

Oil & Gas Lecture Series

Dry Gas Seals in Vapor Recovery and Seal Leakage Recovery

**Some options to consider for reducing
emissions**

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Compressor Sealing Systems

- **Face Sealing Systems**
 - **Different Types of Dry Gas Seals (Recap from 2016)**
 - **Options for Dry Gas Seal Support Systems**
- **Vapor Recovery Application**
- **Closed Loop sCO₂ Seal Recovery Application**

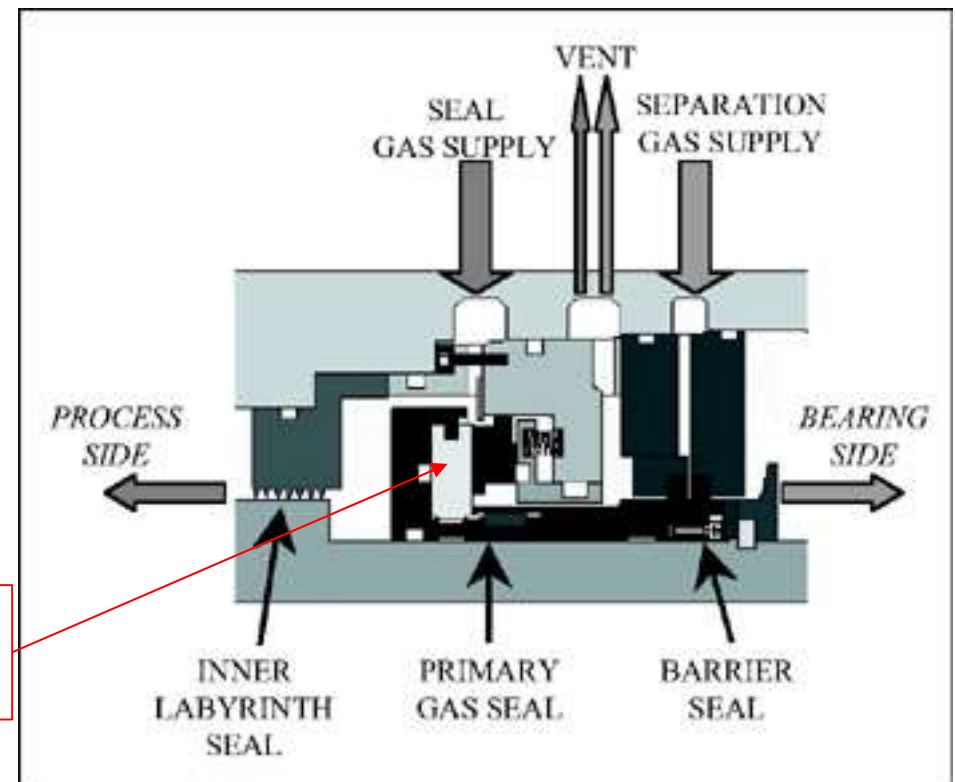
Face Sealing Systems Recap

Dry Gas Seals

- Used extensively in In-Line and Integrally Geared Compressors
- Tight axial running clearance between seal faces → Very Low Leakage
- Axial travel limits but usually sufficiently generous. Self-adjusting.
- Not very tolerant of contamination – requires clean buffer both sides (oil and process).
- Very high pressure capability.
- No known rotordynamic effects.

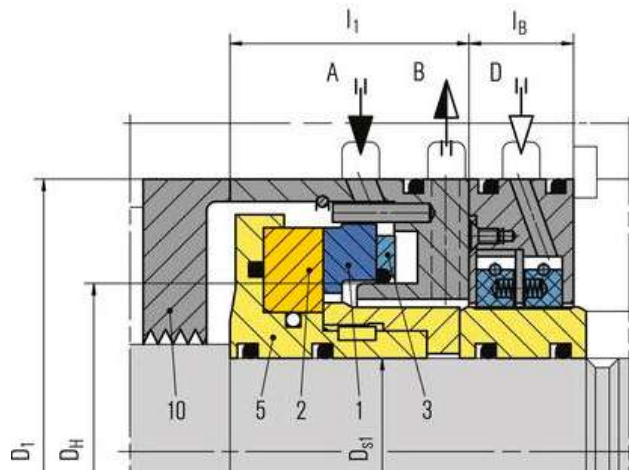


Rotating
Ring

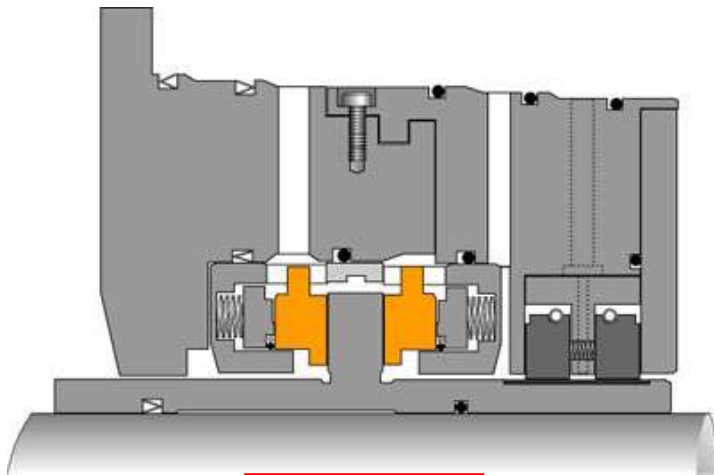


Face Sealing Systems

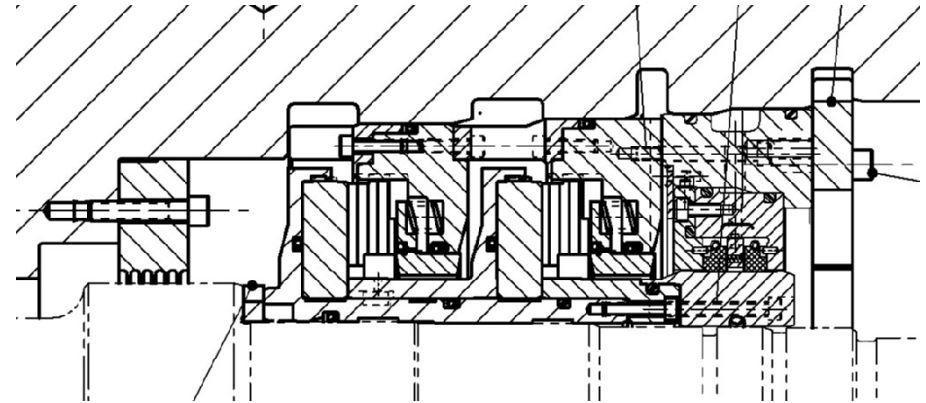
Variations of Dry Gas Seals



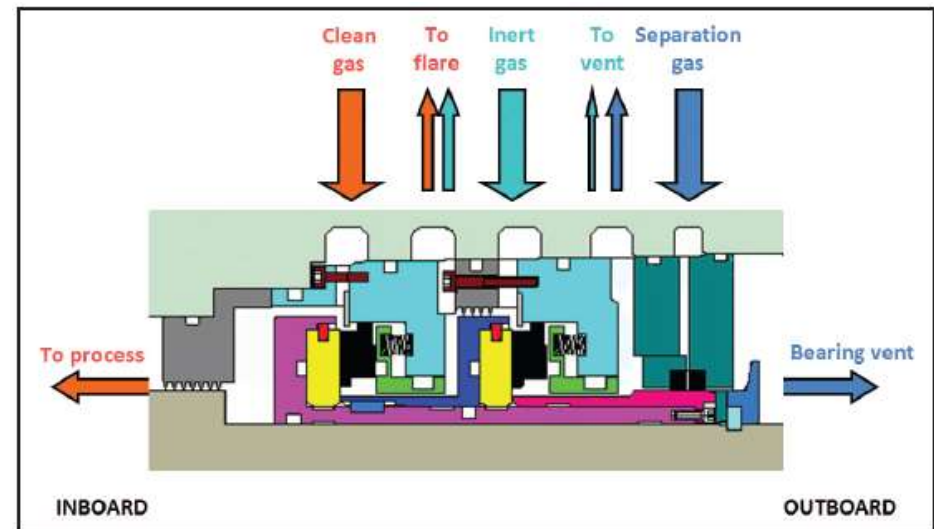
Single



Double



Tandem w/o Intermediate Laby

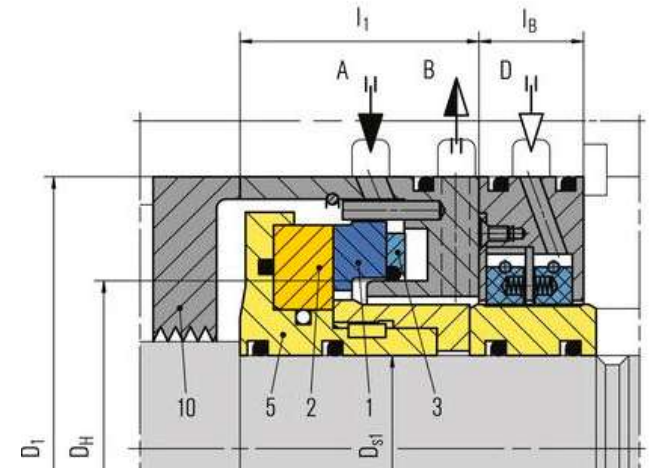


Tandem with Intermediate Laby

Face Sealing Systems

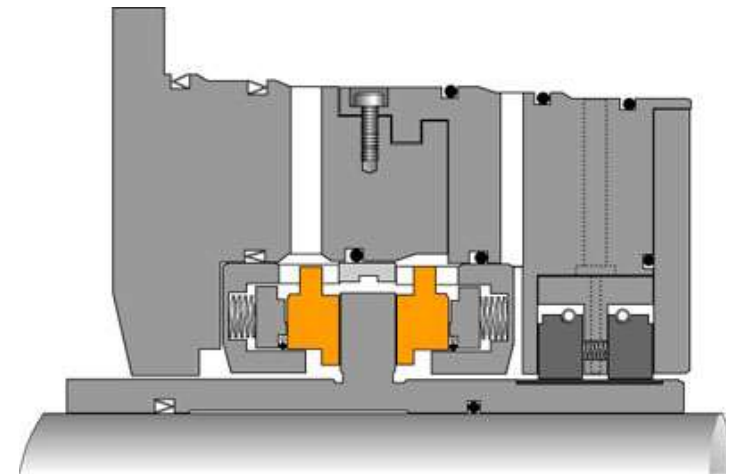
Single Dry Gas Seals

- Used in non-flammable/toxic applications – no back-up sealing element.
- Require a high pressure clean gas supply to the inboard laby.
- Have the shortest axial length – good for rotordynamics.



Double Dry Gas Seals

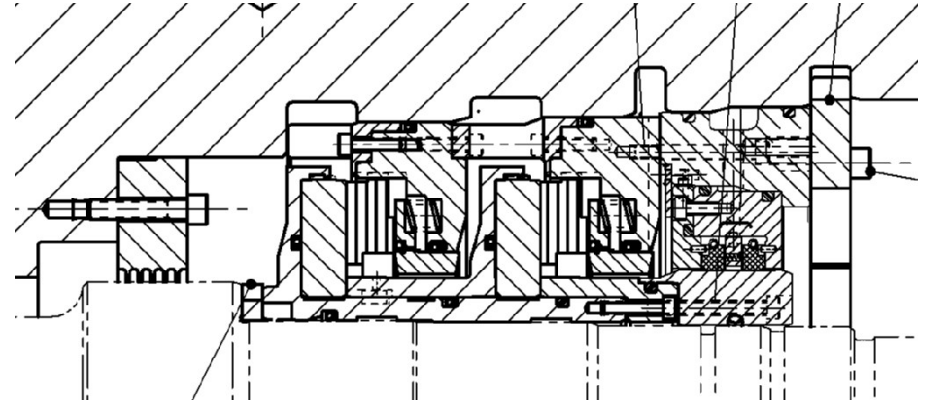
- Used in toxic applications (sour gas).
- Have a shorter axial length than tandem.
- Can be zero process gas leakage to atmosphere - requires a high pressure clean and inert gas supply to the seal.
- Require a high pressure clean gas supply to the inboard laby.



Face Sealing Systems

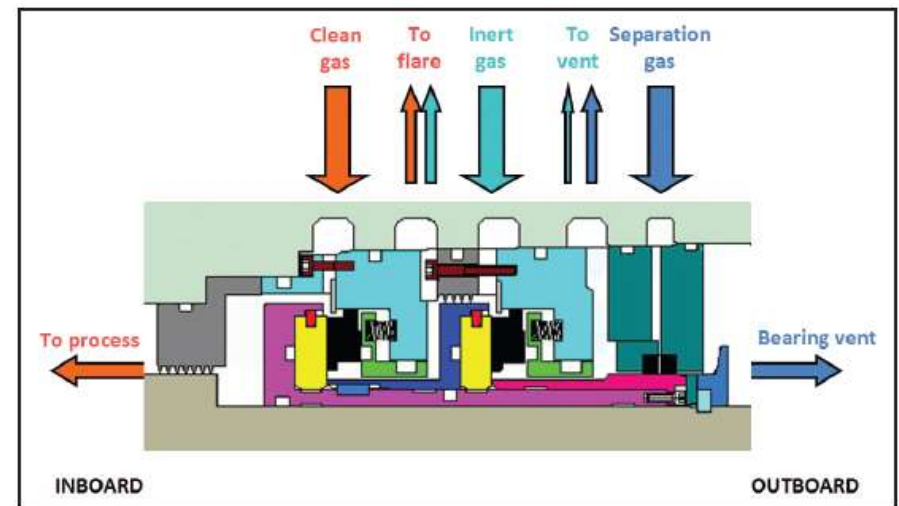
Tandem Dry Gas Seals without Intermediate Laby

- Used in flammable/toxic applications – back-up sealing element.
- Require a high pressure clean gas supply to the inboard laby.
- Longer axial length affecting rotordynamics.
- Process gas can leak to atmosphere.



Tandem Dry Gas Seals with Intermediate Laby

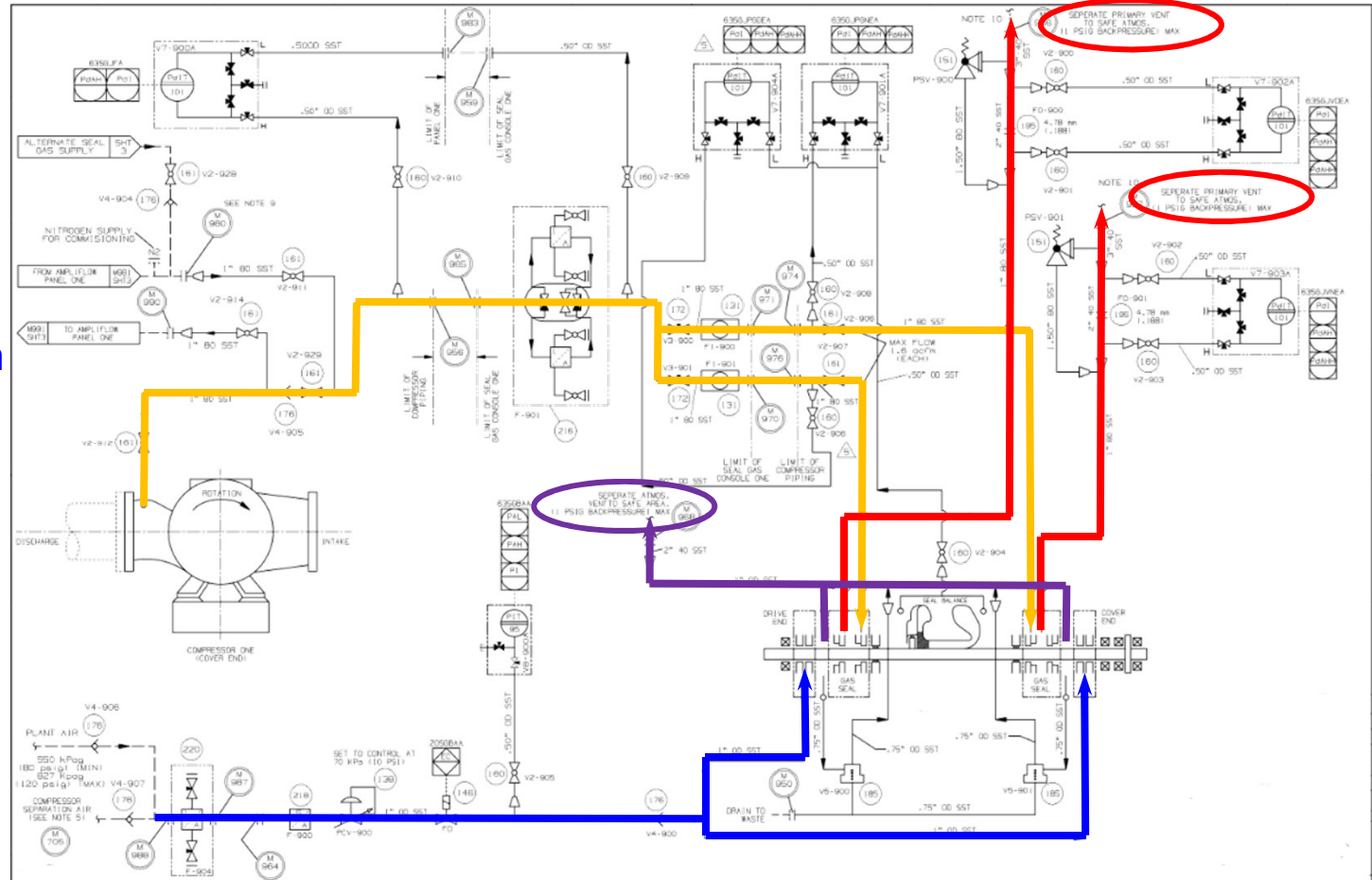
- Same attributes as above, except.
- Requires low pressure clean and inert gas supply to intermediate laby.
- No process gas leakage to atmosphere (if primary leakage gas is recovered or flared).



Face Sealing Systems (Tandem)

This is a relatively simple system.

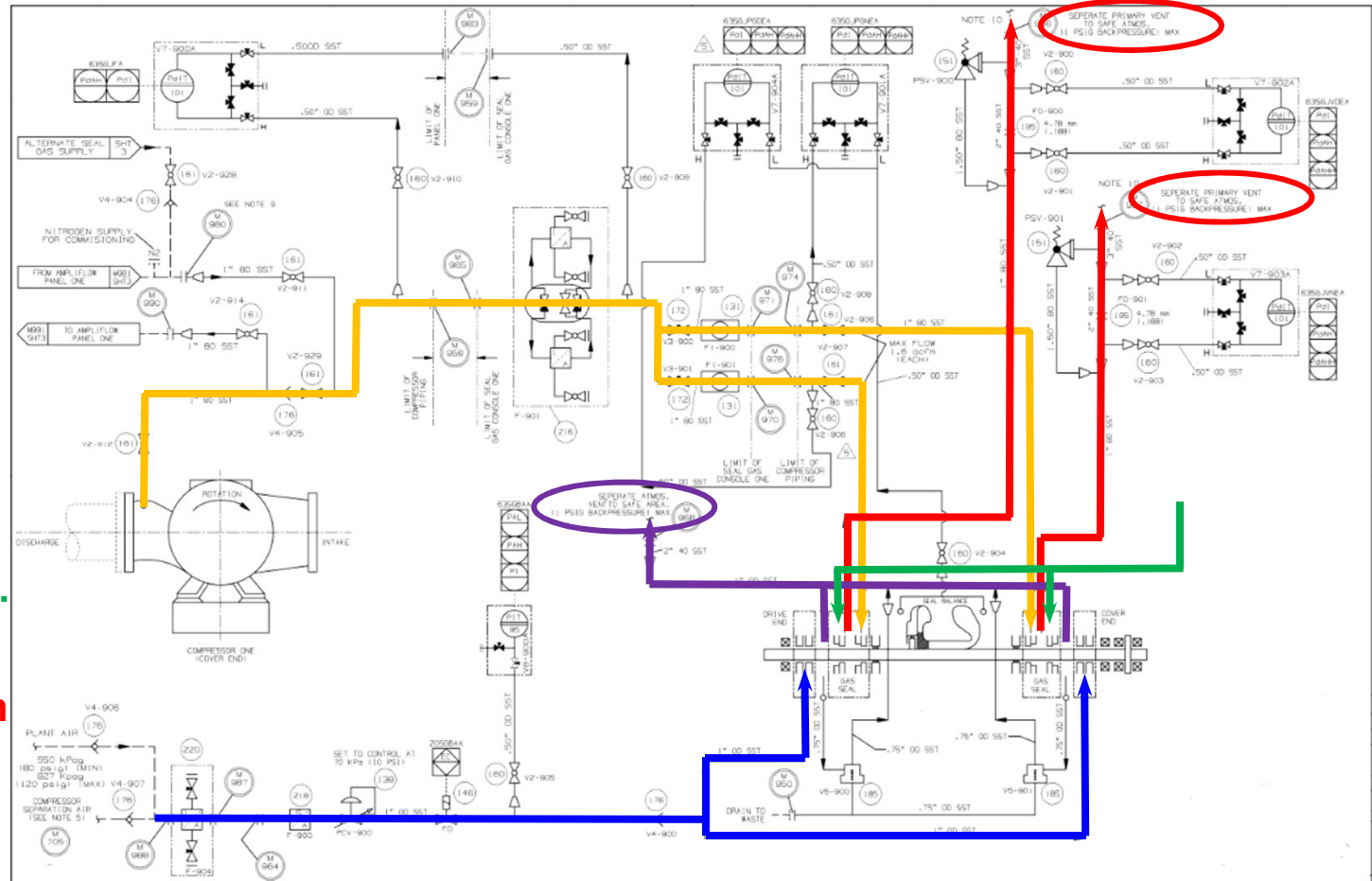
- Filtered seal gas supply from discharge.
- Air or N₂ buffers against oil in the separation seals. If air, there is concern over explosive mixtures.
- Many sweet gas systems vent to atmosphere. However, for natural gas, GHGs are worse than CO₂. Sending to flare can help.
- Some process gas leaks through the secondary seal to atmosphere.



Face Sealing Systems (Tandem)

This is a relatively more complex system.

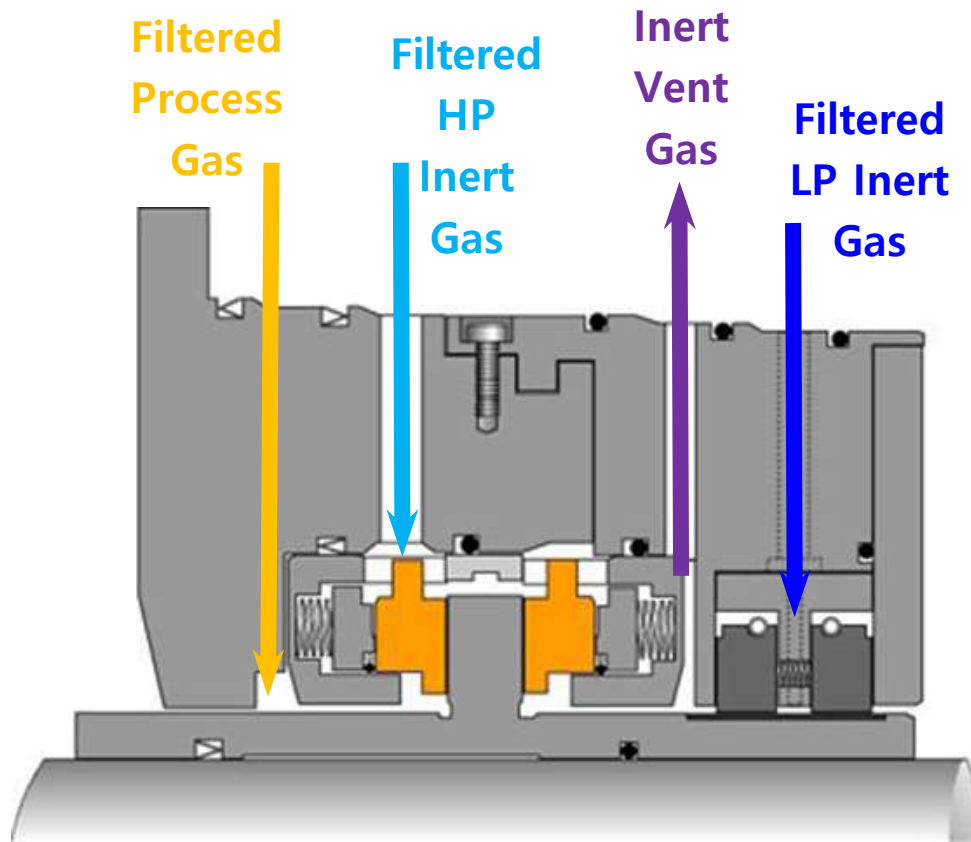
- Filtered seal gas supply from discharge.
- To prevent toxic or process gas emissions to atmosphere, a LP inert gas – usually N₂ - is injected between the primary and secondary seals.
- Primary vent is taken to flare or recovered to the process.
- Only inert gas leaks



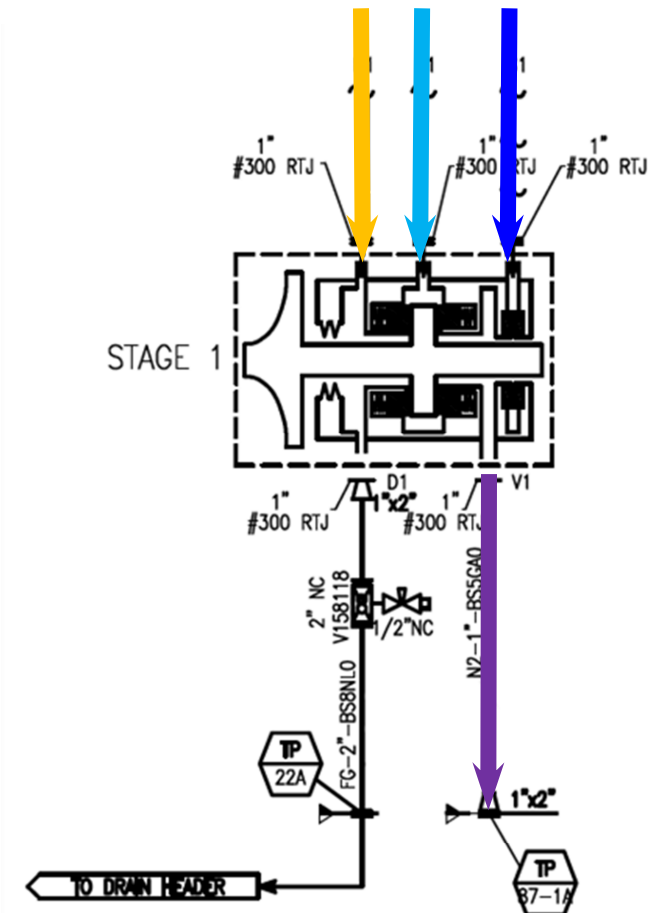
- Air could be used for separation seal supply with no explosive mixture potential.

Face Sealing Systems (Double)

A double seal works a little differently



Double Dry Gas Seal

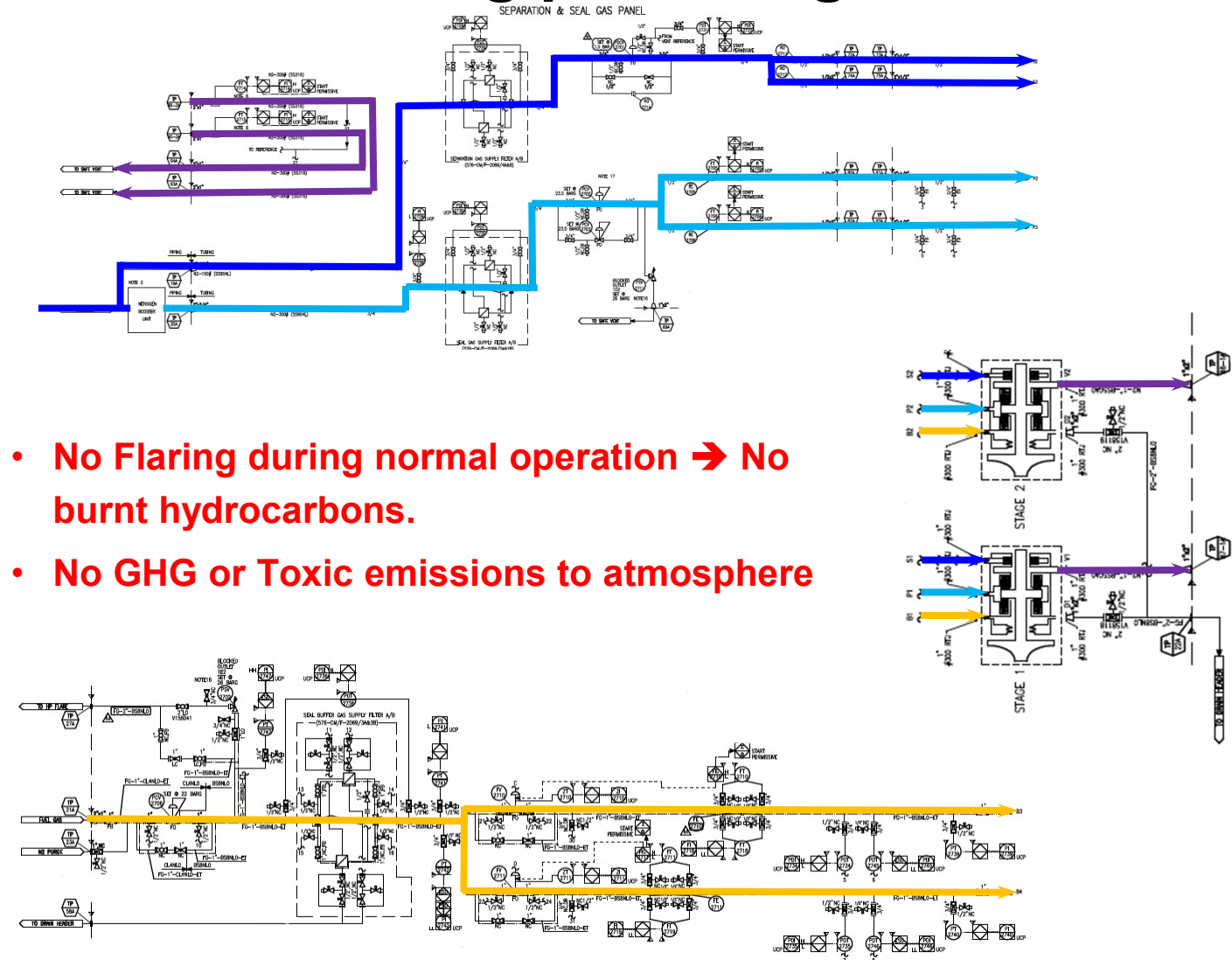


Schematically

Face Sealing Systems (Double)

This system avoids sending process gas to flare.

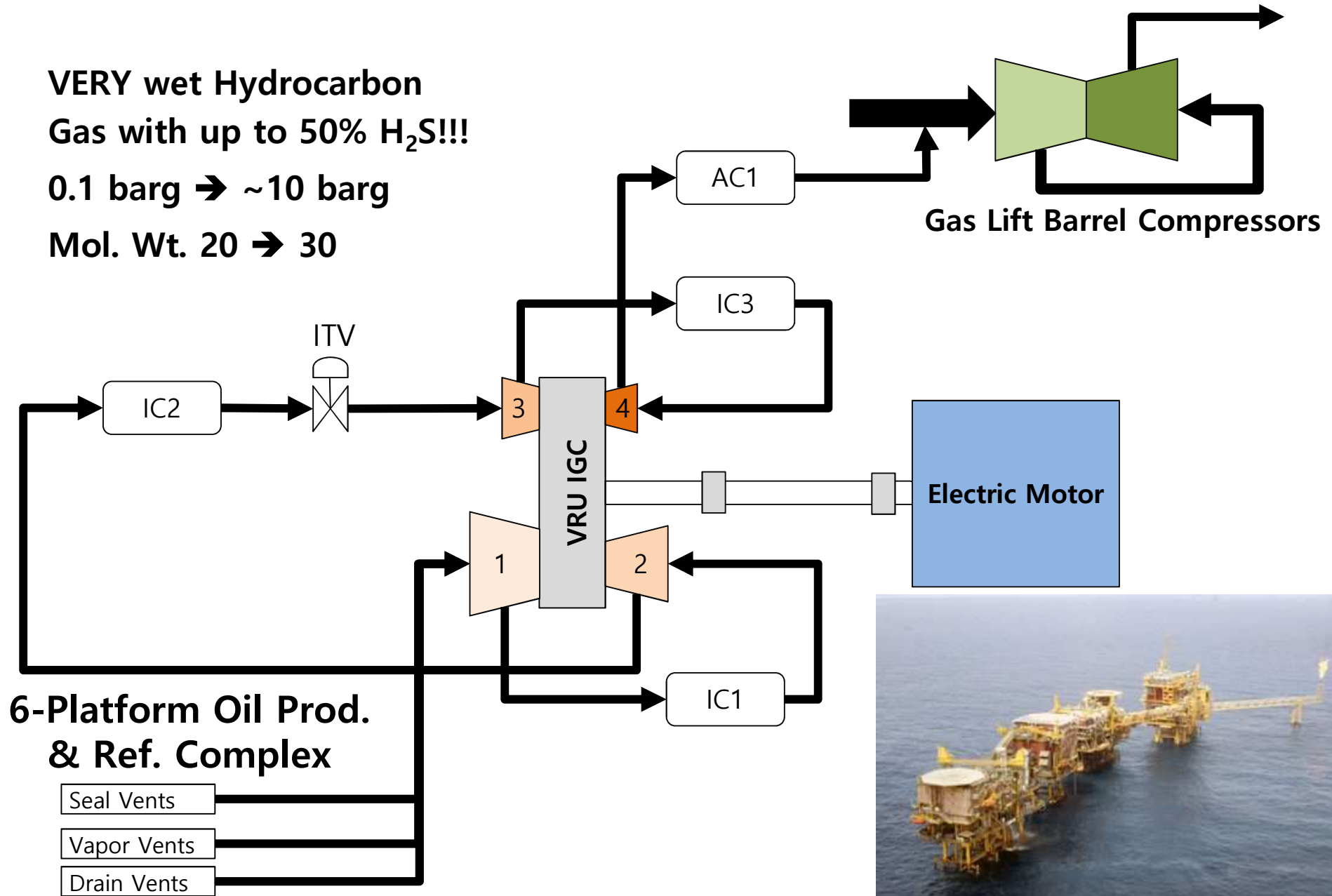
- Filtered process gas supply from discharge creates a clean buffer.
- Seal supply N₂ required to be boosted above max sealing pressure.
- Low pressure N₂ supply for separation gas from plant N₂ generator.
- N₂ to safe vent or Vapor Recovery system.



- No Flaring during normal operation → No burnt hydrocarbons.
- No GHG or Toxic emissions to atmosphere

Application: Vapor Recovery

**VERY wet Hydrocarbon
Gas with up to 50% H₂S!!!
0.1 barg → ~10 barg
Mol. Wt. 20 → 30**

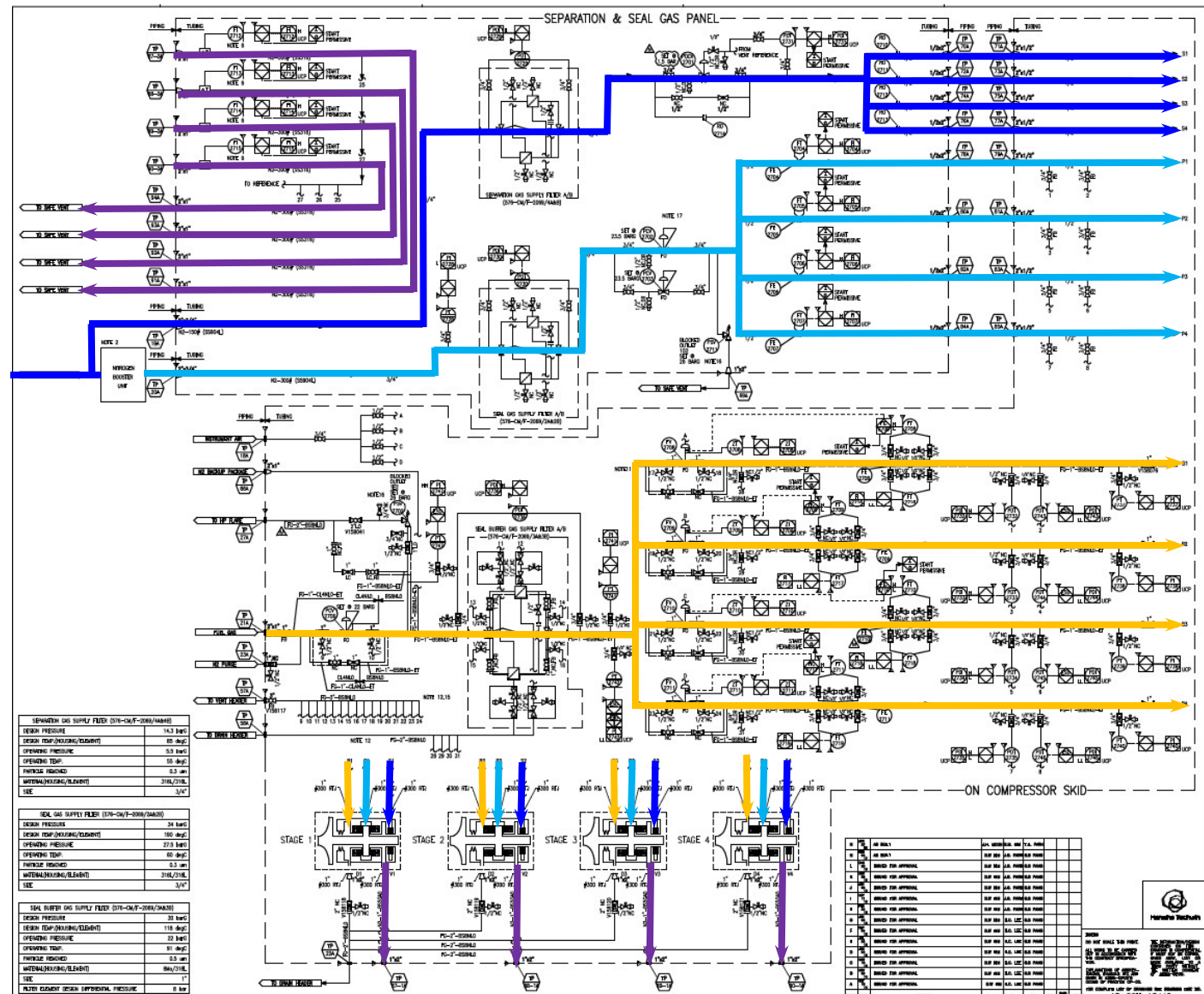


Application: Vapor Recovery



Requirements: Zero Flaring and Zero Process Leakage

- Filtered process gas supply from discharge creates a clean buffer.
- Seal supply N2 required to be boosted above max sealing pressure.
- Low pressure N2 supply for separation gas from plant N2 generator.
- N2 to safe vent or Vapor Recovery system.



Application: Closed Loop sCO₂



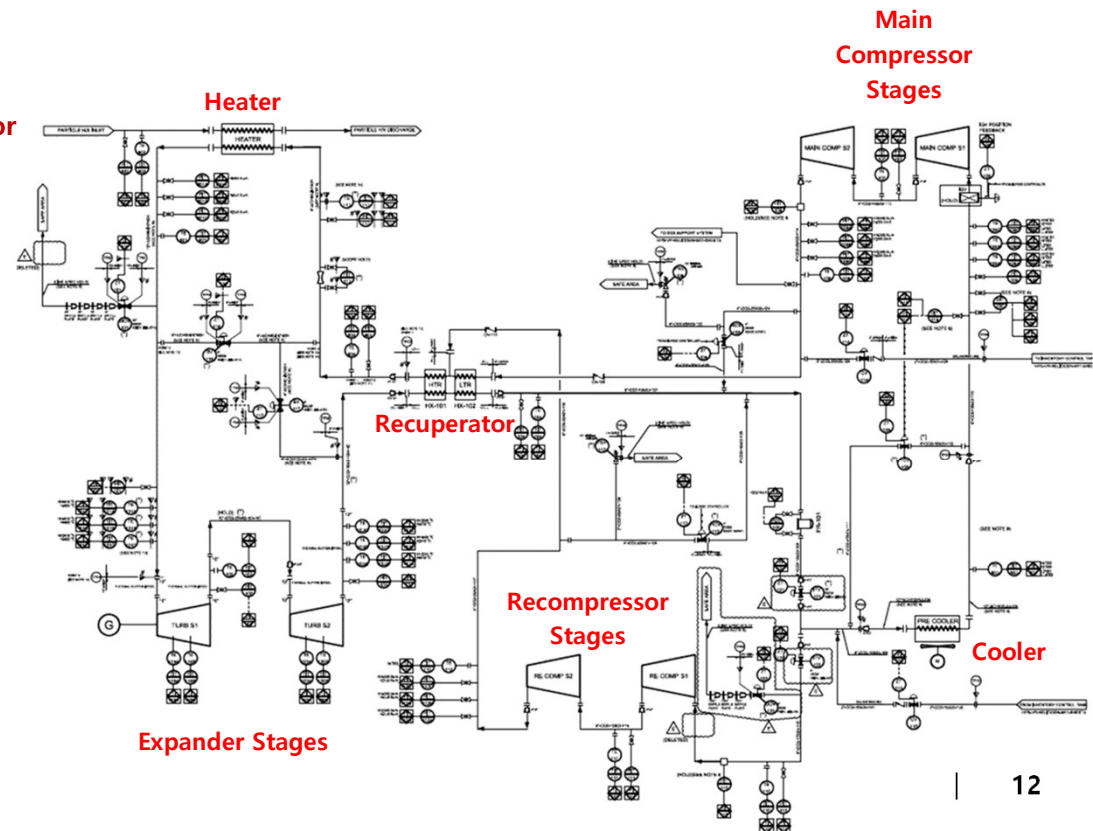
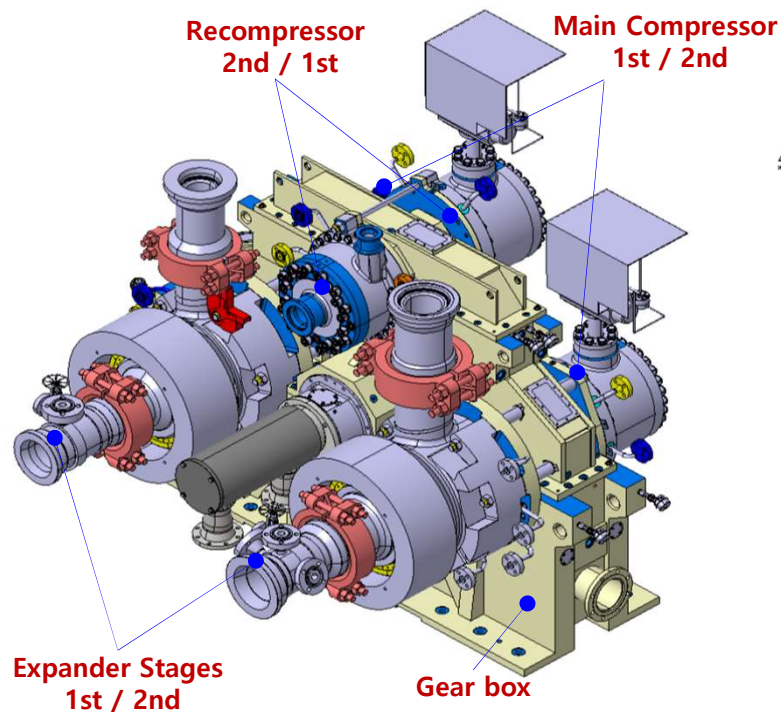
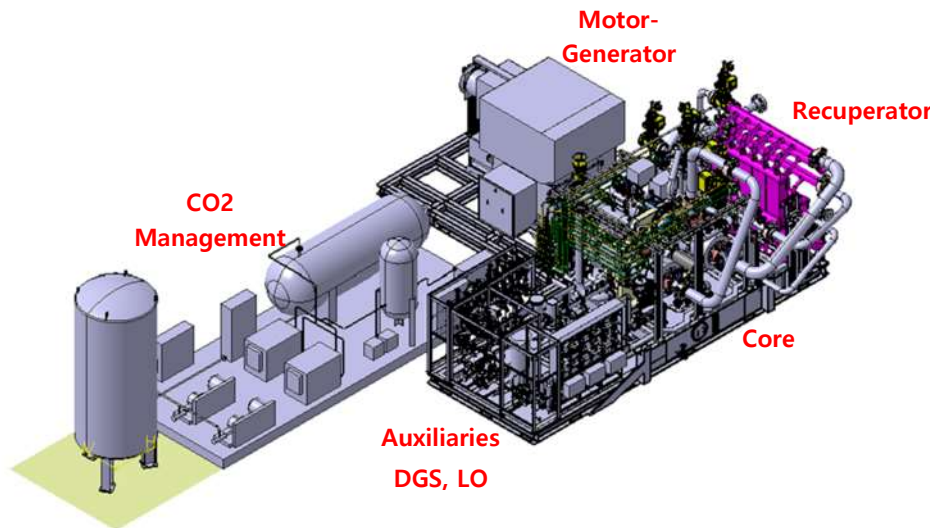
CSP → sCO₂ Recuperated Brayton Cycle

85 bar → 225 bar, 37 C → 600 C

99.9% CO₂ (Food Grade)

5 MWe Net Power Output

37.2 % Thermal Efficiency

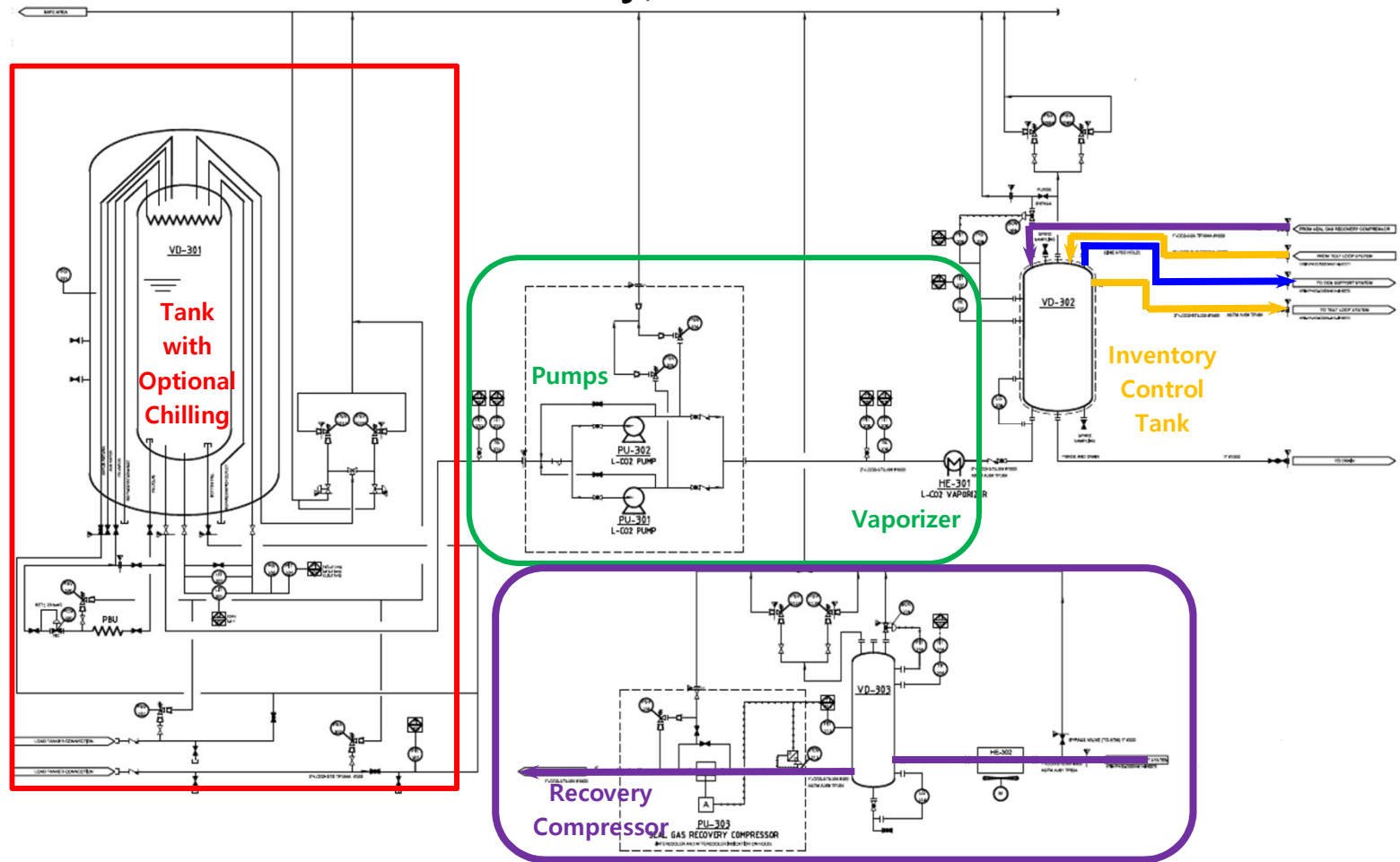


Application: Closed Loop sCO₂



Requirements: Minimize Emissions, Reduce OPEX

- **L-CO₂ Storage Tank** CO₂ Management System has typical DGS support for tandem seals without intermediate laby, but has a few enhancements...
- **L-CO₂ Pump and Vaporizer**
- **Inventory Control for Off-Design Optimization**
- **Primary Vent Leakage Recovery Compressor**
- **~95% Leakage Recovery Saves ~\$300k/year cost of replenishment**
- **Plus Emergency Cooling Flow for Expander Seals**



Application: Leakage Recovery

Potential Applications:

- **Pipeline emissions reduction** – capture the primary leakage and re-compress it into the pipeline.
 - Can be used for fuel: GTs, gas engines, smaller generators.
- Potentially combine the leakage recovery equipment with a system to **replace blow-down** with transfer of gas to sections of pipe that do not need to be evacuated for maintenance.
- Apply leakage **capture to older oil bushing seal** compressors (or even older ones) with eductors/laby seals to significantly reduce GHG emissions.
- **Vapor recovery systems** capture gases and inject into the process instead of flaring – more complex plants have many sources of “vapors” that can be combined to increase effect and need larger machines.

Thank-you!