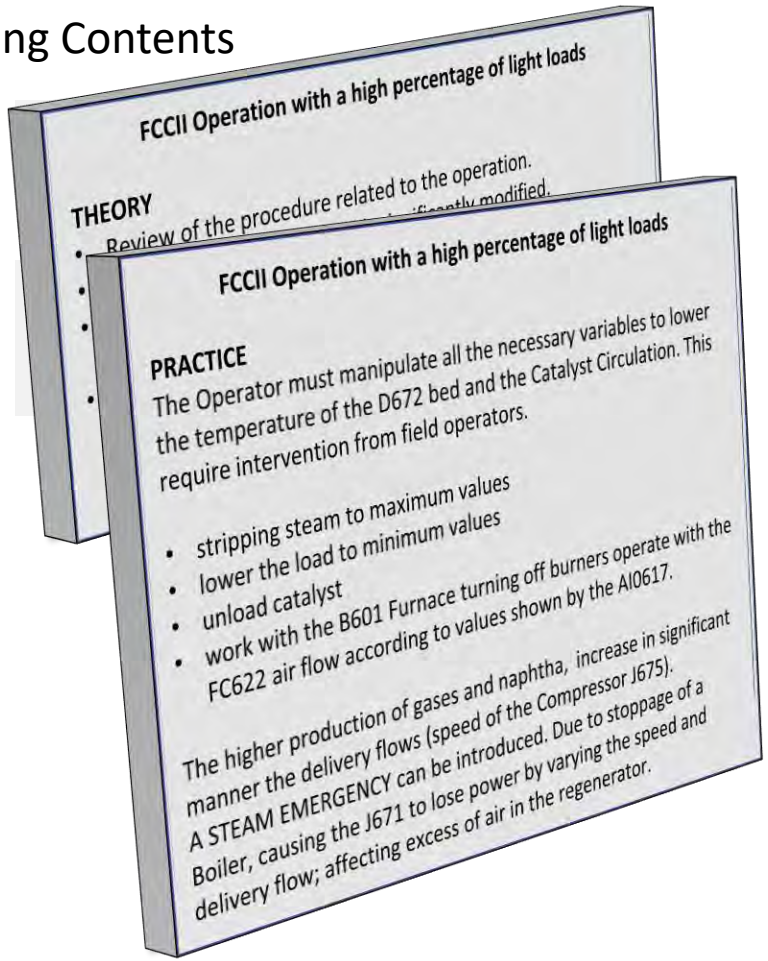
PVC	REACTOR - REGENERADOR	Inf.	Firma	Comentarios	FRACCIONADORA	PLANTA DE GASES
C	Bajar carga paulatinamente a razón de 300m3/h hasta llegar a 1800 m3/d (MINIMO POSIBLE EN FUNCIÓN DE ESTABILIADAD Rx-Rg) J671: ir disminuyendo el caudal en función del exceso de O2. OBJETIVO: no soplar catalizador por chimenea, para ello llevar en todo momento la Estabilidad del Lecho entre (03- 0.4)			Para esta etapa se mantendrá en todo momento OBJETIVO: MANTENER LA PRESION DEL ANILLO por encima de (4,5 – 5) Kg/cm2 (PI 6115). A modo de guía y de acuerdo a la experiencia marzo 2008: ✓ Cuando se llegue a 2700 m3/d bloquear 2 toberas ✓ Cuando se llegue a 2300 m3/d bloquear otra tobera ✓ Cuando se llegue a 2000 m3/d bloquear otra tobera Bloqueo de las toberas, una a la vez en forma diametralmente opuesta	Ir disminuyendo la temperatura a la salida del horno cuidando de no afectar demasiado la temperatura de reacción	Bajar niveles de torres, E651, E653, E654, acumuladores de LPG F653, F656, F65 Comenzar a desorber, bajando el caudal de nafta al Stripper E651, con el objetivo de ir despojando el LPG hacia Fuel gas y disminuir el inventario de nafta
P	Vigilar la presión diferencial de la grilla (PDI0613) no permitir que baje de 0,11				Alinear YP7 colector de FLUSHING	

Impresión: 22/04/2021

Theory Contents

Practical Contents

Training Contents



FCCII Operation with a high percentage of light loads

THEORY

- Review of the procedure related to the operation.

FCCII Operation with a high percentage of light loads

PRACTICE

The Operator must manipulate all the necessary variables to lower the temperature of the D672 bed and the Catalyst Circulation. This require intervention from field operators.

- stripping steam to maximum values
- lower the load to minimum values
- unload catalyst
- work with the B601 Furnace turning off burners operate with the FC622 air flow according to values shown by the AI0617.

The higher production of gases and naphtha, increase in significant manner the delivery flows (speed of the Compressor J675). A STEAM EMERGENCY can be introduced. Due to stoppage of a Boiler, causing the J671 to lose power by varying the speed and delivery flow; affecting excess of air in the regenerator.

Training Program Development

PARO DE LA UNIDAD DE FCC II SEGUN DISEÑO (POST-REVAMPING 2005)

CONTENIDO

1. OBJETO
2. ALCANCE
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P	Vigilar la presión diferencial de la grilla (PDI0613) no permitir que baje de 0,11				Alinear YP7 colector de FLUSHING	

Impresión: 22/04/2021

Theoretical Aspects

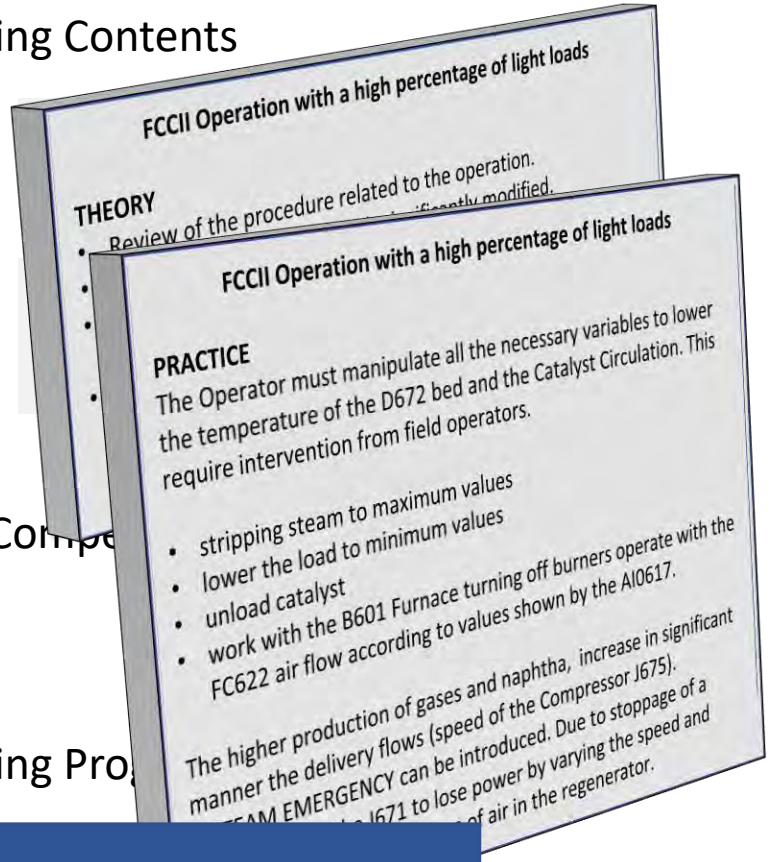
Practical Contents

Operators Candidate

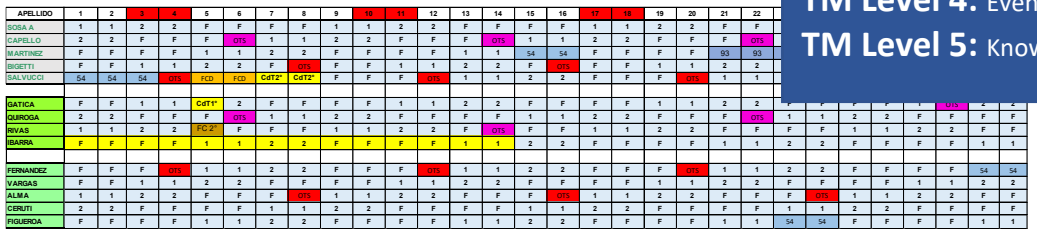
Training Contents

Operators Compe

Training Pro



TM Level 1: Familiarization in Process and ICSS
TM Level 2: Process Unit Start-up and shutdown
TM Level 3: Overall Process Start-up and Shutdown
TM Level 4: Events in operation, stress management
TM Level 5: Knowledge Refresh



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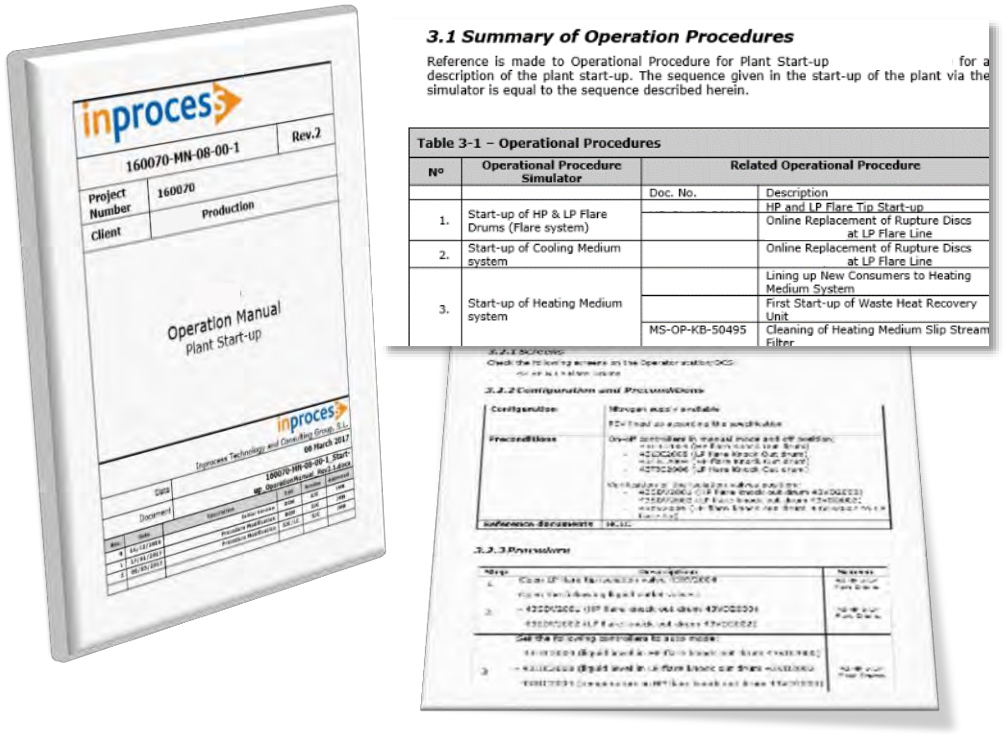
SOSA A	1	1	2	2	F	F	F	F	1	1	2	2	F	F	F	F	1	1	2	2	F	F
CAPELLO	2	2	F	F	F	OTS	1	1	2	2	F	F	F	OTS	1	1	2	2	F	F	F	OTS
MARTINEZ	F	F	F	F	1	1	2	2	F	F	F	F	1	1	54	54	F	F	F	F	93	93
BIGETTI	F	F	1	1	2	2	F	OTS	F	F	1	1	2	2	F	OTS	F	F	1	1	2	2
BALVUCCI	54	54	54	OTS	FCD	FCD	CdT2°	CdT2°	F	F	F	OTS	1	1	2	2	F	F	F	OTS	1	1
GATICA	F	F	1	1	CdT1°	2	F	F	F	F	1	1	2	2	F	F	F	F	1	1	2	2
QUIROGA	2	2	F	F	F	OTS	1	1	2	2	F	F	F	F	1	1	2	2	F	F	F	OTS
RIVAS	1	1	2	2	FC 2°	F	F	F	1	1	2	2	F	OTS	F	F	1	1	2	2	F	F
IBARRA	F	F	F	F	1	1	2	2	F	F	F	F	1	1	2	2	F	F	F	1	1	2
FERNANDEZ	F	F	F	OTS	1	1	2	2	F	F	F	OTS	1	1	2	2	F	F	F	OTS	1	1
VARGAS	F	F	1	1	2	2	F	F	F	F	1	1	2	2	F	F	F	F	1	1	2	2
ALMA	1	1	2	2	F	F	F	OTS	1	1	2	2	F	F	F	OTS	1	1	2	2	F	F
CERUTI	2	2	F	F	F	F	1	1	2	2	F	F	F	F	1	1	2	2	F	F	F	F
FIGUEROA	F	F	F	F	1	1	2	2	F	F	F	F	1	1	2	2	F	F	F	F	1	1

Procedures and Training Program Development

Review of Operating Procedures with timing and transitions conditions

Scope:
- Individual Units
- Overall Operation Procedures

Combining Expertises:
Mix of experienced Engineers / Operators know-how with realistic response of Simulated Process



- Verification of set point consistency between process areas
- Development of operational procedures and training materials with more realistic transitions taking into account unexpected events
  - Learn of control logic Interactions
  - Learn how to manage unexpected events
- Identifying the key parameters during the process operations
- Reduce the Shutdown and Start-Up time

This activity generate a consistent and structured document for the training and the plan for the training program based on the contents.

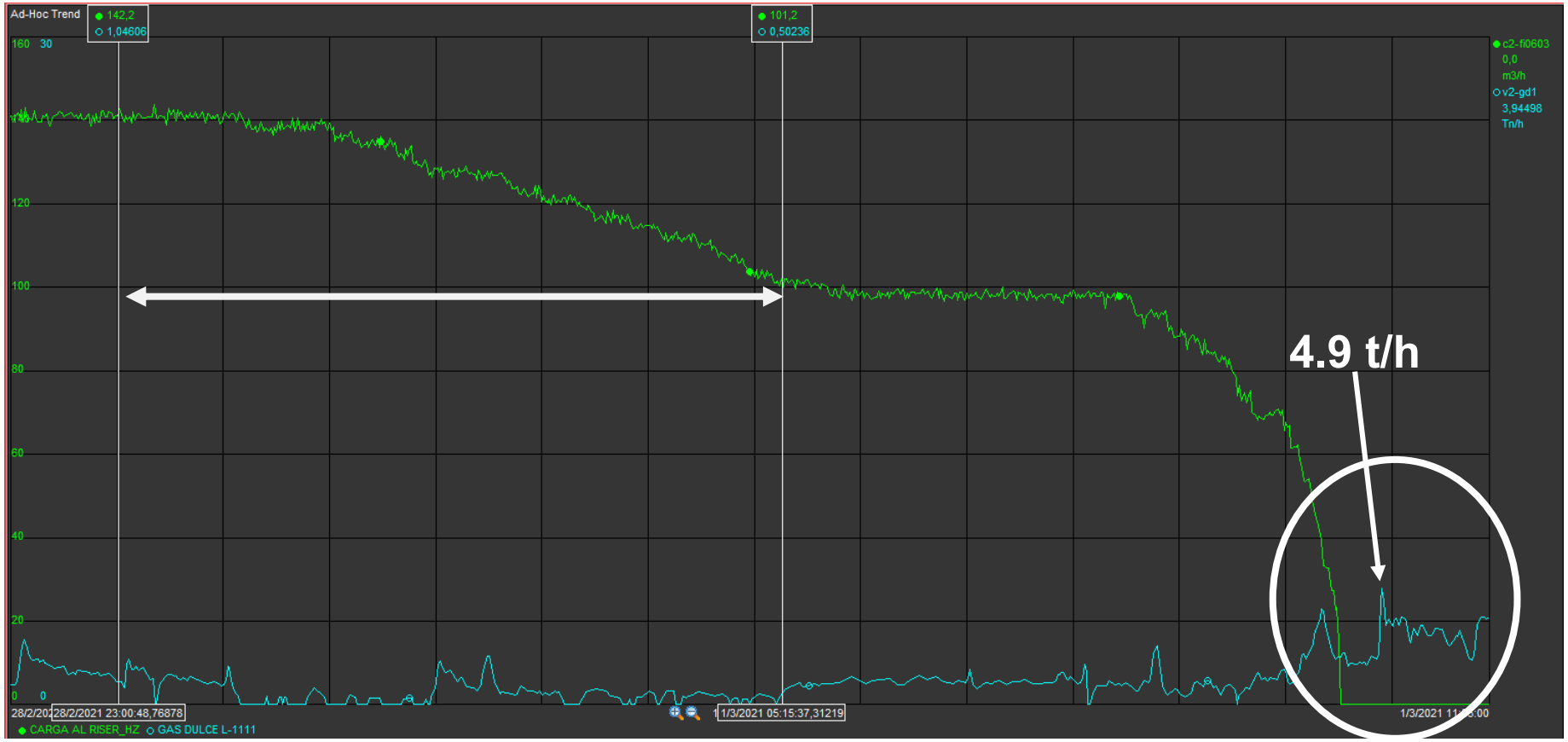
Turn-down and Planned Shutdown – Before Training

Time required 10 hours

Average flaring 30t/h to 50 t/h

Total emisions during the operation 27.7 t

Turn-down and Planned Shutdown – After Training



Time required 7 hours

Average flaring 4t/h to 6 t/h

Total emisions during the operation = 11.3 t

OTS Training Main Results

Since 2019 250 hours of training for 15 operators.

Several retirements occurs during the training period.

Operation improvement

- Turn down and shutdown 30 % reduction in the requirement time
- Emission decrease by 60%
- Flow to flare peak decrease 36.2 t/h to 4.9t/h (86% decrease)

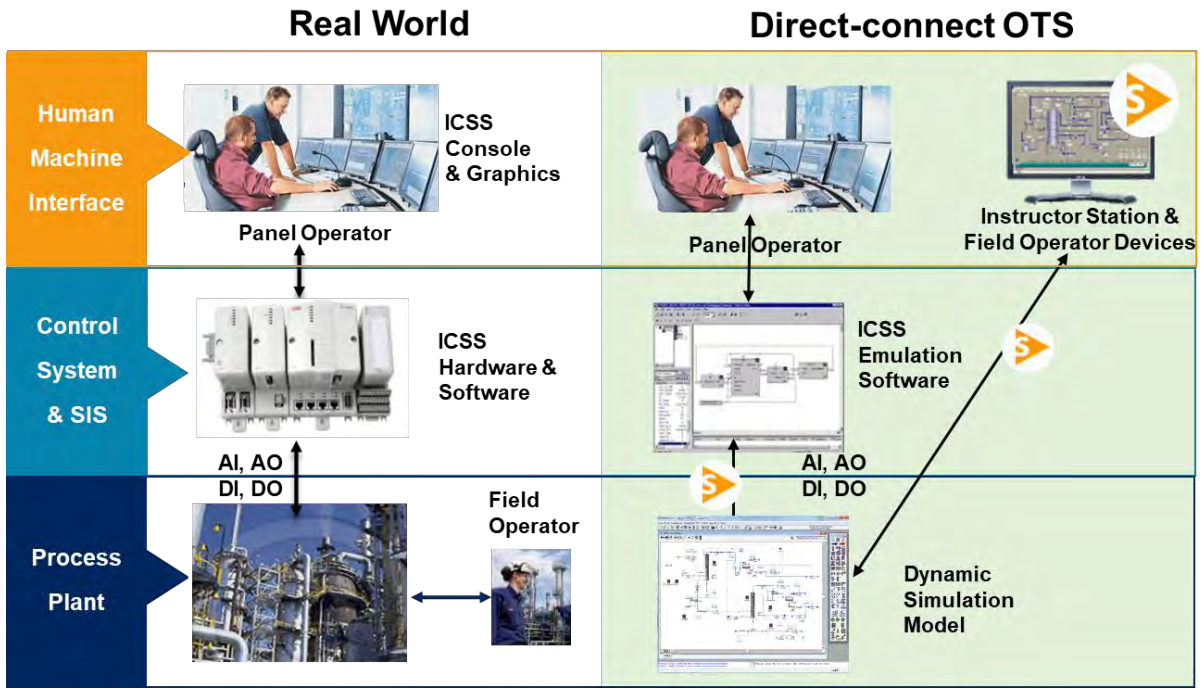
New Operators acquire competence in 6 months before requires 2 years

Support Operations with the OTS model

As shown in the previous slide, using the first principles dynamic modelling approach provides increased added value to the OTS project itself. As it is based on a highly reliable first principles model linked with the actual ICSS.

A direct-connect OTS, based on a first-principles model, allows for:

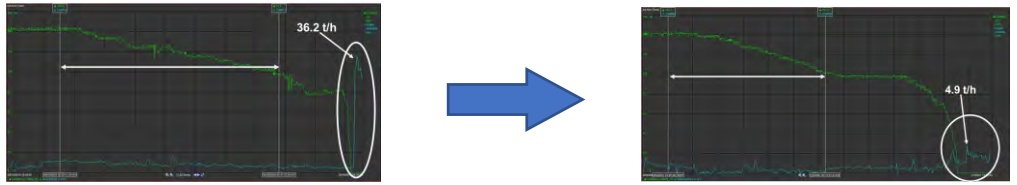
- The evaluation of the controllability and operability of the plant under non design conditions (e.g. Start Up operations).
- The evaluation of the controllability and operability of the plant in unforeseen configurations, with minimum modifications.
- ICSS verification and improvement.
- The evaluation of potential plant limitations (i.e. Debottlenecking studies)



OTS and Operational Excellence

The Operators training system based on first principles simulation is an enabling technology in the way to achieve the Operational Excellence.

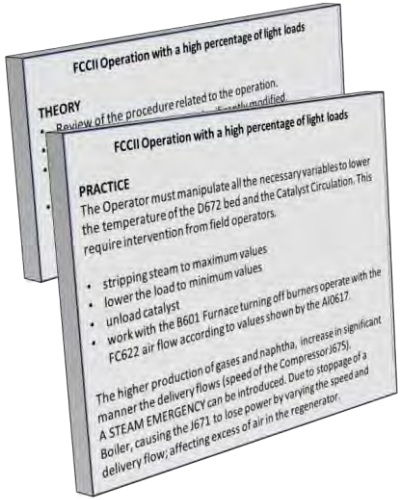
- Learn from events through learning by doing.



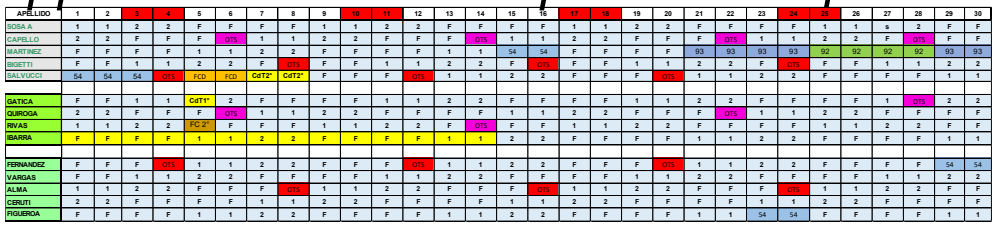
- Easy way to apply lessons learned initiatives with the purpose of ***analyzing, developing and implementing robust solutions to improve operations***.

- Improve the implementation of process safety management in

edures



- ***Implement training programs*** *using learn by doing approach to increase operator competence and knowledge retention in the company*



Benefits

BENEFITS

- Shorten start-up / shutdown
- Minimize incidents
- Reduce unplanned shutdowns
- Minimize flaring
- Improve plant reliability
- Improve safety

- 250 hours training sessions spread over 15 people.
- Operation improvement (30% reduction in execution time)
- Emission reduction (in some operations the reduction is about 60%)
- Experienced operators refreshed knowledge (e.g.: delivery of atypical instruments for repair).
- The training session reduce stress manage in unexpected disturbances when training, and to develop confidence in the operation in critical safety events.
- New operators develop knowledge in 6 months that usually takes 2 years, and they develop the aptitude to be able to operate alone in front of the real console.
- It makes easy to transfer the process and operation knowledge by the instructor.
- Improve the collaboration between operators during the process operation and prevent communication problems during critical events.

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Thank you!

Any question?