

Belanak FPSO – 5 years of Successful Operation and Its Application to Floating LNG



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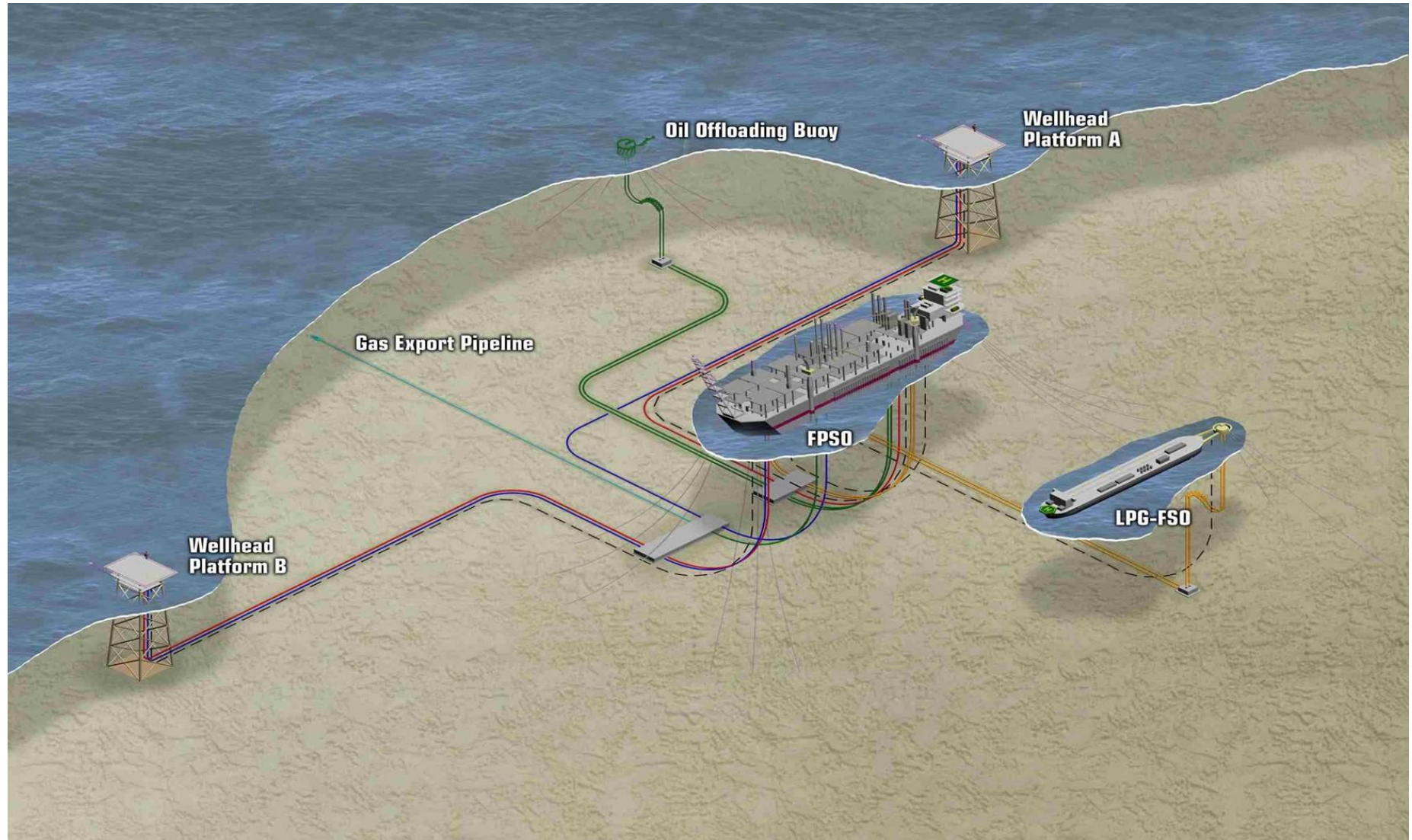
1. Block B Indonesia
2. Field Development
3. FPSO Project
4. FPSO Operating Experience
5. Optimized Cascade[®] Process Overview
6. Floating LNG Challenges
7. Stepping Stones to FLNG

Optimized Cascade[®] is a registered trademark of ConocoPhillips Company

COP Integrated Gas – SE Asia



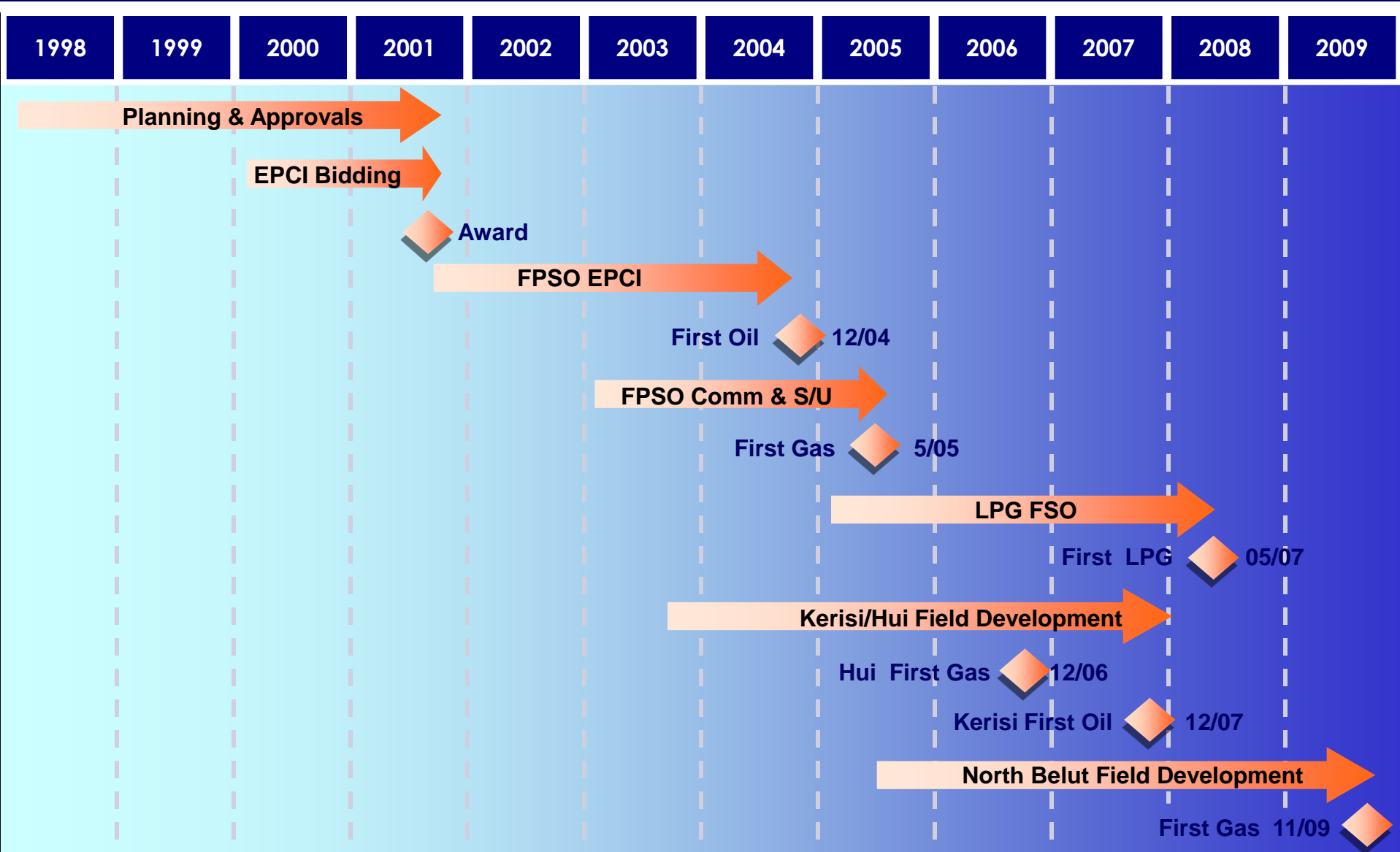
Belanak Field Development Plan



19 FPSO MODULES (~25,000 Te)



Eastern Hub Development



Belanak – Some Facts



- 100,000 BPD Oil
- 500 MMSCFD Produced Gas
- 25,000 BPD LPG
- 4,000 BPD Condensate
- 120 Person Living Quarters

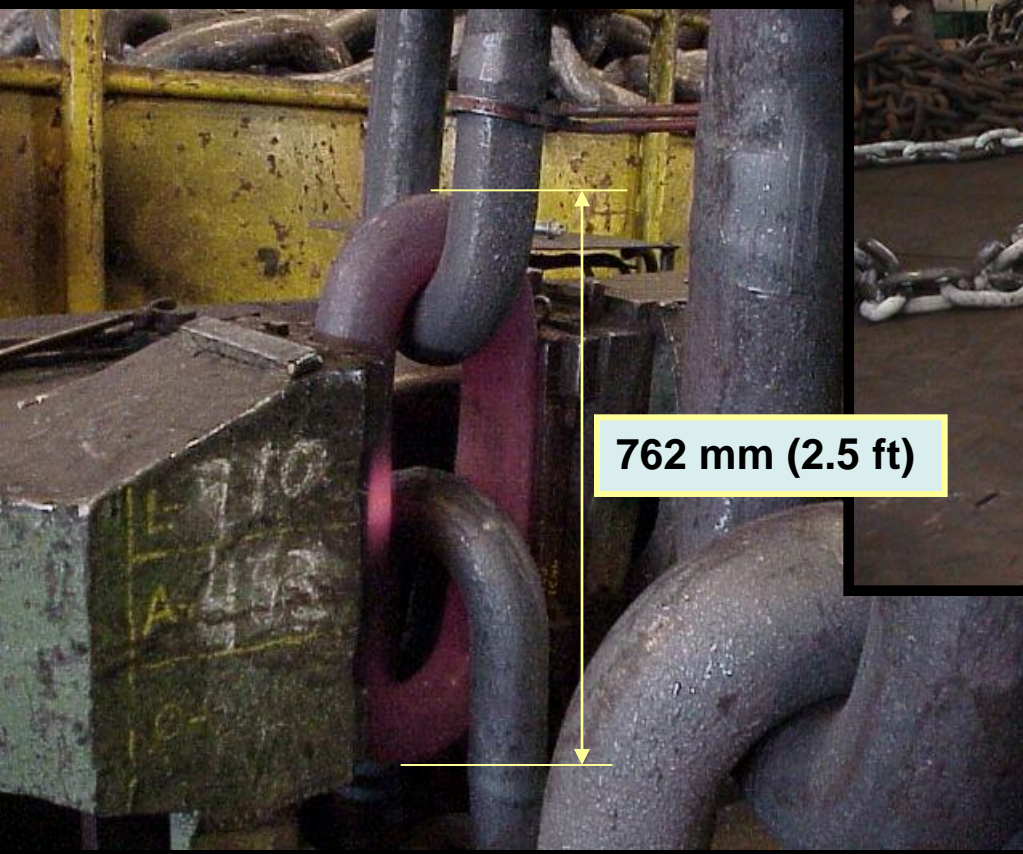
- 285m LOA x 58m W x 26m D
- 1,140,000 Bbls oil storage
- 11 km of anchor chains

- 112 MW of gas turbines
 - 2 x RR RB-211 Export Compression
 - 5 x RR Avon Power Generation

- 25,000 Te of topsides (dry)
- 7,500 Te of structural steel
- 225 pieces of equipment
- 2,500 valves
- 34 km of piping
- 117 km of cable
- 3,500 peak construction labor

FPSO Fixed Mooring System

14 Suction Piled Anchor Chains
Total Length: 10,750 m
Max pull: 358 Te (398 Te 2 stall)
Fairlead to Chain Burial: 639 to 755 m



127mm, R3, Standard Link = Top Chain
132mm, R3, VGW Link = Main Chain

High Pour Point Waxy Crude

- Wax Appearance Temperature as high as 55 °C
- Pour Point as high as 24 °C
- Mercury content

Blending with gas plant condensate reduces WAT for offloading
Mercury contamination managed through testing and process optimization

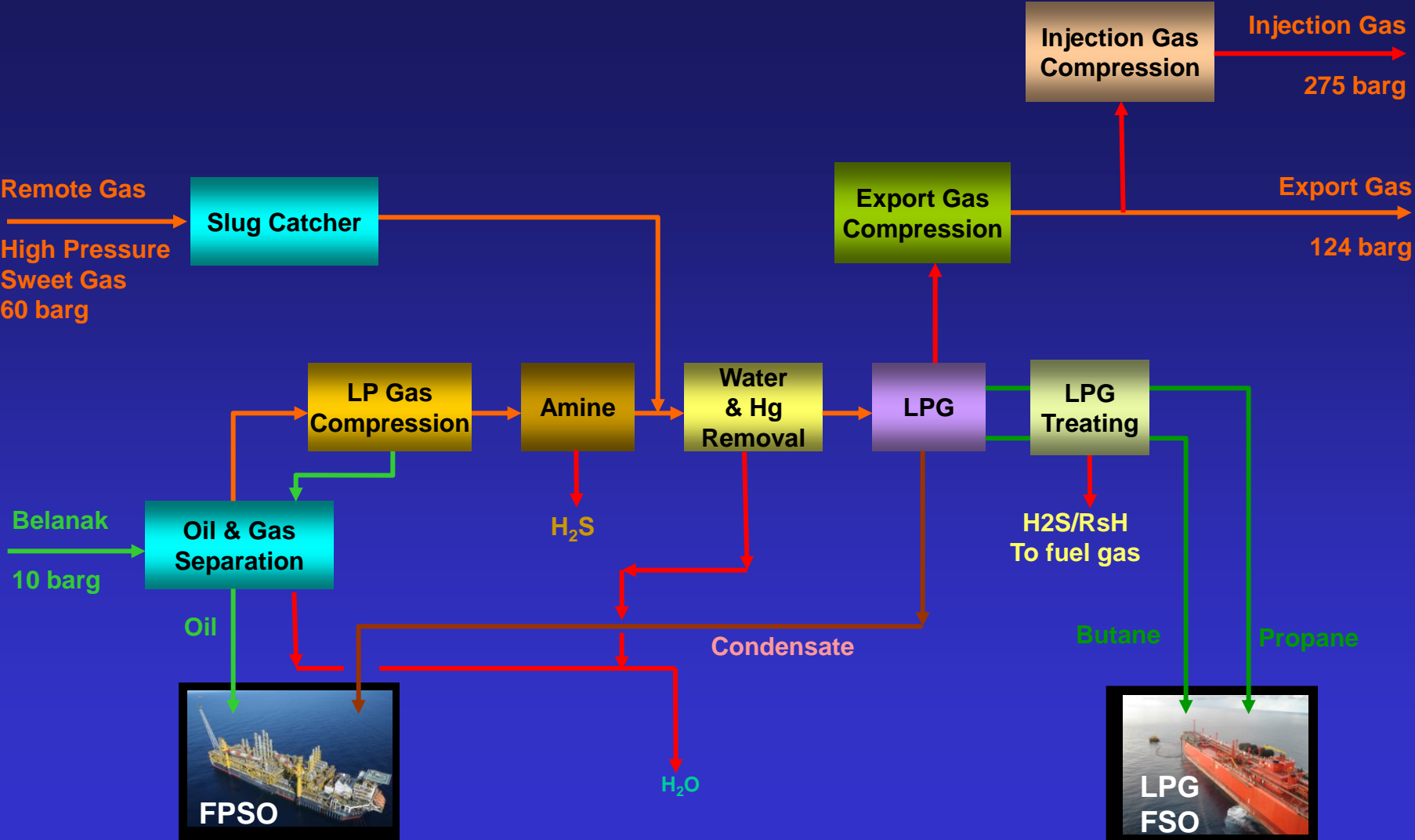
Sour Gas

- Up to 100 ppm H₂S
- 8-10% CO₂
- Mercaptans
- Mercury

Gas treatment to pipeline specification

Mercury Guard bed and Hg Sieve adsorbent in the Molecular Sieve for series mercury removal and polishing upstream of aluminum feed gas exchangers

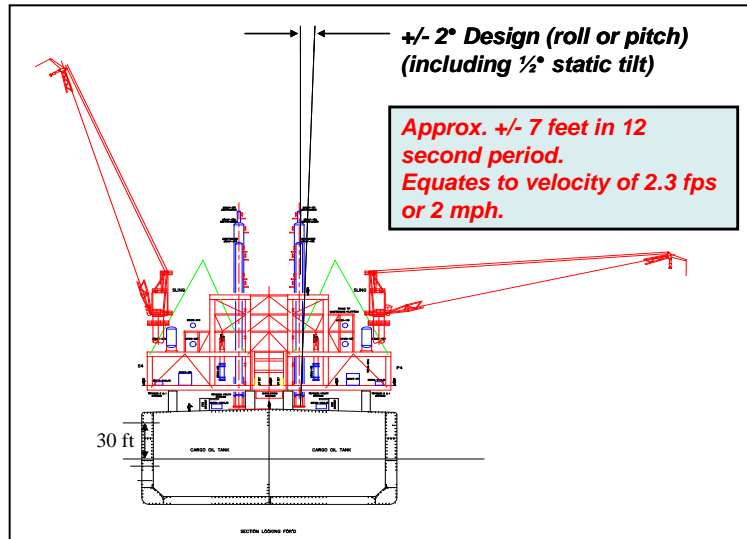
Belanak Topsides Process Flow



- Ship Motions Impact on Distillation
- Safety of LPG Inventories
- Commissioning & Start-Up

The Voyage to Floating LNG – Belanak

- Gas treatment & processing design for vessel motions



Process Column Design Limits

- +/- 2° roll or pitch
- Roll/pitch/trim exceeds 1.75° < 1%



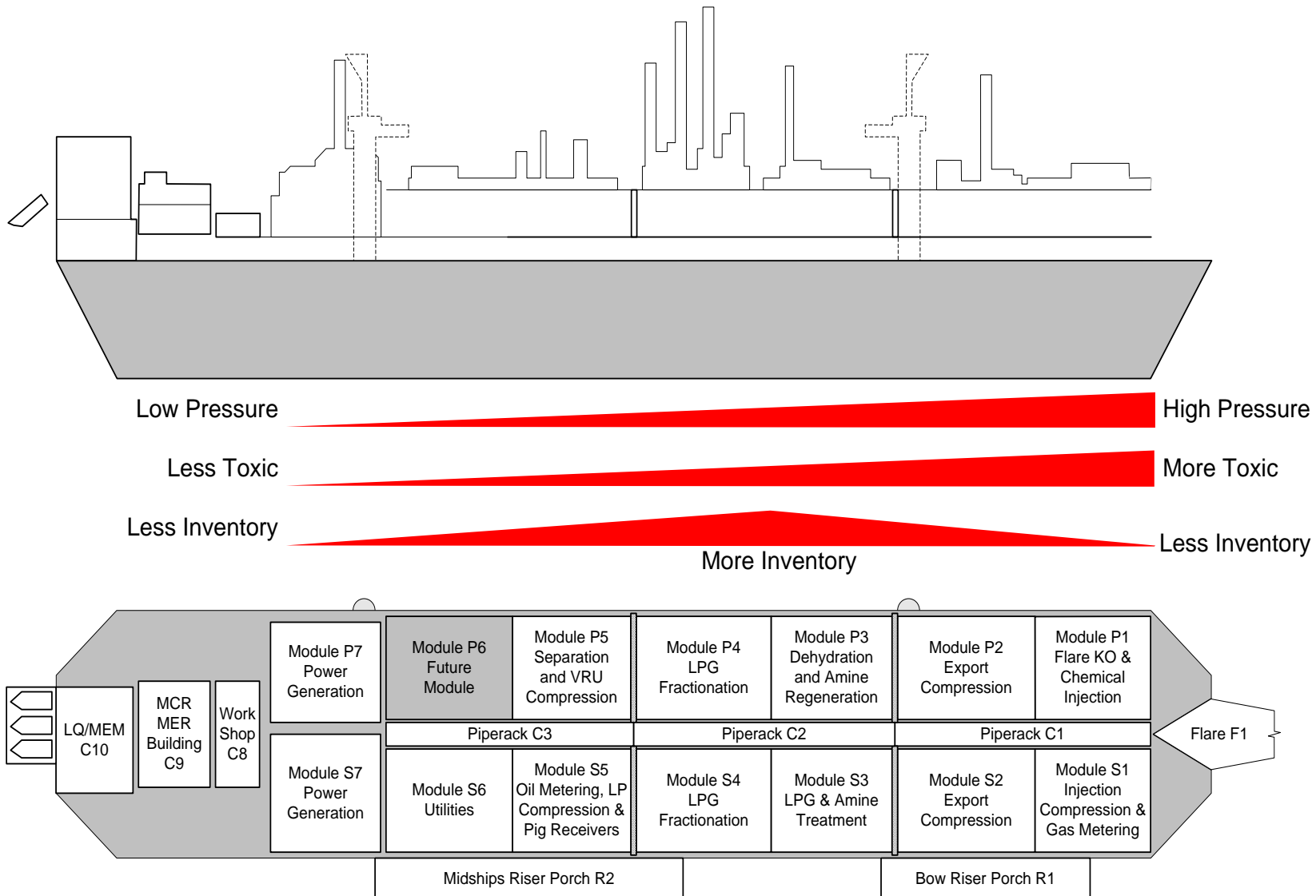
Design Approach

- Only use proven distributor design
- Extensive design verification
- Close inspection
- Motion distributor testing at supplier

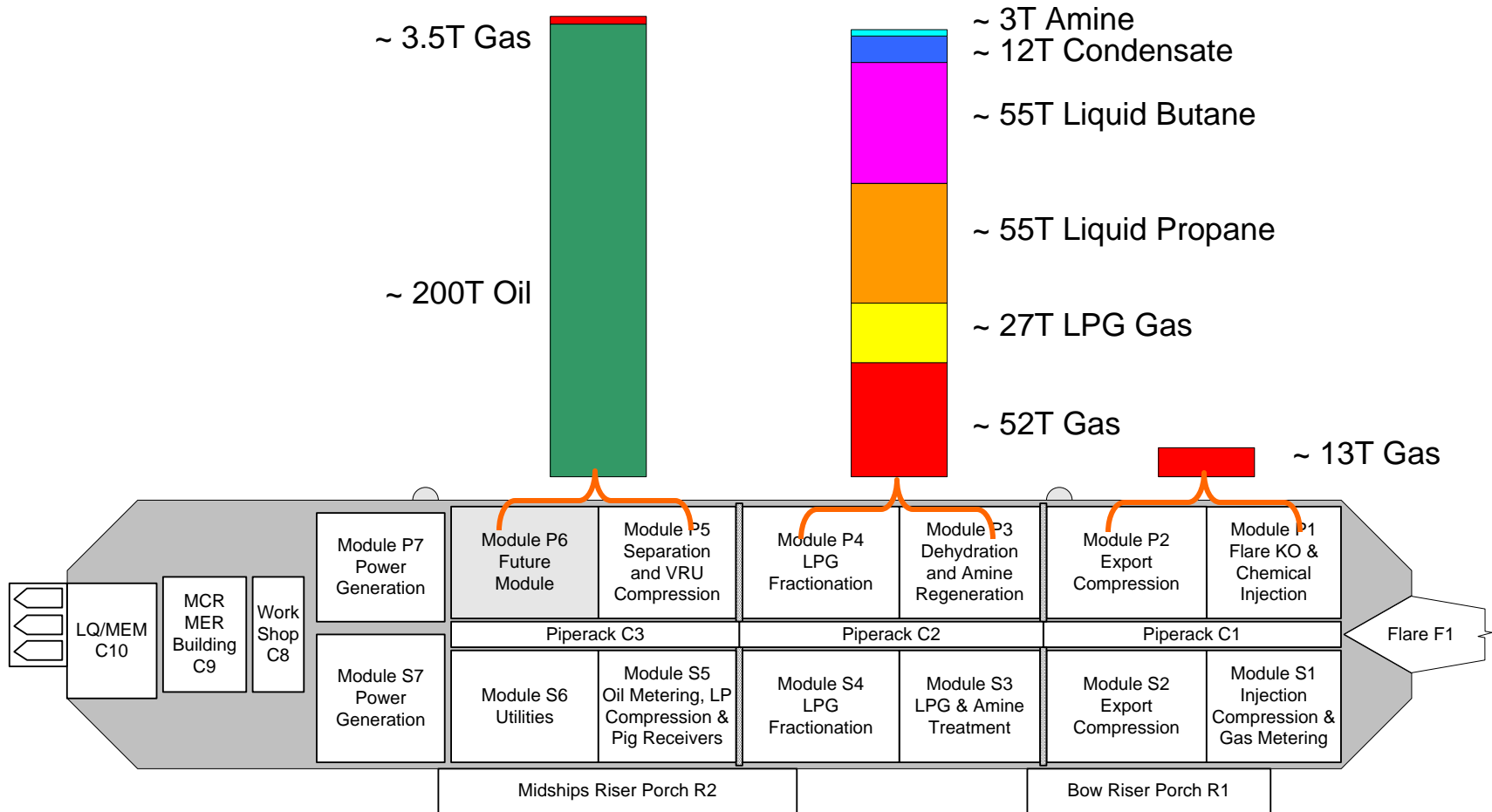
Packing Motion Tests

- Random & Structured packing
- Distribution is critical to performance

Belanak FPSO Topsides Layout



Topsides Hydrocarbon Inventory



**The Belanak FPSO topsides contains
~ 415 Tonnes of Gas or Liquefied Gas**

Design Phase Activities

- Maximise Inherent Safety
- Risk Based Design (Safety Case Approach)
- Formal HSE Assessment Process
 - Identify
 - Assess
 - Mitigate
- Implement Risk Reduction Measures
- Design verification (quality of engineering)
- Ease of Operability and Maintainability
- Quality control (materials, equipment, construction)

**Overall Aim – Consider all Eventualities and Achieve
Zero Design Defects**

Gas Plant Module Lift (S4)
2,347 Te Lift Weight
Asian Hercules II
in Batam Island Indonesia



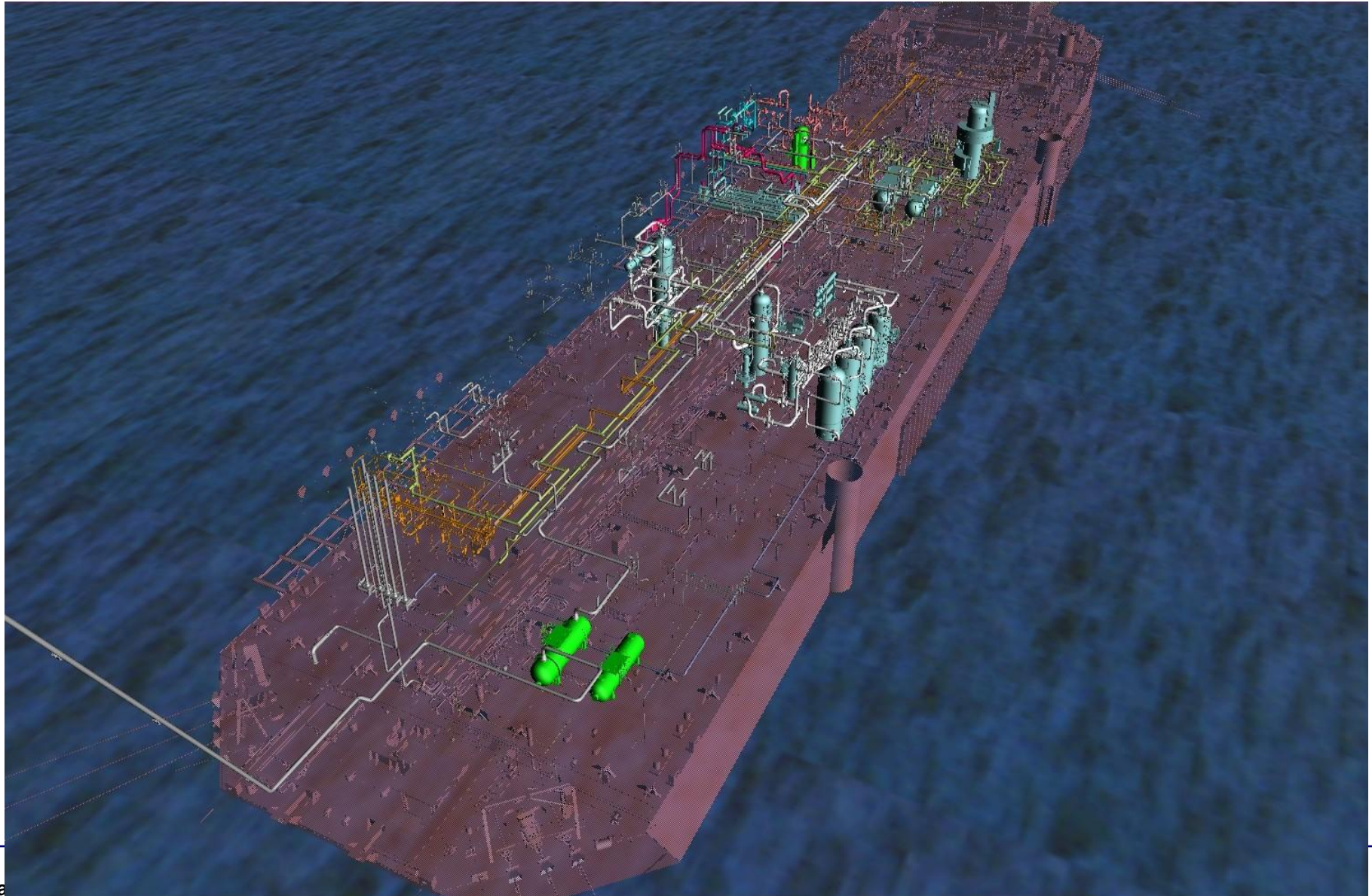
Belanak FPSO – Module S4 Lift



HSE Start-up Readiness Plan covers 15 elements of the COPI HSE Management System

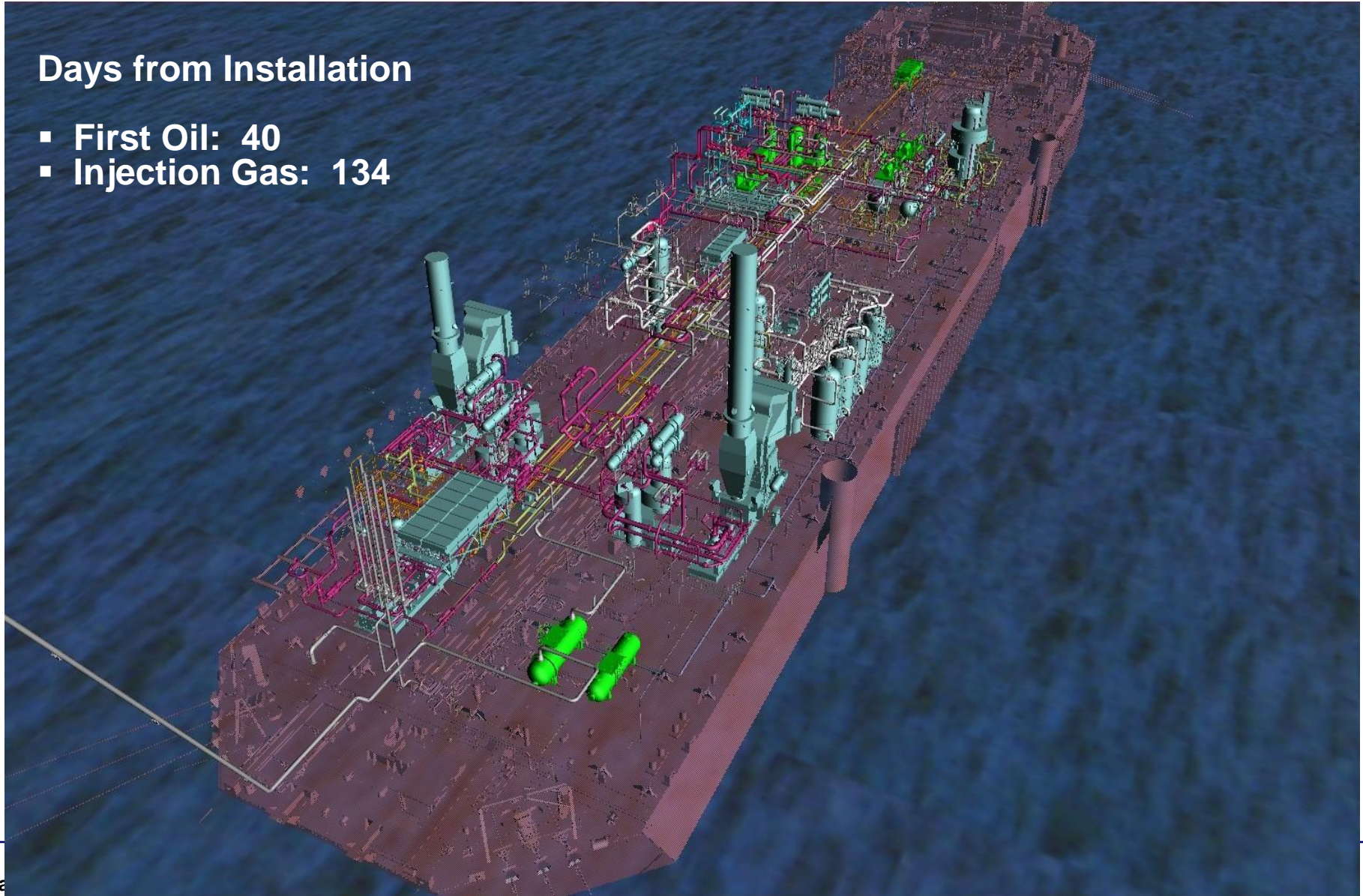
- Management's commitment towards HSE
- Operational risk assessment & management process
- Maintaining compliance with Legal requirements and operating standards
- Establishment of HSE strategies & planning
- Establishment of HSE structure and roles/responsibilities
- Development of Belanak HSE site-specific procedures/programs
- Managing changes to organization and personnel
- Managing emergency preparedness
- Delivery of mandatory HSE training
- Managing Non-conformance & corrective action process
- Development of HSE communication system
- Managing HSE document control process/system
- Managing HSE Performance measurement & monitoring
- Development of HSE Audit/inspection system
- Managing HSE Review

Phase 1 Start-up: First Oil – Dec 3 2004



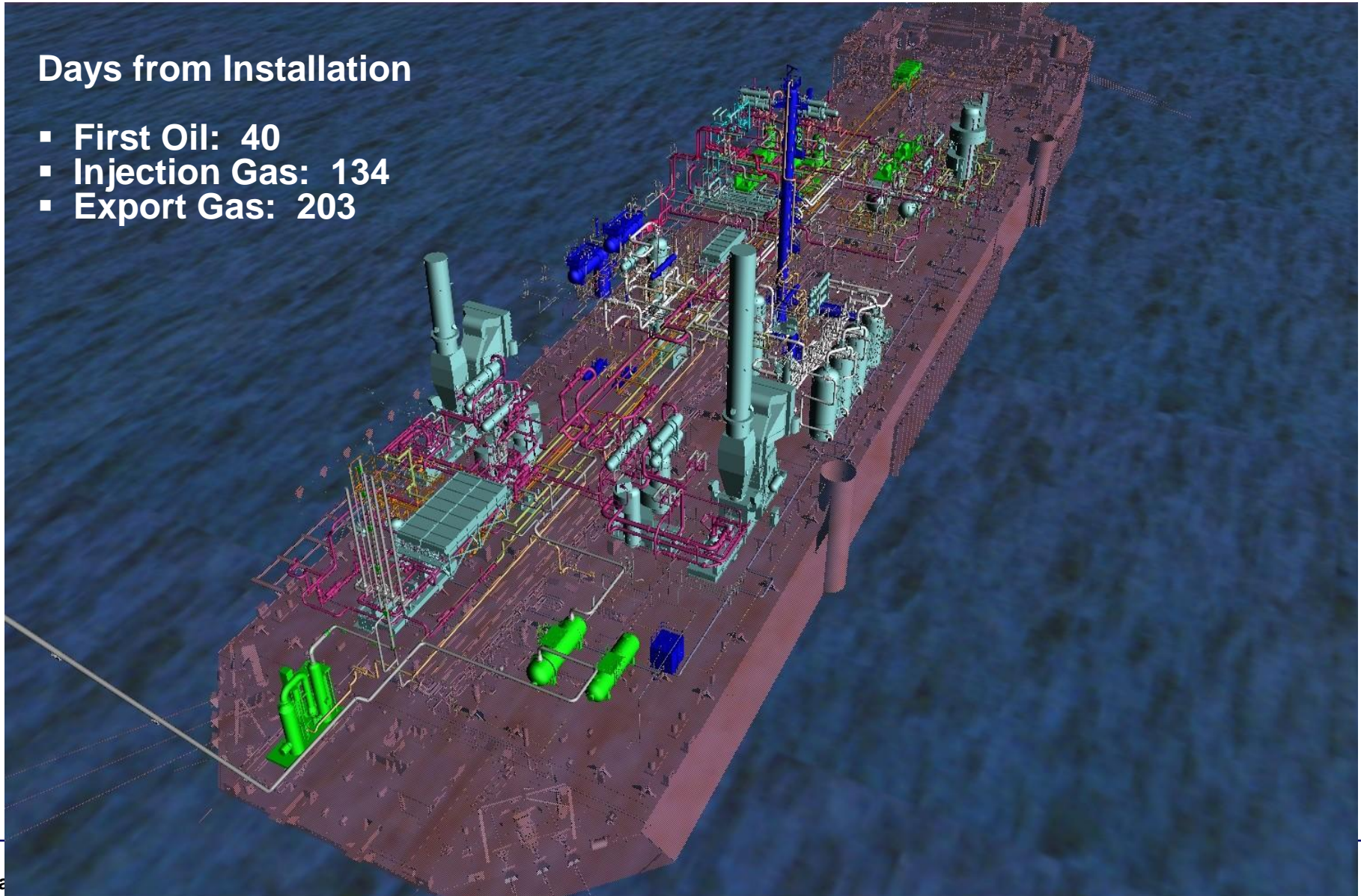
Days from Installation

- First Oil: 40
- Injection Gas: 134



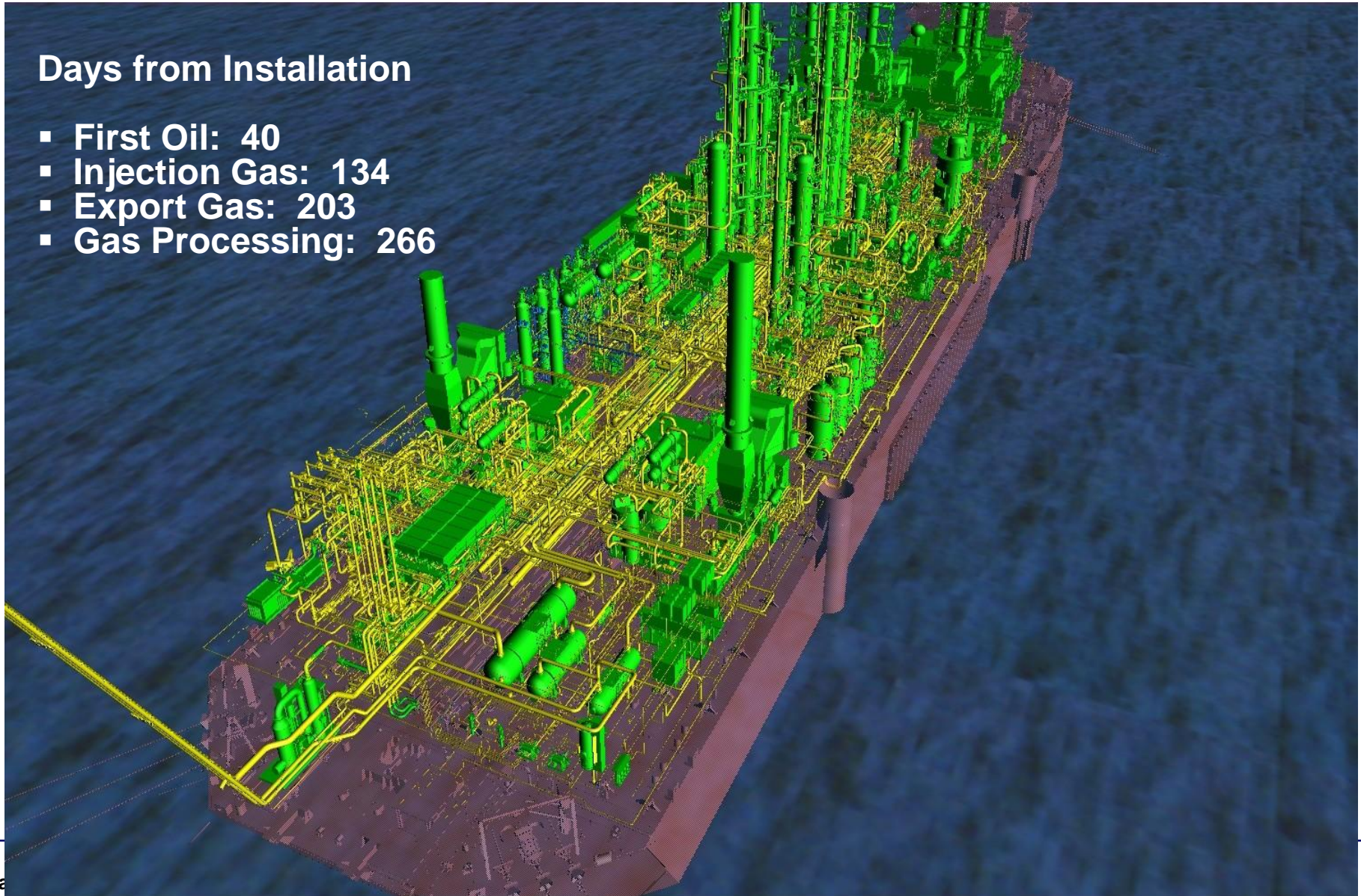
Days from Installation

- First Oil: 40
- Injection Gas: 134
- Export Gas: 203



Days from Installation

- First Oil: 40
- Injection Gas: 134
- Export Gas: 203
- Gas Processing: 266



- Early planning of offshore activities and utilizing a phased offshore start-up approach allowed for flexibility in start-up
- Water circulation through oil systems proved isolation and control system in preparation for first oil
- Dynamic simulation / Operator Training Simulation assisted engineers and operators prepare for start-up operations
- Integrated “One Team” approach between project and operations led to a more efficient handover and management of simultaneous operation activities
- Commissioning scope growth offshore. Need a more robust assessment of carryover prior to sail away

- Hull Fabrication: 4,200,000 man-hours – Zero LTI
- Hull Tow – Zero LTI
- Offshore Installation: Zero LTI
- Over 8,500,000 man-hours at topsides fabrication and integration site with only one LTI
- Project TRR of 0.374 (per 200,000 hrs)

Belanak Operations (2005 – 2010)



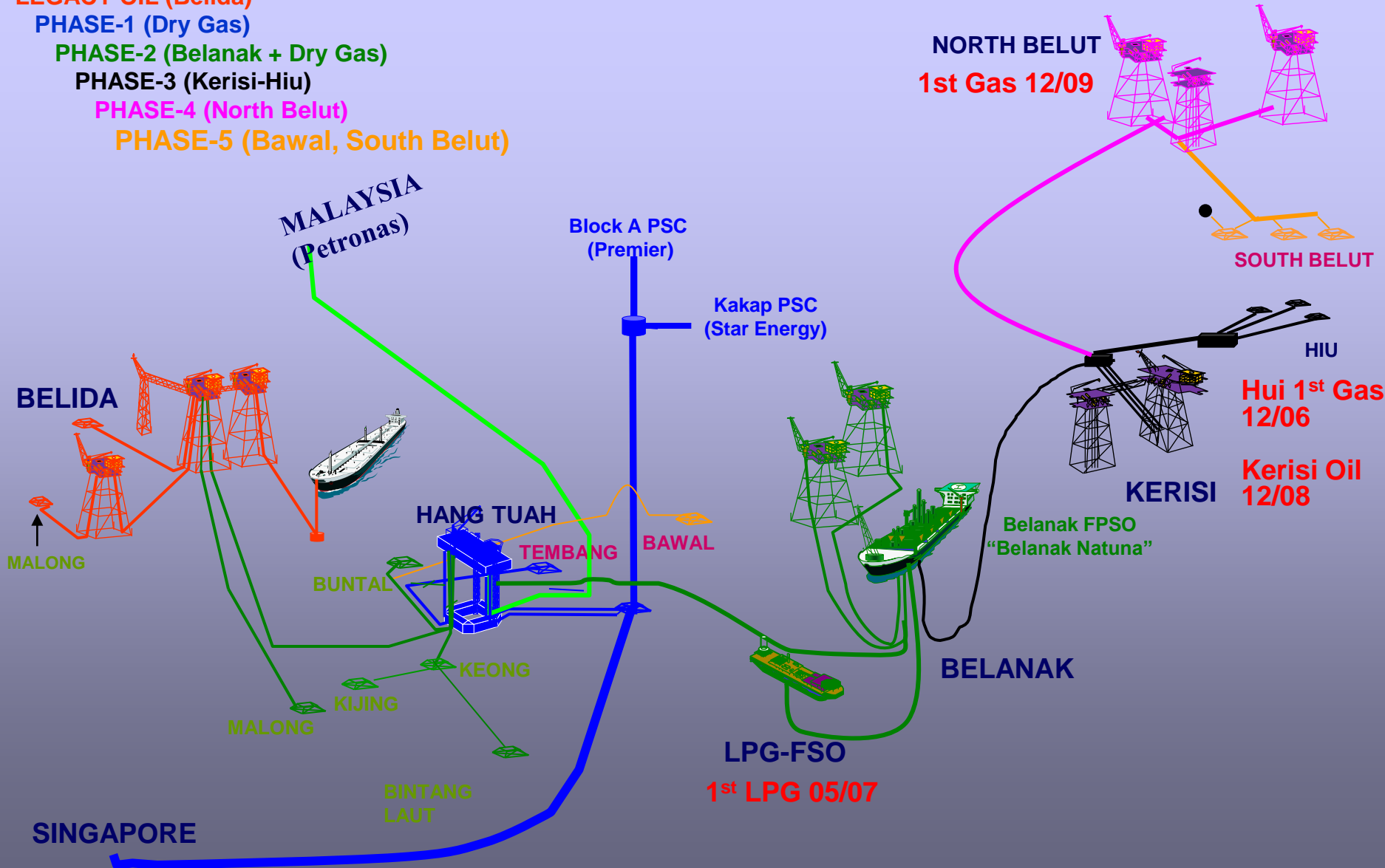
2,000+ DAYS OF SAFE OPERATION
(Zero LTI)

4,000,000+ Man-hours in over Five Years of Operation

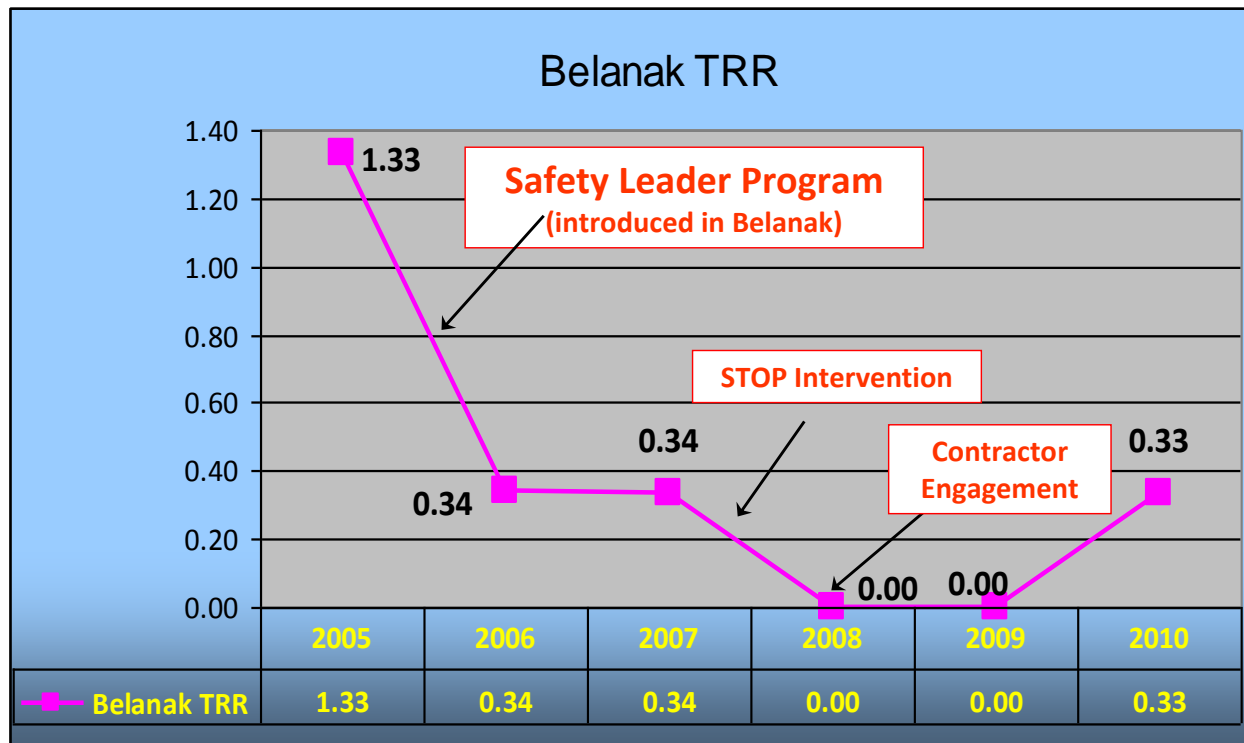
Last Recordable Incident was 19 Jul, 2005
(LTI during initial Start-up Operations)

Offshore Block B Development

- LEGACY OIL (Belida)
- PHASE-1 (Dry Gas)
- PHASE-2 (Belanak + Dry Gas)
- PHASE-3 (Kerisi-Hiu)
- PHASE-4 (North Belut)
- PHASE-5 (Bawal, South Belut)



- Normal Operations Crew Size of 120 person
- 4,000,000+ Operational Man-hours
- July 19th, 2010 milestone of 5 years without LTI
- Currently 2,000+ days since last LTI



In Operations, the Belanak Team Incorporates Safety into all Activities

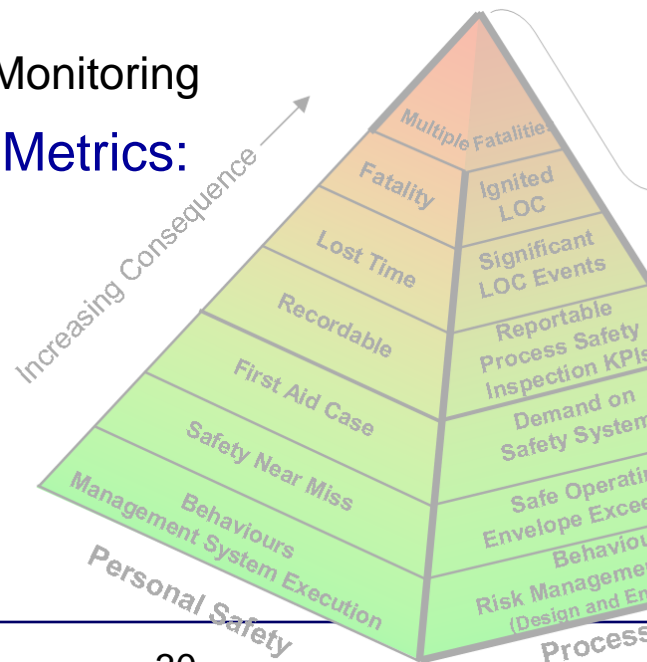
■ Focus on Leading Safety Metrics:

- STOP Program
- HSE Audits (Self Assessment, BU & Corporate)
- Risk Assessment & Hazard Identification
- Safety Campaigns
- Near Miss Analysis
- Contractor Engagement
- Occupational Health Programs
- Industrial Hygiene Programs
- Health Challenge Programs
- Environmental Performance Monitoring



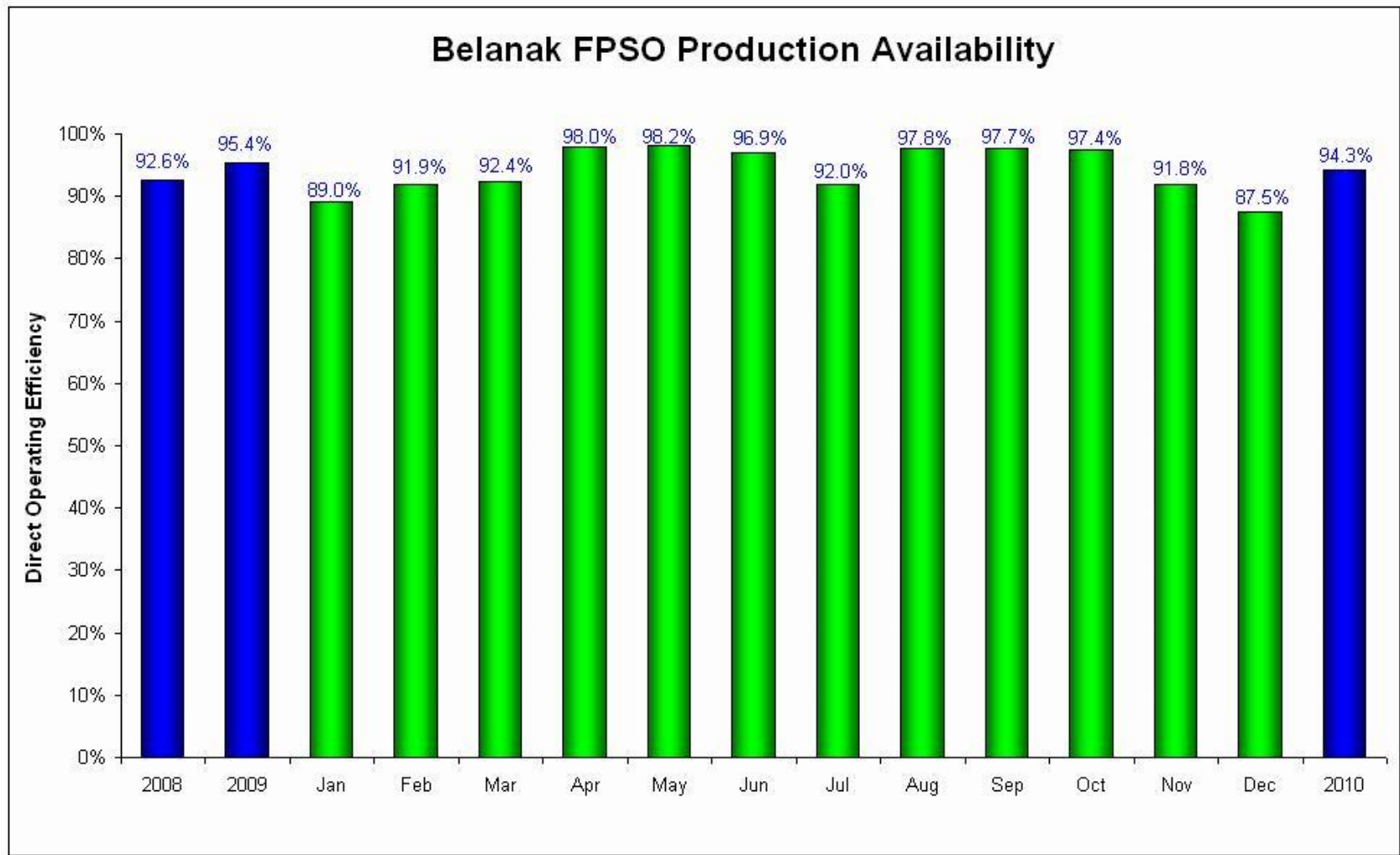
■ Apply Lessons from Trailing Metrics:

- TRR
- HSE Snapshots
- Safety Milestones
- Incident Pyramids
- Incident Analysis



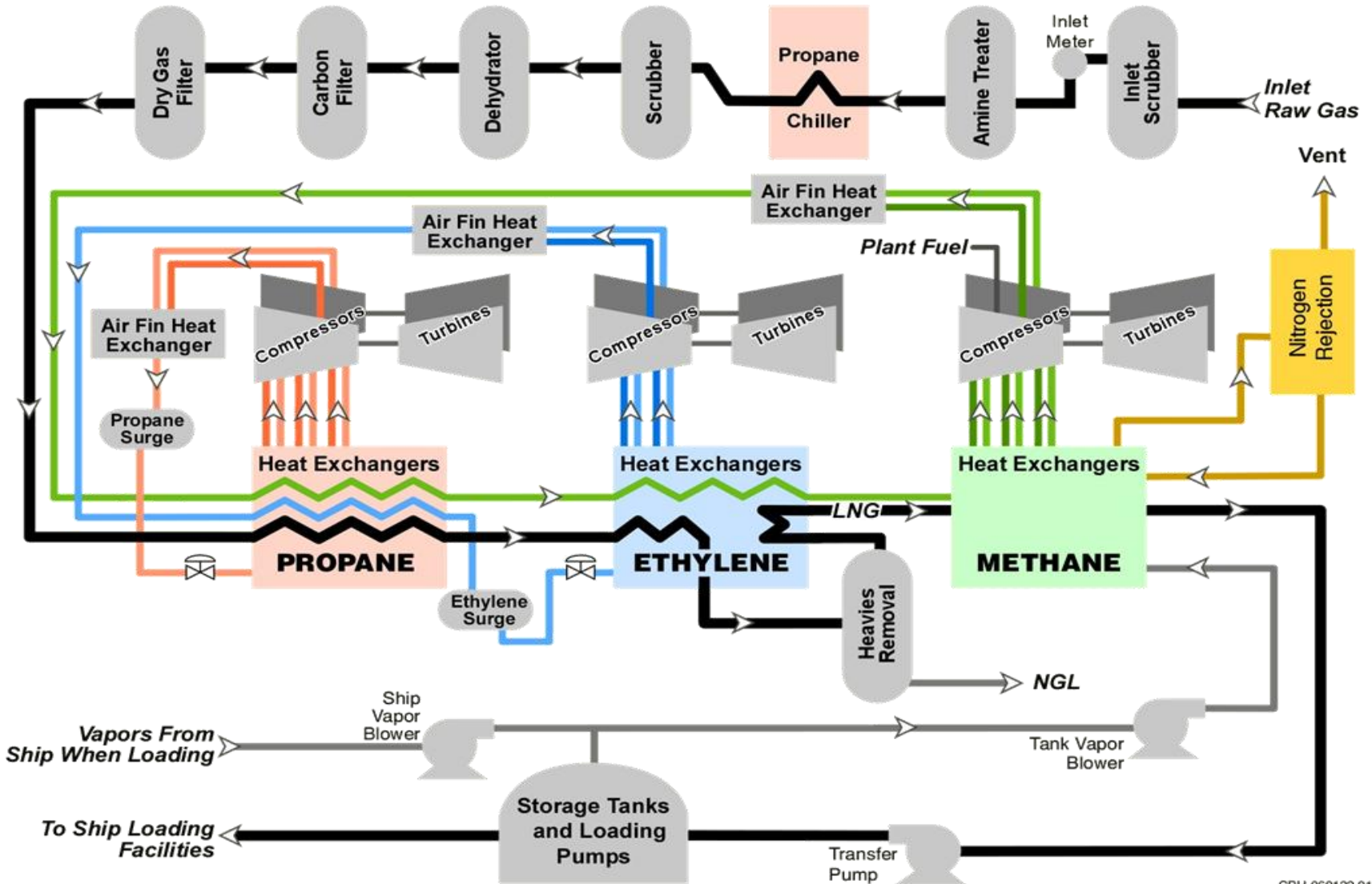
- Belanak production availability exceeded 94% in 2010
- **Operability Assurance** program permits flexibility in operations
- **Operations Excellence** program drives high availability
 - Integrated Planning & Scheduling
 - Opportunity Maintenance Optimization
 - Maintenance & Reliability System
 - Production Surveillance & Optimization System
 - Asset & Operating Integrity Management
 - Ongoing Minor Capital Improvement Program





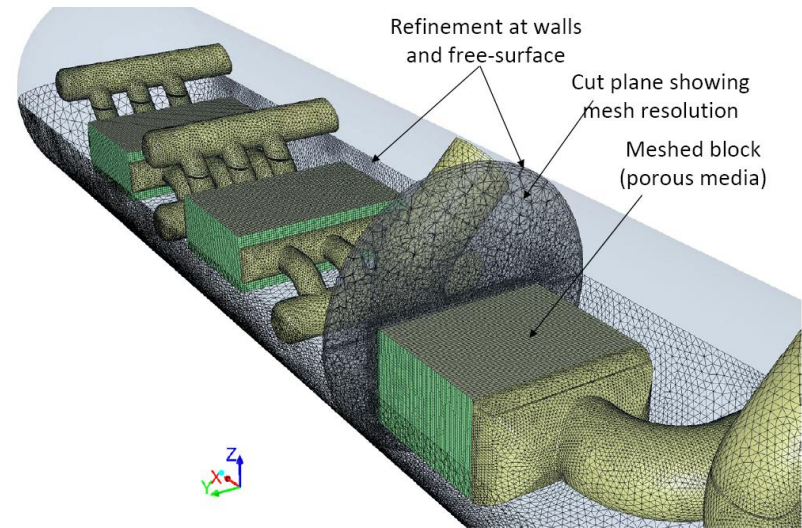
- Vessel Motion impact on process equipment
- Process Hazard Mitigation
- Unsteady production flow
(closer to production system)

The Optimized Cascade Process



CPH-060122.01

- **Proven Process**
- **Ease of Operation**
 - Two-Trains-in-one Reliability
 - Pure Refrigerants
- **Direct Drive Aeroderivatives**
 - Used Successfully at Darwin LNG
 - Light Weight and Rapid Replacemer
 - FPSO Experience
 - Efficient
- **Cold Box Design**
 - Low Profile Exchangers Well Suited for Marine Environment
 - Tall Vessels Limited to Fractionation and Amine Columns
 - Modular Construction
- **Flexible Regarding Sudden Changes in Gas Rate**
- **Operability, Turndown and Simplicity**



Mitigating Risk through Design and Layout

- Cryogenic Spills:
 - Cold Box Design
 - Protective Coating
- Fire & Gas Explosion
 - Layout Mitigation
 - Isolation, Relief & Blowdown Philosophies
 - Alternative Refrigerants to replace hydrocarbon based refrigerants
- Tank Dome Fire Protection
 - Lower Process Decks Plated And
 - Passive Fire Protection Applied
- Accommodation Protection:
 - Separation Via Blast Wall, Fire Wall and Layout Principles
 - Location up wind from process
- Low-speed Collisions: Double Hull Design Includes Collision Bulkheads and Fendering Plans

- Continue Developing Integrated FLNG Solutions
- Safety Risks Reduction Measures
- Key Component Designs for Motion
- Perform Full QRA on a mid-scale 2 to 3 MTPA design
- Review Marine Technology Developments
- Refine the EPC Philosophy, Execution Plan and Cost
- Field Specific Pre-FEED Study in 2011
- Prepare to implement in 2016-2019 timeframe