Liquefaction Plant Operations and Maintenance

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Bechtel Oil and Gas Inc.

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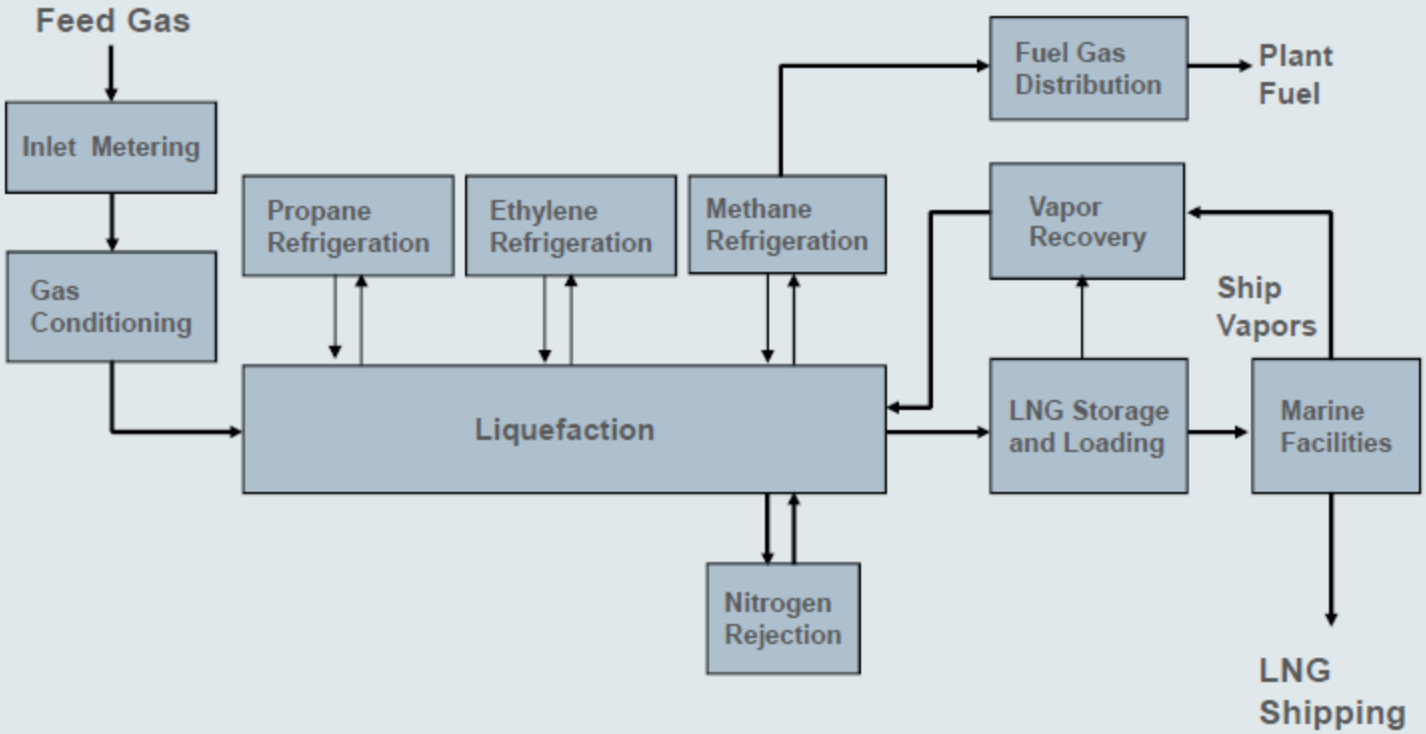
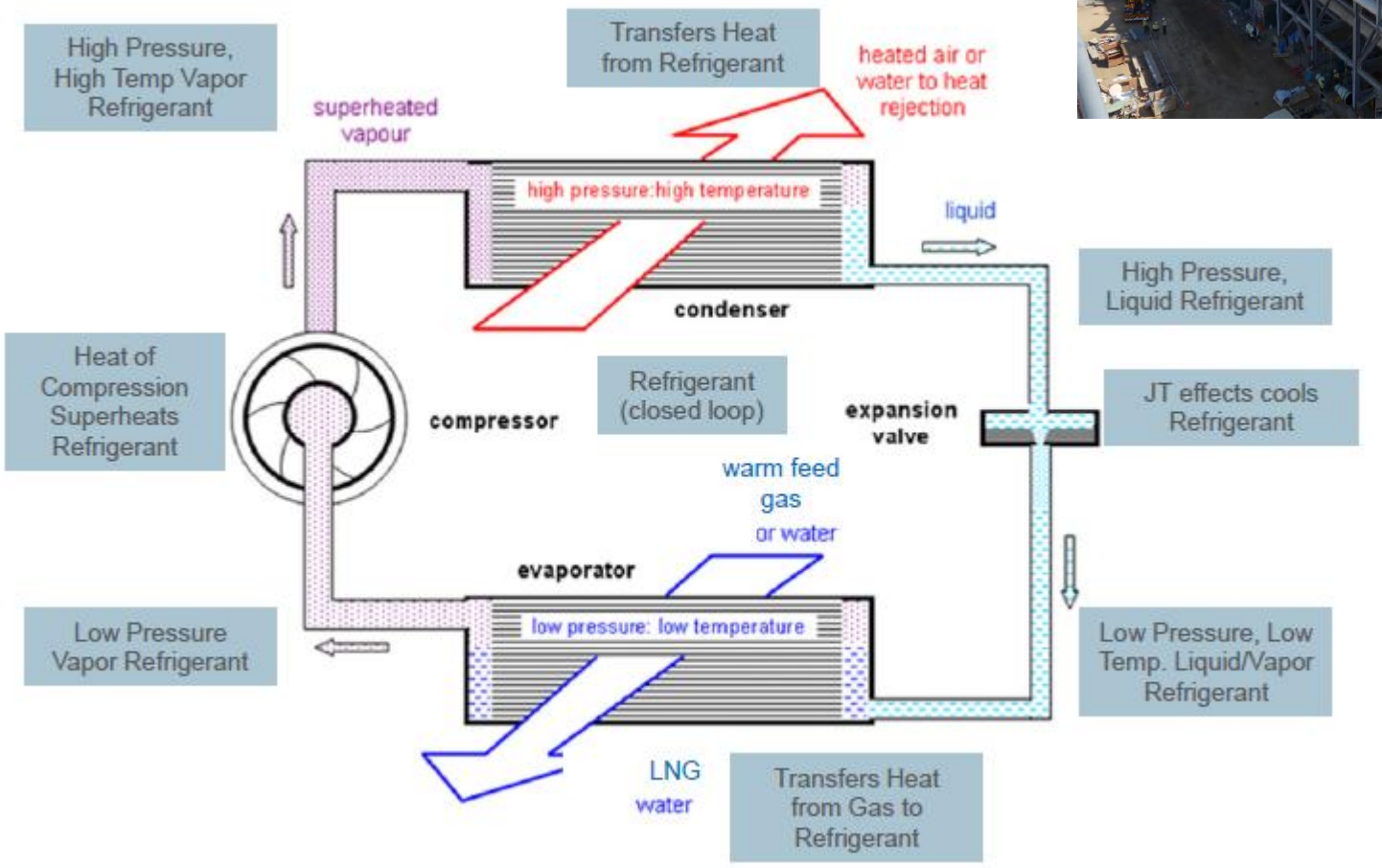
- **High Feed Gas Price**
- **Potential CO2 taxation**
- **GHG Footprint reduction**
- **Feed Supply Limitation**

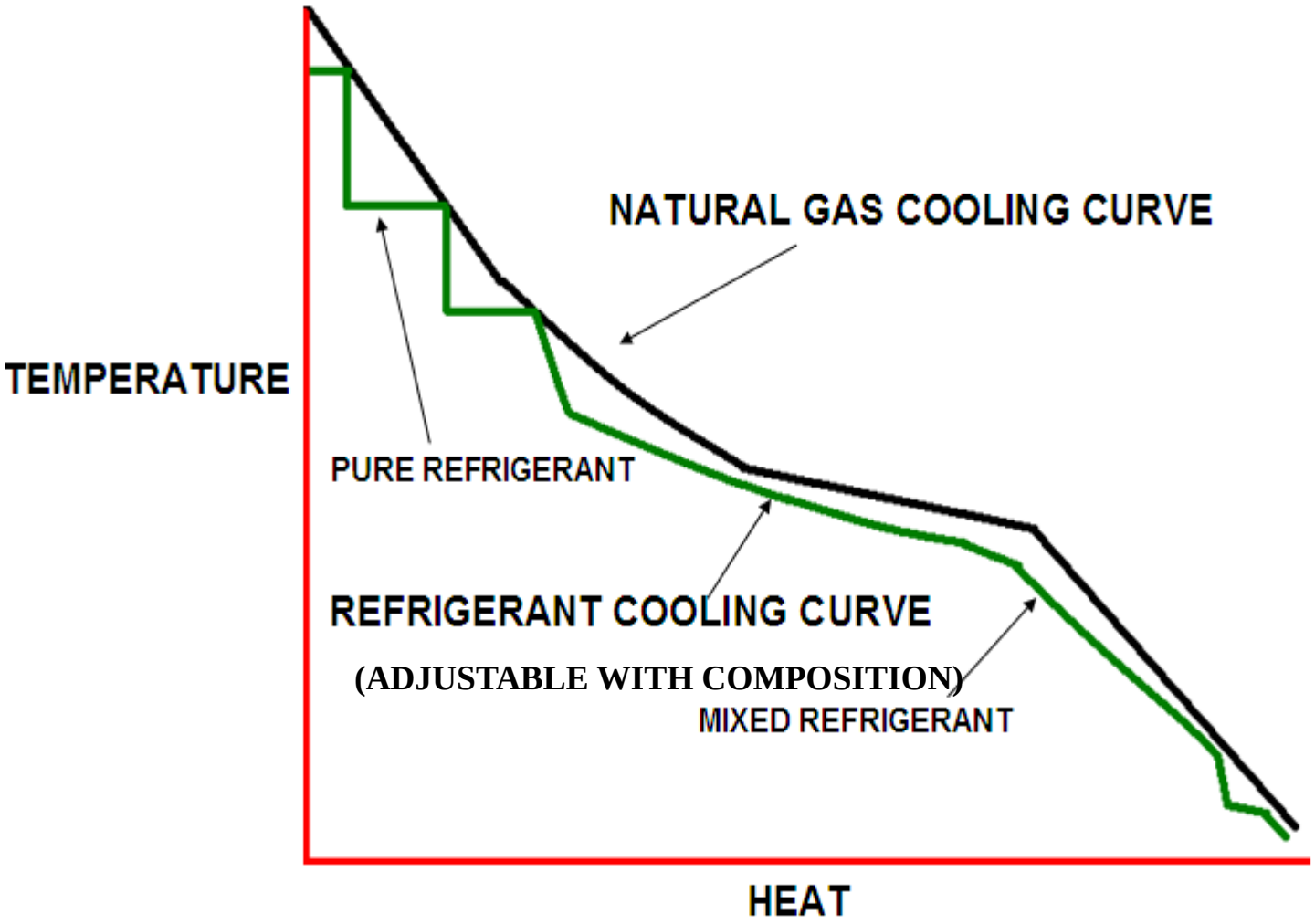
LNG Block Flow Diagram



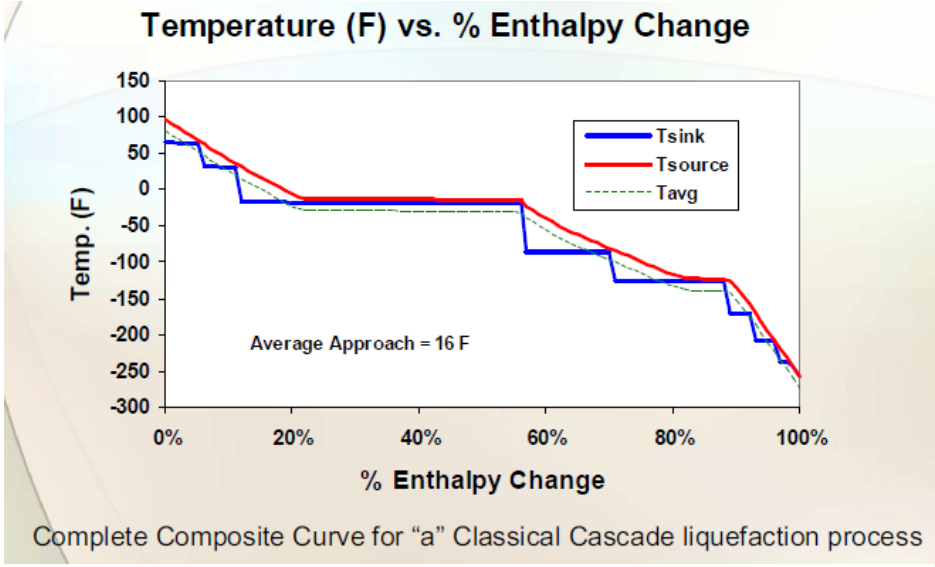
Basic Refrigeration Process



Understanding Cooling Curves

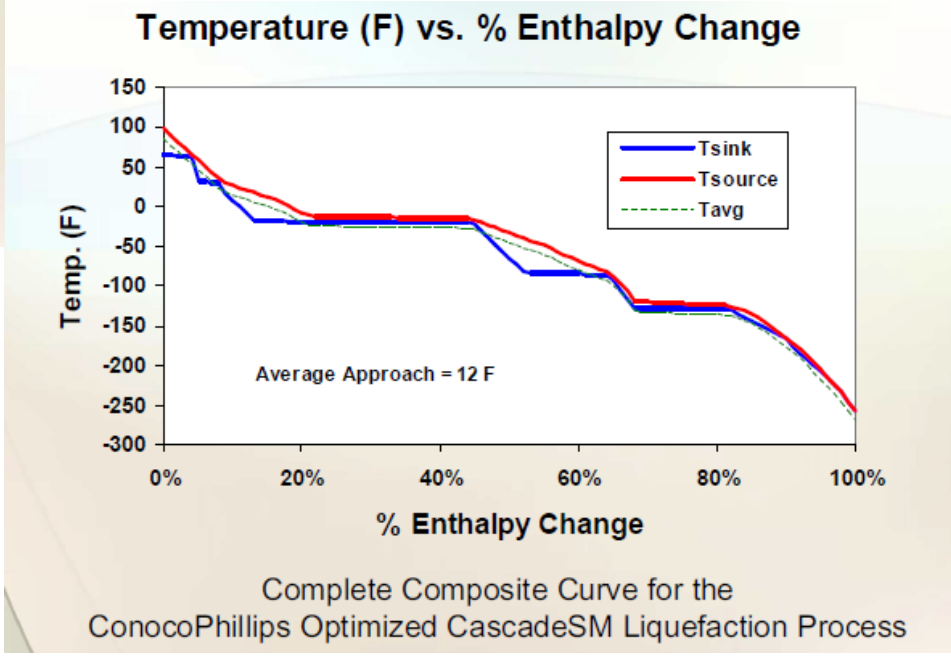


Cooling Curves



Complete Composite Curve for "a" Classical Cascade liquefaction process

Avg approach= 16F



Complete Composite Curve for the
ConocoPhillips Optimized CascadeSM Liquefaction Process

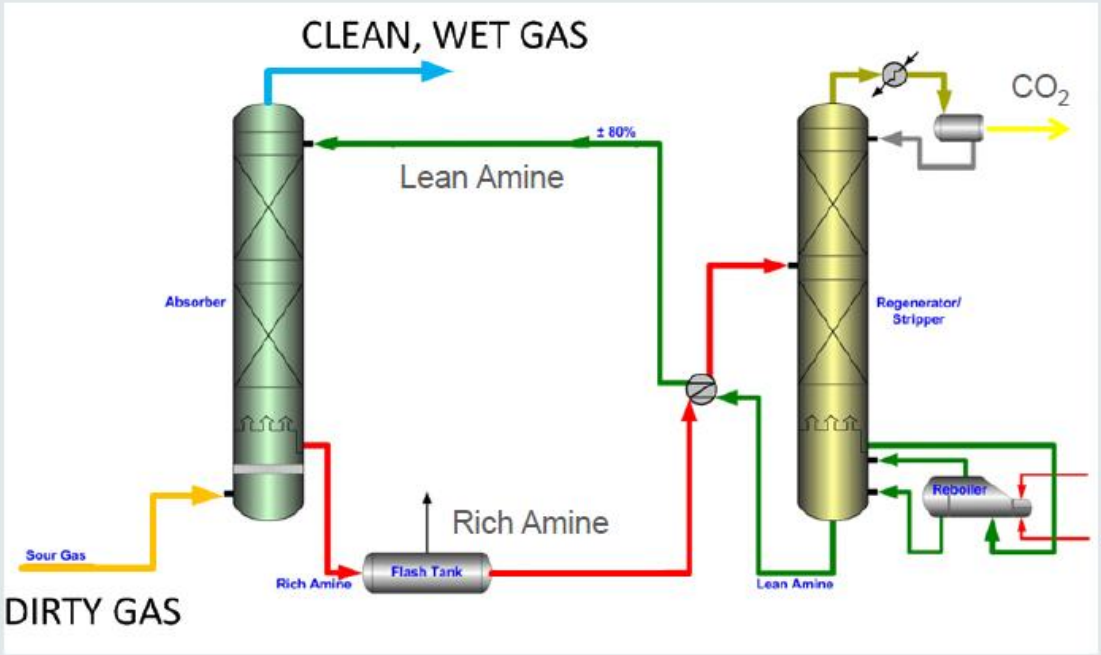
Avg approach= 12F

Plant Auxiliary Systems and Utilities

An LNG Facility requires key utility systems

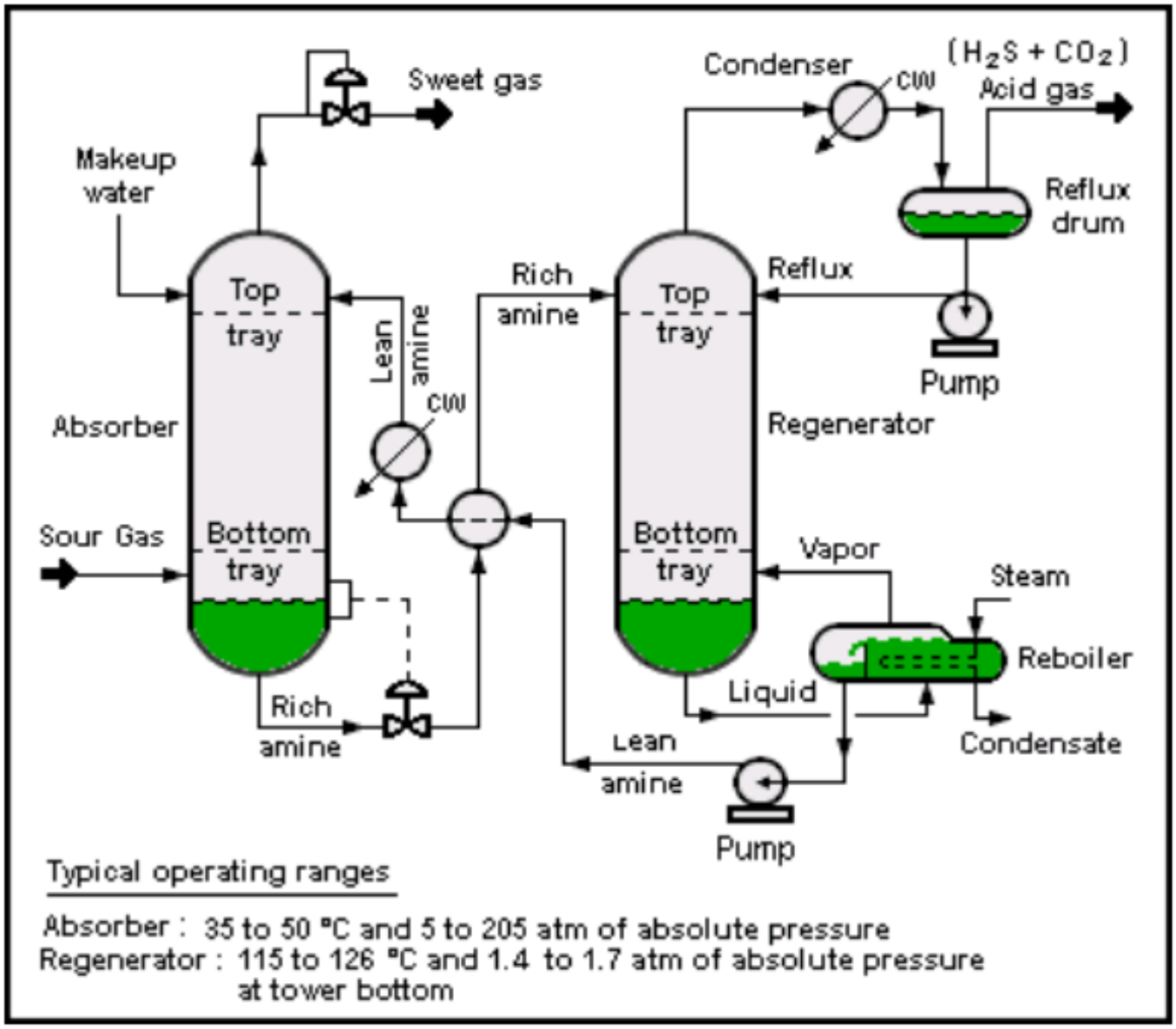
- Flare System
- Fuel Gas
- Hot Oil
- Power Generation
- Refrigerant Storage
- Firewater
- Water & Effluent Treatment Systems
- Plant & Instrument Air, and Nitrogen Systems

Acid Gas Removal



CO2 Absorber – Regenerator Stripper

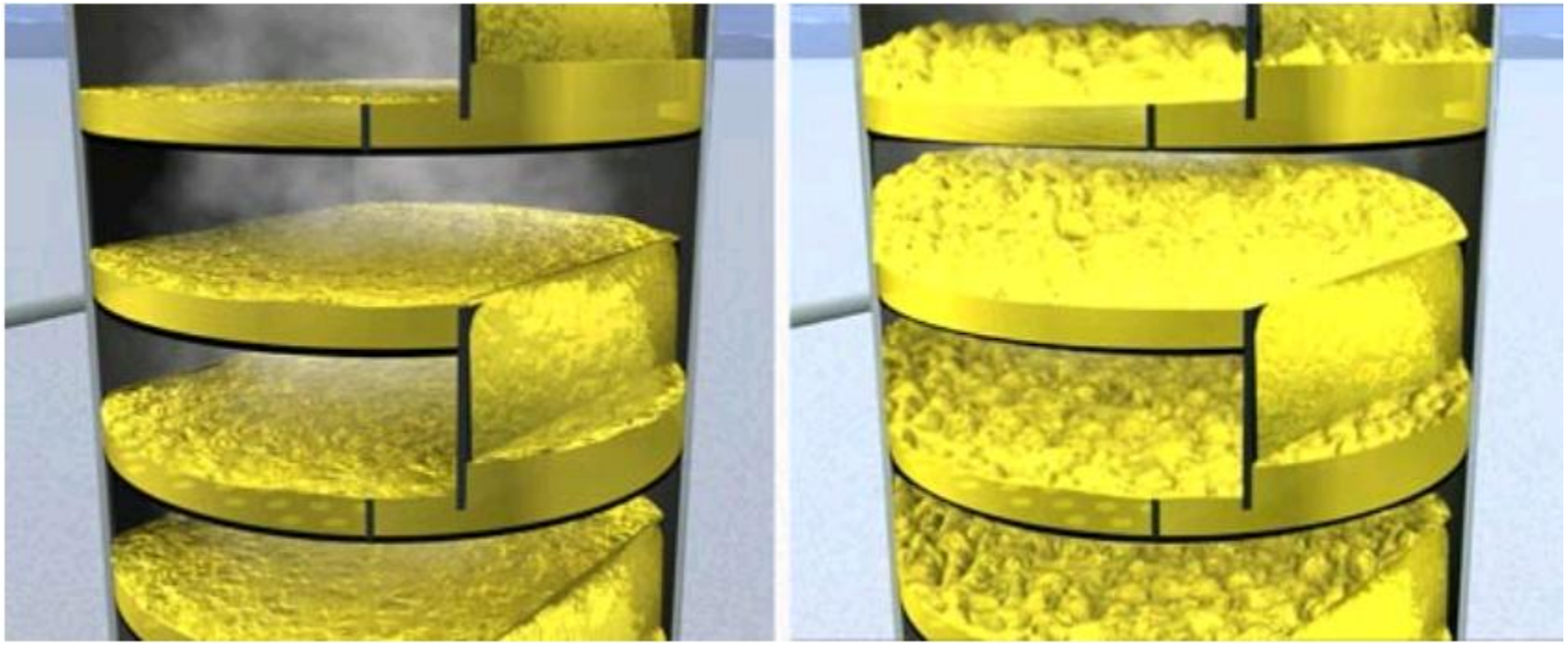
Acid Gas Removal



Acid Gas Removal

- **Acid Gas Specifications**
- **Foaming**
- **Corrosion**
- **Amine Losses**

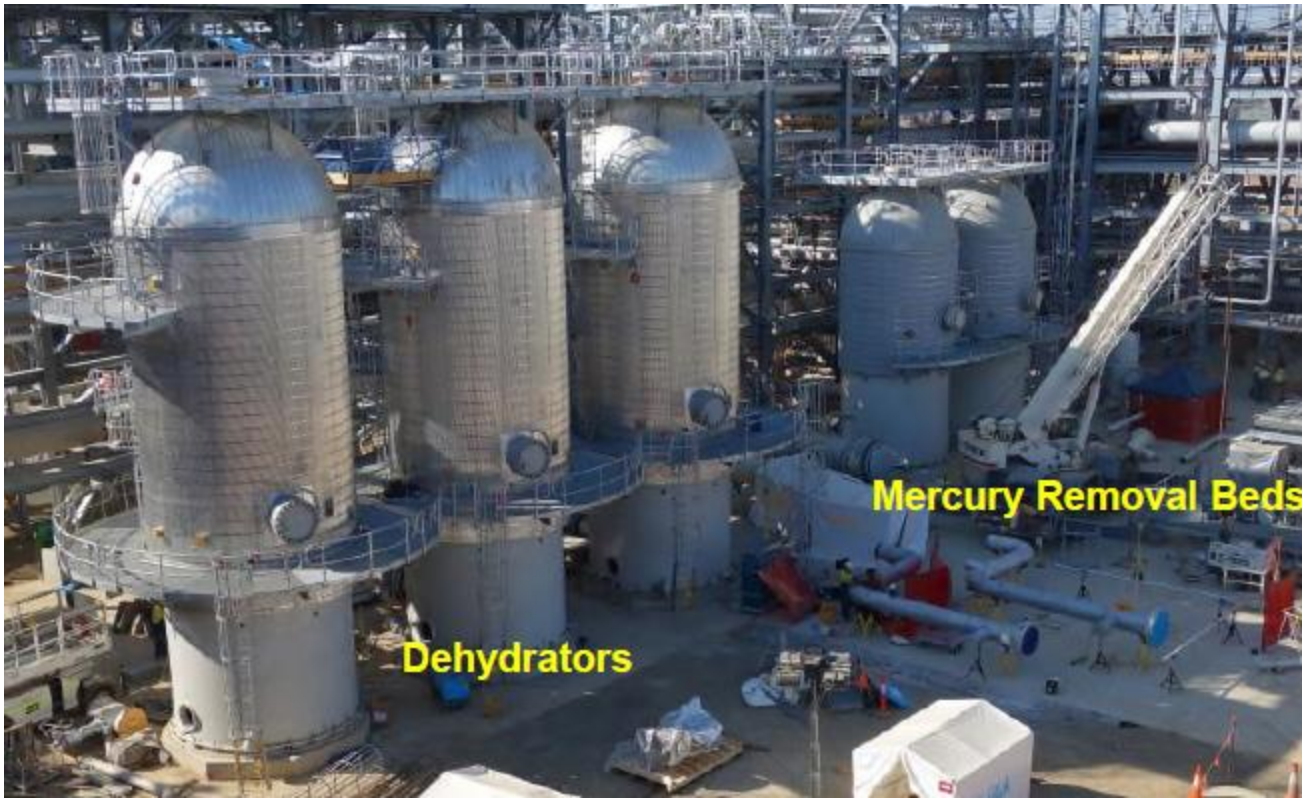
Amine Absorber Foaming



Amine Foam Test

Amine Regenerator Reboiler Corroded

Dehydration

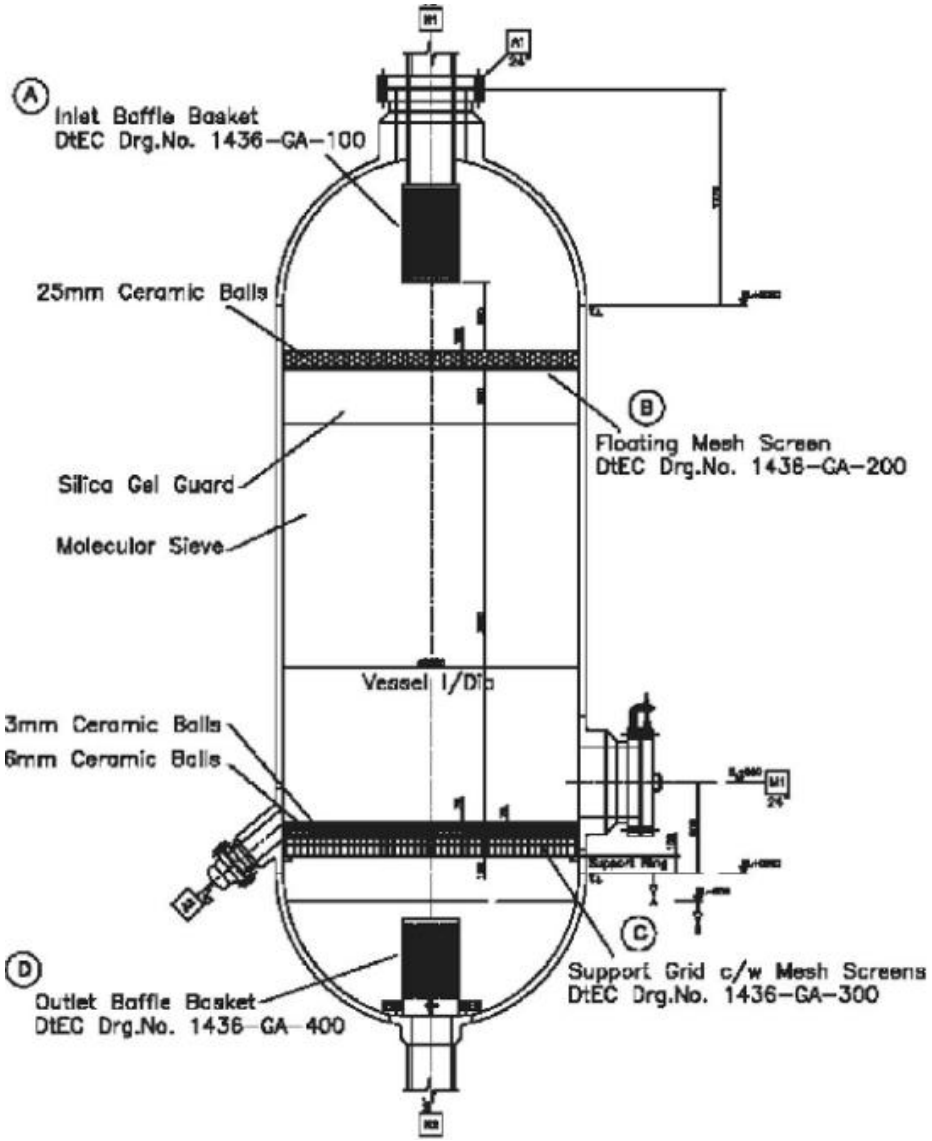


Absorption Mode:
Wet Feed Gas enters the dehydrator from the top. Moisture in the wet gas adheres to the porous surface of the adsorbent as it flows downward through the bed.

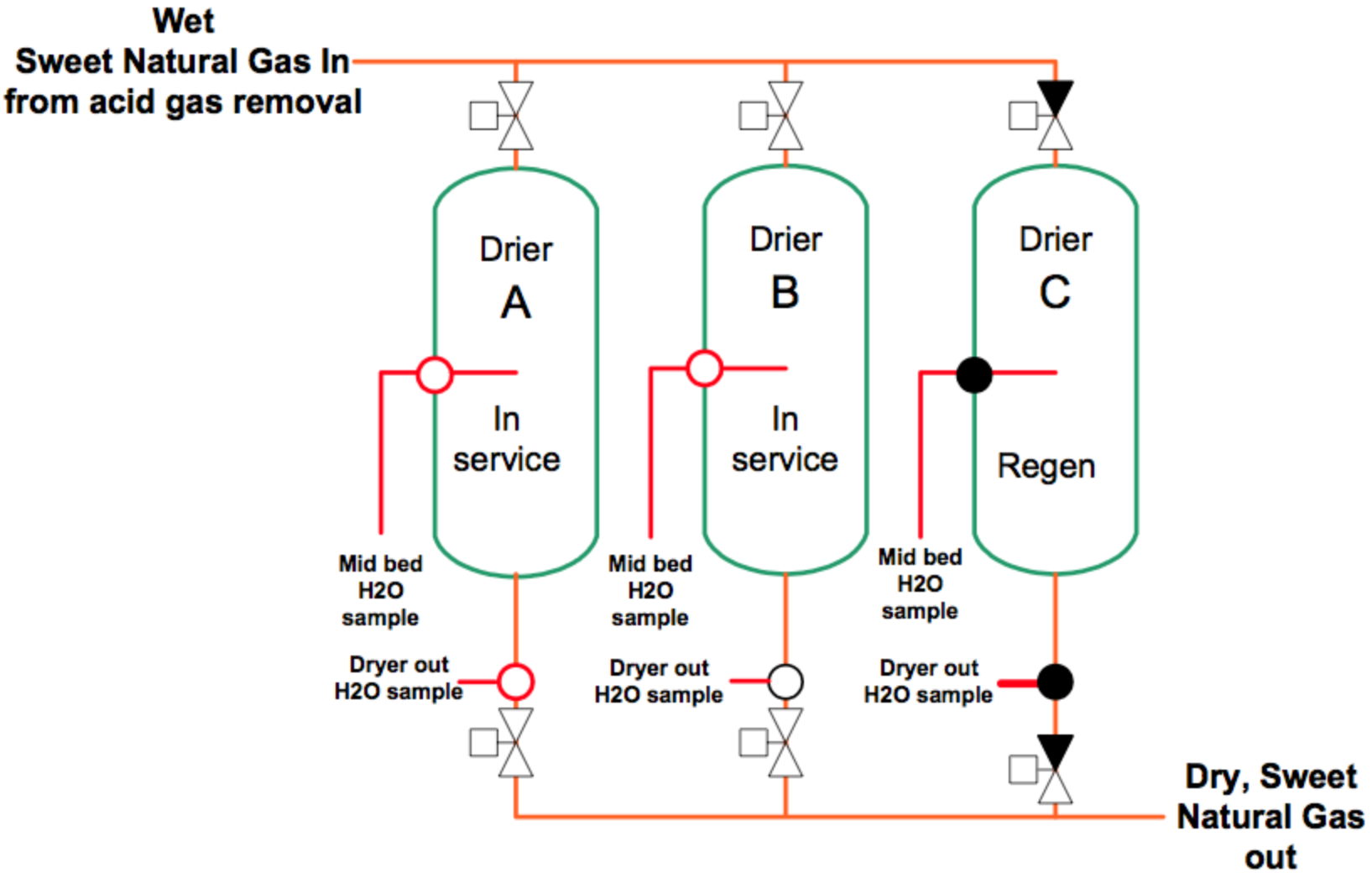
Regeneration Mode:
Hot Regen Gas enters the dehydrator from the bottom. Moisture is driven off by the hot, dry gas restoring the adsorbent capacity.

CoolingMode:
Dry, cool Regen Gas enters the dehydrator from the bottom. The bed is cooled getting is ready for the Absorption mode.

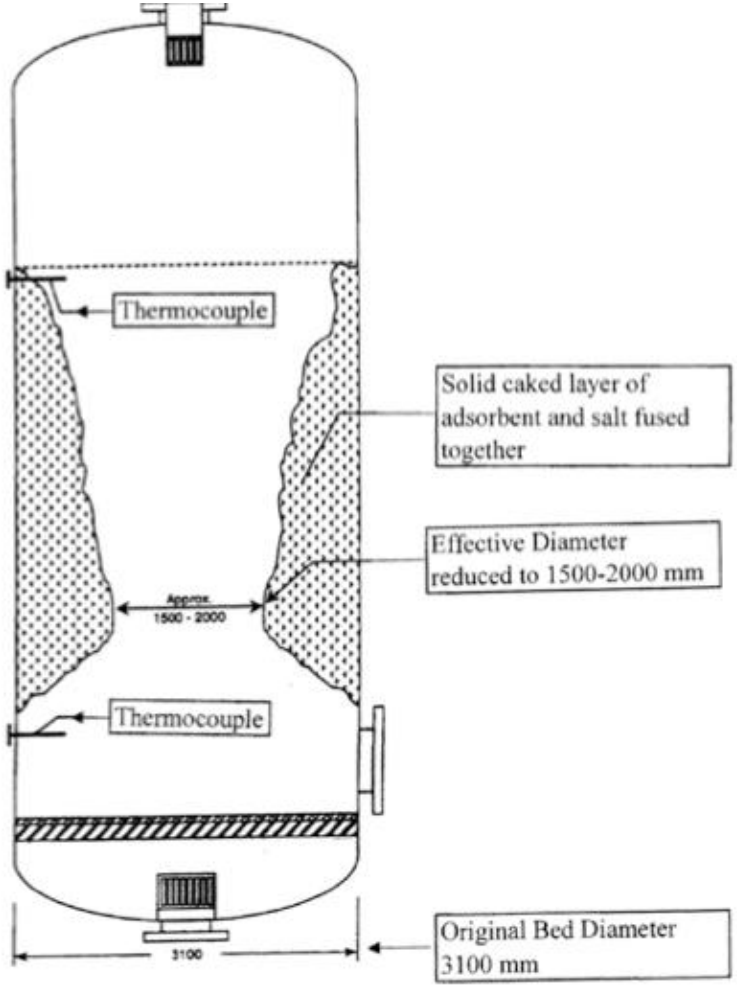
Dehydration



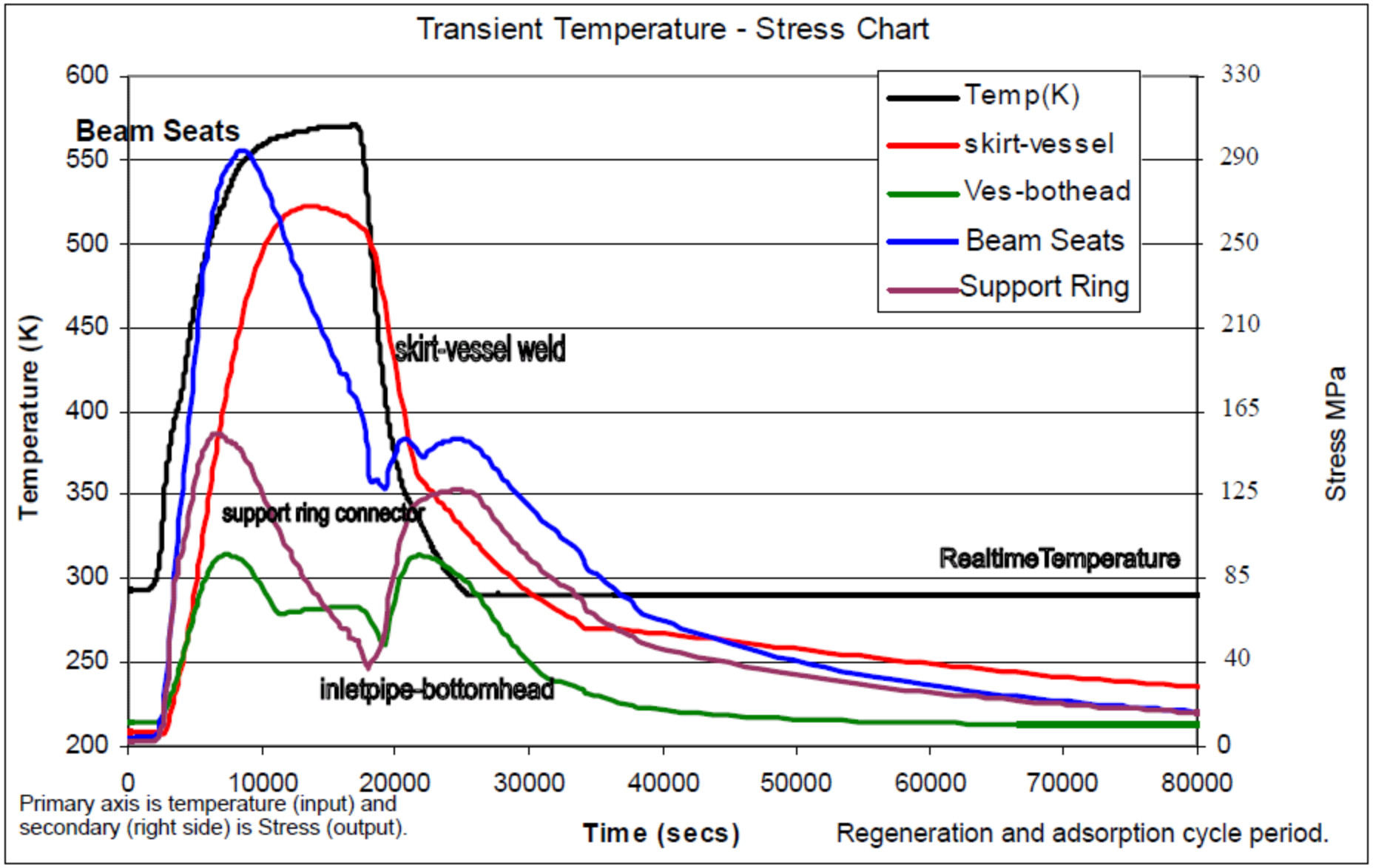
Dehydration



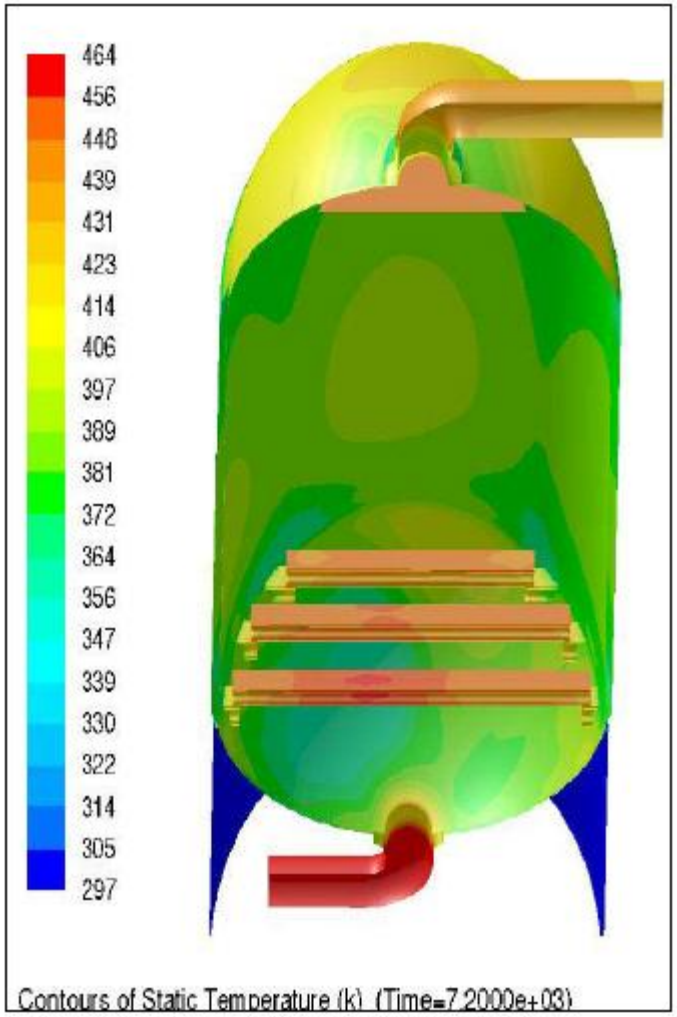
Dehydration



Dehydration



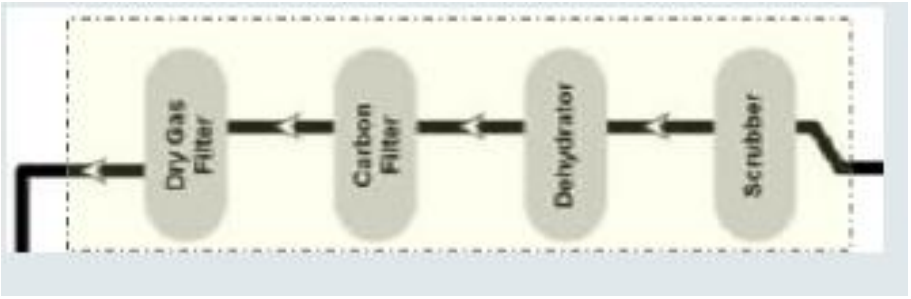
Dehydration



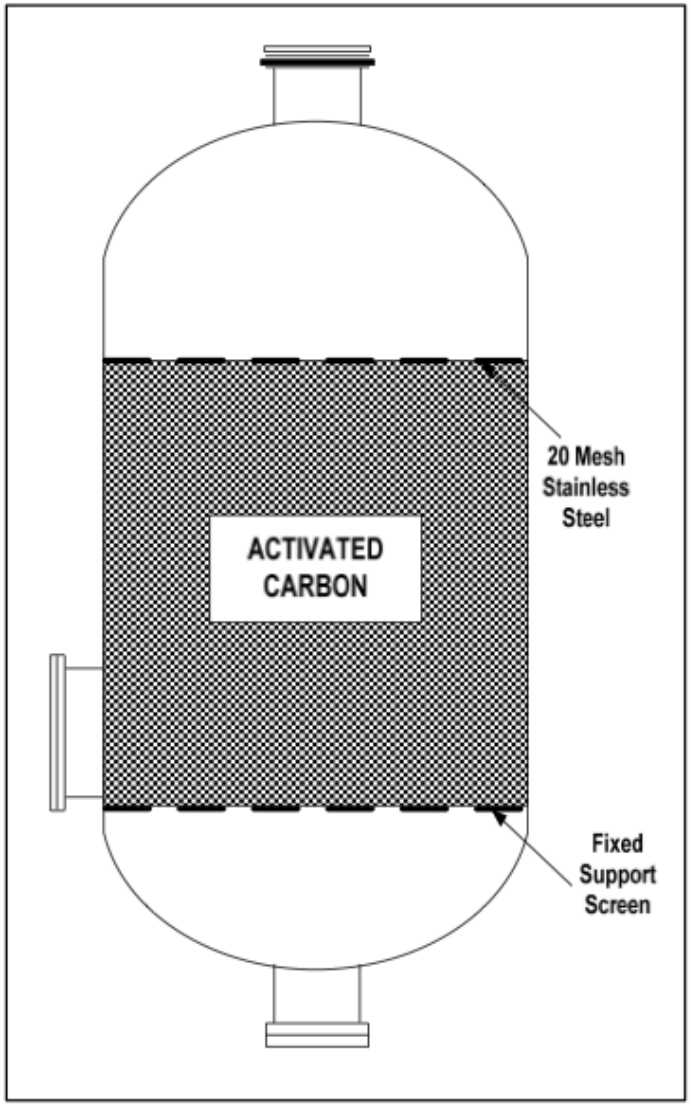
Mercury in LNG Feed

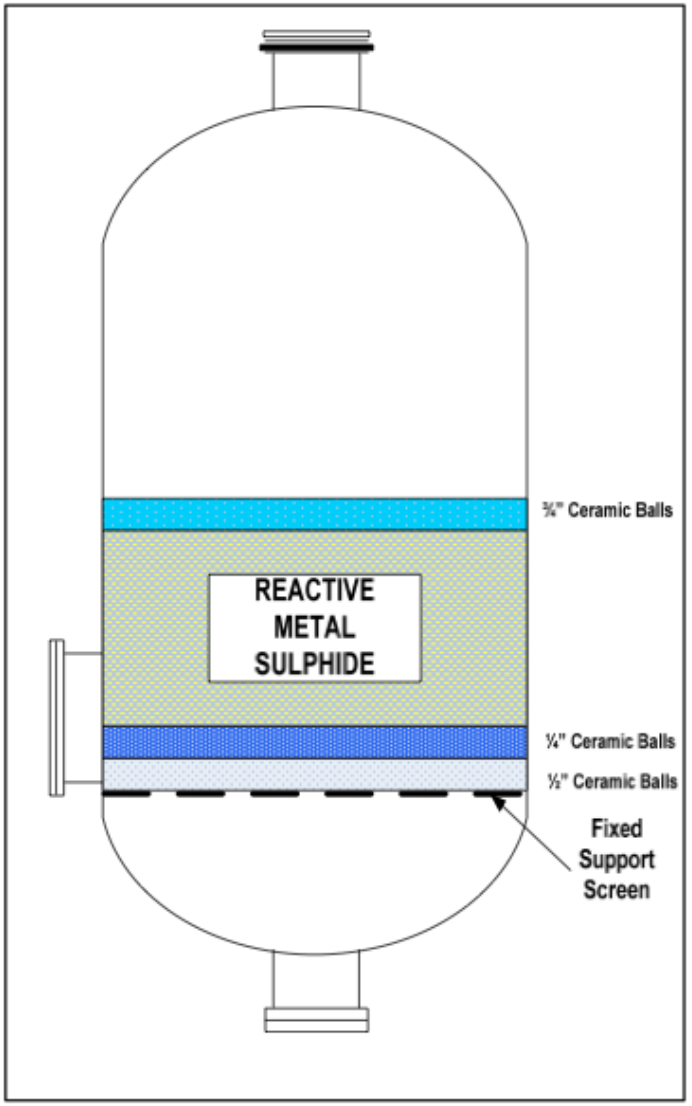
Gas Field	Amount (µg/Nm^3)
Groningen	180 - 200
Arun	250 - 300
Albatross & Askeland	1.0
Niger Delta	10
North & East Coast Trinidad	12
Goodwin,N Rankin & Perseus	38
Saih Nihayda & Saih Rawl	60

- Mercury Removal Beds utilize sulfur impregnated carbon to remove mercury contaminants.
- Finally, the gas is dust filtered via the Mercury Removal After Filters before flowing into liquefaction.

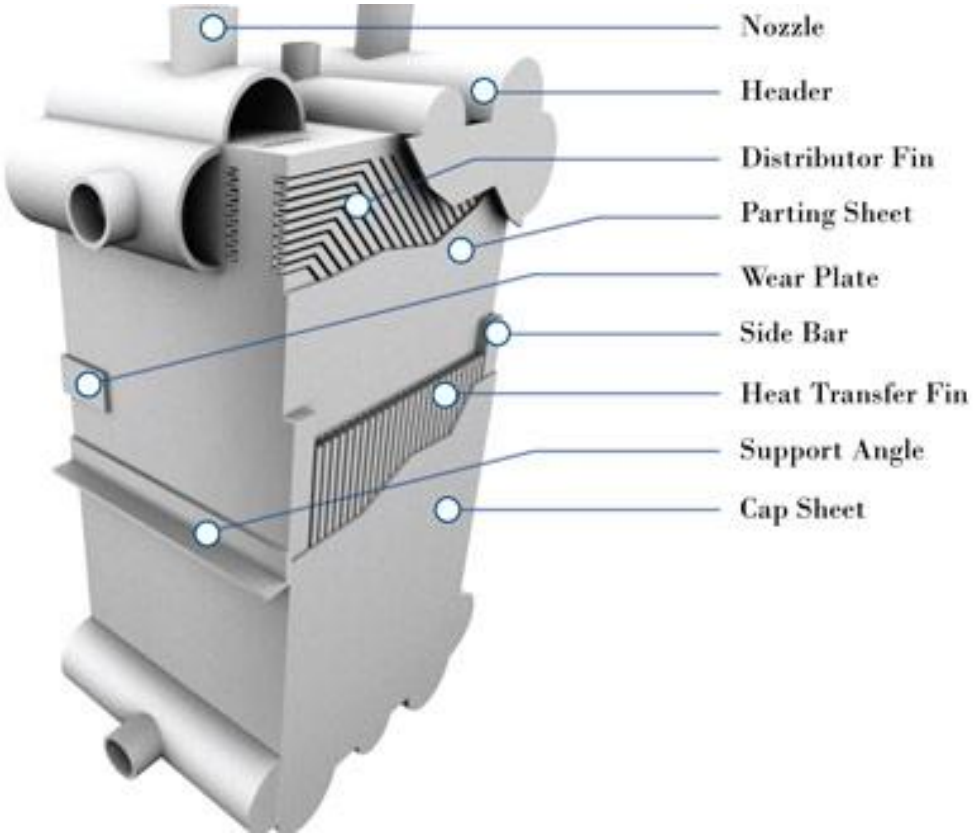


Mercury Removal

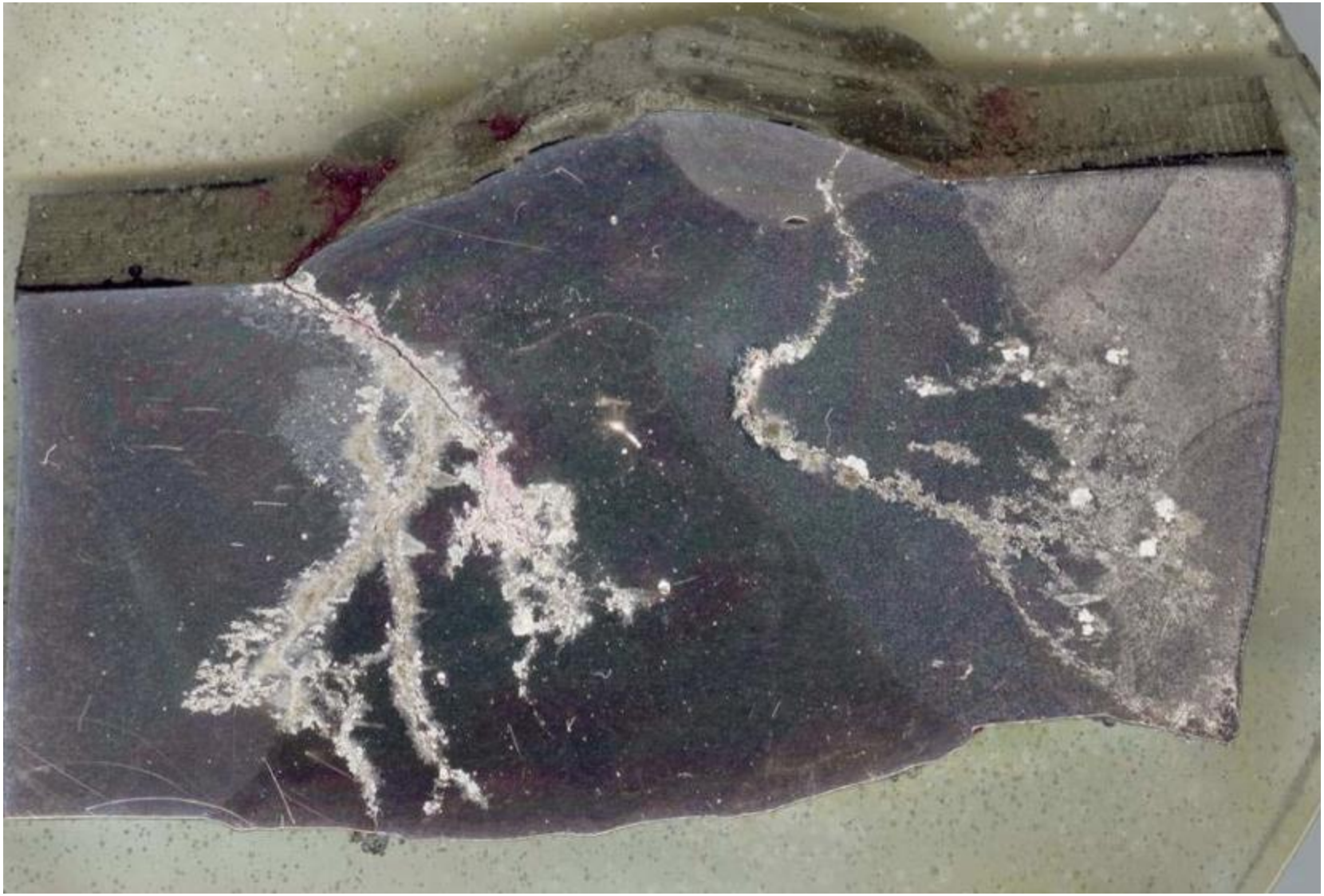




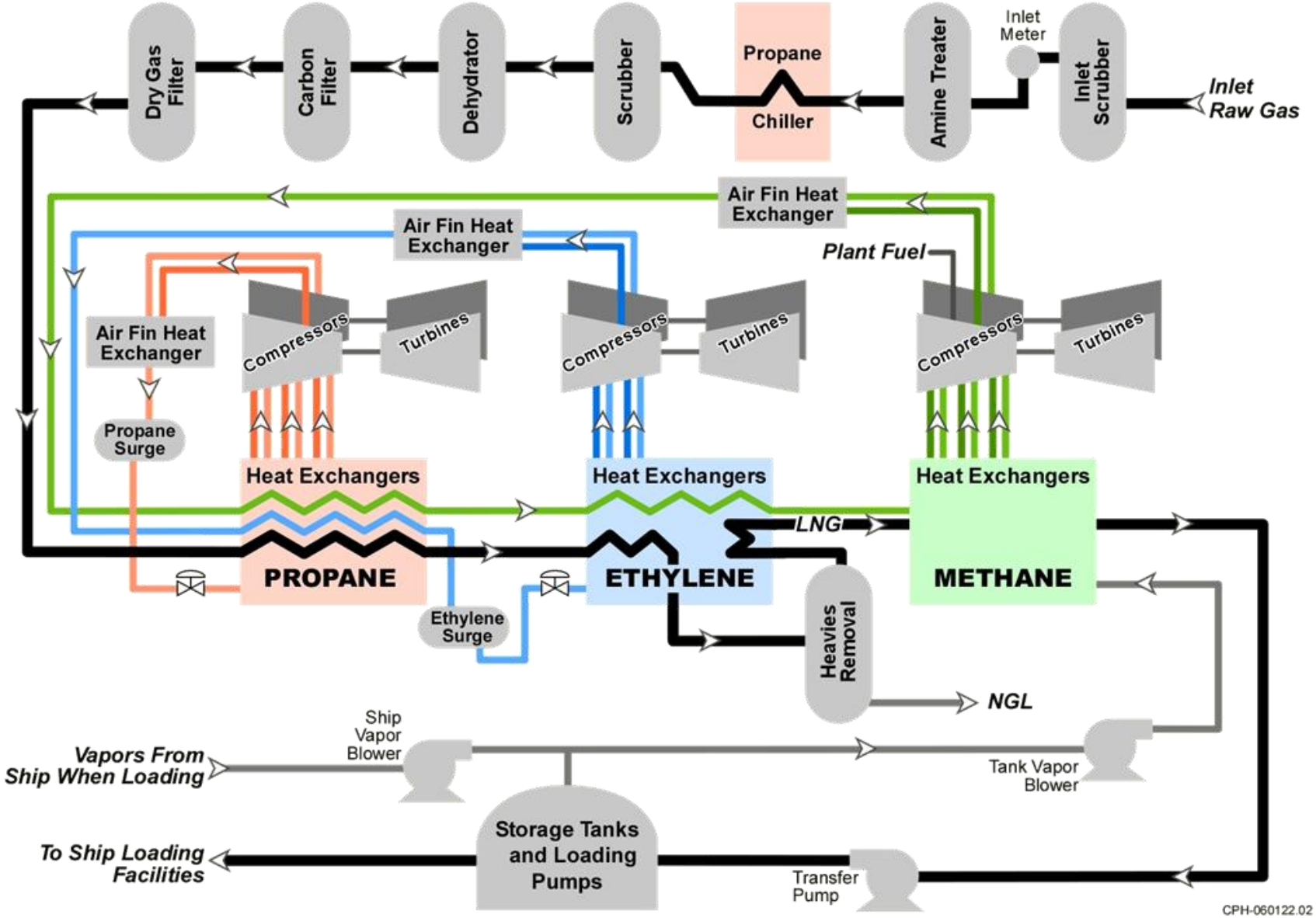
Brazed Al Heat Exchanger



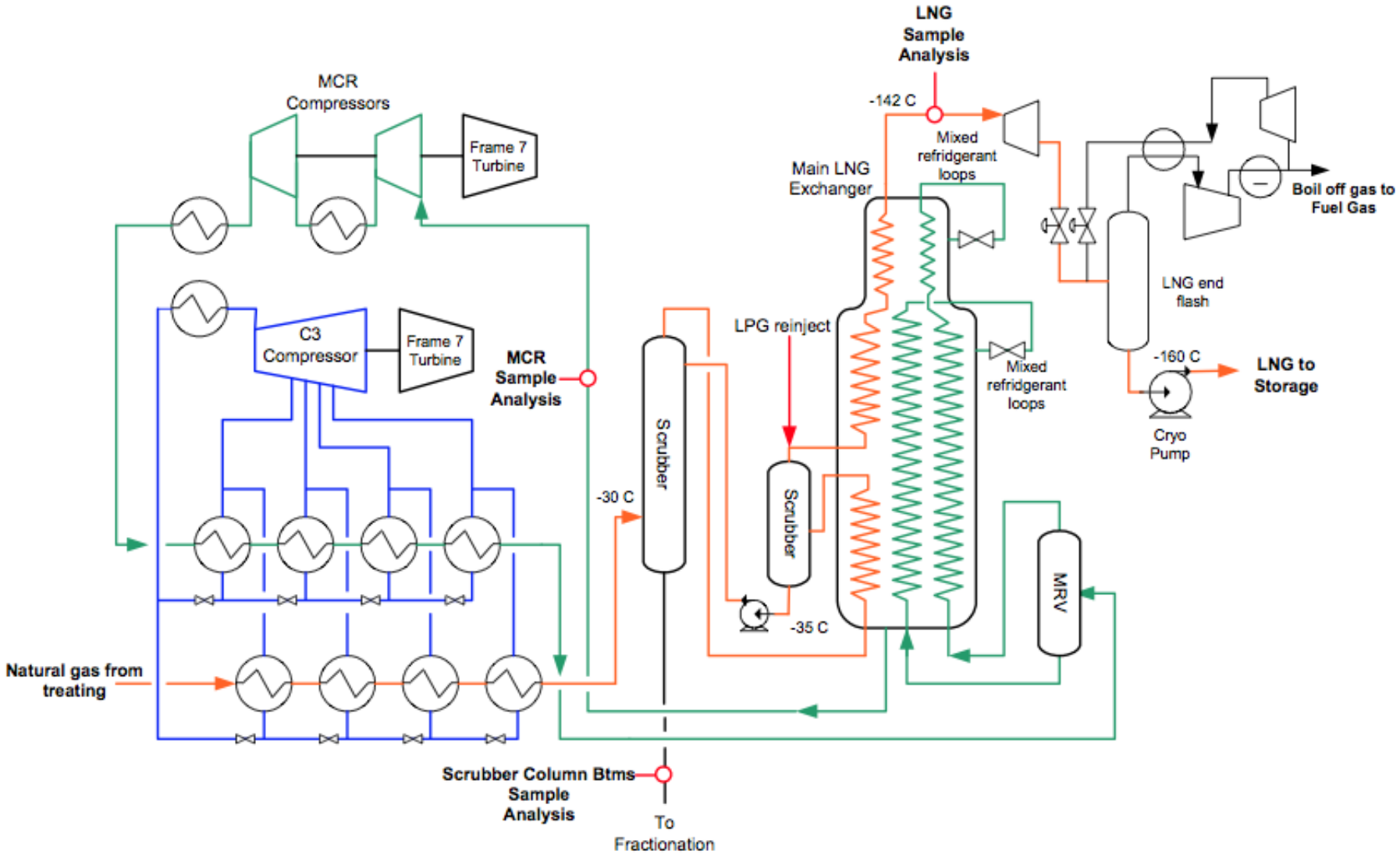
BAHX Corrosion



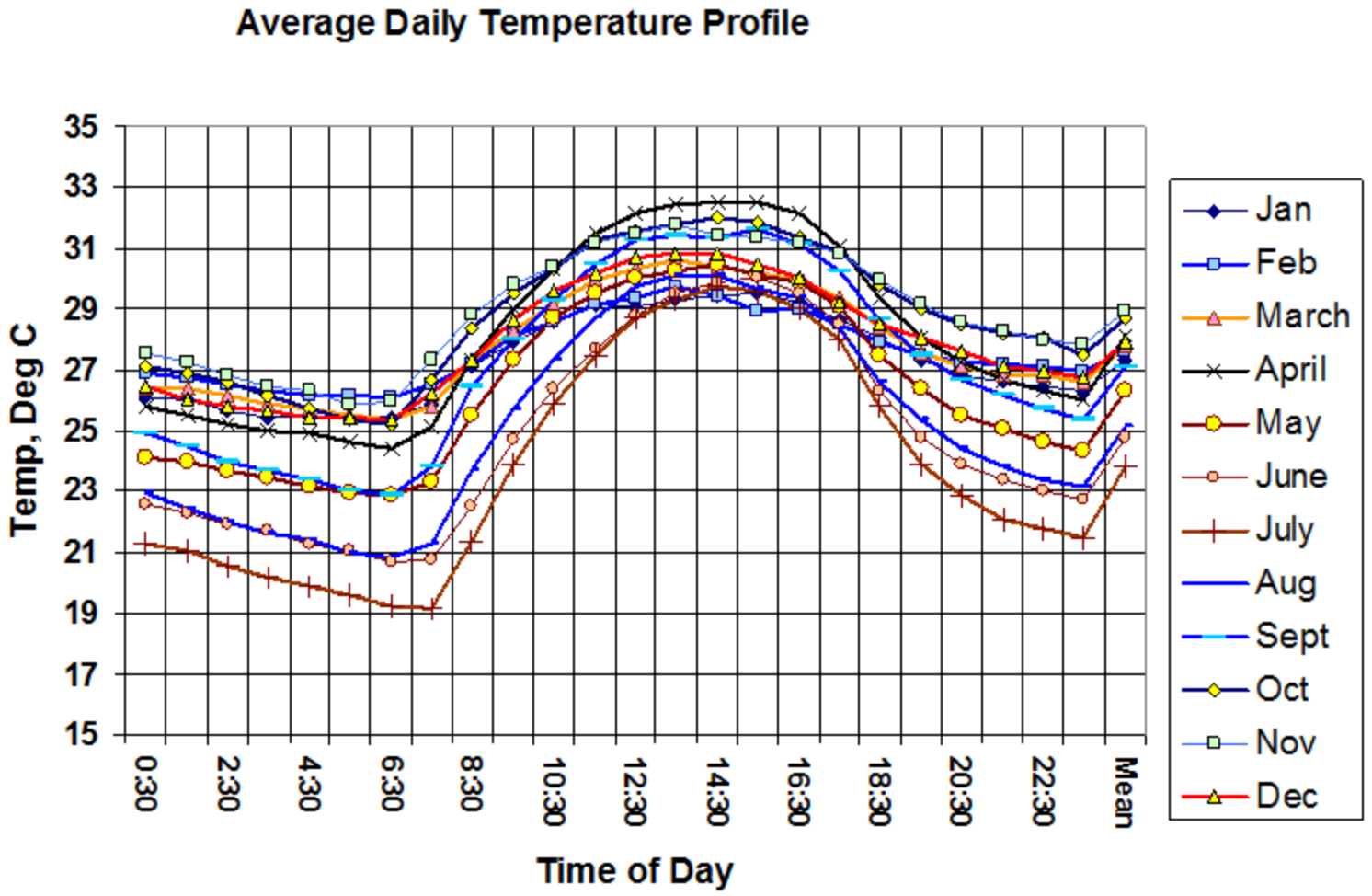
ConocoPhillips Optimized Cascade Process



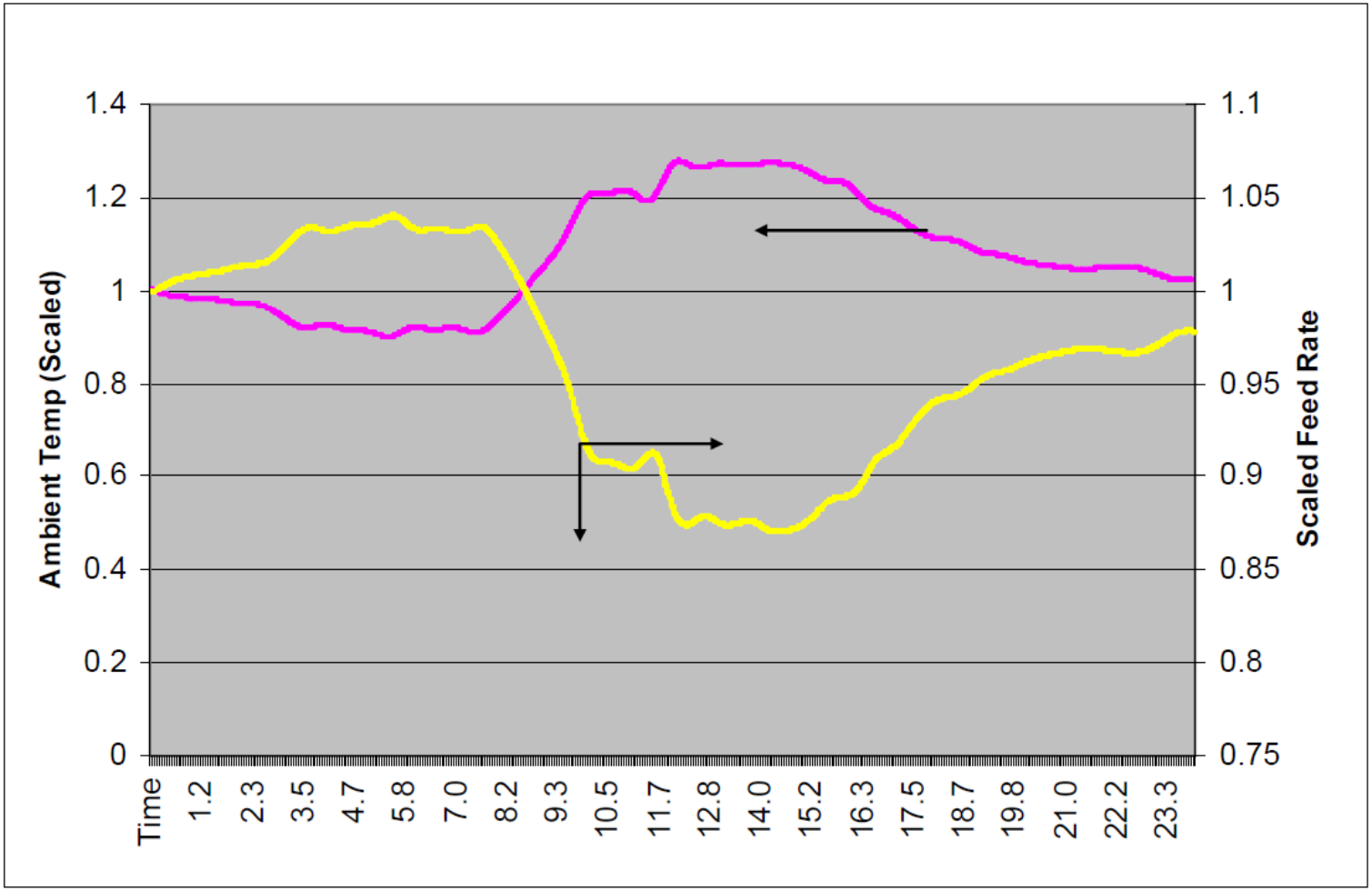
APCI- C3 MR Process



Temperature Profile



Plant Production and Ambient Temperature



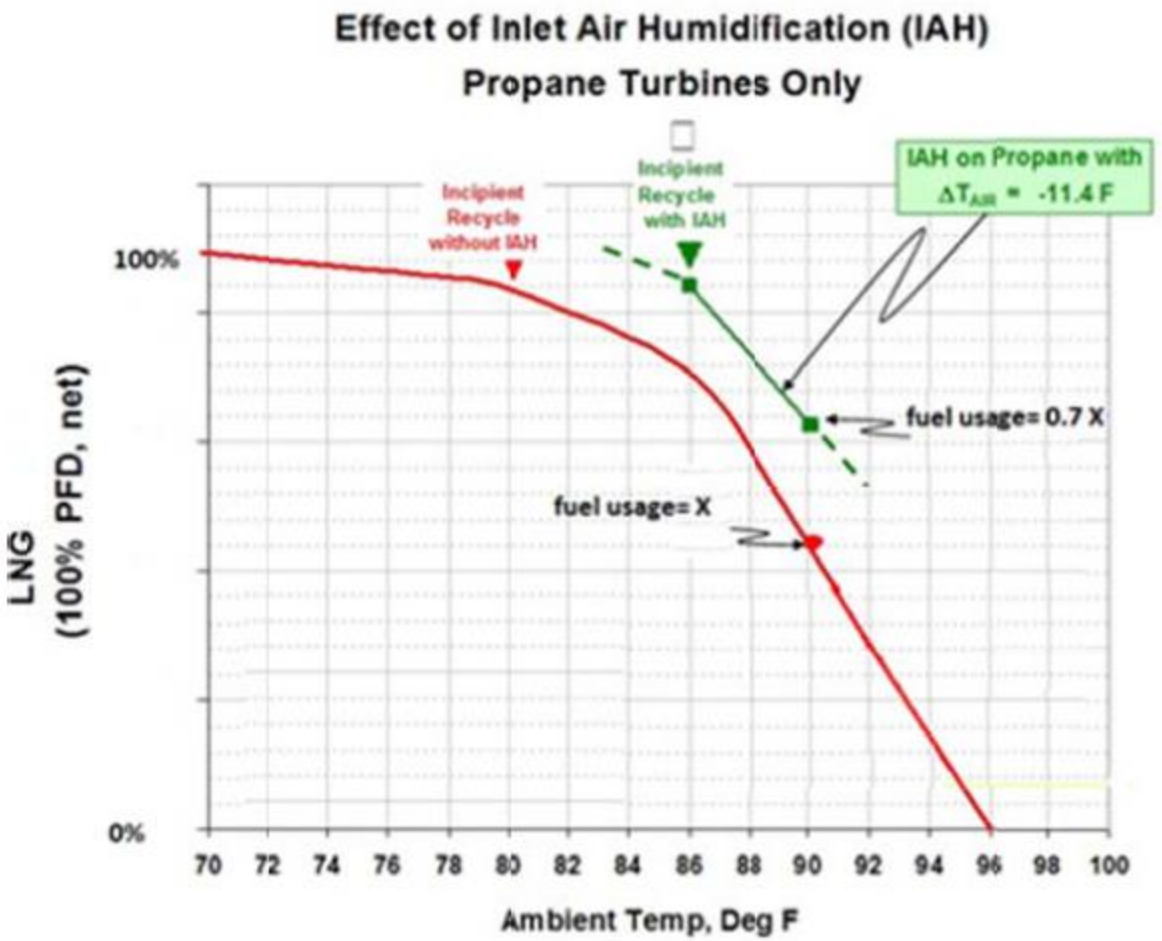
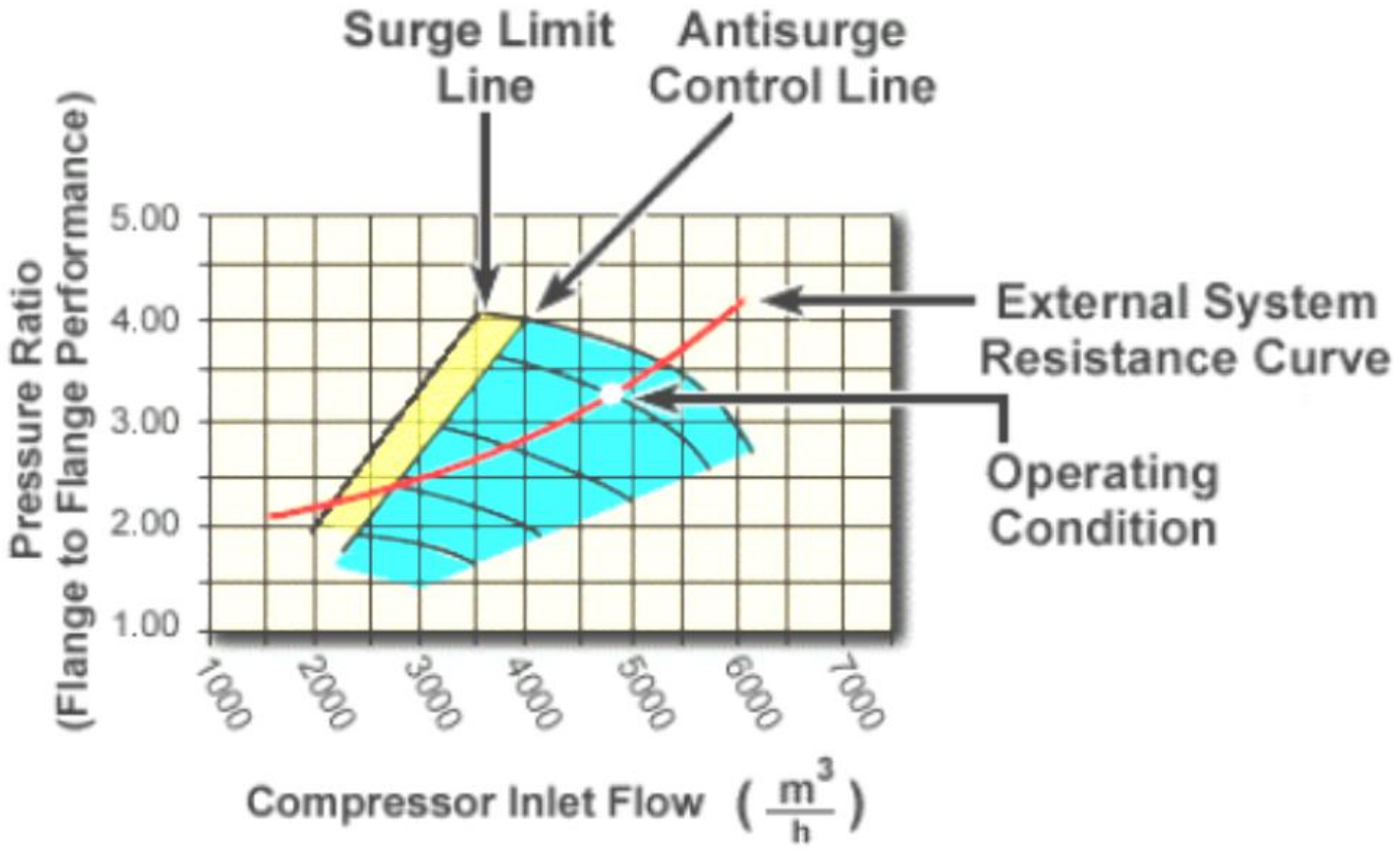


Figure 11. Impact of Evaporative Cooling on LNG Production and Fuel Usage.

Operating Condition



Boundary Conditions

- No Recycle for High Ambient (HA) Case
- Margin to Surge
- Low Ambient (LA) Case
- Margin to Stonewall
- Compressor Speed
- Generally limit to 102-103%
- Operable for High-High Ambient (HHA) Case
- Operating on Surge Control

BOG Generation and Management

- ***Rotating Equipment Heat Gain***
- ***Ambient Heat Leak***
- ***BOG from Flash***
- ***Ship Return Vapor***
- ***Additional BOG from Piping/Existing Facility***
- ***Multiple LNG Trains and BOG Networks***

Ship Loading Vapor- BOG

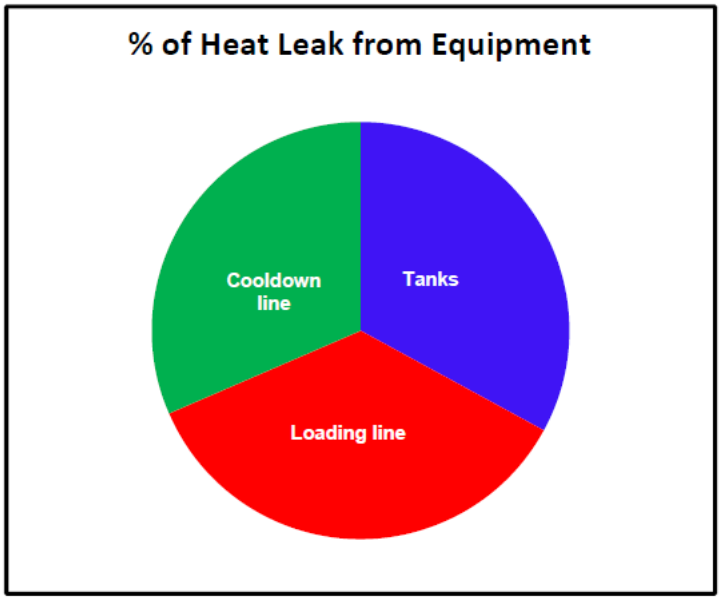
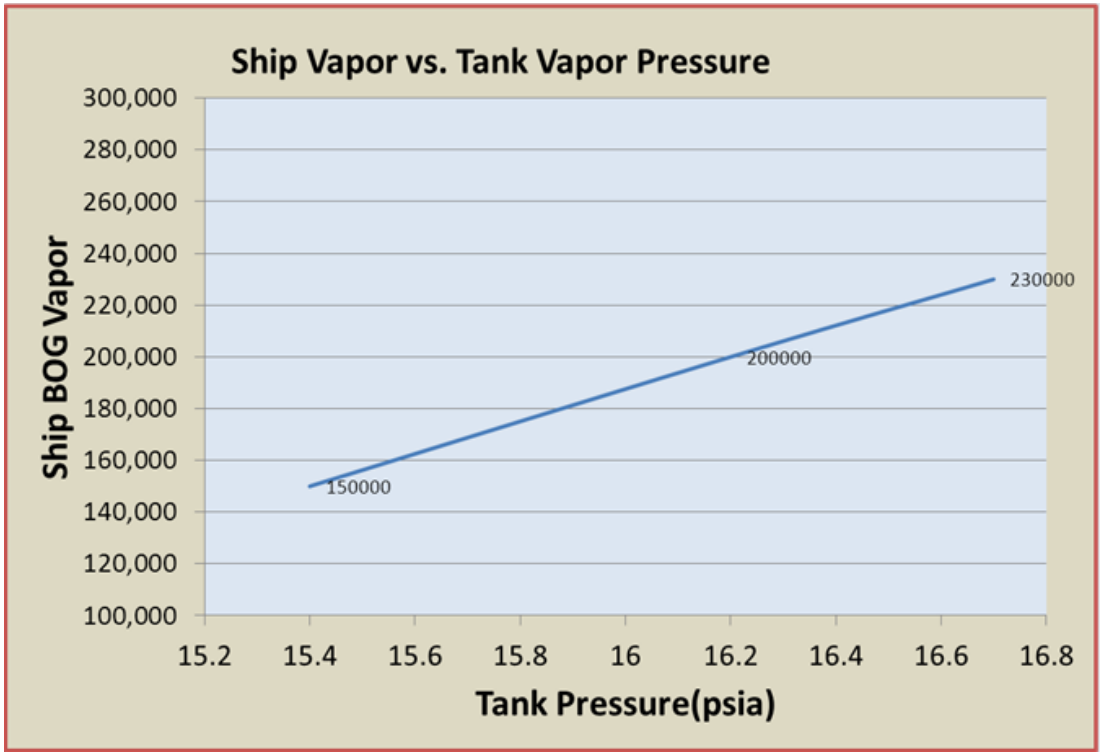
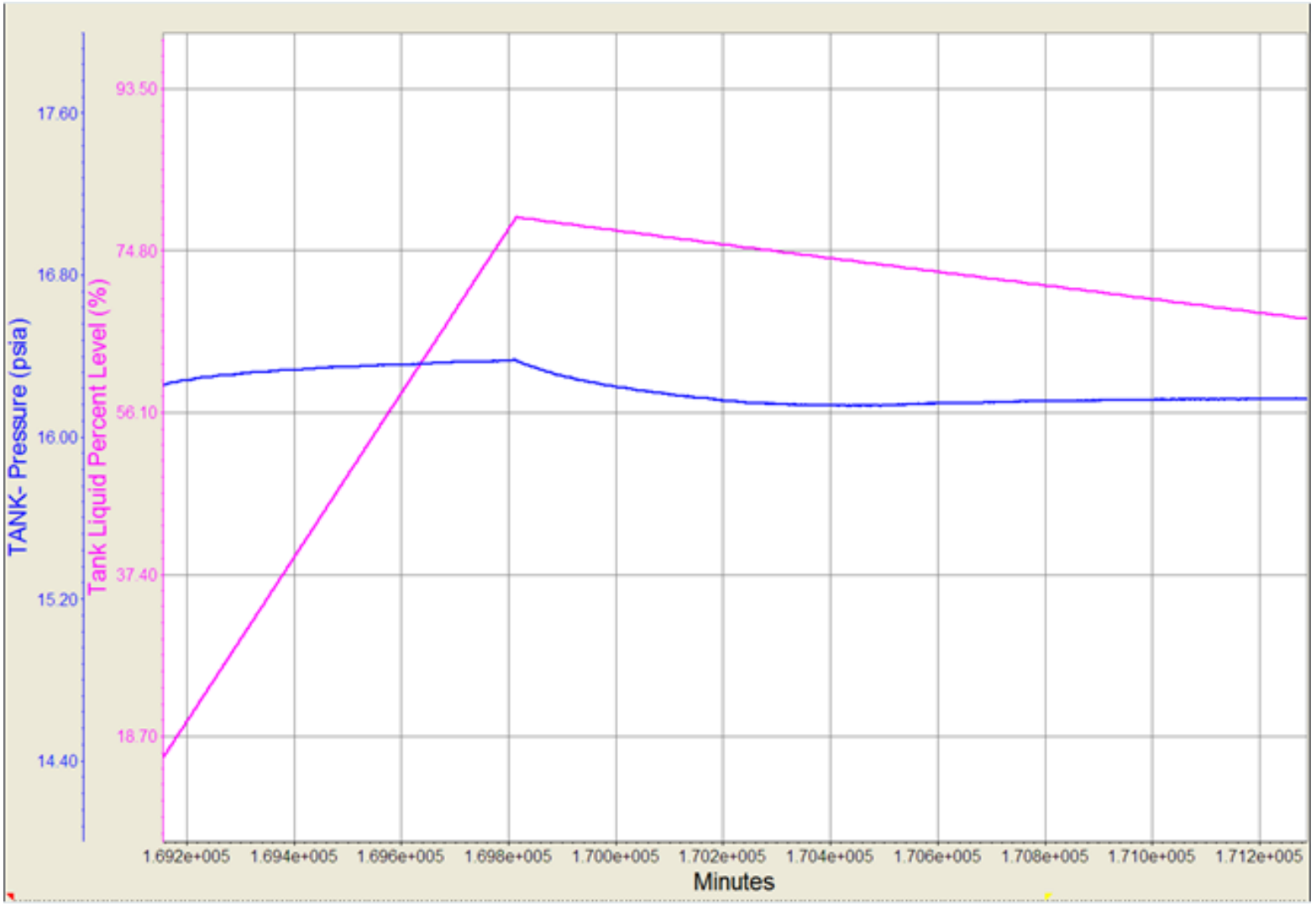


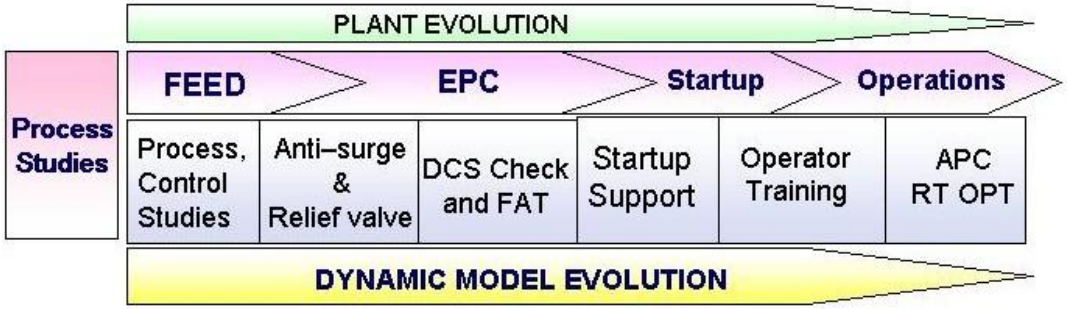
Figure 6. Heat Contribution Factors Generating BOG.

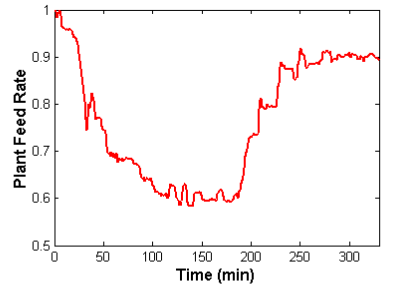


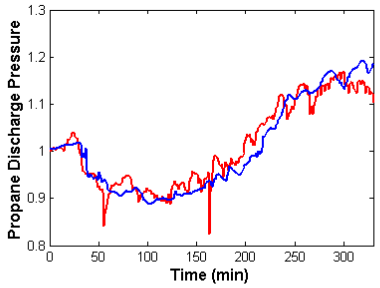
LNG Tank Pressure- Ship Loading

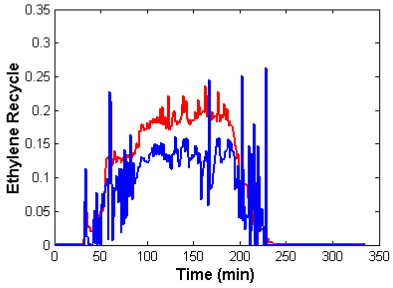


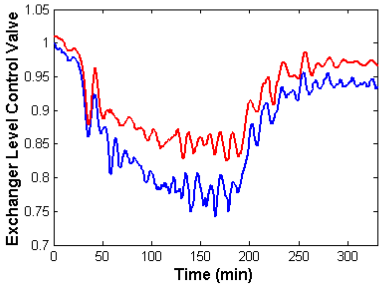
Dynamic Simulation



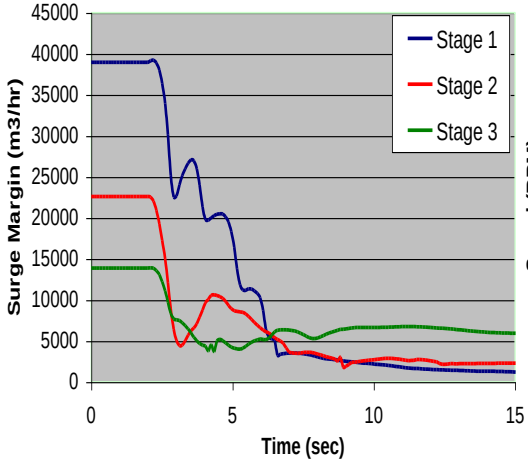


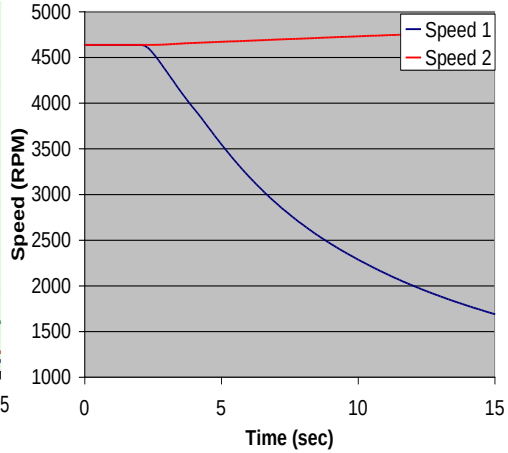






Comparison of model predictions (blue) with plant data (red)



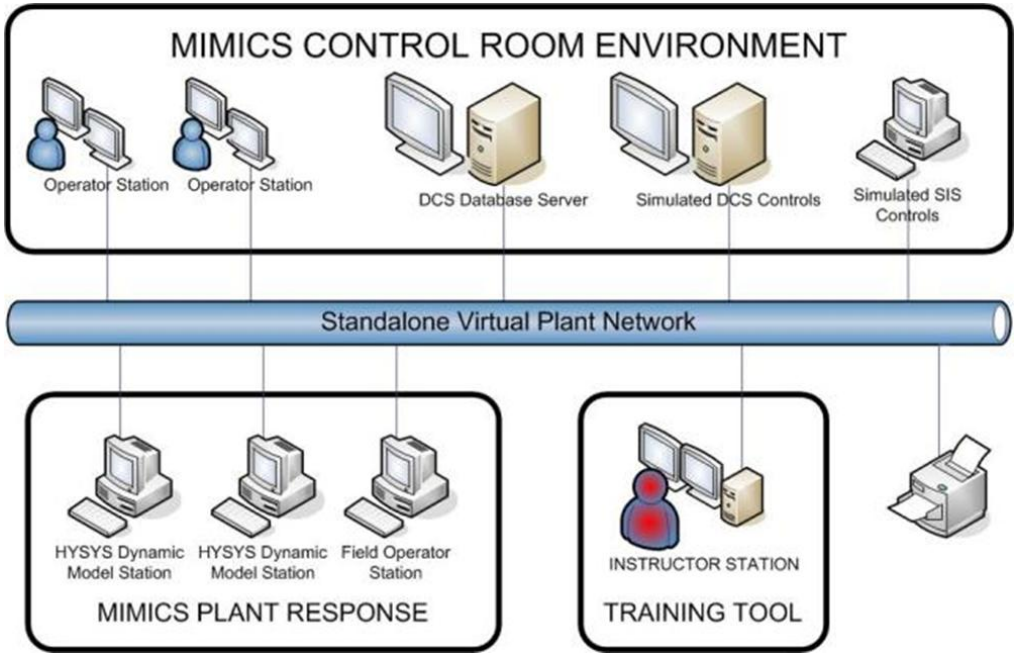


The response of refrigeration compressor in a trip that happens at 2 sec. The surge margins for 3 stages are shown in the left plot.

The right plot shows the speed response of the tripped compressor (blue line) and the parallel compressor that is still in operation

Operator Training Simulator - Components

- OTS stands for Operator Training Simulator
- Instructor Station
- Model Station(s)
- DCS and Safety System
- Operator Stations



Operator Training Simulator – How it is used

- Client
  - Exact replica of the plant and control system
  - Train new operators – new skills
  - Train experienced operators – refresh skills
  - Train for process upsets, plant start-up, shutdown and emergency response
- Bechtel
  - Check control strategy
  - Safety system design issues
  - Verify Start-up/Shutdown procedures

Operator Training Simulator – How it is used

- APC is a multi-variable control
  - One controller with many manipulated variables and many control variables
  - APC “sits” on top of DCS control
- Objective is to increase production
- smooth out LNG production as ambient temperature changes
- Maximize plant efficiency for same feed rate

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