

# 2024



Offshore Technology Conference

LEADING THE GLOBAL ENERGY EVOLUTION

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Paper No. OTC-35247-MS | Enhancing FPSO Control Systems: A  
Dynamic Simulation and Virtual Commissioning Approach

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## Summary

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- Introduction
- MPDS and OTS
- Virtual Commissioning
- Applications
- Conclusions



Since 2006 helping the processing industries in solving design and operational issues

**inprocess**

**independent** from any provider  
(process simulator or ICSS)

our **core business** is Process  
Simulation

keen to **share its knowledge** with  
clients

## Inprocess Solutions & Services

**Lifecycle Modelling  
and Operator  
Training Simulators**

**Process  
Simulation  
Studies**

**Professional  
Development  
& Training**

**Applications  
and Software  
Products**

  
**2006**  
est. in Barcelona  
by domain experts

  
**65 countries**  
worldwide  
presence

  
**90+**  
simulation  
engineers

  
**480+**  
years experience

  
**430+**  
executed  
projects

  
**340+**  
training courses

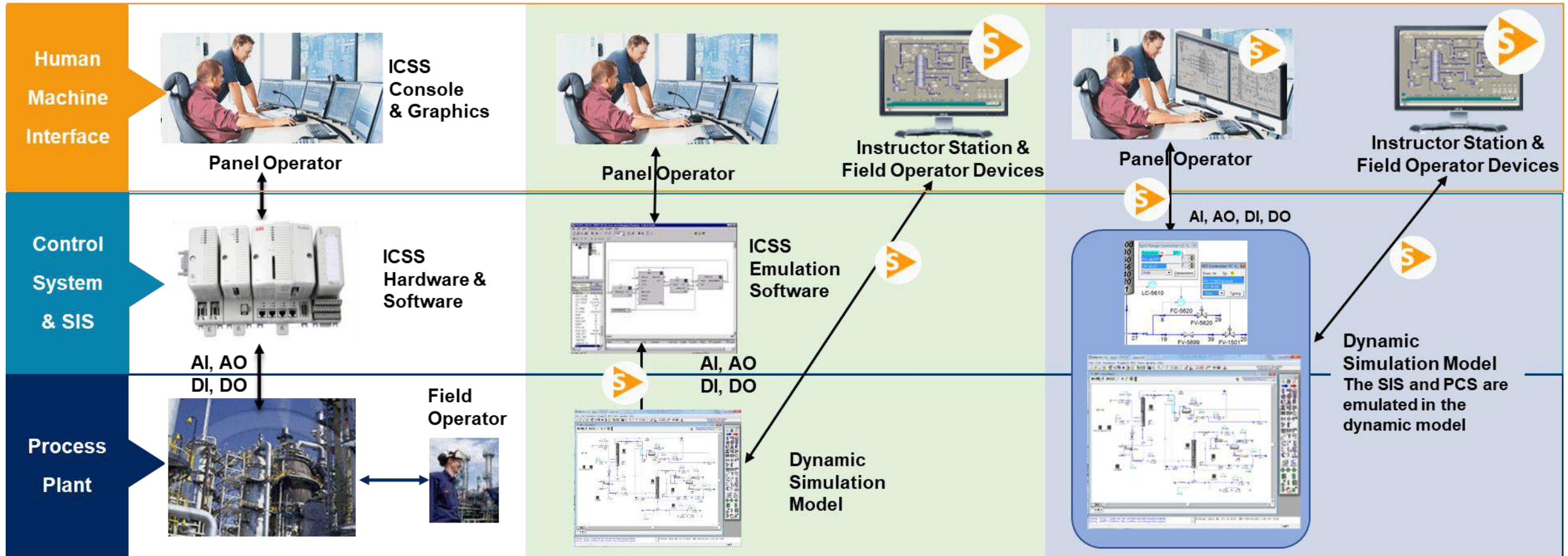


# Operator Training System (OTS)

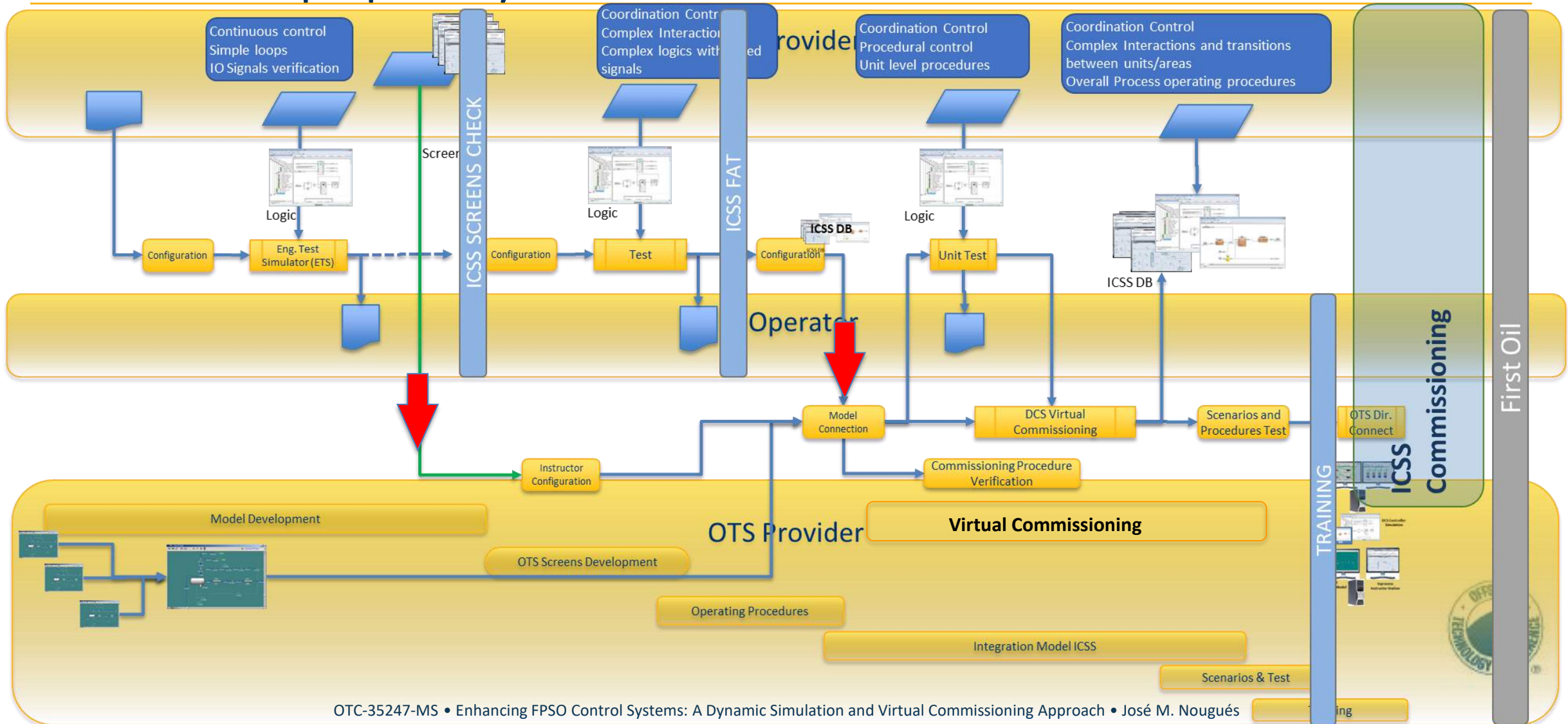
## Real World

## Direct-connect OTS

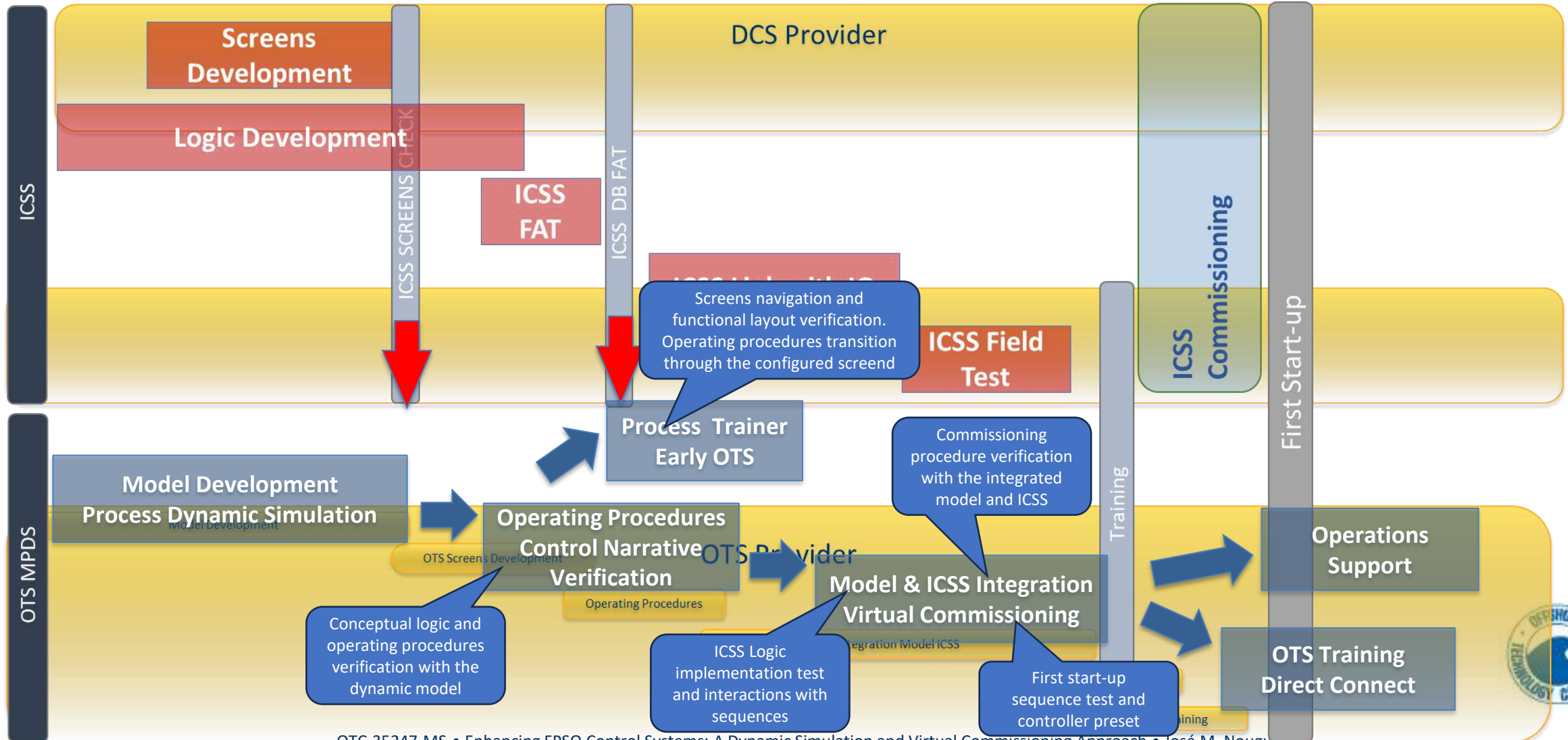
## Emulated OTS



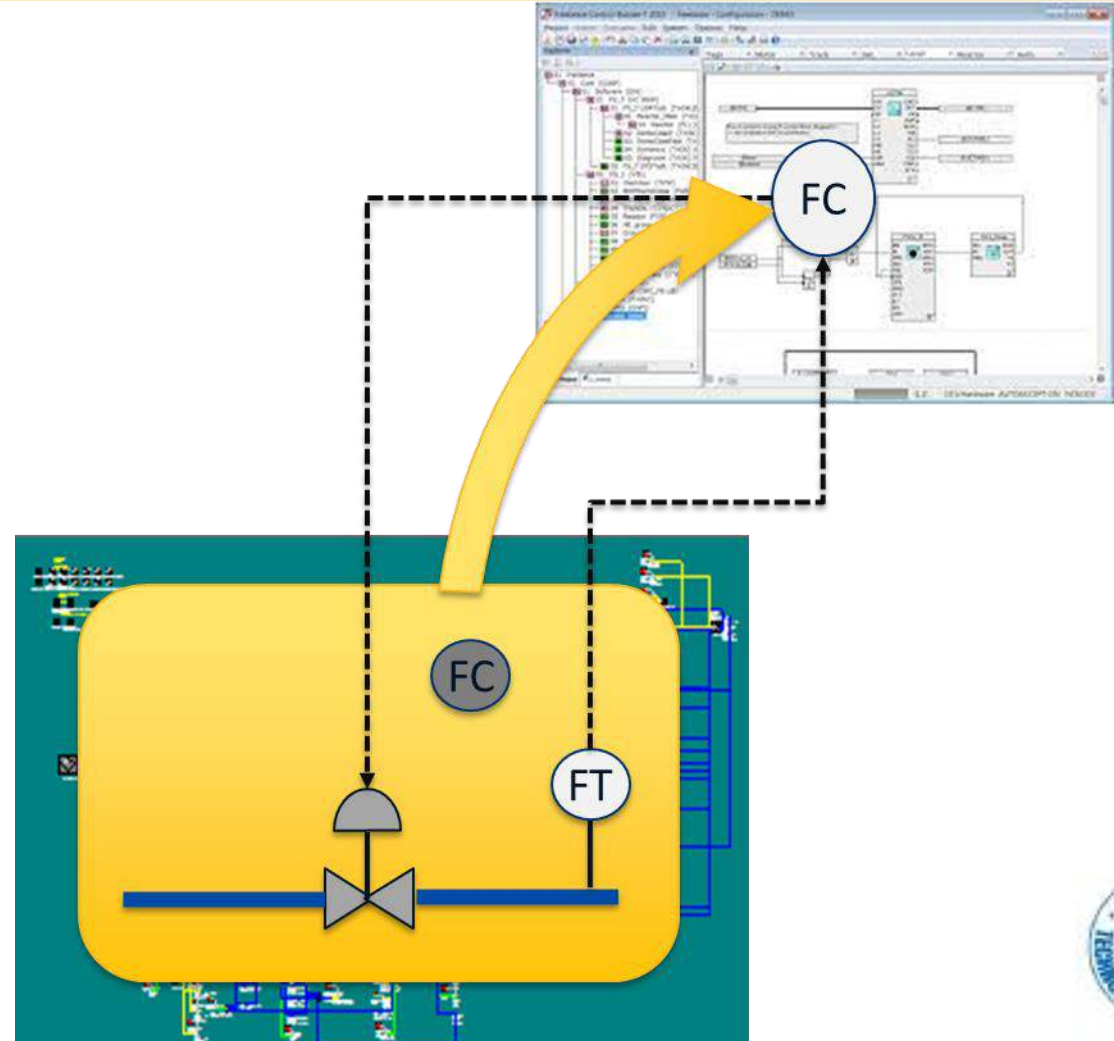
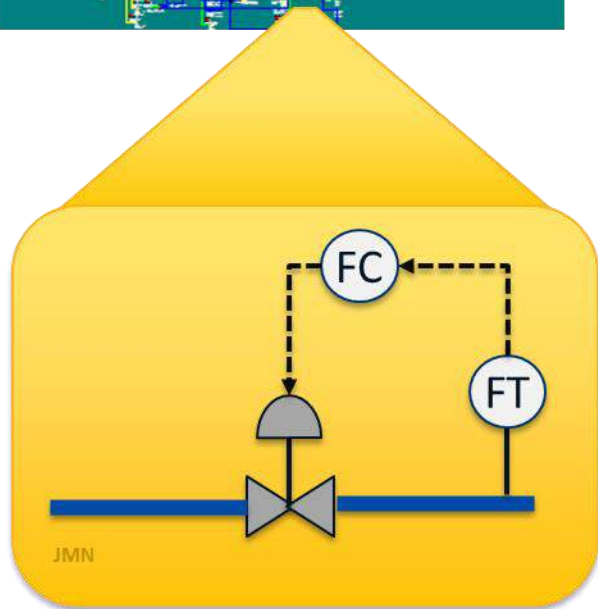
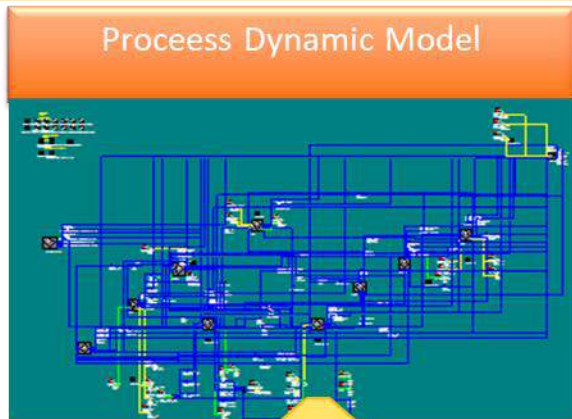
# ICSS and Multipurpose Dynamic Simulation OTS



# ICSS and Multipurpose Dynamic Simulation OTS

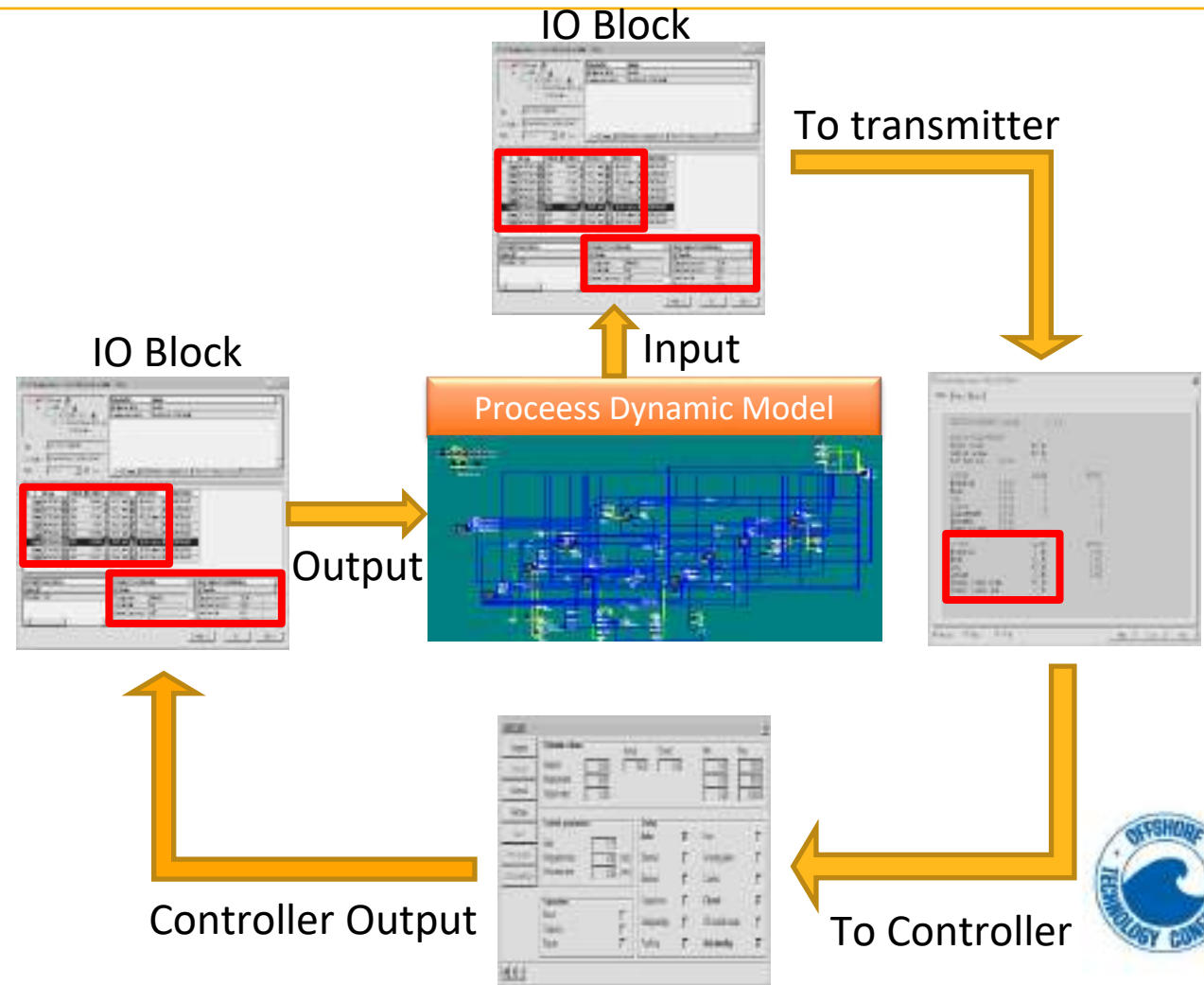


# Multipurpose Dynamic Model Integration with ICSS



# Virtual Commissioning

- Signals Integration and Virtual Wiring
- Controllers Switchover
- Safety Logic Integration
- Perturbation Test
- Integrated Control Narrative Verification
- Commissioning Procedure Verification

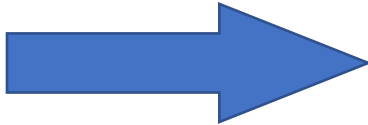
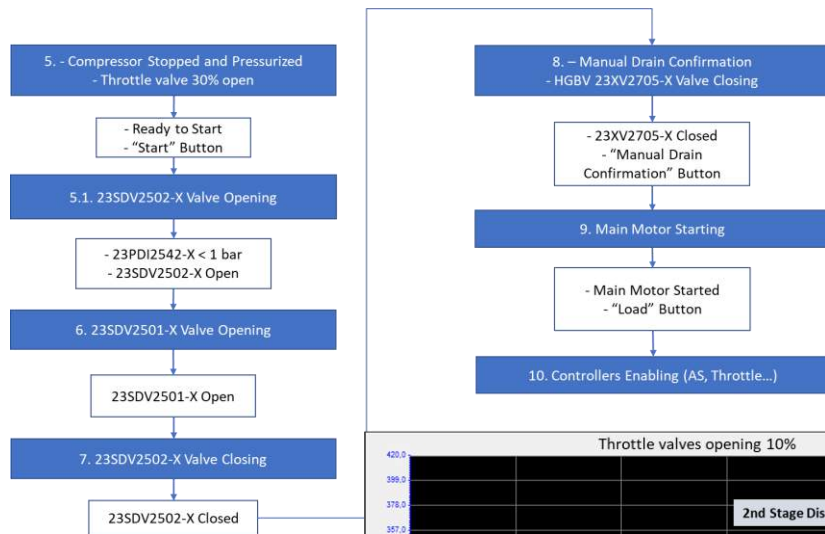




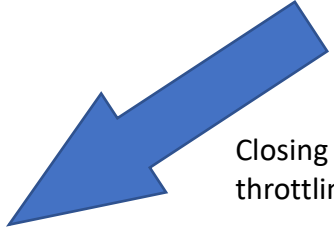
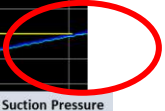
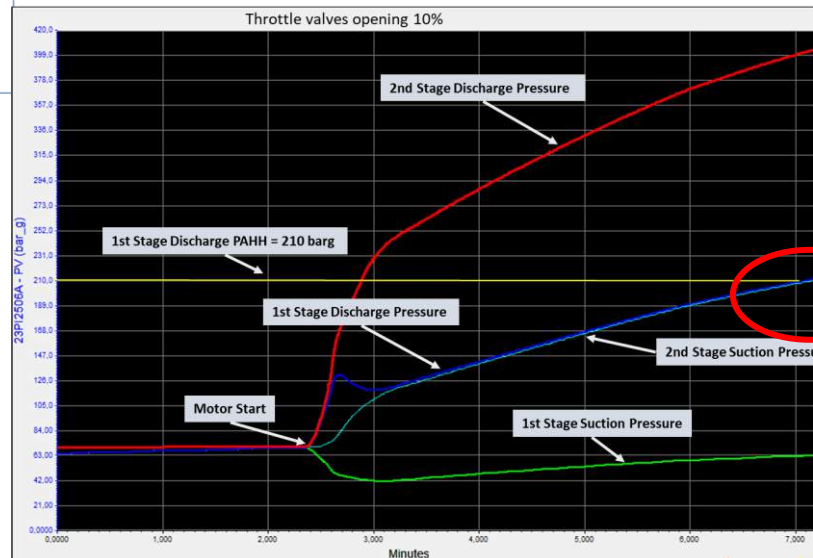
# Case: FPSO Gas Injection Start-up procedure verification



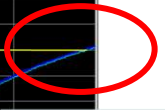
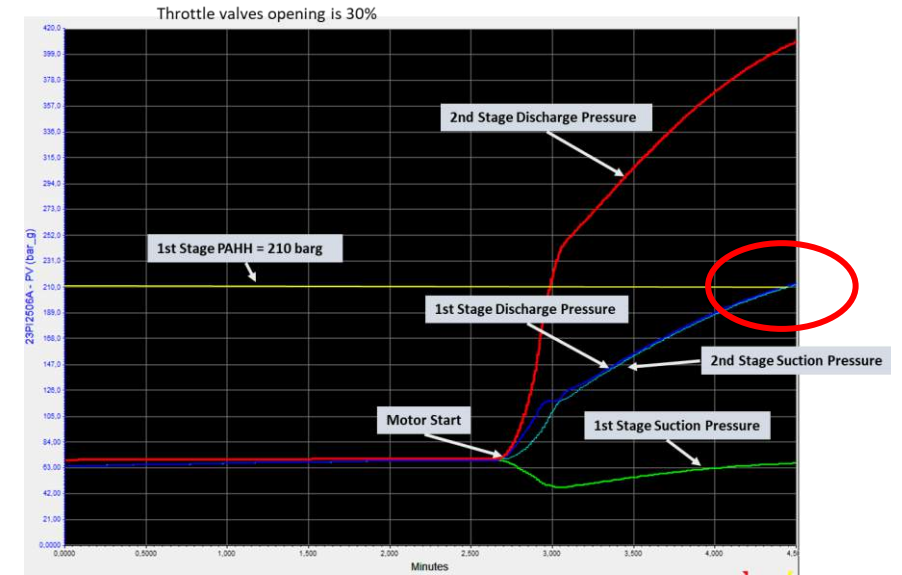
During the virtual commissioning of the topside process for an FPSO, the plant start-up procedure underwent thorough verification using dynamic simulation and DCS emulation.

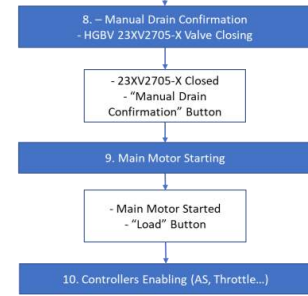
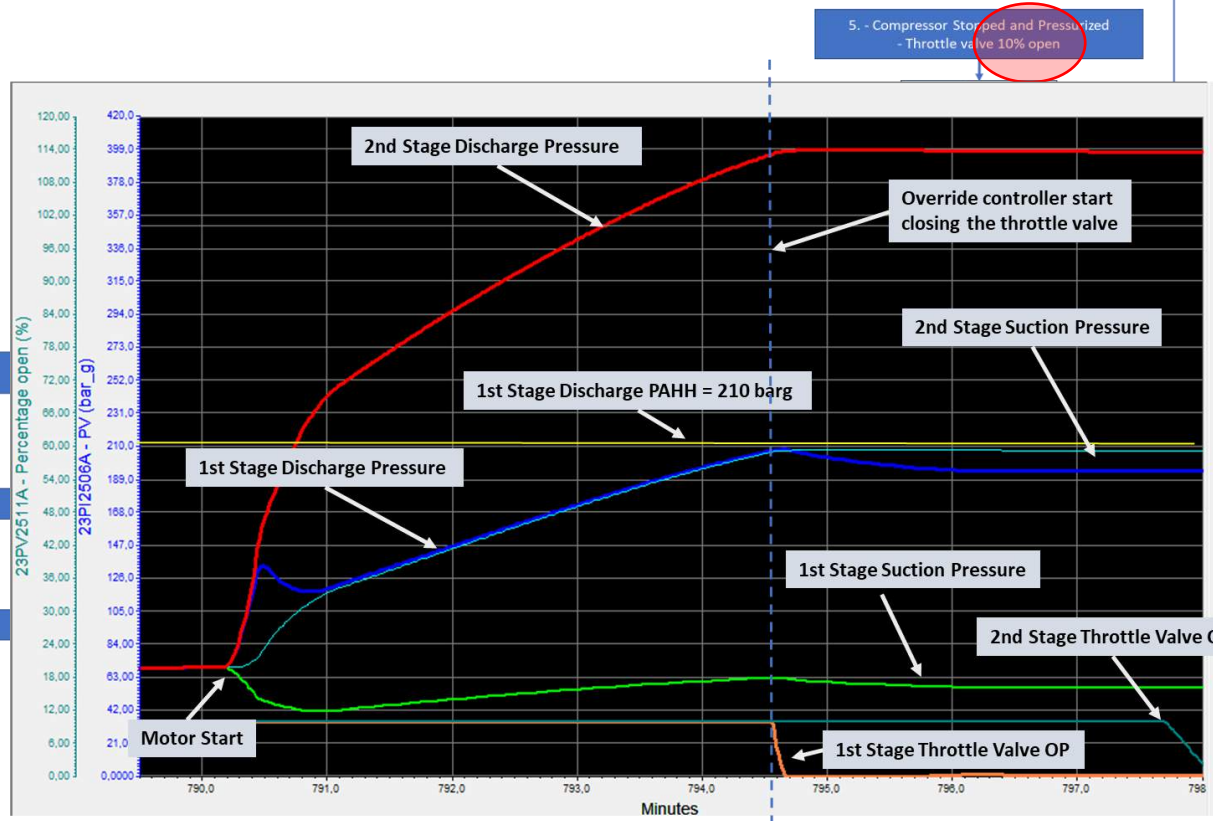
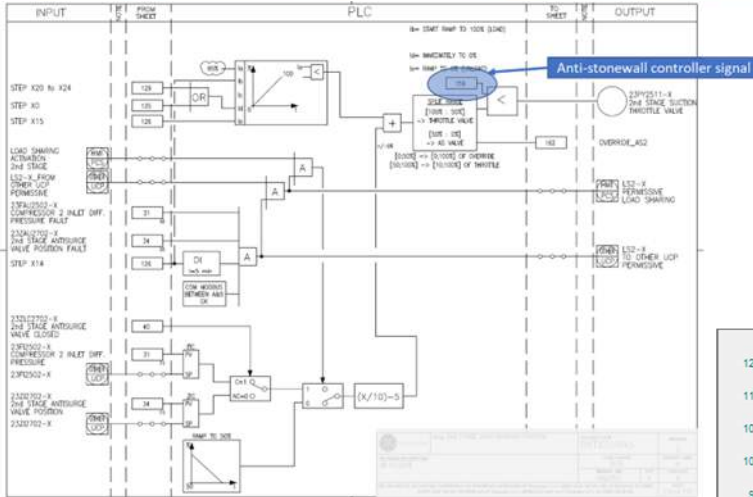


When the current procedure is executed, after the motor start, the machine is not able to remain in full recycle operation conditions.



Closing more the throttling valve





5. - Compressor Stopped and Pressurized  
- Throttle valve 10% open

8. - Manual Drain Confirmation  
- HGBV 23XV2705-X Valve Closing

- 23XV2705-X Closed  
- "Manual Drain Confirmation" Button

9. Main Motor Starting

- Main Motor Started

9.1. Antistone Wall controller Enabling

"Load" Button

10. Controllers Enabling (AS, Master controller...)



After the virtual commissioning and test of the compressor unit start-up the main conclusions are:

- With the current valve size (antisurge and throttle) and initial opening the GI 1st stage reaches the discharge trip condition when the system remain in full recycle after the motor start
- The GI 1st Stage reaches the PAHH (210 barg) at the discharge side if no override action on the throttle valve is enable after the motor start and the compressor Load
- The modification of the start-up procedure to avoid overpressurization is the following:
  - a) Pressurization and motor start are performed with throttle valve 10% (step 1)
  - b) Antistone wall controller is automatically enabled when the motor is started (step 9.1)
- With the suggested procedure where anti-stonewall is enabled, the compressor system does not pressurize
- It should be noted that 2<sup>nd</sup> stage discharge pressure stabilizes below the PALL (410 barg). Nevertheless, in the Control Narrative Review it was confirmed that the PALL setting could be decreased.



# Real Plant Startup Experience: Pentanal vs. 2-Propylheptanol

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# Pentanal and 2-Propylheptanol Process

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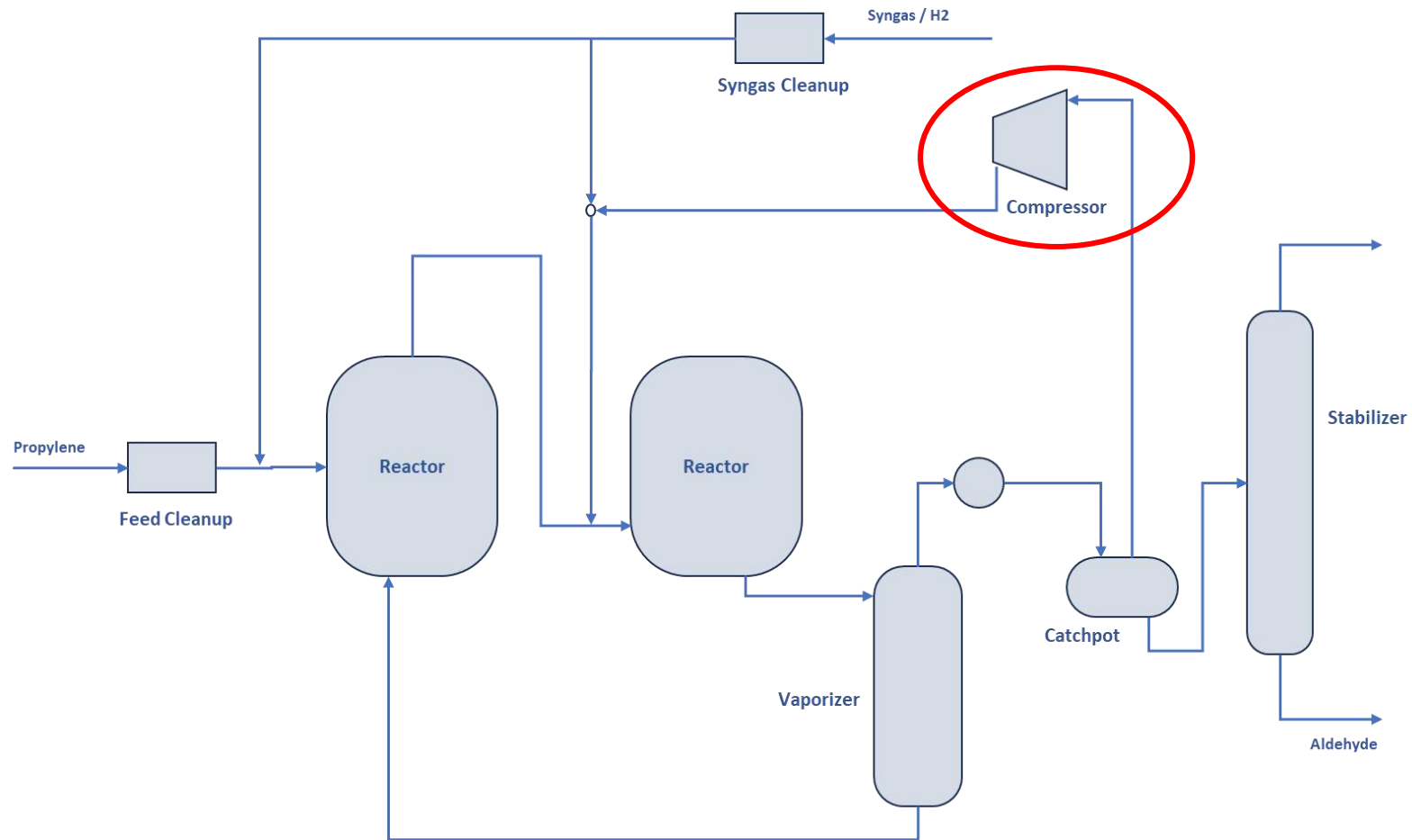
## Pentanal Production Process

- Hydroformylation process
- Synthesis of Pentanal from butene or C4 mixtures
- Catalyst composition and selectivity towards Pentanal

## 2-Propylheptanol Production Process

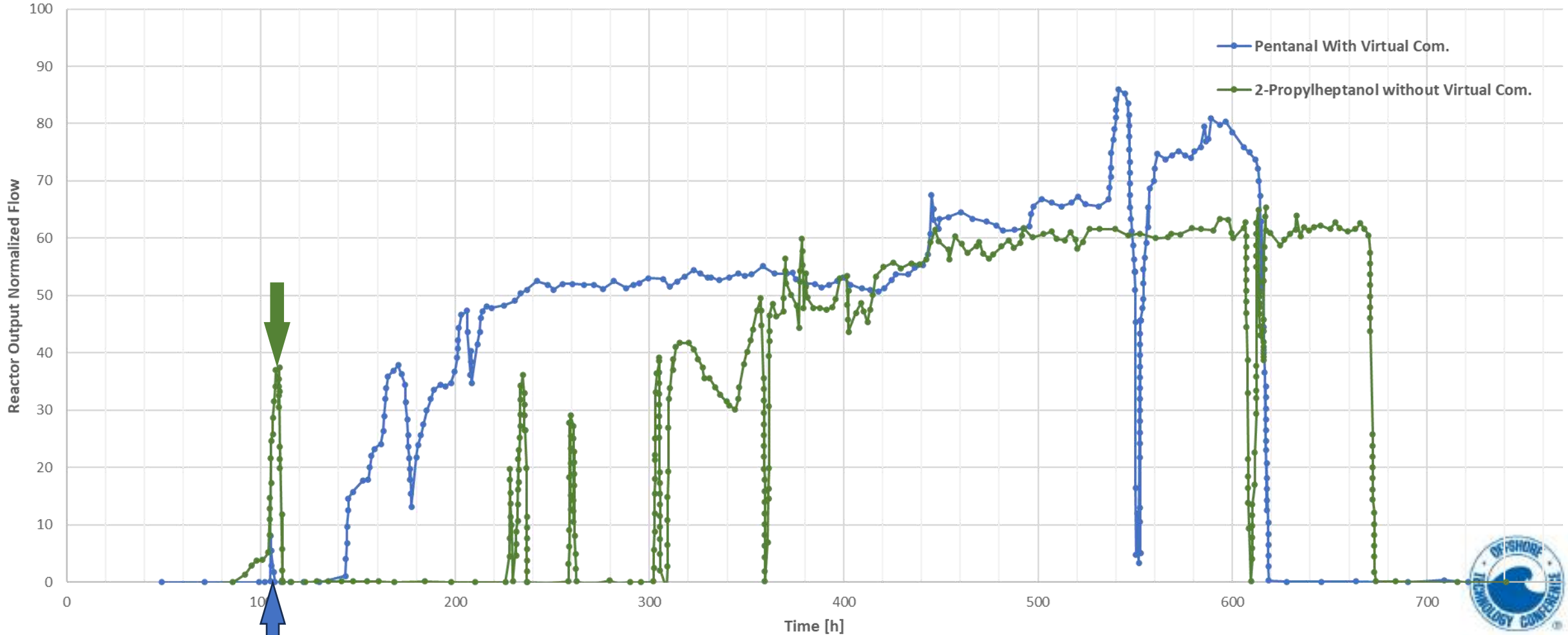
- Similarities with Pentanal process
- Hydroformylation of C4 alkenes and hydrogenation
- Requirement for compressor unit during stabilization





# Real Plant Startup Experience: Pentanal vs. 2-Propylheptanol

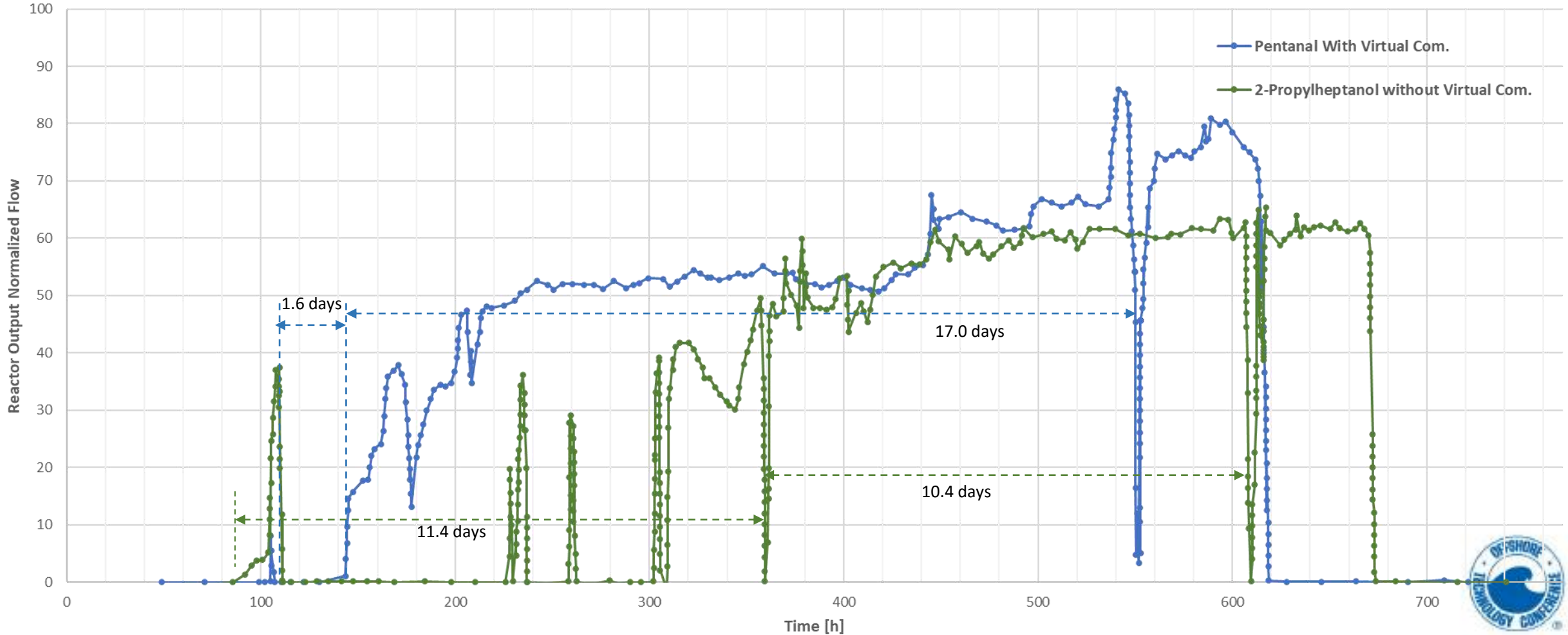
Initial Start-up comparison Process with (Pentanal) and without (2-Propylheptanol) Virtual Commissioning





# Real Plant Startup Experience: Pentanal vs. 2-Propylheptanol

Initial Start-up comparison Process with (Pentanal) and without (2-Propylheptanol) Virtual Commissioning



## Comparison of startup experiences

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- Benefits of virtual commissioning evident in Pentanal process
- Pentanal process: 2 successful startups in 1.6 days, running for 17.0 days
- 2-Propylheptanol process: Extended startup period of 11.4 days with 7 attempts, running for 10.4 days



## Conslusions

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Virtual commissioning as a valuable tool for process optimization and ICSS verification

Comprehensive verification of ICSS Logics

Verify the Commissioning Procedure

Shorten first start-up

Minimize incidents

Reduce unplanned shutdowns

Minimize flaring and emission through improvement of process operations

Improve plant Reliability & Safety





# THANK YOU

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