YINSON PRODUCTION

Lifecycle Modelling for FPSO, from Engineering Studies to OTS

Lifecycle Aspen HYSYS Modelling for FPSO, from Engineering Studies to OTS

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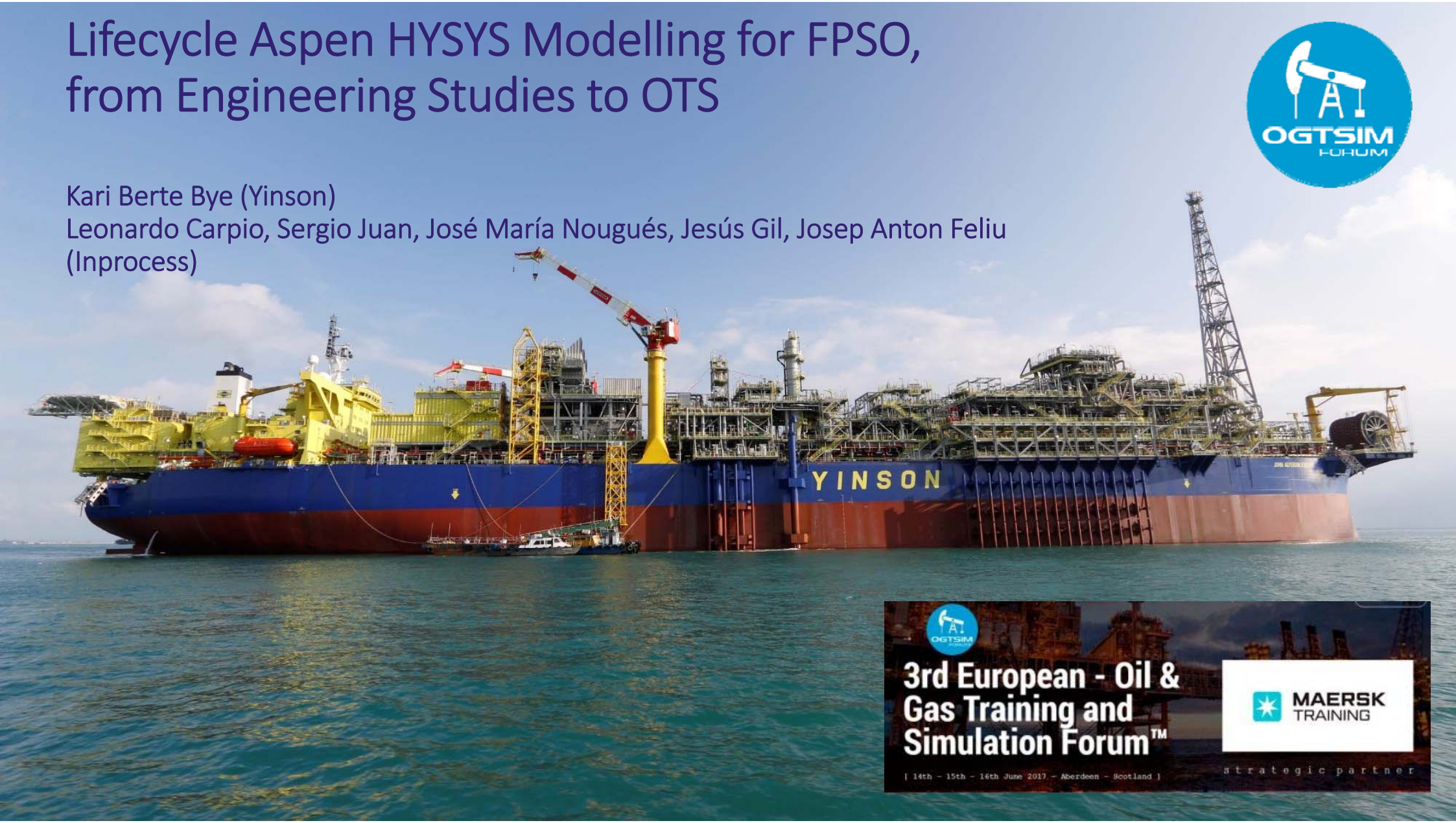

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A more comprehensive discussion of the risk factors that may impact Yinson's business can be found in the Group's latest Annual Report, a of copy which can be found on the Group's corporate website, www.yinson.com.my

Agenda

Yinson and Eni´s OCTP Project

- Motivation for Lifecycle dynamic modelling
  - Phase 1: Process Design & Control Validation
  - Phase 2: Procedures Verification & Early Senior CRO´s Training
  - Phase 3: ICSS Database Checkout
  - Phase 4: Operator Training System
  - Phase 5: FPSO Start-up Support
- Operator competency training program
- Yinson´s approach to Lifecycle
- Conclusions

YINSON PRODUCTION

Yinson Production – Our Fleet

FPSO Name	FPSO Allan
Charterer	CNR
Field	Olowi, Gabon
Storage Capacity	1.04 million barrels
Production Capacity:	
Oil	35,000 BOPD
Liquid	50,000 BLPD
Gas Compression	75 MMSCFD
Contract Duration	2009 – 2019 (2029)
Ownership	100% YINSON

FPSO Name	FPSO Adoon
Charterer	Addax Petroleum
Field	Block OML 123, Nigeria
Storage Capacity	1.7 million barrels
Production Capacity:	
Oil	60,000 BOPD
Liquid	140,000 BLPD
Water Injection	50,000 BWPD
Gas Compression	7 MMSCFD
Contract Duration	2006 – 2018 (2022)
Ownership	100% YINSON

FPSO Name	PTSC Lam Son
Charterer	PetroVietnam
Field	Block 1-2/97, Vietnam
Storage Capacity	350,000 barrels
Production Capacity:	
Oil	18,000 BOPD
Liquid	28,000 BLPD
Water Injection	15,000 BWPD
Gas Compression	47 MMSCFD
Contract Duration	2014 – 2021 (2024)
Ownership	51% PTSC, 49% YINSON

FSO Name	PTSC Bien Dong 01
Charterer	PetroVietnam
Field	Block 05-2/05-3, Vietnam
Storage Capacity	350,000 barrels
Contract Duration	2013 – 2023 (2033)
Ownership	51% PTSC, 49% YINSON

FPSO Name	Four Rainbow
Storage Capacity	600,000 bbls
Production Capacity:	
Oil	40,000 BOPD
Liquid	52,000 BLPD
Gas	10 MMSCFD
Ownership	51% YINSON, 49% PREMUDA

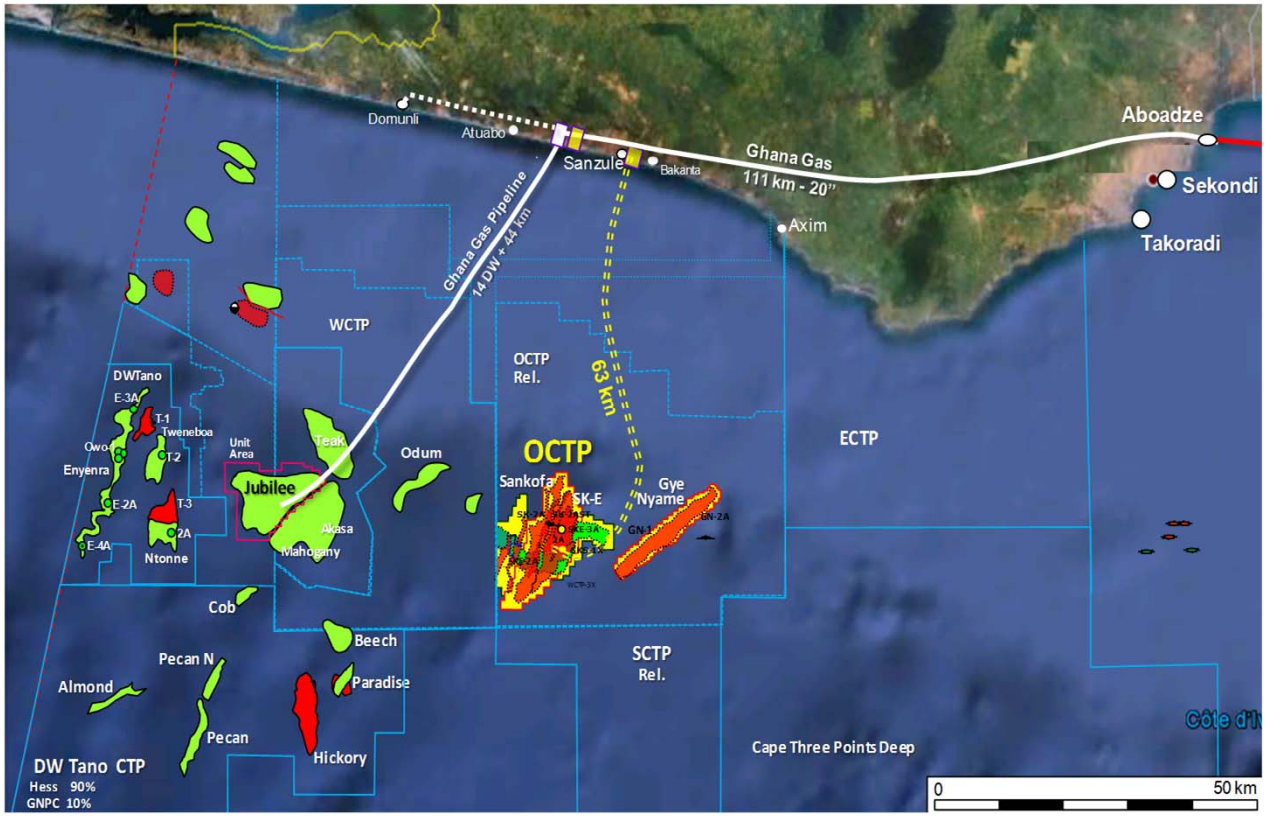
*For redeployment opportunity

FPSO Name	FPSO John Agyekum Kufuor
Charterer	ENI
Field	OCTP Block, Ghana
Storage Capacity	1.4 million barrels
Production Capacity:	
Oil	58,000 BOPD
Liquid	75,000 BLPD
Water Injection	55,000 BWPD
Gas Injection	165 MMSCFD
Gas Export	210 MMSCFD
Contract Duration	2017 – 2032 (2037)
Ownership	100% YINSON

Yinson Production and Eni´s OCTP Project

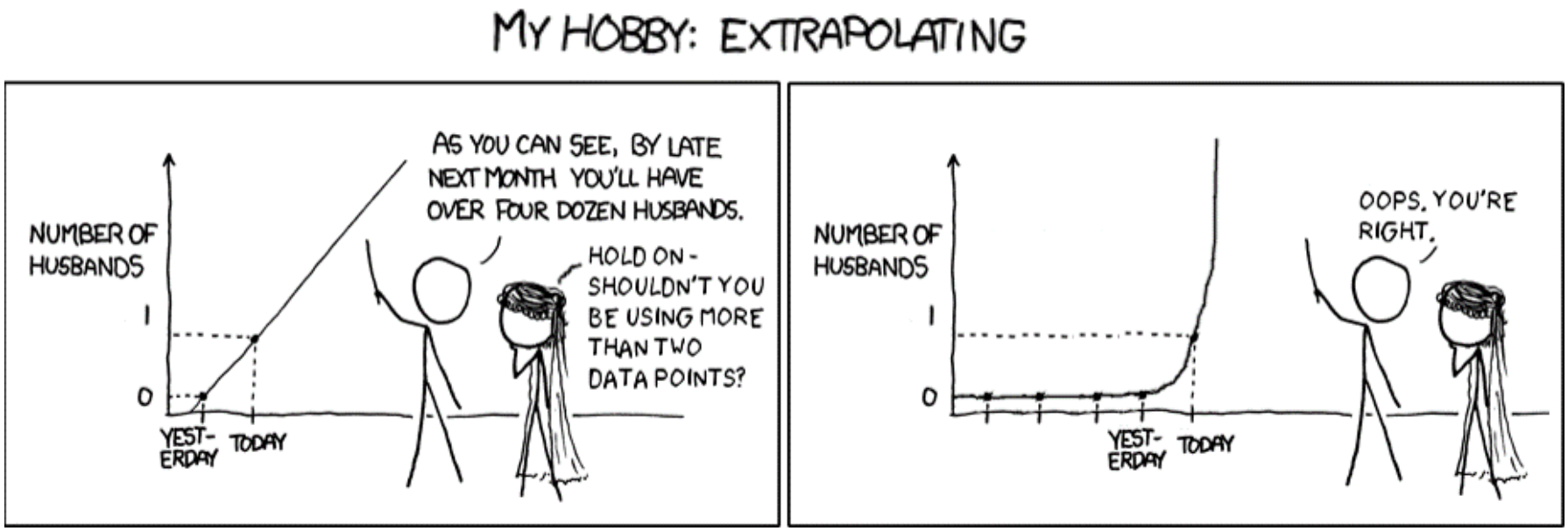
Yinson Production Pte Ltd (YP) is developing the Offshore Cape Three Points (OCTP) field, converting a double hull Very Large Crude Carrier (VLCC) oil tanker to a Floating Production Storage and Offloading (FPSO) to be located offshore of the Western Region of Ghana.

The OCTP block is located in approximately 900m of water depth and about 60km from the coast.



https://www.youtube.com/watch?v=1mxC1_1B6cM

Extrapolating experiences



Motivation for Lifecycle Dynamic Modelling: Challenges

Code is massive in modern ICSS, Can we test it in advance?

Is the design suitable for all potential transients?

How will the vendor packages (UCPs) interact with the ICSS?

Are equipment protected?

Will the Safety System perform well?

How to fully test the Operating Procedures?

Can we improve the plant's availability?

How to effectively train experienced CRO´s in advance?

How to safely train inexperienced operators?

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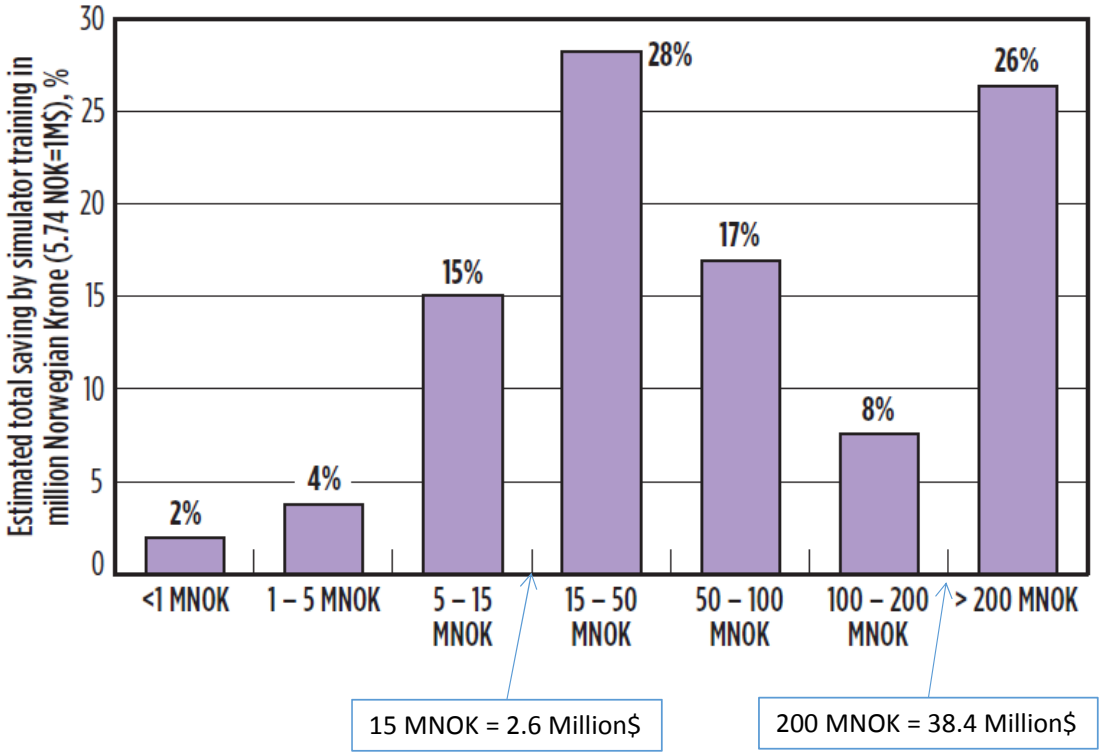
OTS Value Survey

- Increased Safety
- Minimize incidents (28% due to human error)
- Shortening start-up: around 10-20 days
- Reducing unplanned shutdowns by 2-3 per year
- Speeding-up planned shutdowns/start-ups by 2-3 days per year
- Increased production by 1-2%
- Flaring episodes minimized

15.3 million$ average estimated savings due to OTS

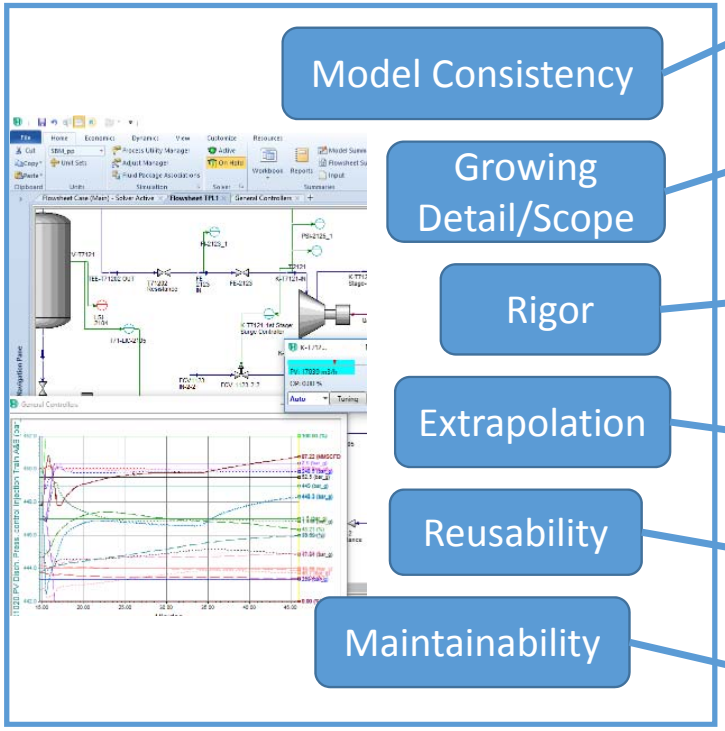


Source: http://hdl.handle.net/10642/1544

Motivation for Lifecycle Dynamic Modelling: Why Aspen HYSYS?

Yinson conceived the FPSO modelling from a Lifecycle perspective. But, what additional value does Aspen HYSYS provide to the Lifecycle?

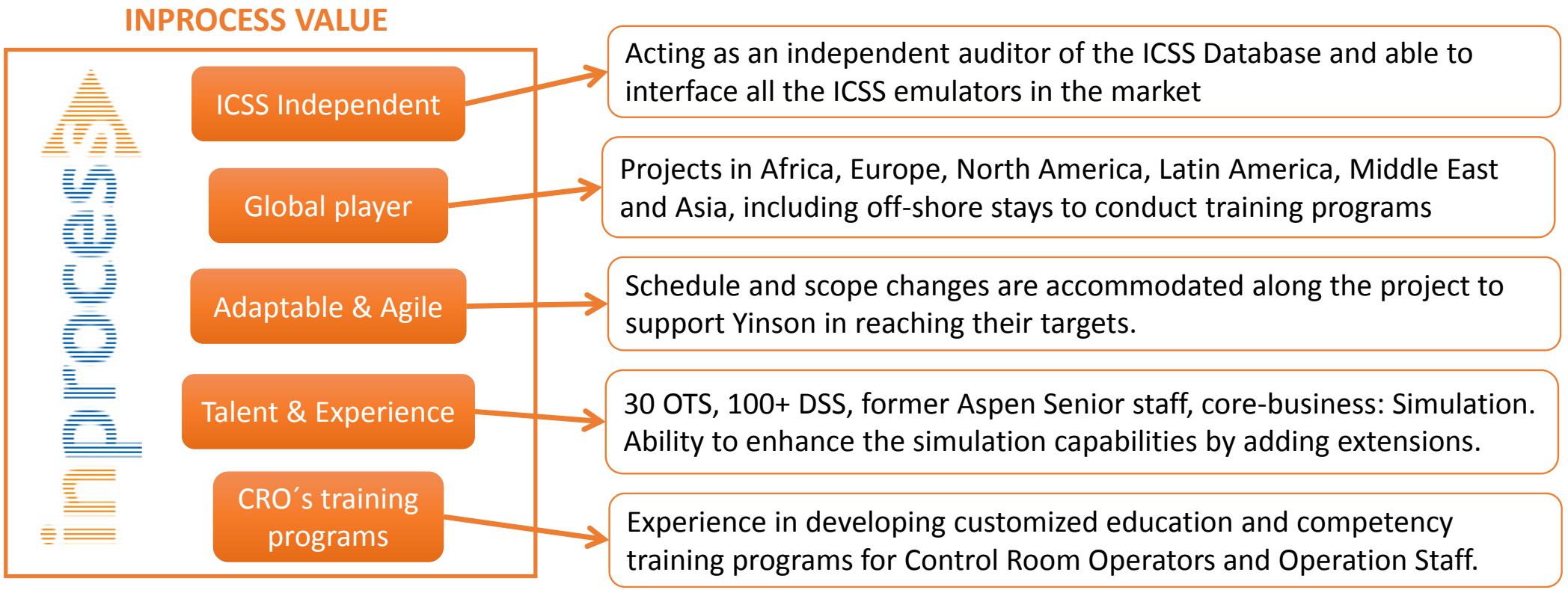
HYSYS LIFECYCLE PILLARS



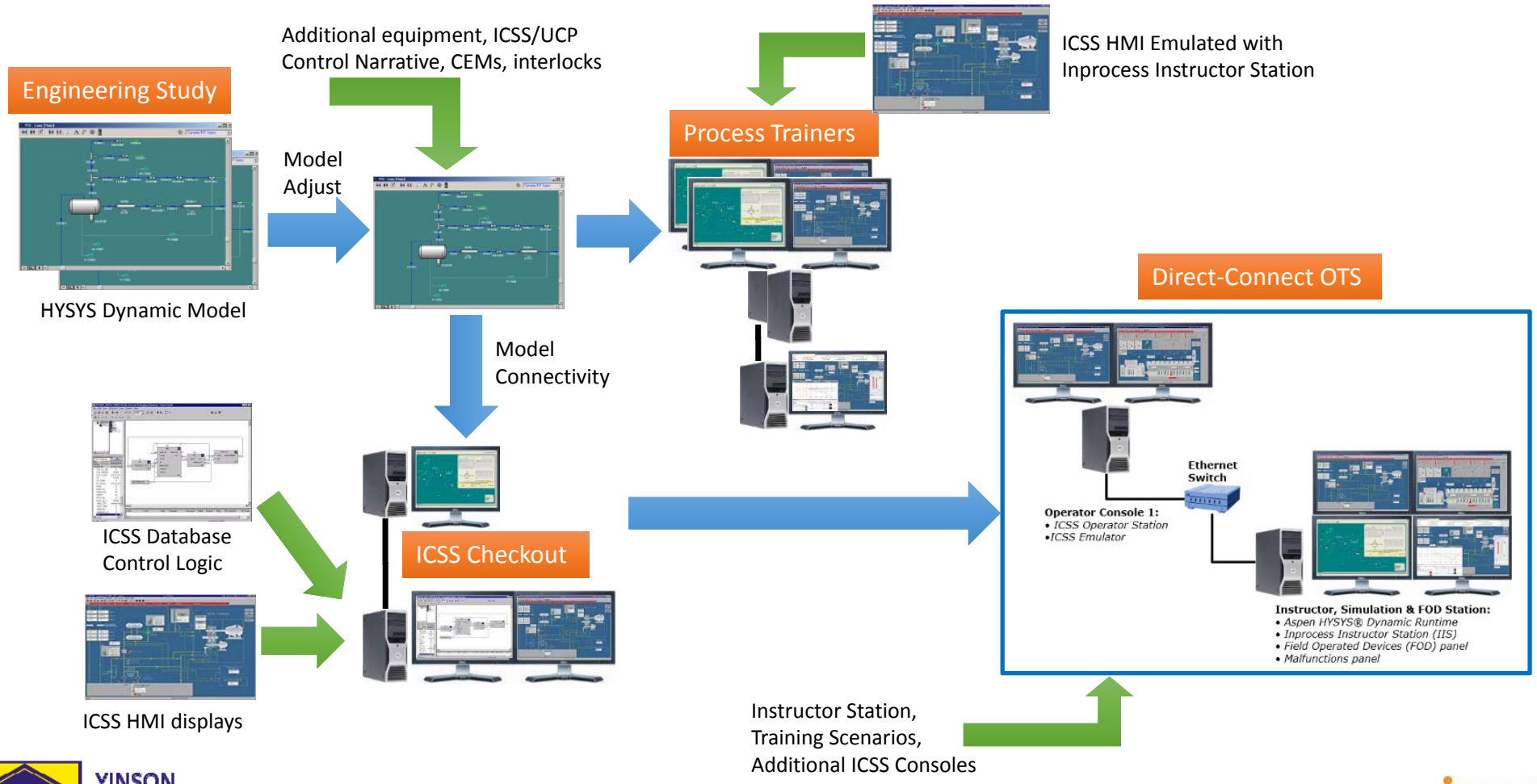
- **Model Consistency** → Thermo Packages are consistent with the Steady-Sate Design models. Data is introduced once and the model is used along the phases of the lifecycle.
- **Growing Detail/Scope** → Detailed Equipment data is available and refined as the project evolves. Additional process units can be incorporated as needed in the application.
- **Rigor** → CRO´s 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.

Motivation for Lifecycle Dynamic Modelling: Why Inprocess?

Yinson chose Inprocess as the company to fully exploit the HYSYS Lifecycle Dynamic Modelling envisioned for the OCTP project.



HYSYS Lifecycle Dynamic Modelling for the OCTP FPSO



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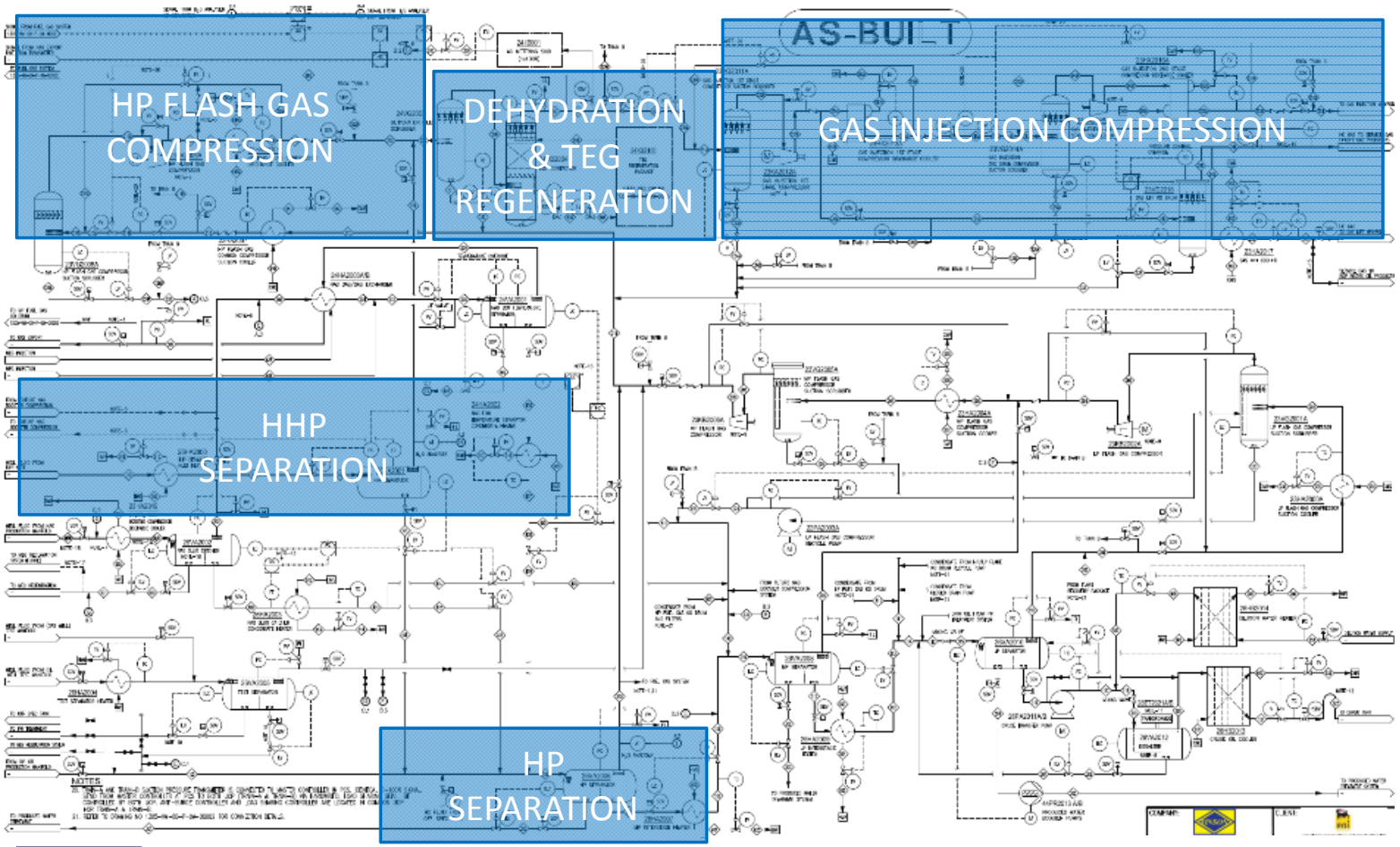
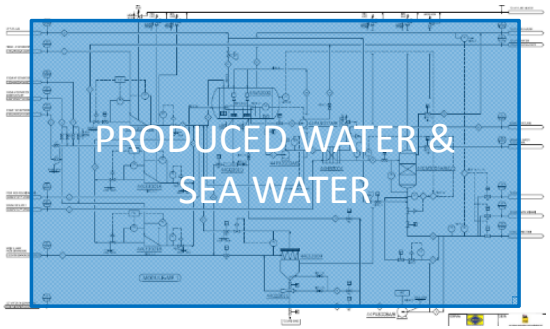
Phase 1: Process Design & Control Validation, DSS model scope



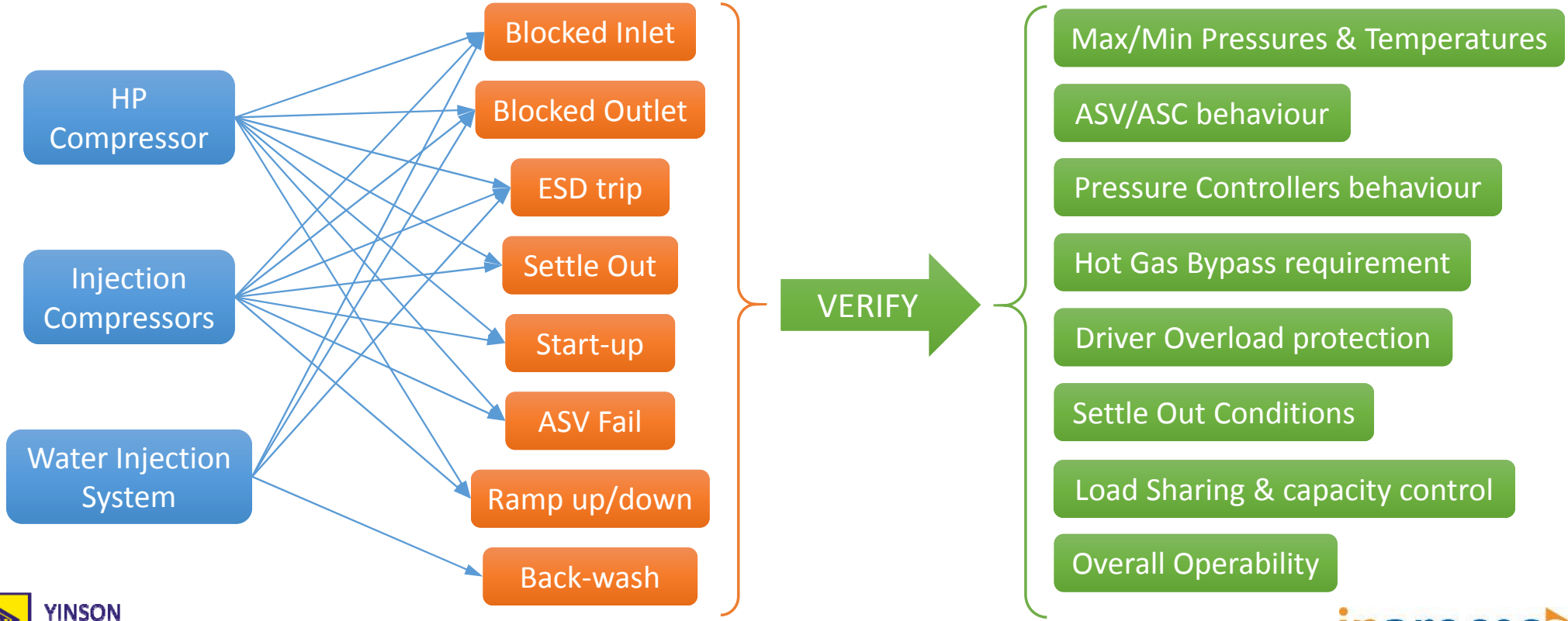
DSS →

Blue boxes indicate the areas included in the scope of the Dynamic Simulation Study

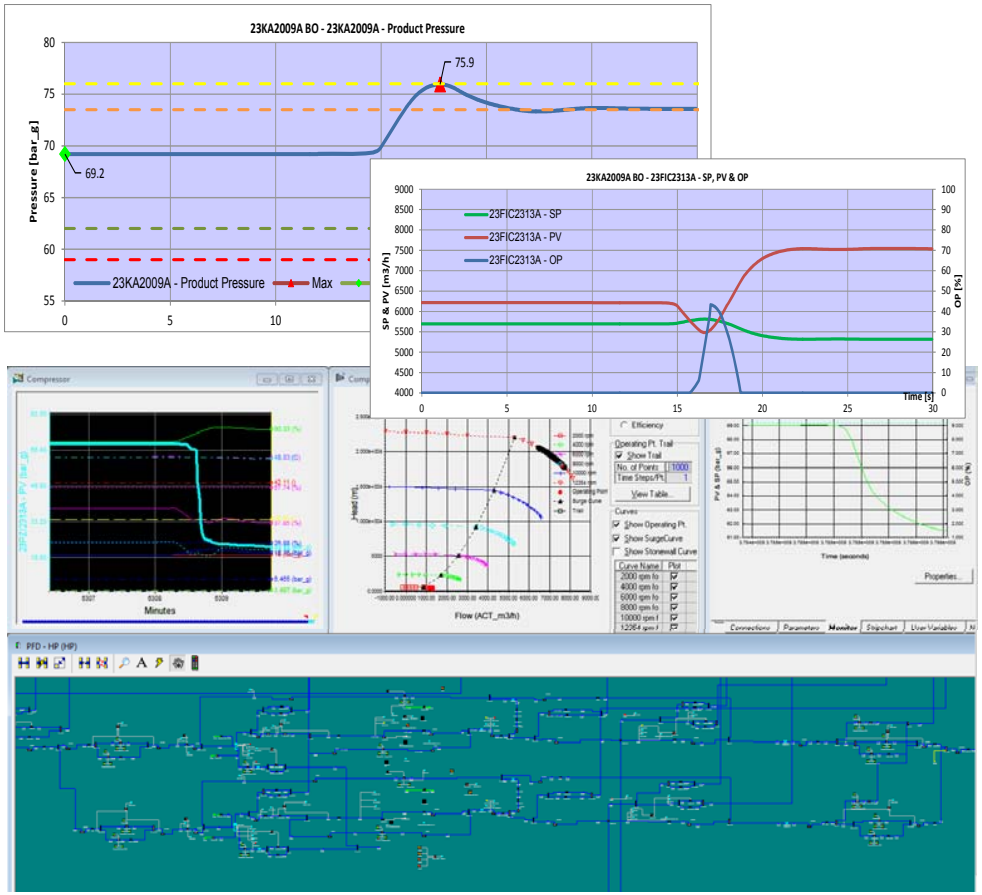


Phase 1: Process Design & Control Validation → Dynamic Simulation Study

20 dynamic simulation studies were performed during this phase to analyse the plant's transient dynamics, the control logic response , the procedures and the necessity of additional protective equipment



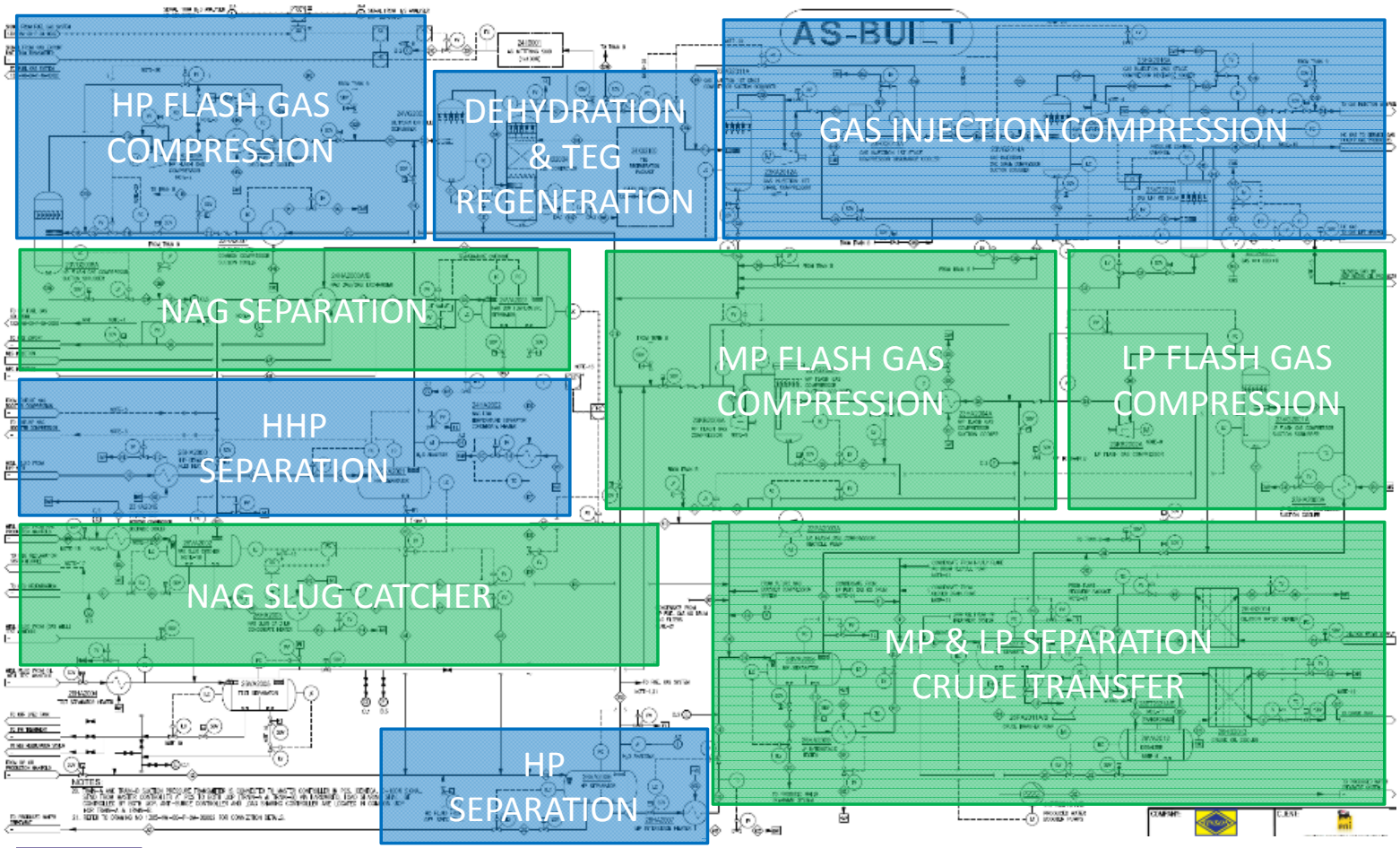
Phase 1: Process Design & Control Validation → Dynamic Simulation Study



Main findings of dynamic analysis:

- Discharge pressure override for throttle valve is required
- Settings of the ASC to avoid certain trip conditions
- Requirements for additional protection in surge scenarios
- No additional torque requirements for start-up after ESD
- Settle out conditions after ESD
- Verification of alarms, trip limits and PSVs setting
- Gain insight of the timing and procedures
- Verification of the 3rd party package procedures

Phase 2: Process Trainer - DSS model scope versus Training model scope



DSS → 

Blue boxes indicate the areas included in the scope of the Dynamic Simulation Study

Training →  + 

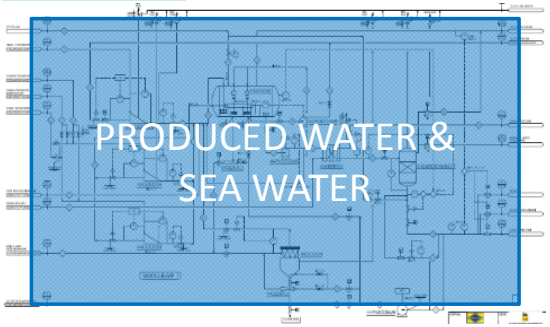
Green boxes indicate the areas added to the HYSYS Dynamic model for training

HEATING COOLING MEDIA

MEG REG. SYSTEM

HP & LP FLARE

FG SYSTEM



Phase 1/2: Control Narrative Verification

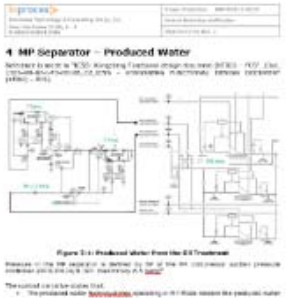
The HYSYS Dynamic model from the DSS was expanded with new units, the latest control logic implemented and the UCP sequences from the compressor packages.

The model was used to verify the Control Narrative Specifications:

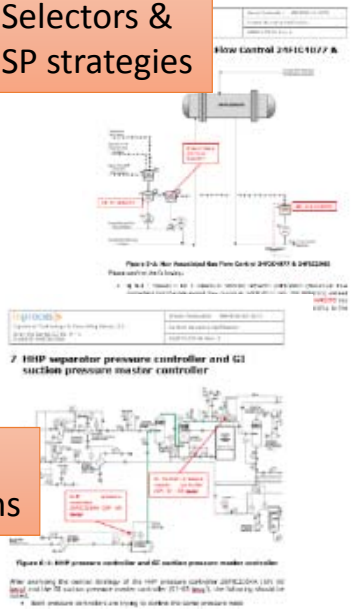
- Control interactions with UCP
- Normal operation
- During non-design conditions
- During specific procedures
- Understanding the limits of the system
- Alarm & Trip limits
- Controller pre-setting
- Verify equipment protection

Flare Controller Set Points

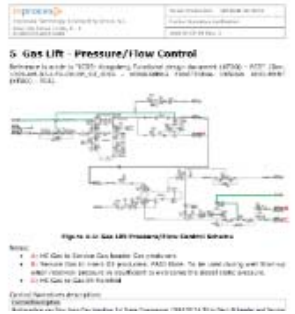
Instrument Ranges & Trip Settings



Selectors & SP strategies



Calculations & Override Controllers



Loops Interactions

Phase 2: Procedures Verification

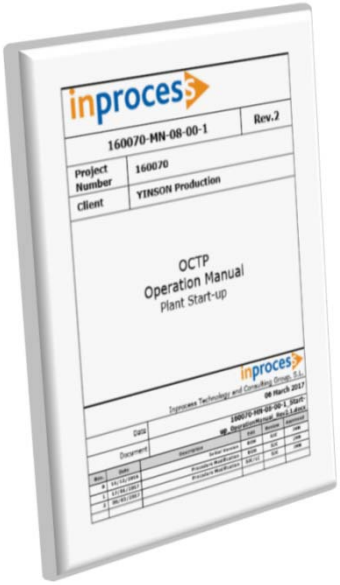
Early verification of Operating Procedures with timing and transitions conditions

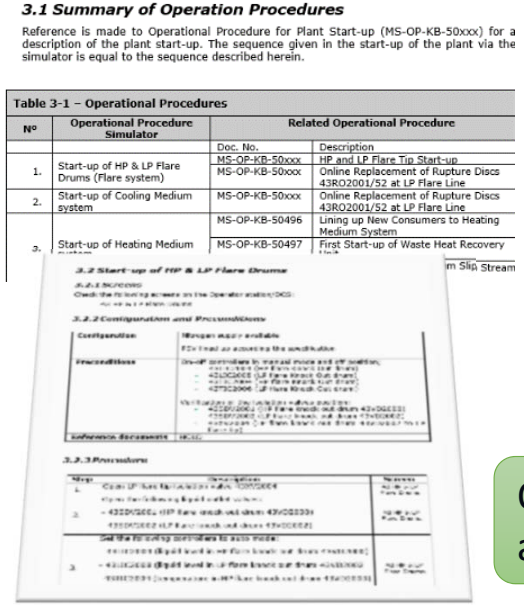
Scope:

- Individual Units
- Overall Start-up process

Combining Expertise's:

Mix of experienced Engineers / Operators know-how with realistic response of Process Trainer



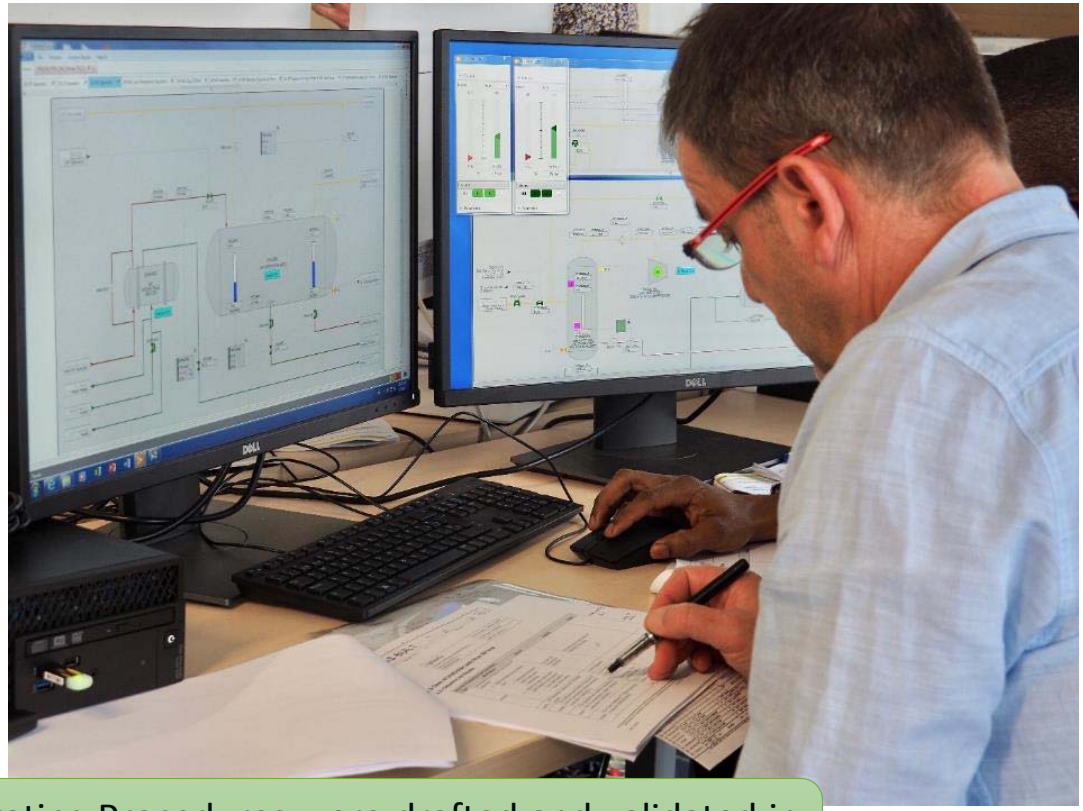


3.1 Summary of Operation Procedures

Reference is made to Operational Procedure for Plant Start-up (MS-OP-KB-50xxx) for a description of the plant start-up. The sequence given in the start-up of the plant via the simulator is equal to the sequence described herein.

Table 3-1 – Operational Procedures

N°	Operational Procedure Simulator	Related Operational Procedure	
		Doc. No.	Description
1.	Start-up of HP & LP Flare Drums (Flare system)	MS-OP-KB-50xxx	HP and LP Flare Tip Start-up
		MS-OP-KB-50xxx	Online Replacement of Rupture Discs 43RO2001/52 at LP Flare Line
2.	Start-up of Cooling Medium system	MS-OP-KB-50xxx	Online Replacement of Rupture Discs 43RO2001/52 at LP Flare Line
3.	Start-up of Heating Medium	MS-OP-KB-50496	Lining up New Consumers to Heating Medium System
		MS-OP-KB-50497	First Start-up of Waste Heat Recovery



Operating Procedures were drafted and validated in a close interaction between Yinson and Inprocess

Phase 2: Process Trainer - Early CRO´s Training

Using the ***Inprocess Instructor Station*** software, an HMI layer was added on top of the HYSYS model using the same displays of the ICSS control room.

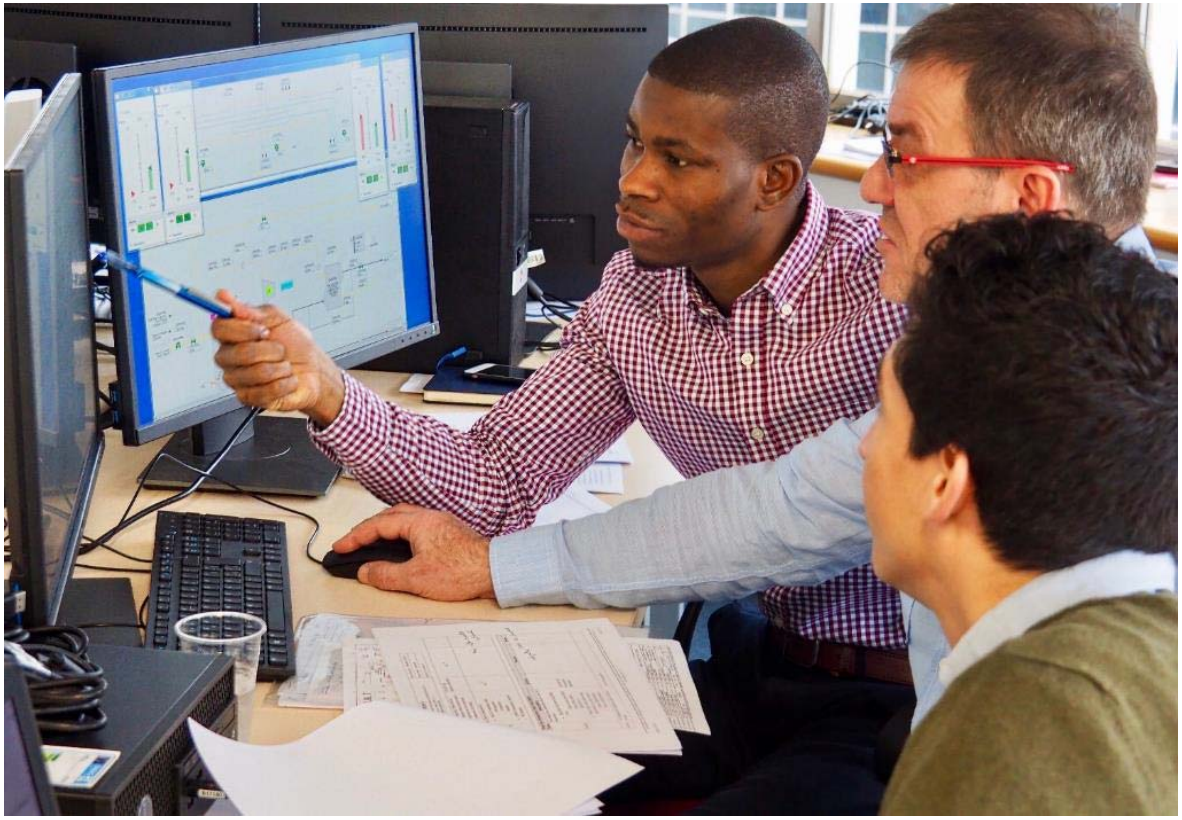
Early CRO´s and Supervisor Training

Knowledge Transfer

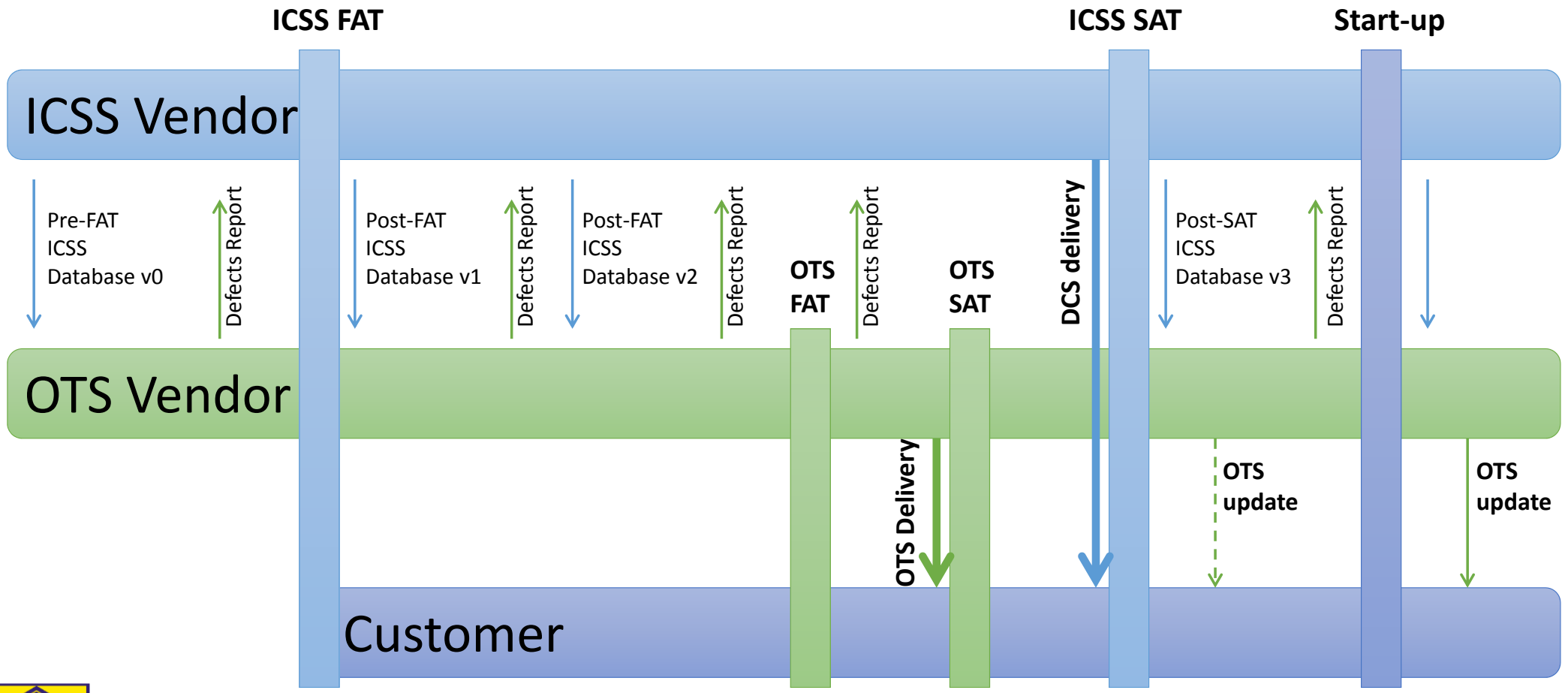
- Control Interactions and Issues
- Limits of the system

Training Scope

- ICSS displays familiarization and operability verification
- Start-up / Shutdown Procedures
- Trip scenarios
- Disturbances and Malfunctions



Phase 3: ICSS Database Checkout



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Phase 3: ICSS Database Checkout

	STANDARD ICSS FAT	ICSS FAT with HYSYS
Hardware	Actual ICSS modules	Standard PCs or laptops
Software	Actual ICSS software	ICSS emulator, Aspen HYSYS Dynamics
Location	At ICSS vendor Facilities	At any location (Inprocess, Customer, EPC, etc)
Timing	When ICSS hardware and I/Os modules are available	As soon as ICSS logic and configuration is available
Testing proceeding	Limited to the I/O signal introduced by hand	Same as commissioning & start-up with real plant
Procedures testing	Limited verification	All procedures and start-up/shutdown sequences
Loop testing	No possible	Full, as in real plant
Alarm verification	Only non-time dependent	Full, as in real plant
SIS verification	Limited, no plant interaction	Full, as in real plant

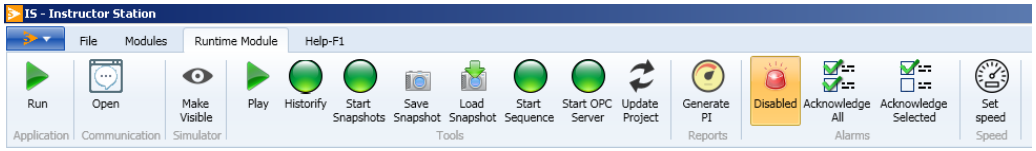
Phase 4: Operator Training System Development - Inprocess Instructor Station

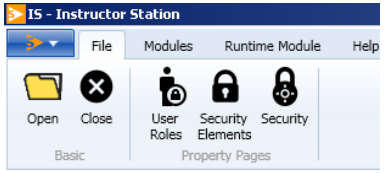
Inprocess Instructor Station (IIS) is the backbone of any Inprocess OTS. IIS is the glue that connects all other data nodes in our OTS solutions.

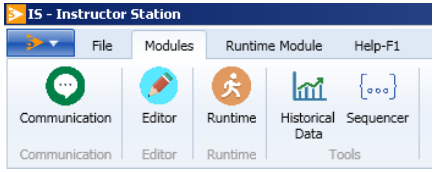
IIS allows to load models, navigate through process displays, make parameter changes, save snapshots, launch scenarios, insert malfunctions, log actions and evaluate operator performance, etc.

Furthermore, the instructor is able to see all the process information available to the operator, as well as certain “key” internal process variables.

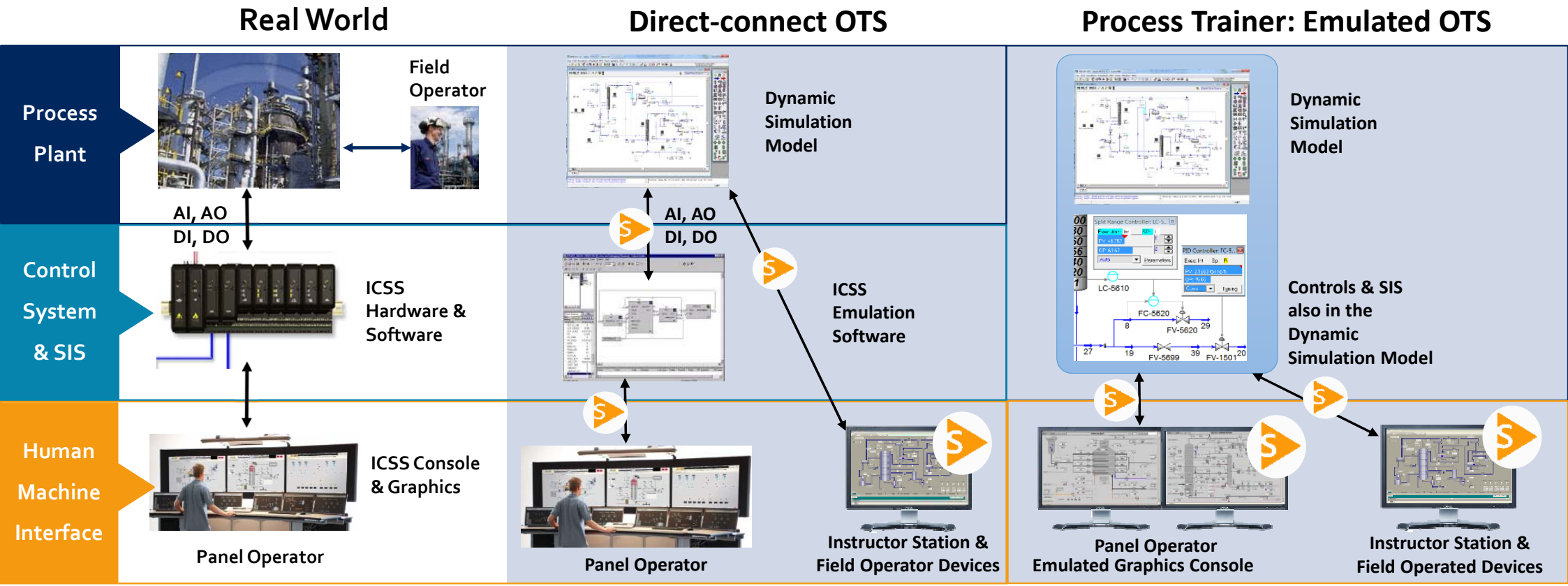
It is also used as the Field Operated Devices station.





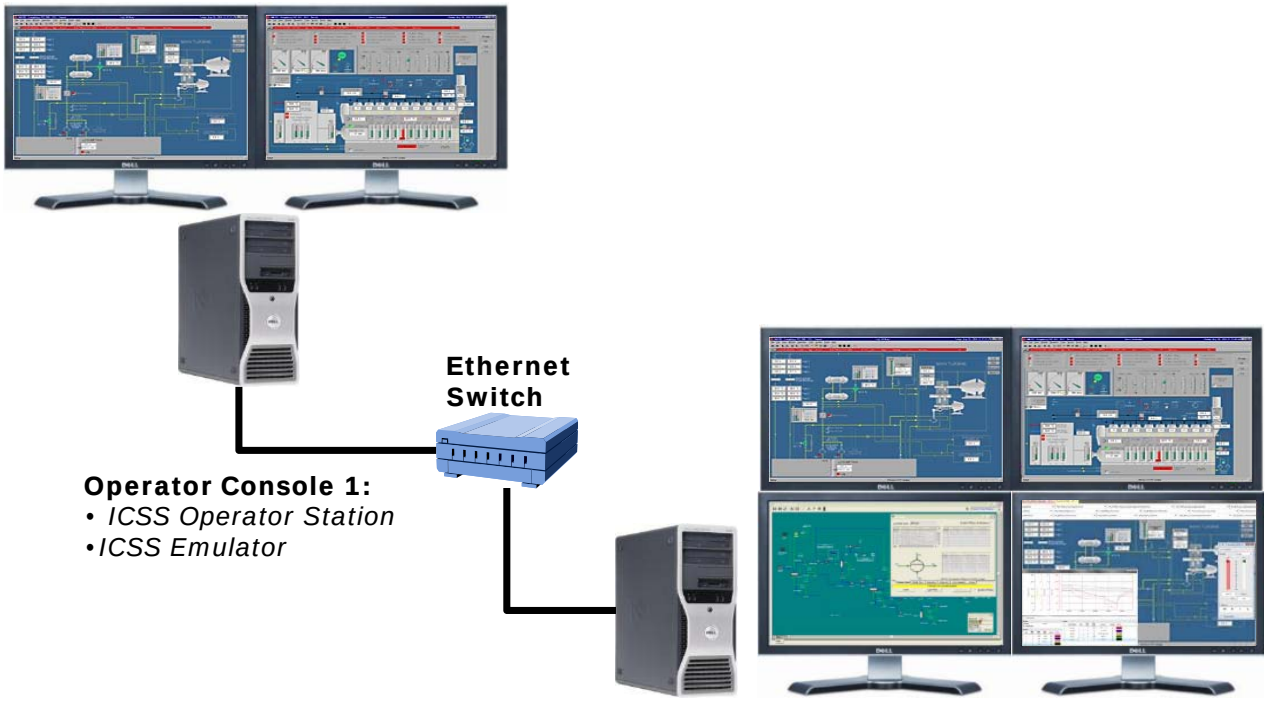


Phase 4: Operator Training System Development

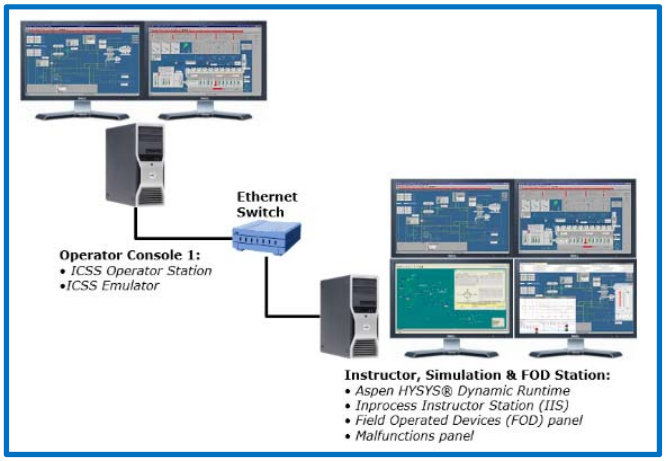


Inprocess Instructor Station connects all these items, and fills some gaps in certain architectures.

Phase 4: Operator Training System Development - Architecture

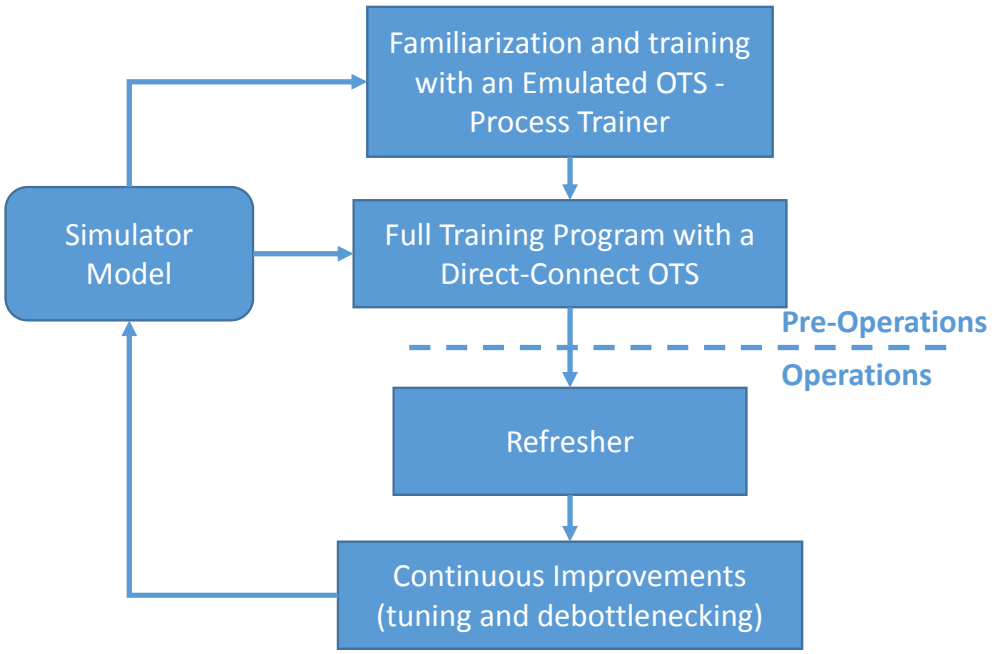


OTS replica



In addition to the OTS installed in the onshore Yinson Training Center in Ghana, a full replica is also installed at the FPSO

Operator Competency Development Program

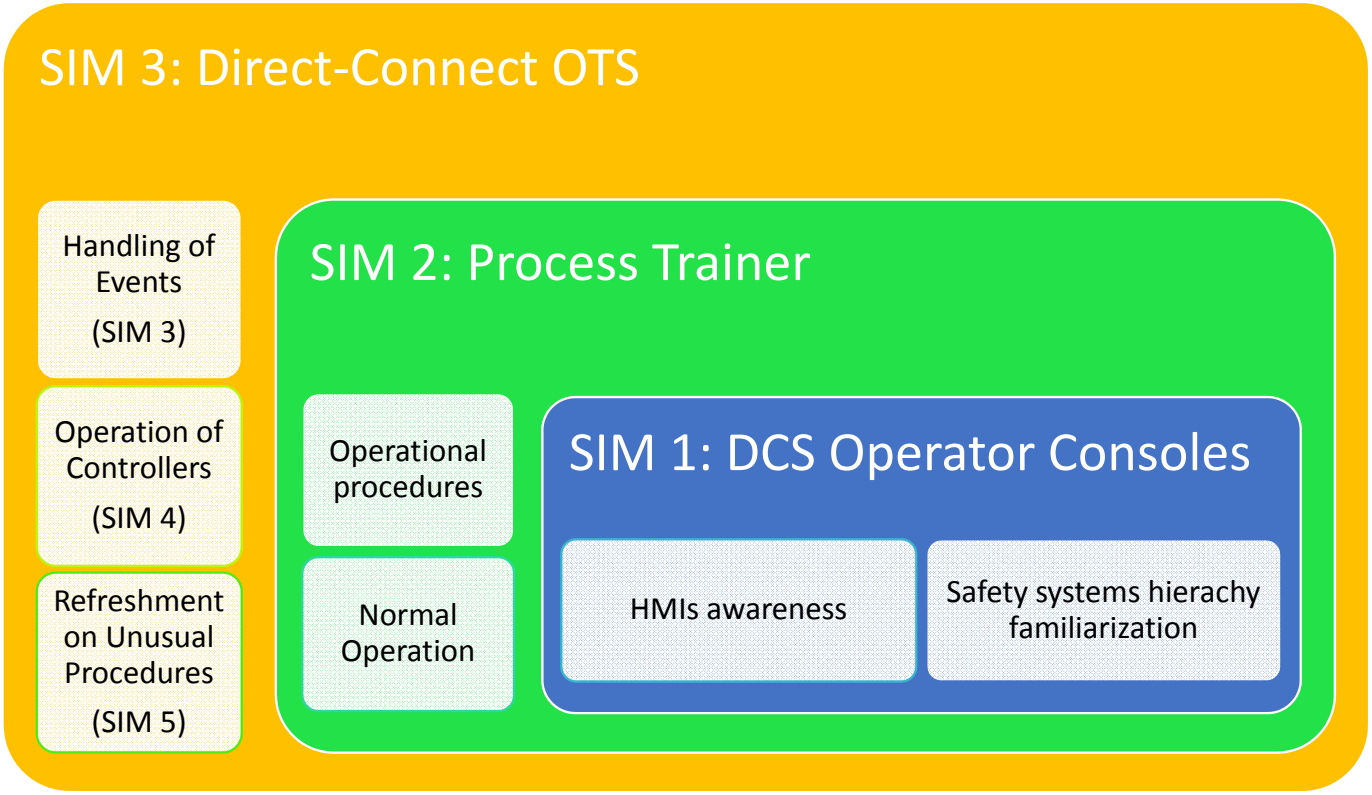


Yinson, in adherence to their Asset Integrity Management, needed an operators competency development plan, based on a high-fidelity simulator model, that should involve the pre-operation, operation and continuous improvements phases of the FPSO:

- The program begins with training sessions to get familiarized with the system and to identify and understand its limitations. The Process Trainer is used to gain process insight and to verify and improve the operating procedures.
- Once the process model is connected to the emulated ICSS, training sessions for all scenarios will commence with the Direct-Connect OTS solution
- Finally, the need for refreshment and continuous improvement during the operations phase leads to continuous updates in the real ICSS and in the OTS

Operator Competency Development Program

Along three project stages, Yinson will benefit from different project deliverables to develop the skills of the FPSO operators:



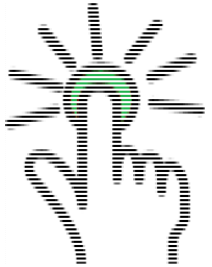
Phase 5: Start-up Support

- Re-run of low gas production scenarios
- Tuning of all controllers
- Supporting the instructor during SIM-3 training lessons
- Troubleshooting of potential issues with controllers tuning, alarms setting, start-up procedure, safety system, etc.

Yinson Production's Quotes after Start-up

"The preparations through the simulator exercises and pre-tuning of the controllers really seems to pay off – basically the operators have been running everything in auto since the start-up. Thank you very much for your effort and dedication to the simulator! Well done!"

"We have been running through the oil train with diesel pumped by the diesel circulation pumps, down to the subsea flowlines and up into the oil separation train HP/MP/LP and to Offspec Tank. Looking real good. The variations in flow has been from 5m³/h to more than 230m³/h. All three vessels has a constant level and interface level."



"We have "produced" for about 40 hrs in auto mode with only some fine tuning here there. What can I say, except so far this model of yours have performed far above all expectations. Very impressive."

"They actually managed to start the process in auto, and the oil process has been running smoothly for 3 days now, despite the wells being quite "sluggy"! This is quite extraordinary, and is something Company has never experienced before, according to feedback from start-up team."

Kari Berte Bye, OTS Project Leader at Yinson Production

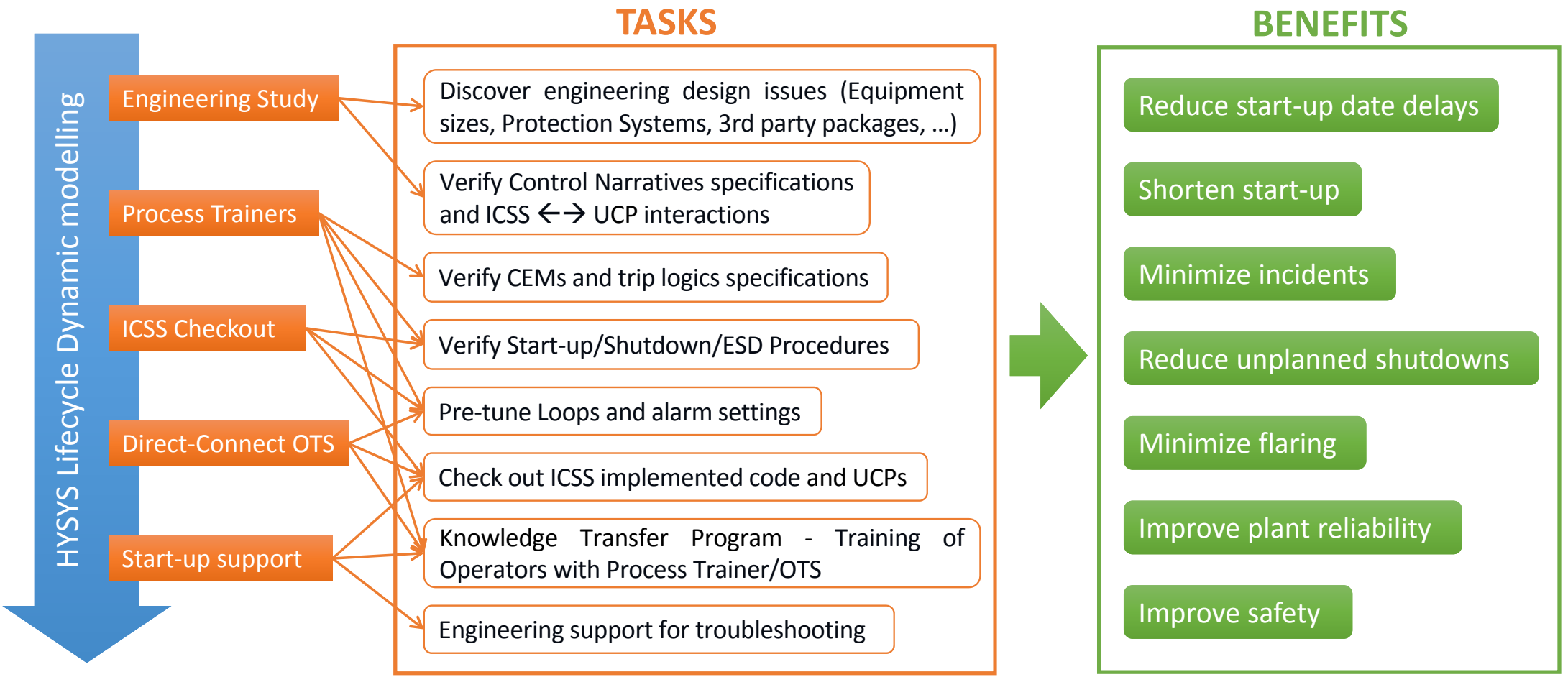
ENI's Press Release after Start-up

Eni has launched production from the Integrated Oil&Gas Development Project, in the Offshore Cape Three Points (OCTP) block, off Ghana's western coast, in just two and a half years, and three months ahead of schedule, reaching another record time-to-market

"Starting production only two and a half years after the approval of the Development Plan – *Eni CEO Claudio Descalzi said* - is an extraordinary result and a reason for great pride. It certifies our exploration skills and knowledge, as well as our field development vision, and it confirms the effectiveness of our new operational model, where Eni has a central role in project management, aimed at improving time-to-market"

https://www.eni.com/docs/en_IT/enicom/media/press-release/2017/05/PR_First_oil_Ghana.pdf

Conclusions



Q&A

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