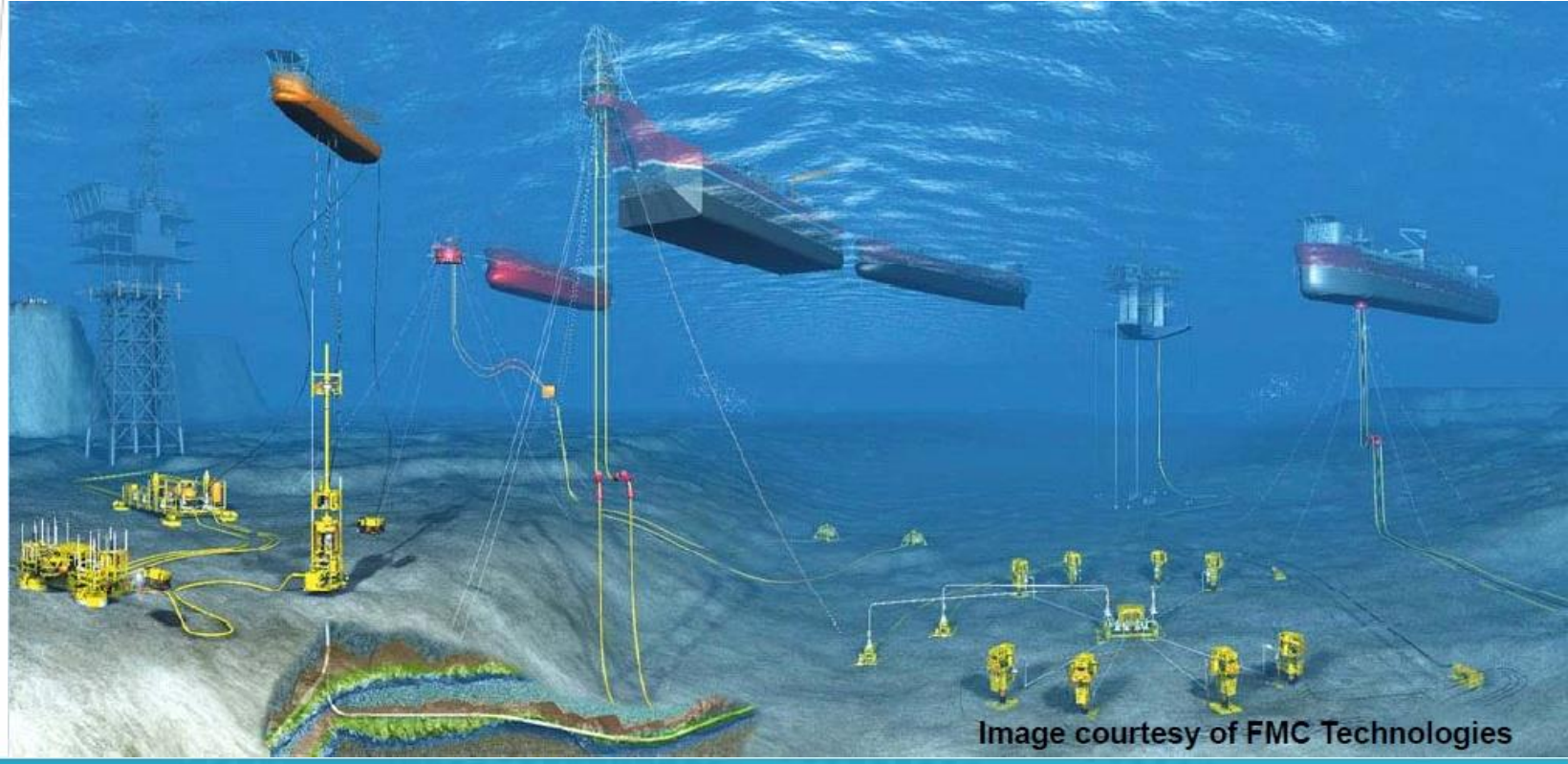
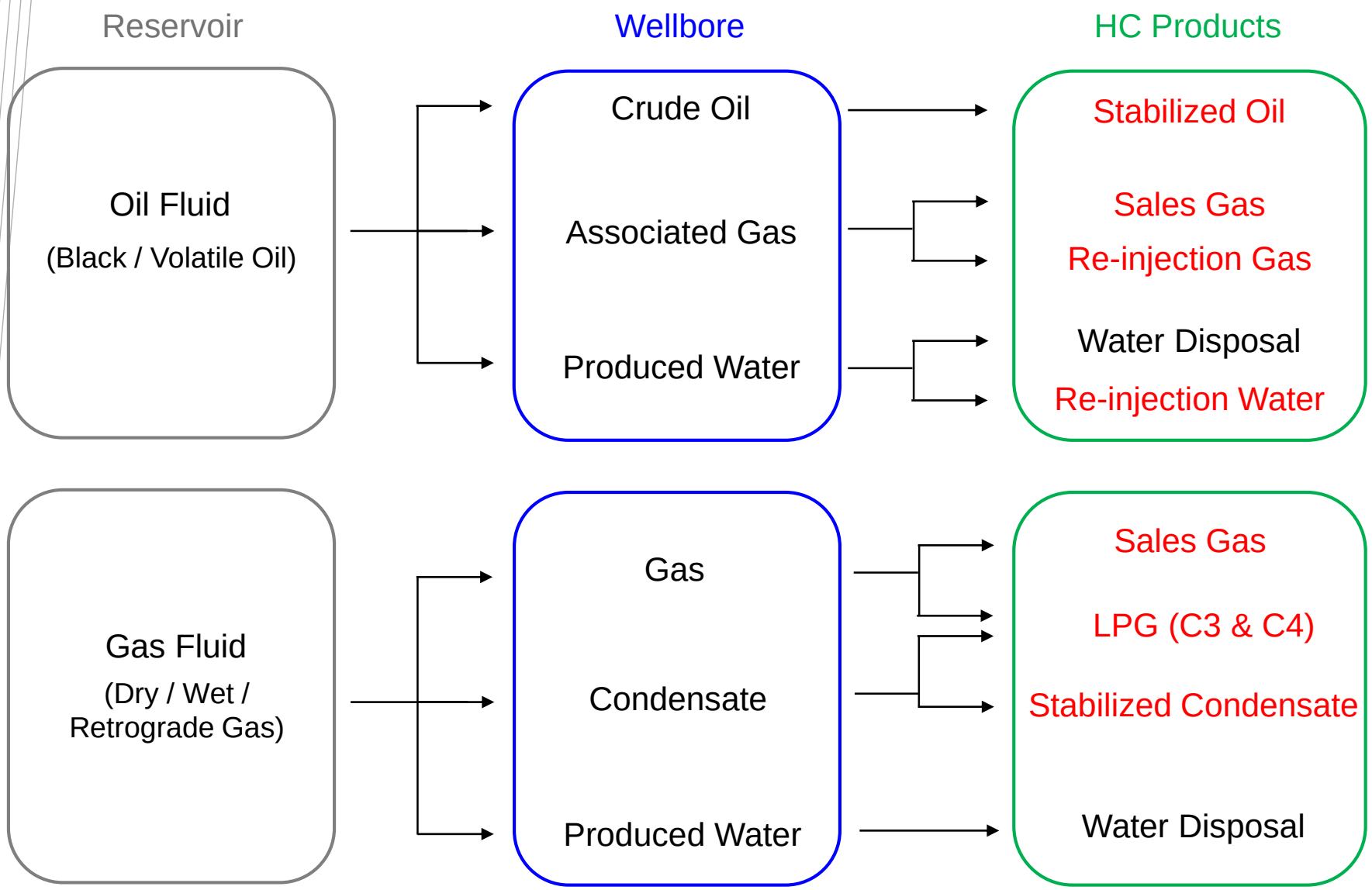


Offshore platform FEED

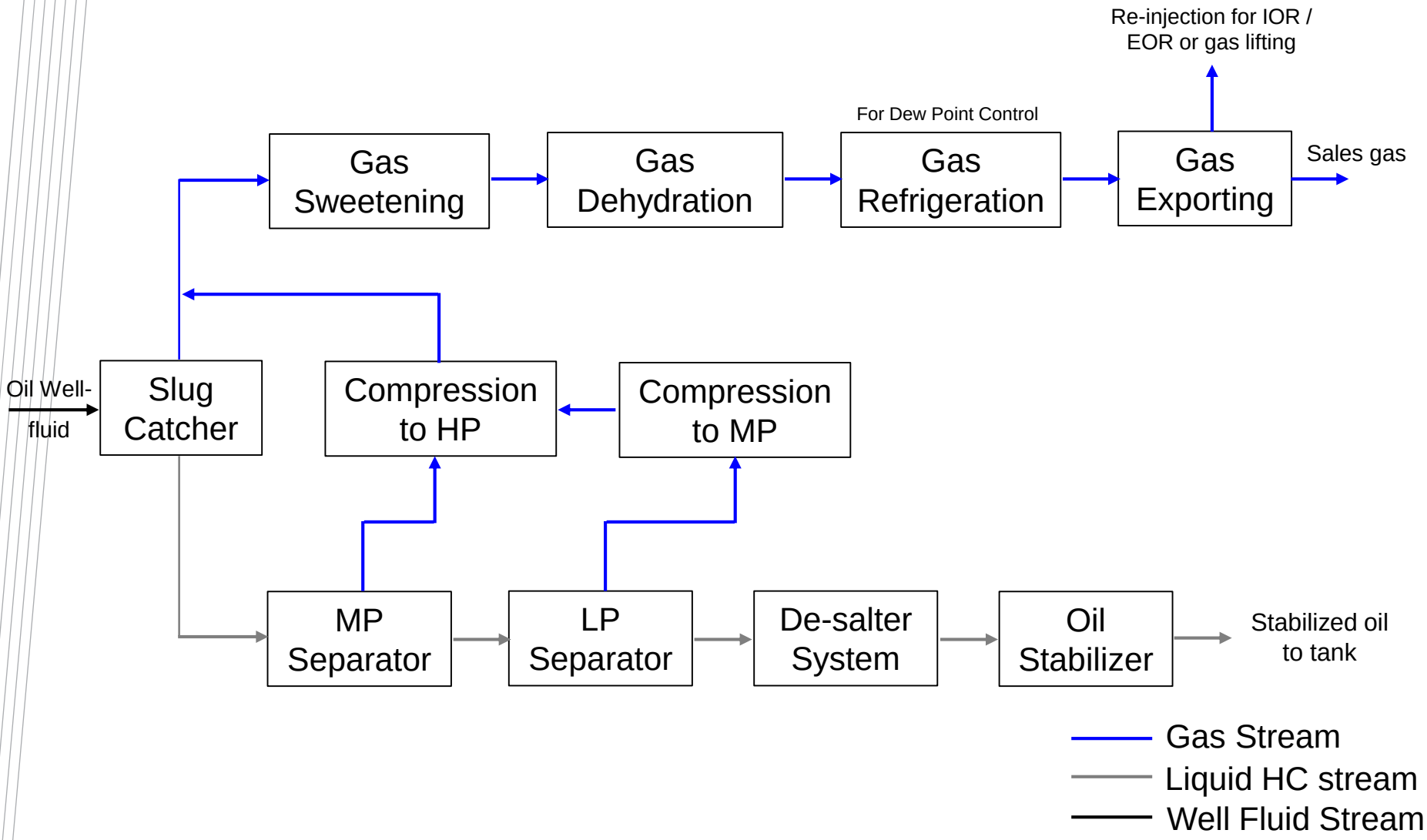
Yutaek Seo

Processing in offshore platforms

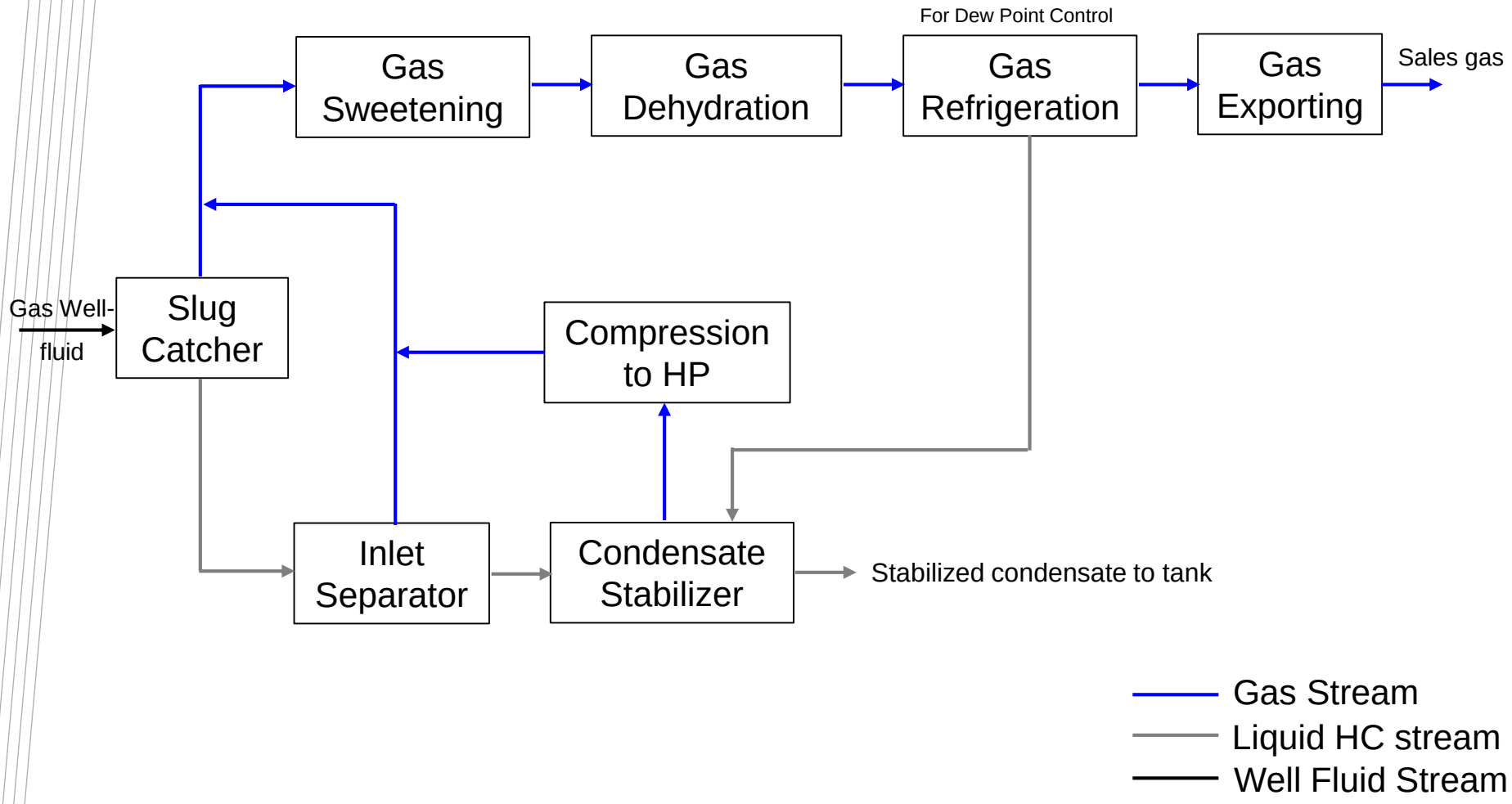
CPF Process General



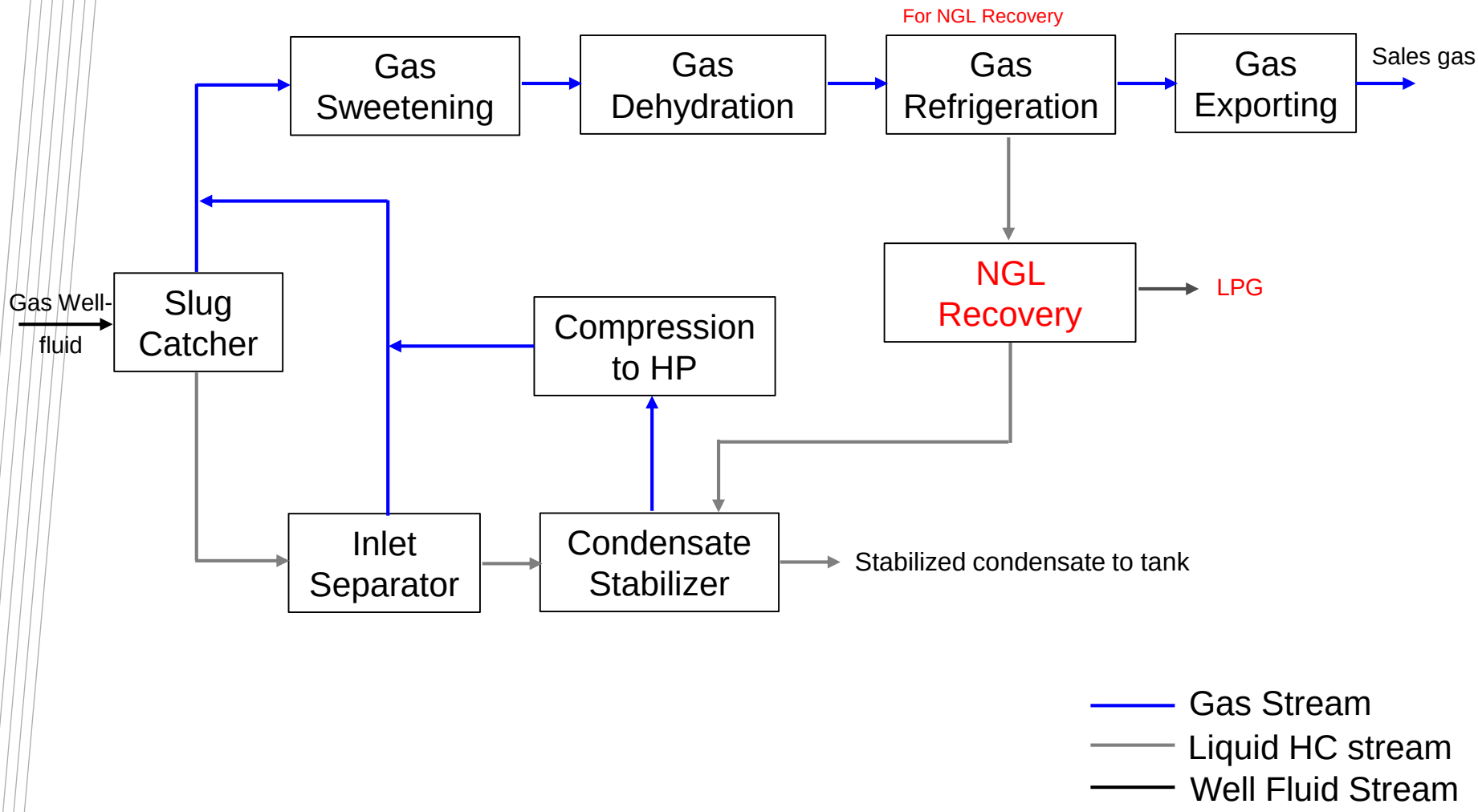
Typical CPF : Oil Field



Typical CPF : Gas Field (1)

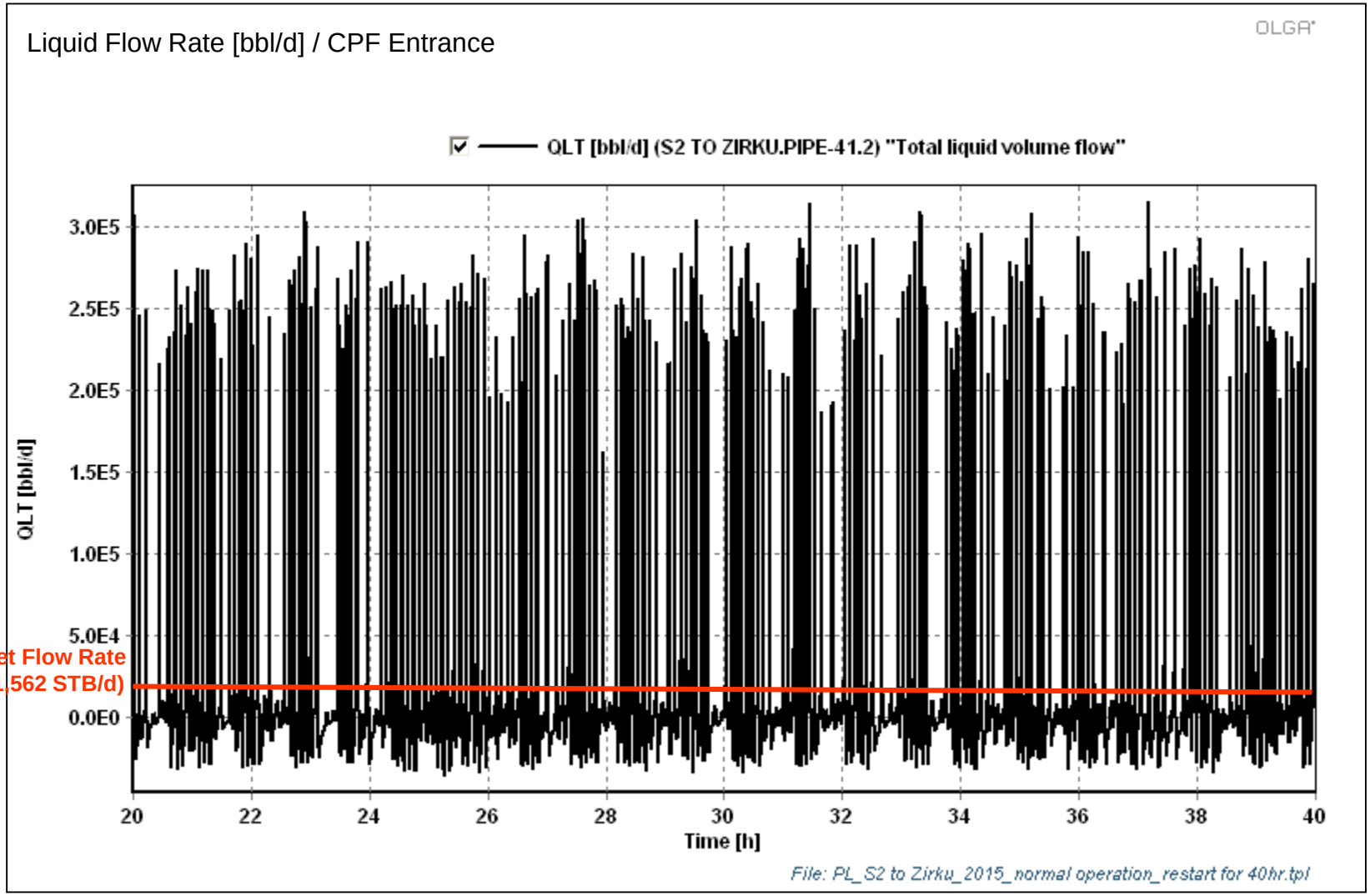


Typical CPF : Gas Field (2)



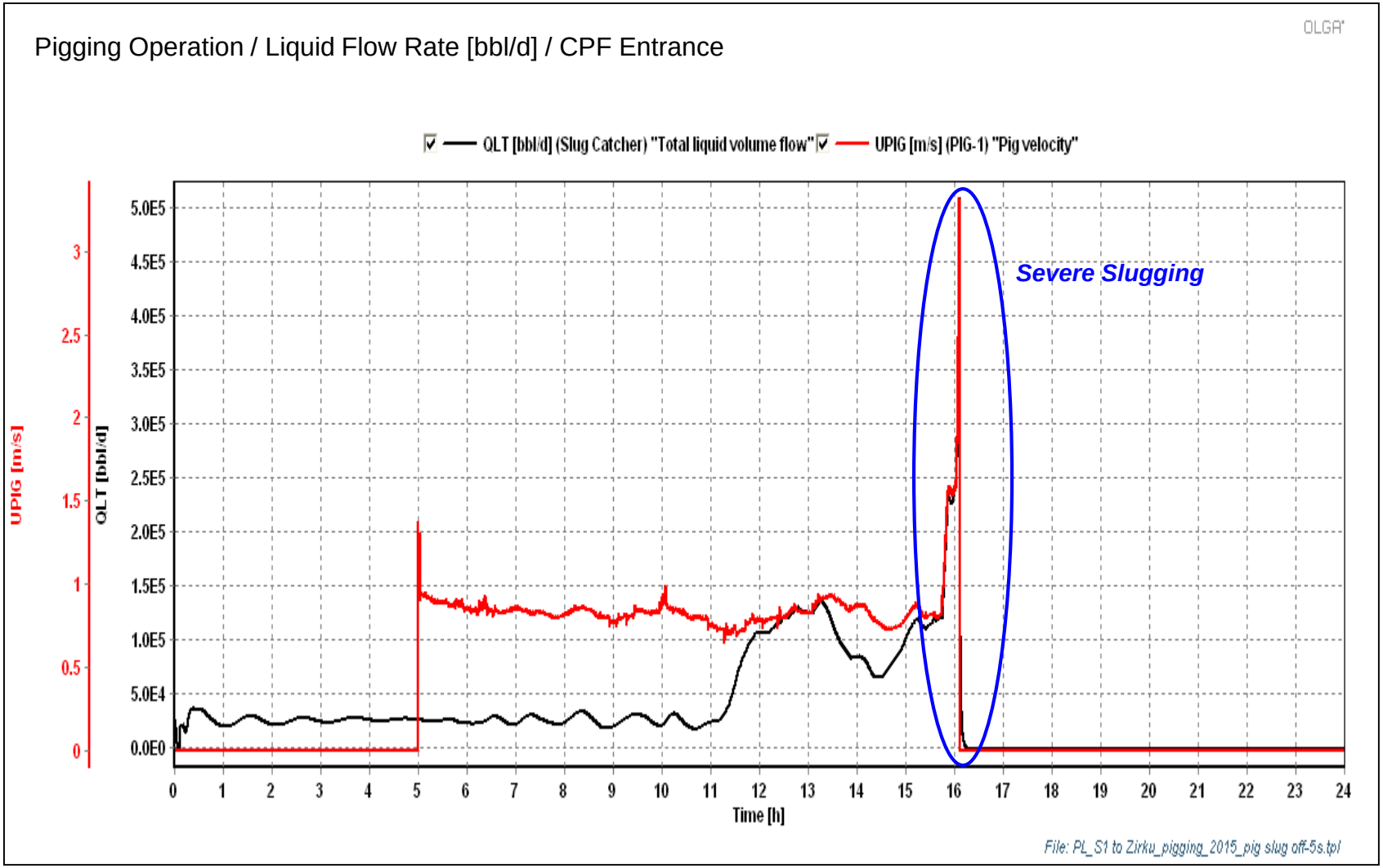
Liquid Slug Problem : Normal Operation

SARB-4_Subsea Flow-line (Length = 33 km)



Liquid Slug Problem : Pigging

SARB-4_Subsea Flow-line (Length = 33 km)

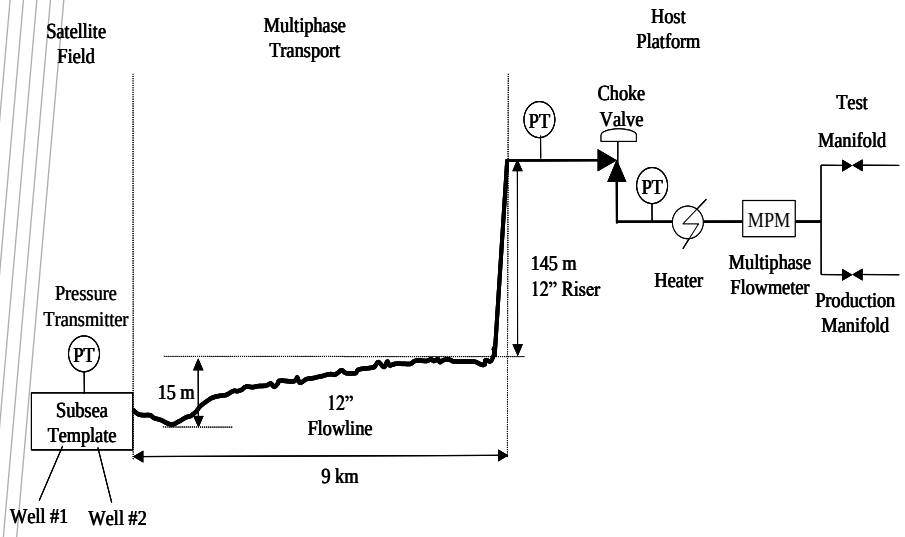


For Accommodation of Liquid Slug

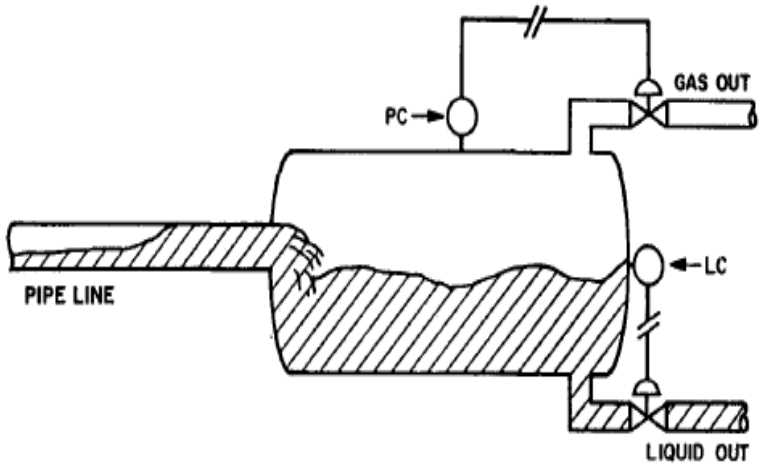
Control vs. Big vessel

Control?

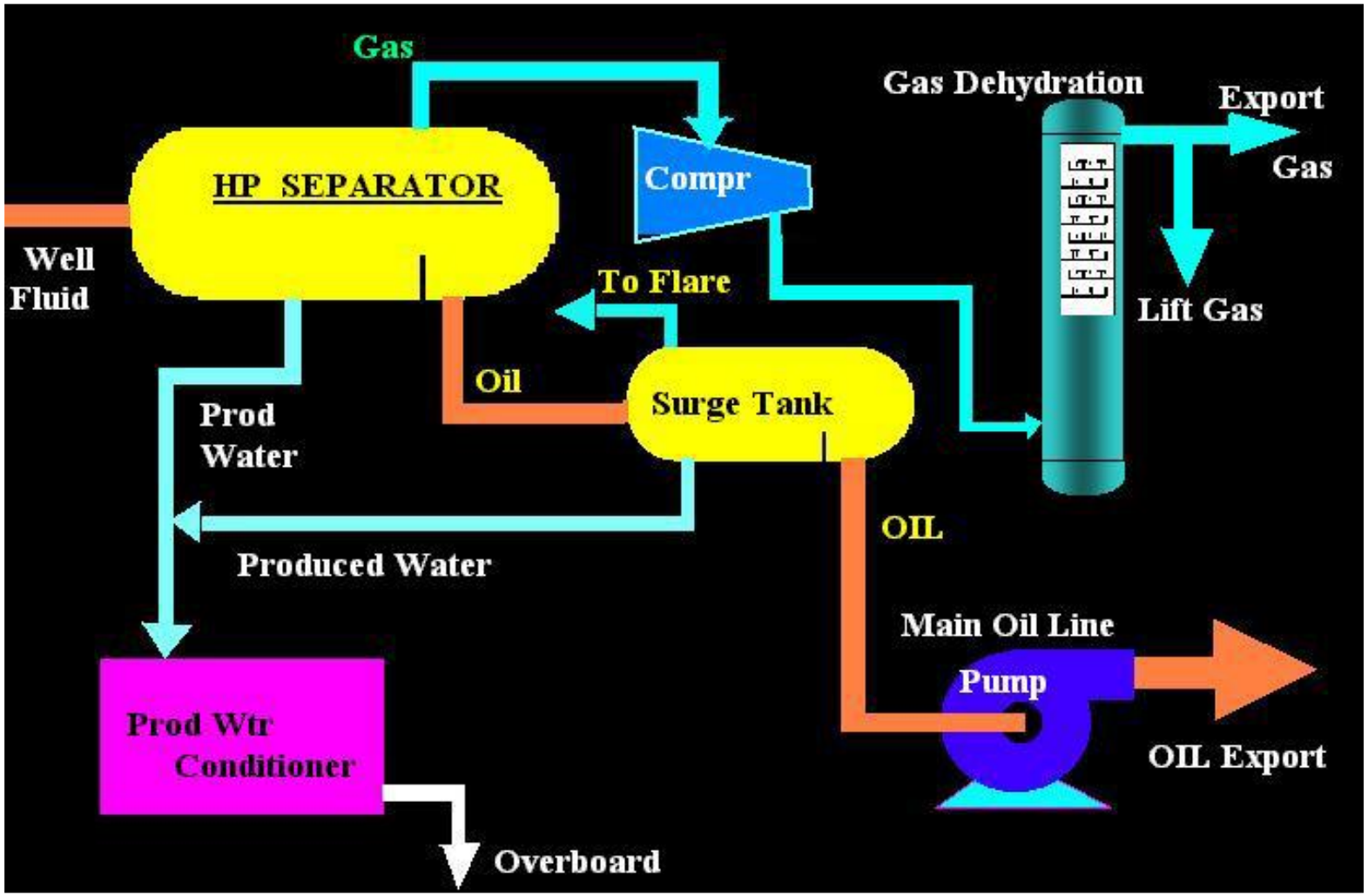
Slug Catcher?



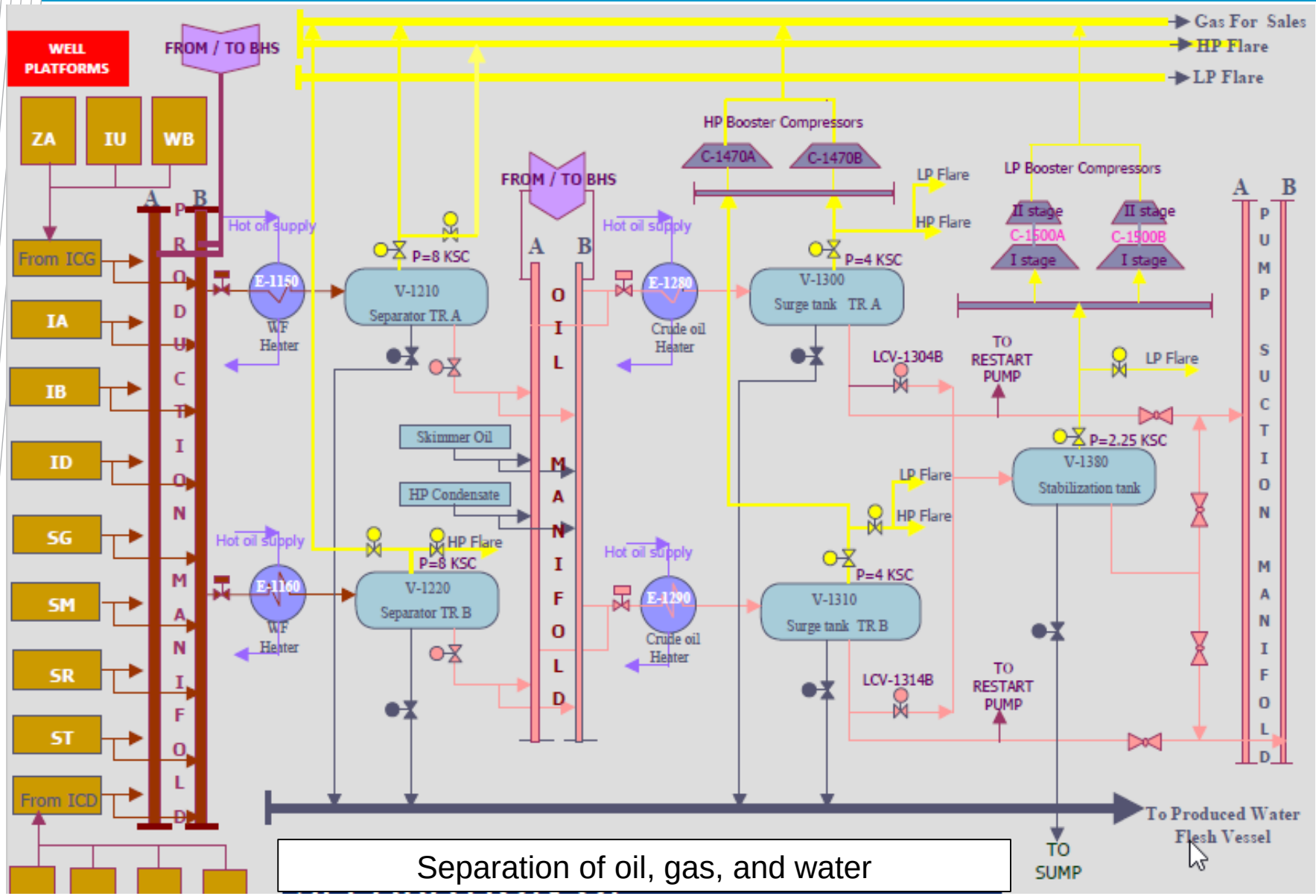
Slug Catcher → GOOOOD



Process flow for separation



Separation trains

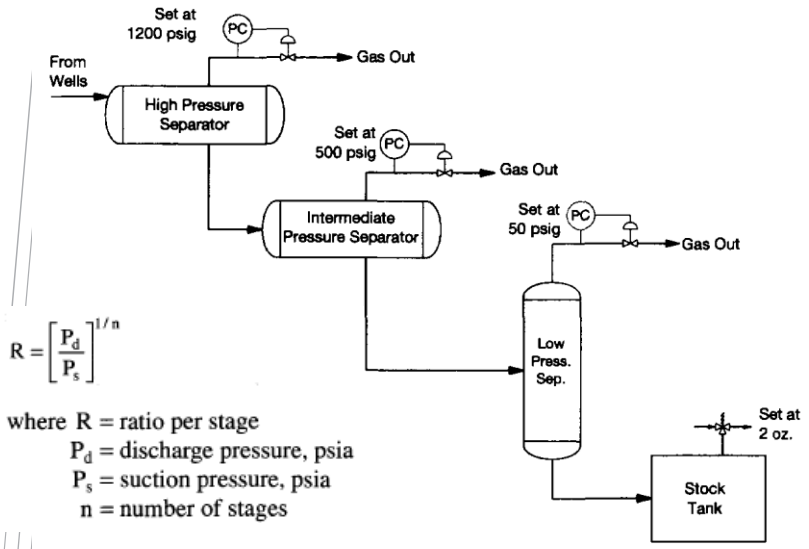


Separation of oil, gas, and water

Oil / Condensate Stabilization (1)

Multi Stage Separator

1) It is preferred for "Crude oil separation and stabilization".



$$R = \left[\frac{P_d}{P_s}\right]^{1/n}$$

where R = ratio per stage
P_d = discharge pressure, psia
P_s = suction pressure, psia
n = number of stages

Stage Separation Guidelines

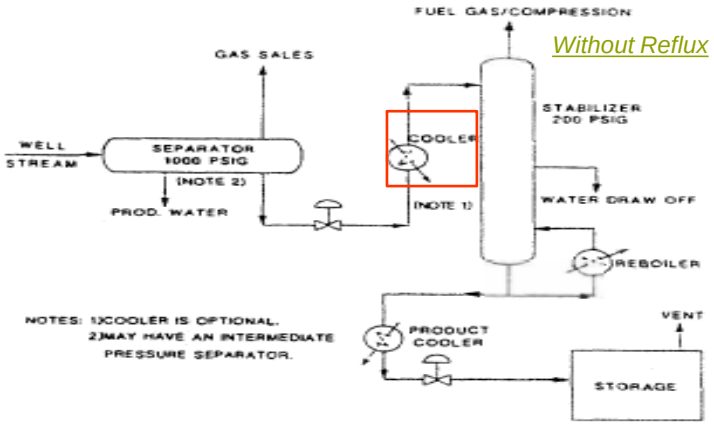
Initial Separator Pressure, psig	Number of Stages*
25–125	1
125–300	1–2
300–500	2
500–700	2–3**

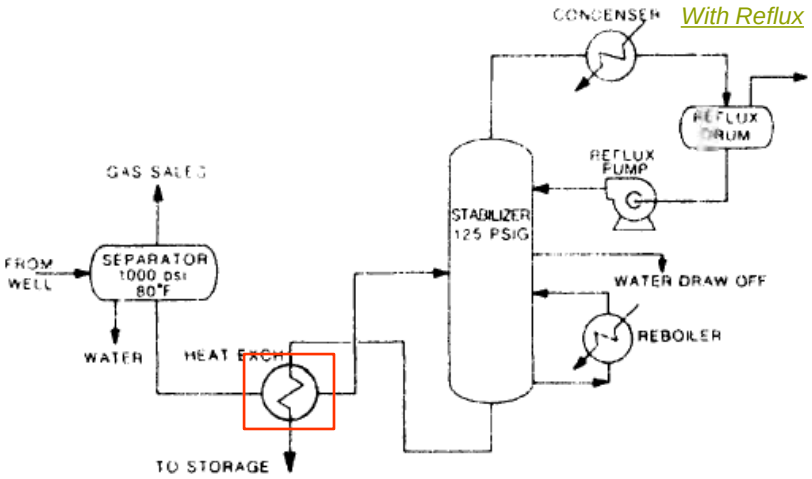
* *Does not include stock tank.*
** *At flow rates exceeding 100,000 bopd, more stages may be appropriate.*

Stabilization Column

1) It is preferred for "Condensate stabilization".

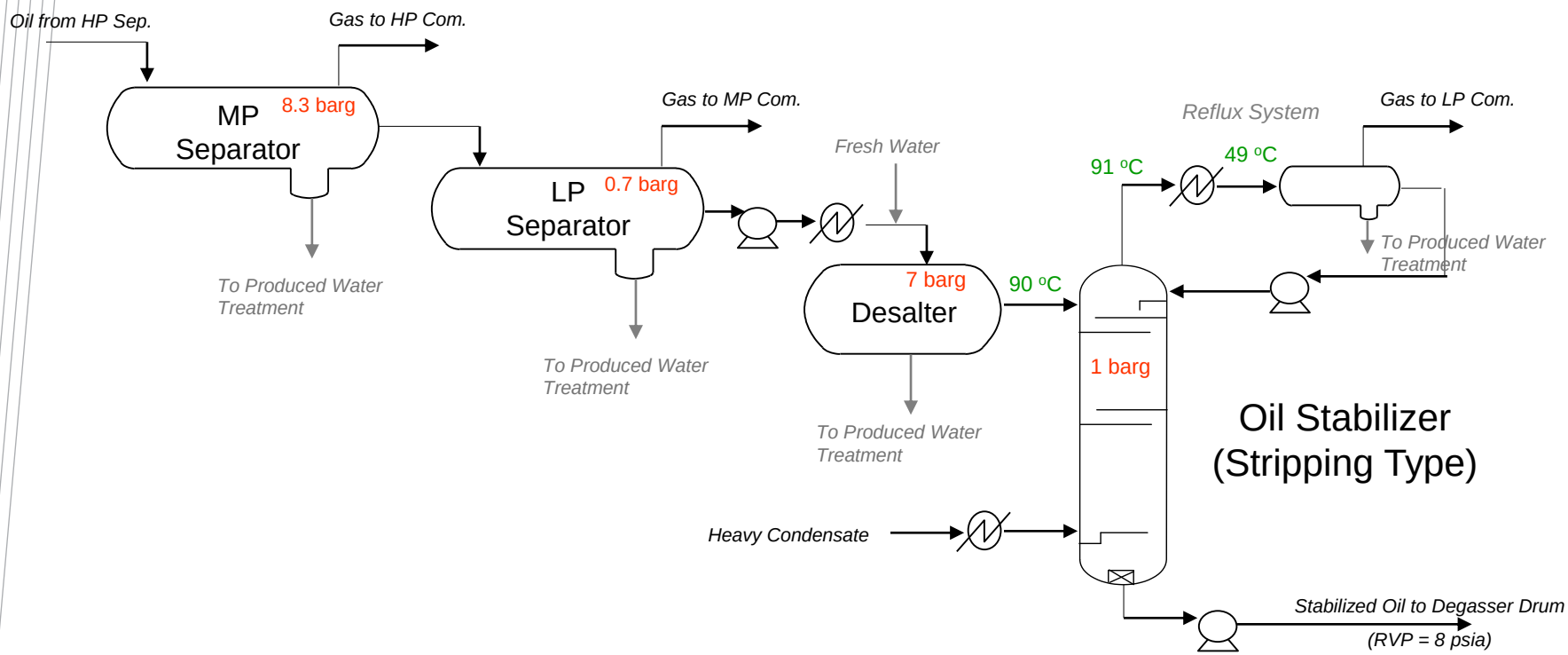
2) It is used for "Oil Stabilization" for H_2S < 50 ppm and lower RVP.





Example for Oil Stabilization

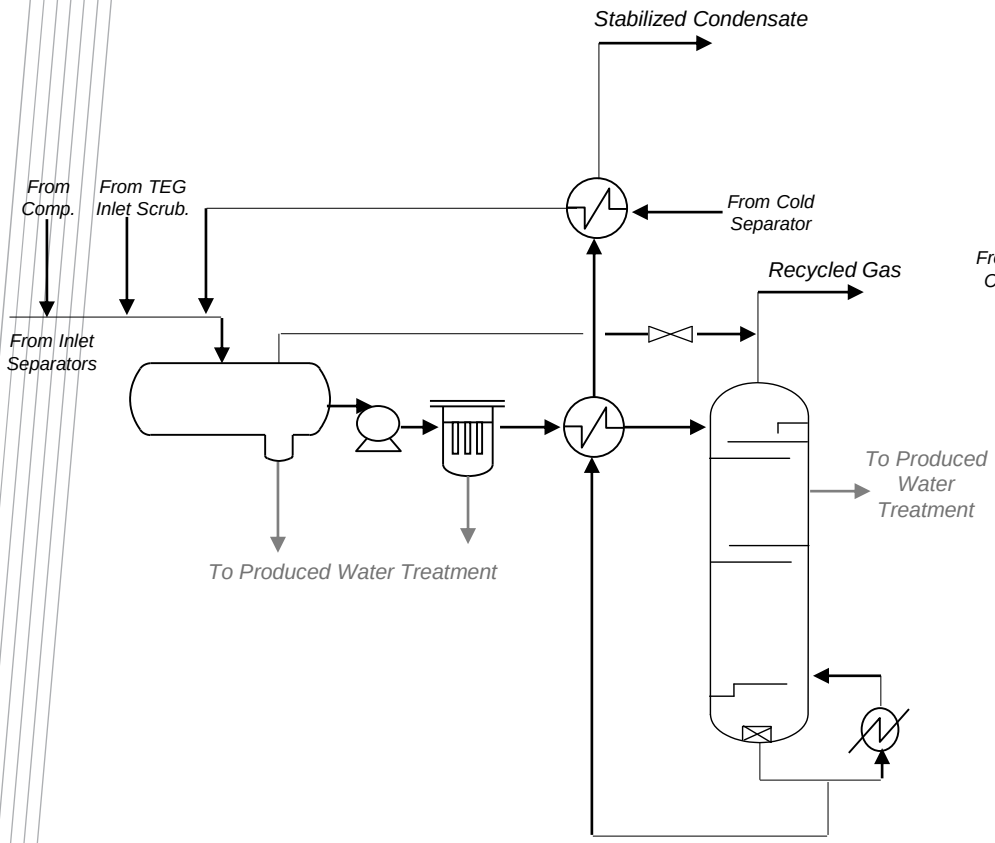
SARB-4 Project (Oil Reservoir)



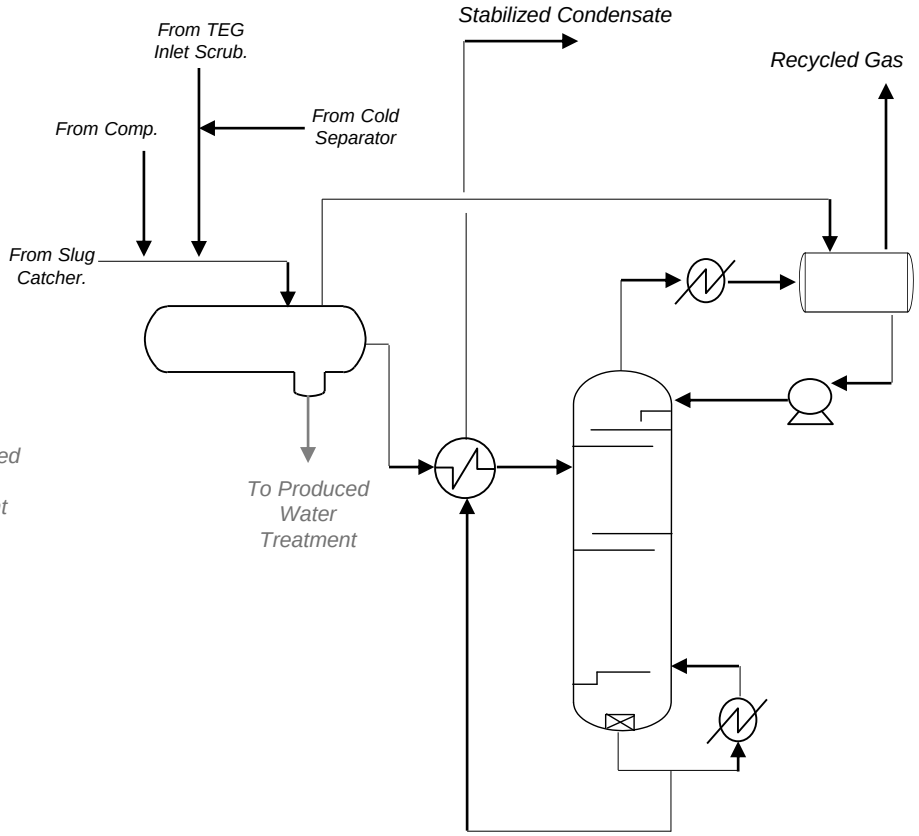
1. Multistage separation + Stabilization column (stripper type)
2. Design for *1) maximized oil production* and *2) minimized H_2S ppm*
3. Heavy condensate was used for striping un-stabilized oil → *for preventing scale problems in the reboiler*

Example for Condensate Stabilization

Touat-Gaz Project (Gas Reservoir)



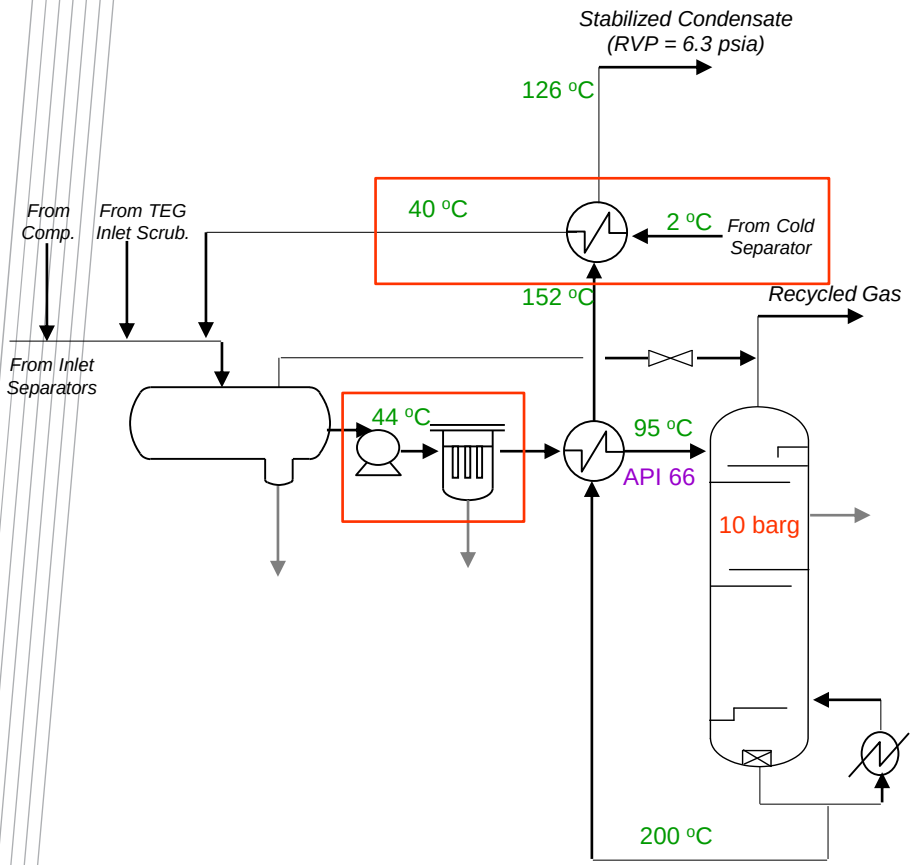
MIDYAN Project (Gas Reservoir)



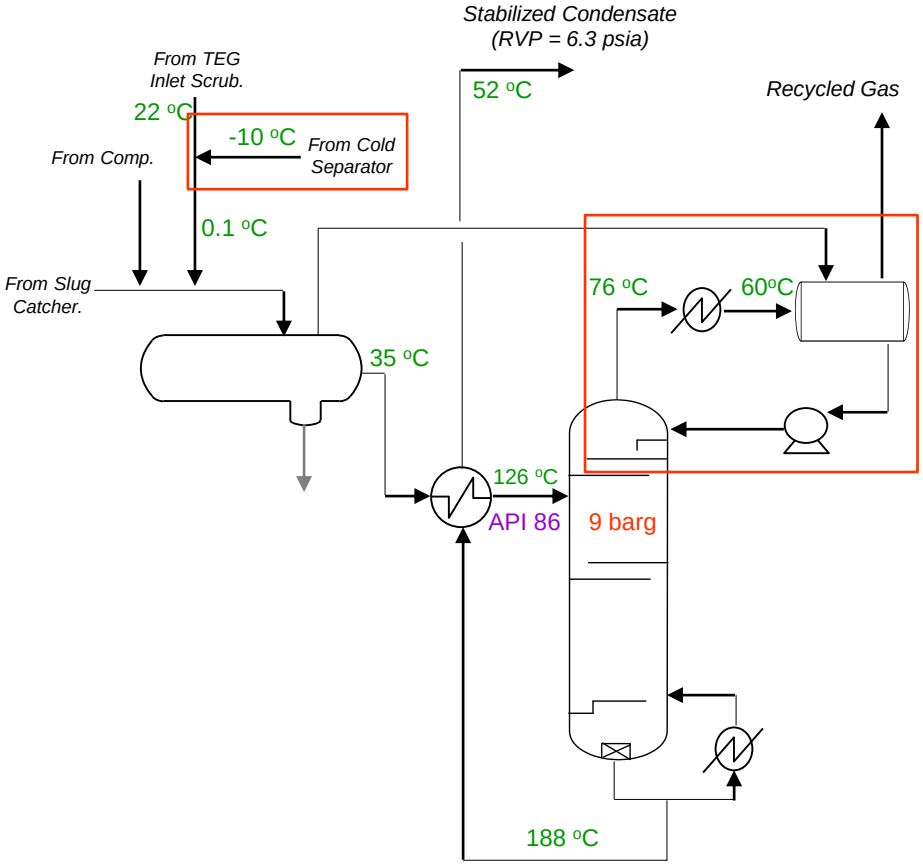
Note 1) Touat-Gaz CPF does not have Slug Catcher.

Example for Condensate Stabilization

Touat-Gaz Project (Gas Reservoir)

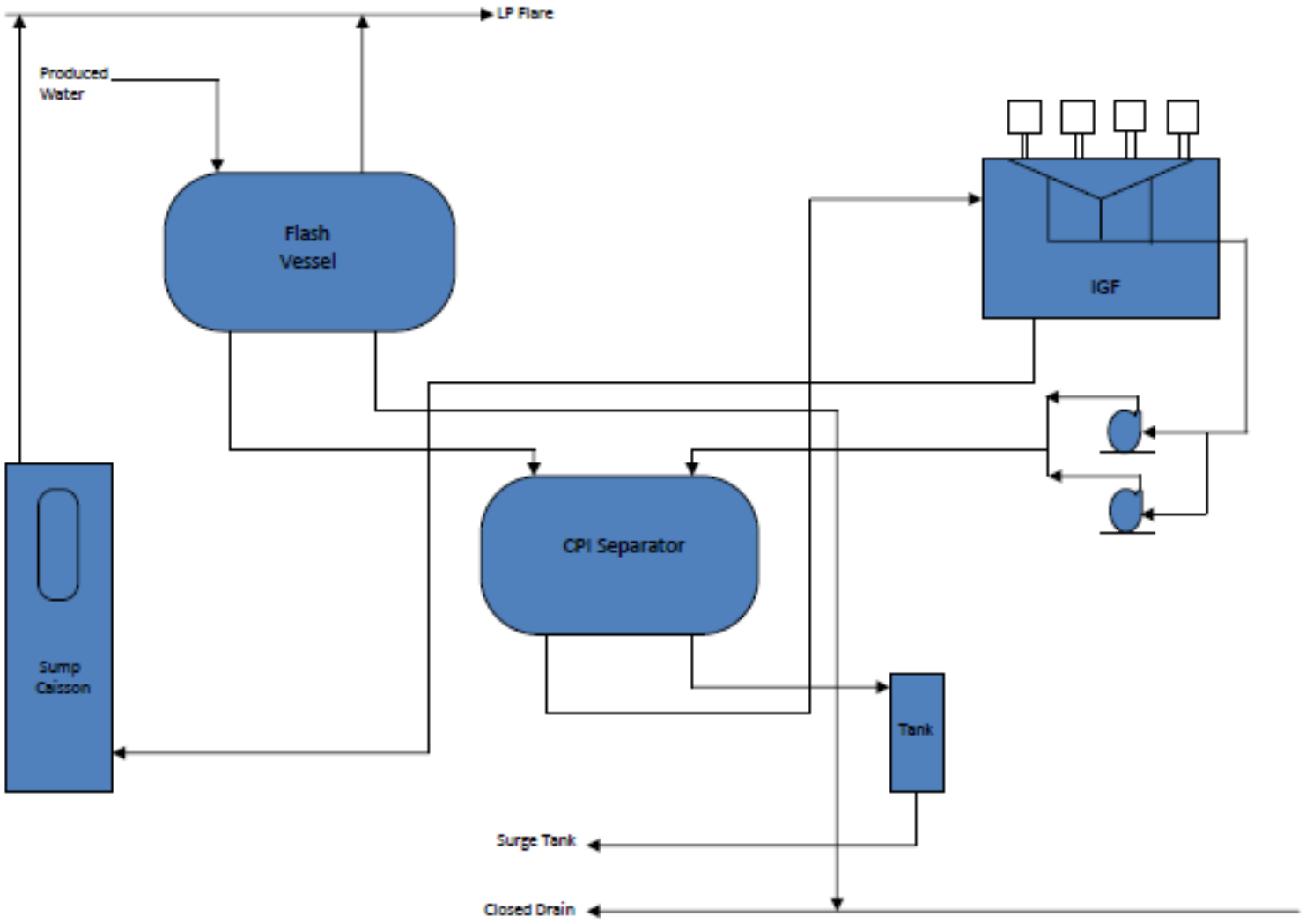


MIDYAN Project (Gas Reservoir)

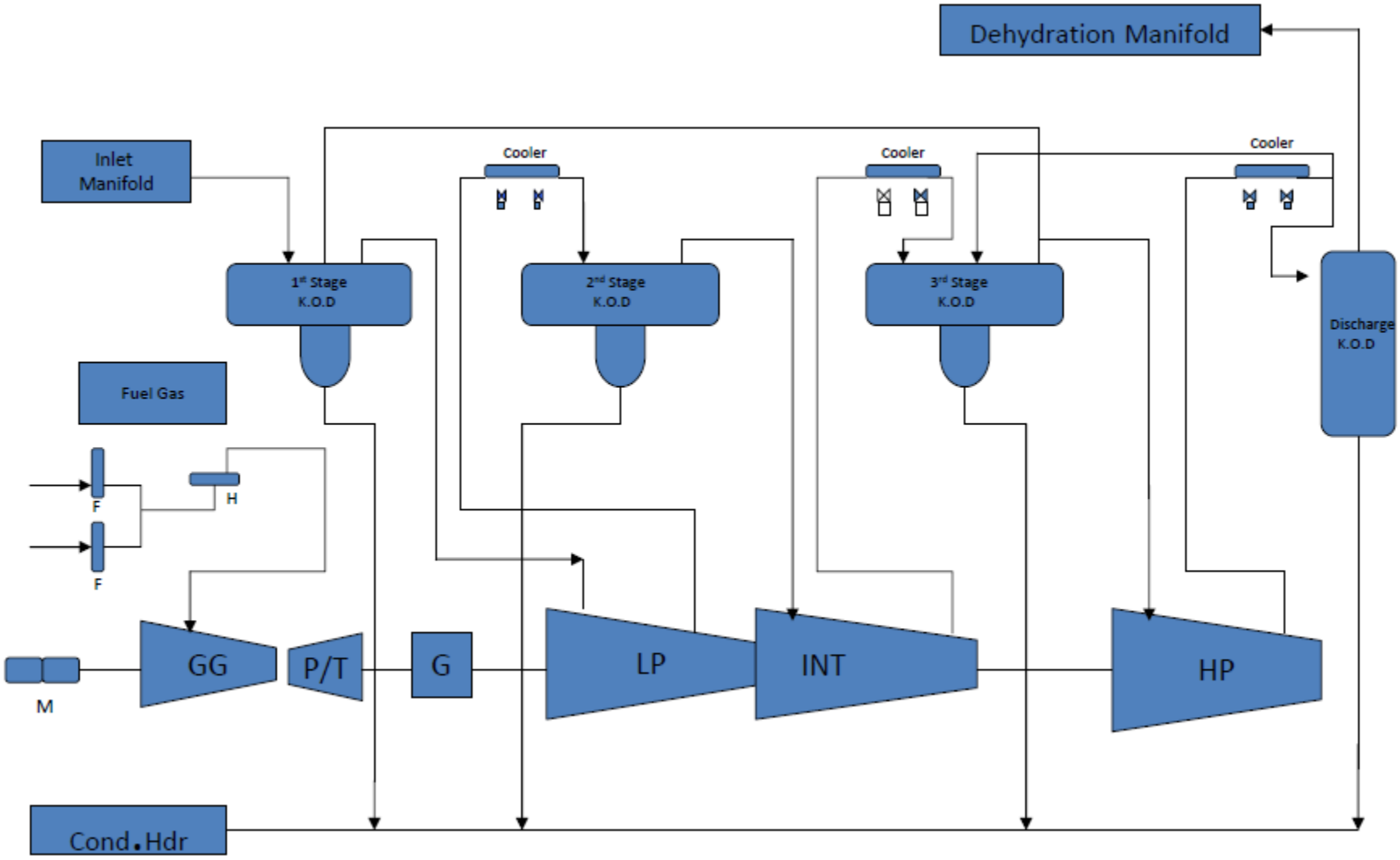


Crude oil export via tanker

Water treatment



Gas collection and compression



Gas Dehydration Unit (1)

FACTORS TO DETERMINE DEHYDRATION METHOD

Initial water content of the feed/ Water spec of dried gas/ Process character/ Operational nature/ Economic aspect

Most of the CPFs use TEG

	Compression and Cooling	Absorption (TEG)	Adsorption (Molecular Sieve)	Membrane
cost	low	moderate	high	low
water spec.	-	10 ppmv	0.1 ppmv	20 ppmv
dew point spec.	38 ℃	-32 ℃	-100 ℃	-
regen. T	-	191~204 ℃	200~315 ℃	-
application	Field use	Most widely use	Cryogenic process	Offshore process
Advantage and Disadvantage	- Simple - Cannot remove the water enough	- Economic (glycol cost is relatively cheap)	- Can obtain the lowest water content - Cost high	- Light - Modular - Only economic for low feed flow

Gas Dehydration Unit (2)

FACTORS TO DETERMINE DEHYDRATION METHOD

Initial water content of the feed/ Water spec of dried gas/ Process character/ Operational nature/ Economic aspect

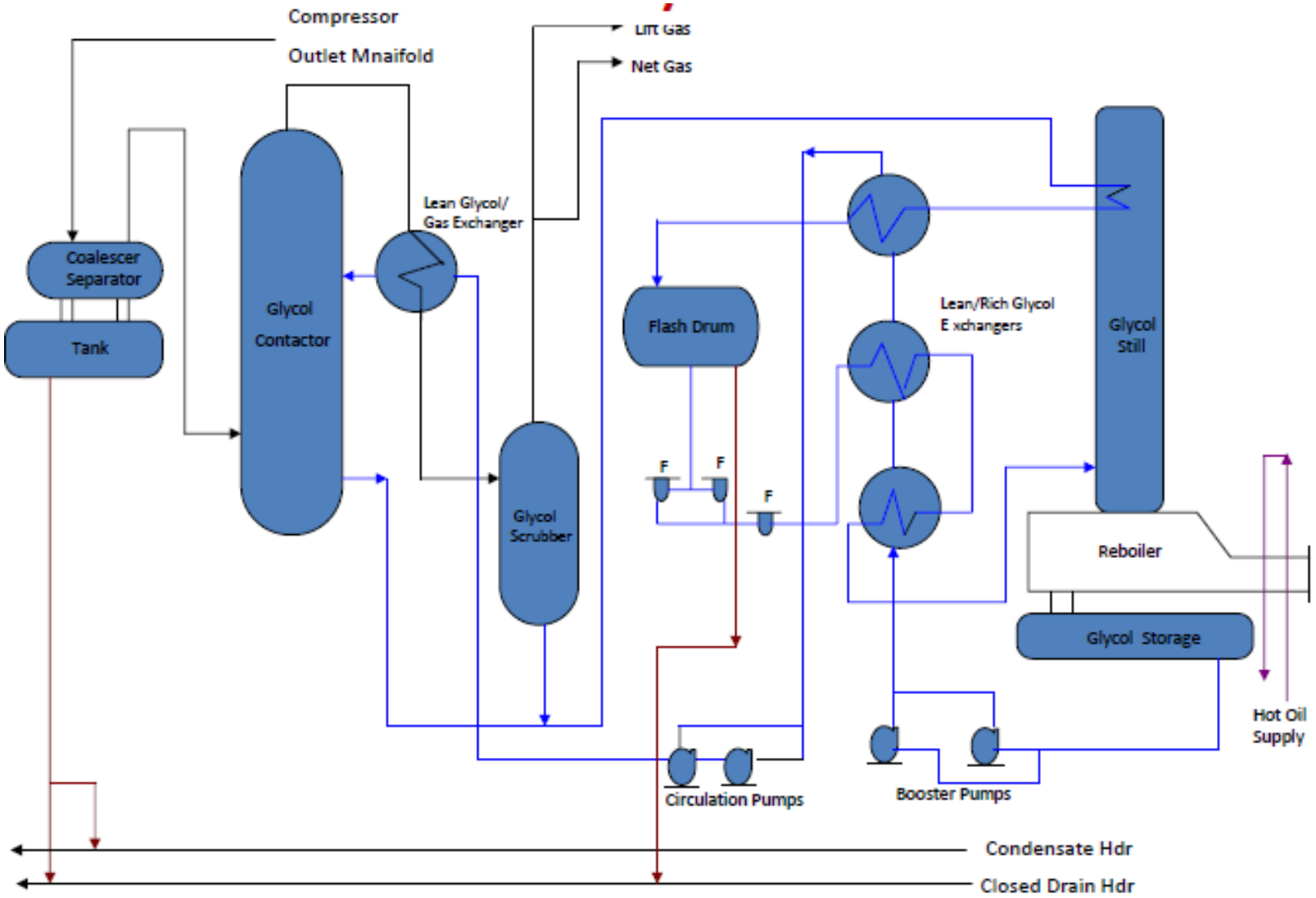
For TEG Dehydration Unit Design

1. Determine Lean TEG Inlet Flow Rate (2 – 5 gal / removed water lb)
2. Determine Lean TEG Concentration
3. Determine introducing Gas Stripper or DRIZO

Most of the CPFs use TEG

	Absorption (TEG)	Adsorption (Molecular Sieve)	Membrane
	moderate	high	low
	10 ppmv	0.1 ppmv	20 ppmv
	-32 ℃	-100 ℃	-
	191~204 ℃	200~315 ℃	-
application	Most widely use	Cryogenic process	Offshore process
Advantage and Disadvantage	- Economic (glycol cost is relatively cheap)	- Can obtain the lowest water content - Cost high	- Light - Modular - Only economic for low feed flow
Field use	- Simple - Cannot remove the water enough		

Gas dehydration

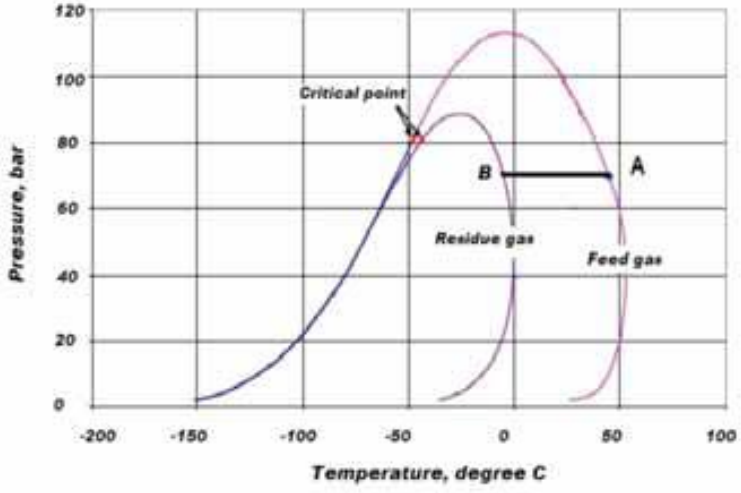


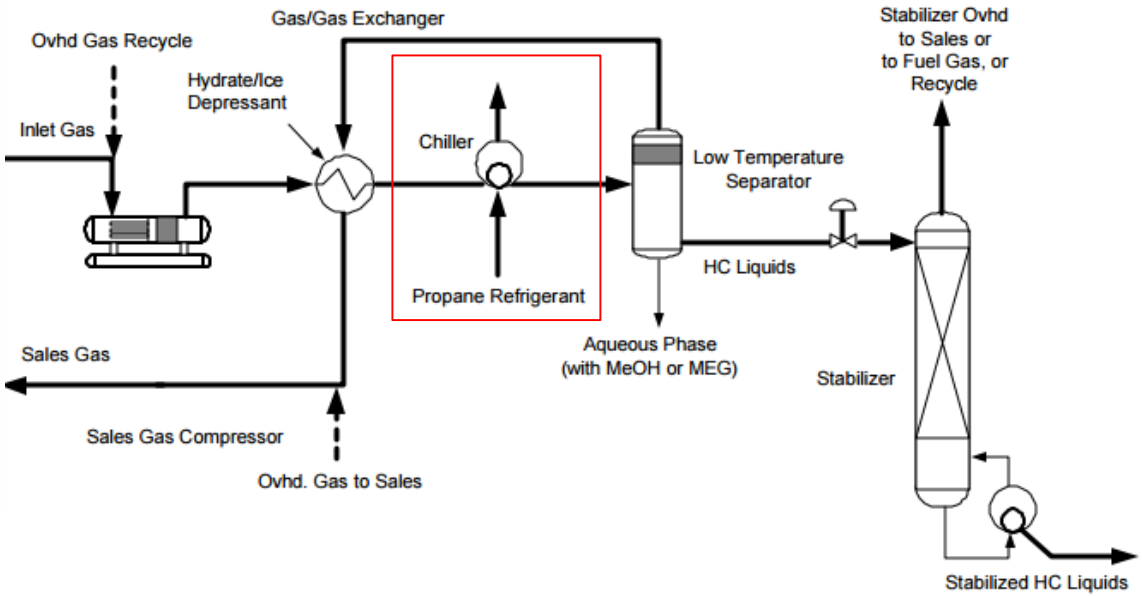
Dew point control via refrigeration

- **Refrigeration**

  : The most common method used for gas dew point control is mechanical refrigeration. This technology is suited especially when pressure is not available to be used to self refrigerate the gas.

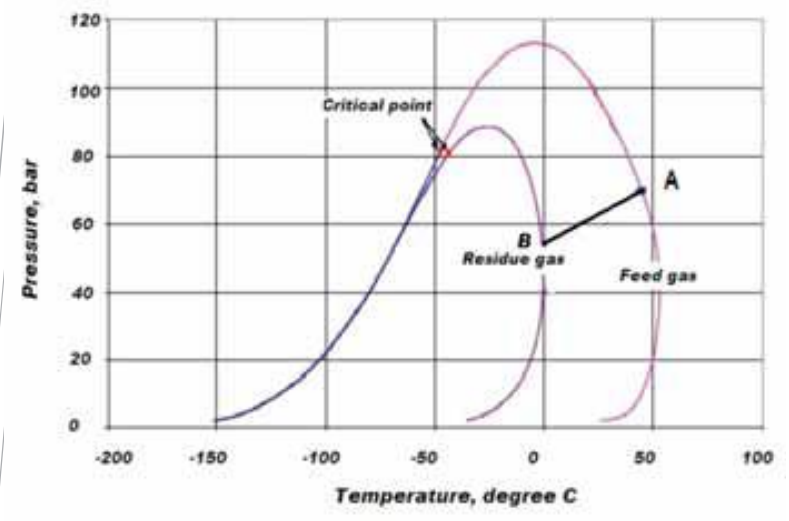
  : Two variations exist of this process. one that recycles the stabilizer overhead to the front end of the plant, used to maximize the recovery of certain components, and a second that re-injects the stabilizer overhead in the residue gas stream.

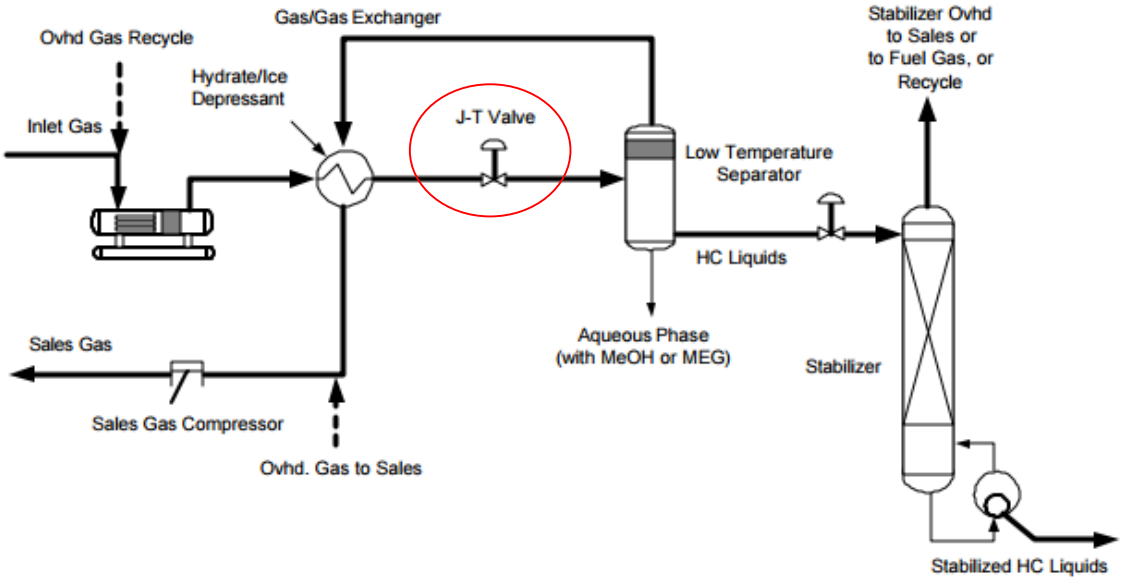




Mechanical Refrigeration

- **J-T valve**
  : If the raw gas is at high pressure, the removal of hydrocarbons can be accomplished by refrigeration obtained through the expansion of gas by means of a Joule -Thomson valve.
  : Injection of glycol is required to prevent the formation of hydrates.



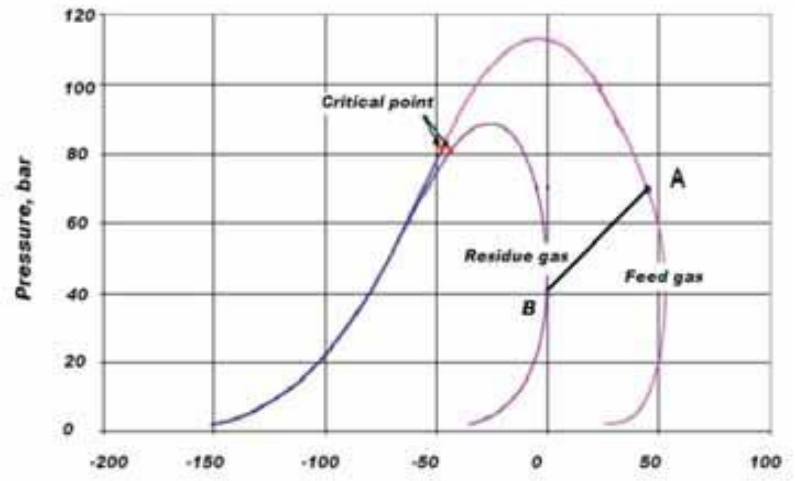


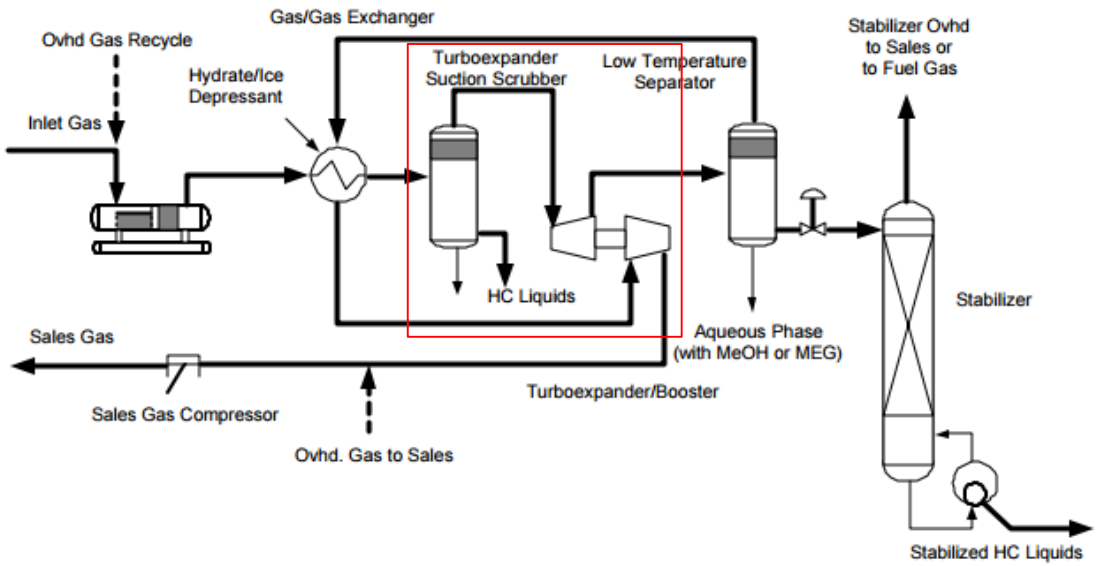
J-T Valve

- **Turboexpander**

  : This process is a variation of the Low Temperature Separation process in which the pressure hold in the gas is used to move an expander turbine, which in the isoentropic expansion generates refrigeration and exports mechanical work.

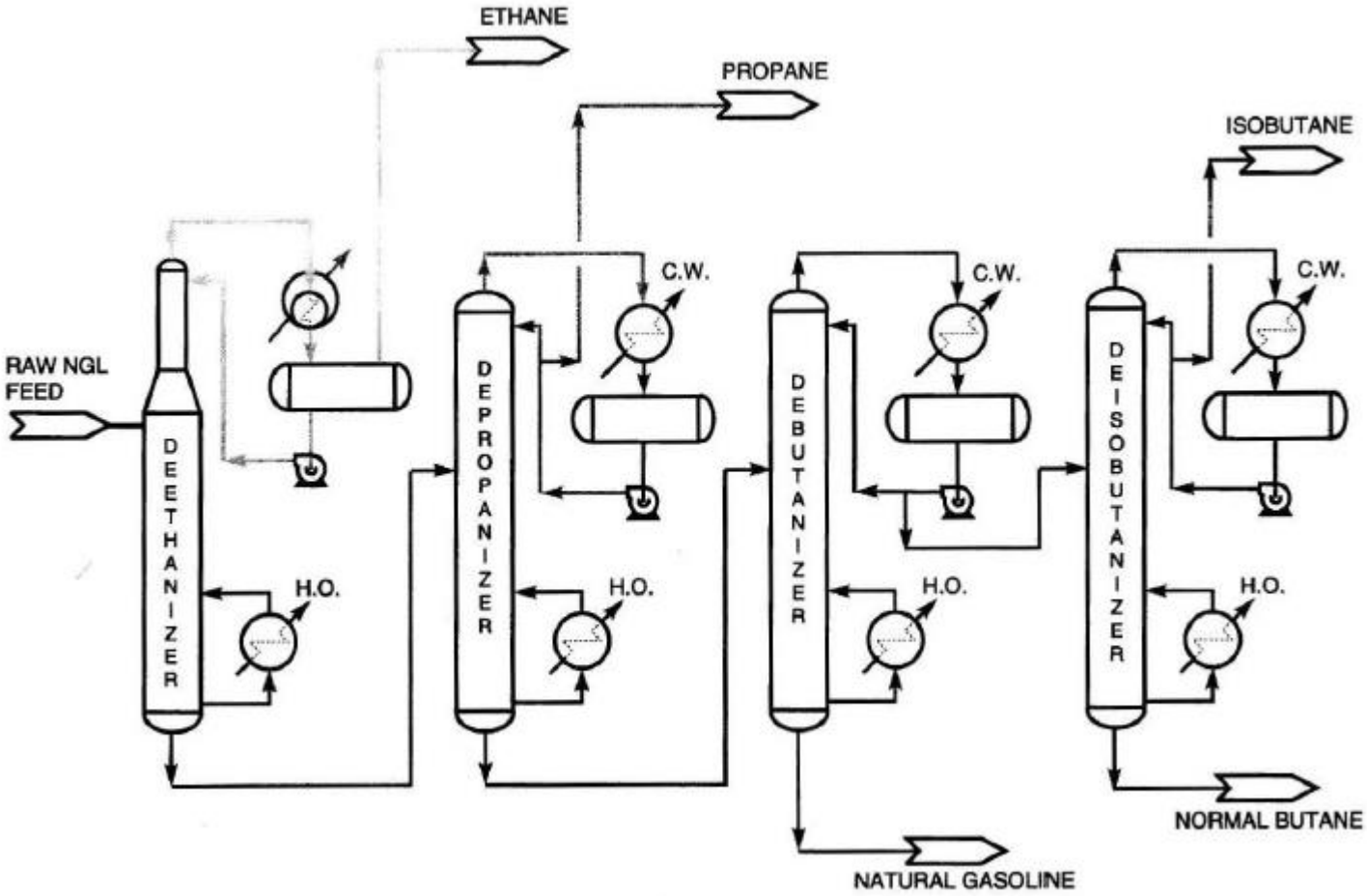
  : This work is used to drive a compressor to partially restore the gas pressure.





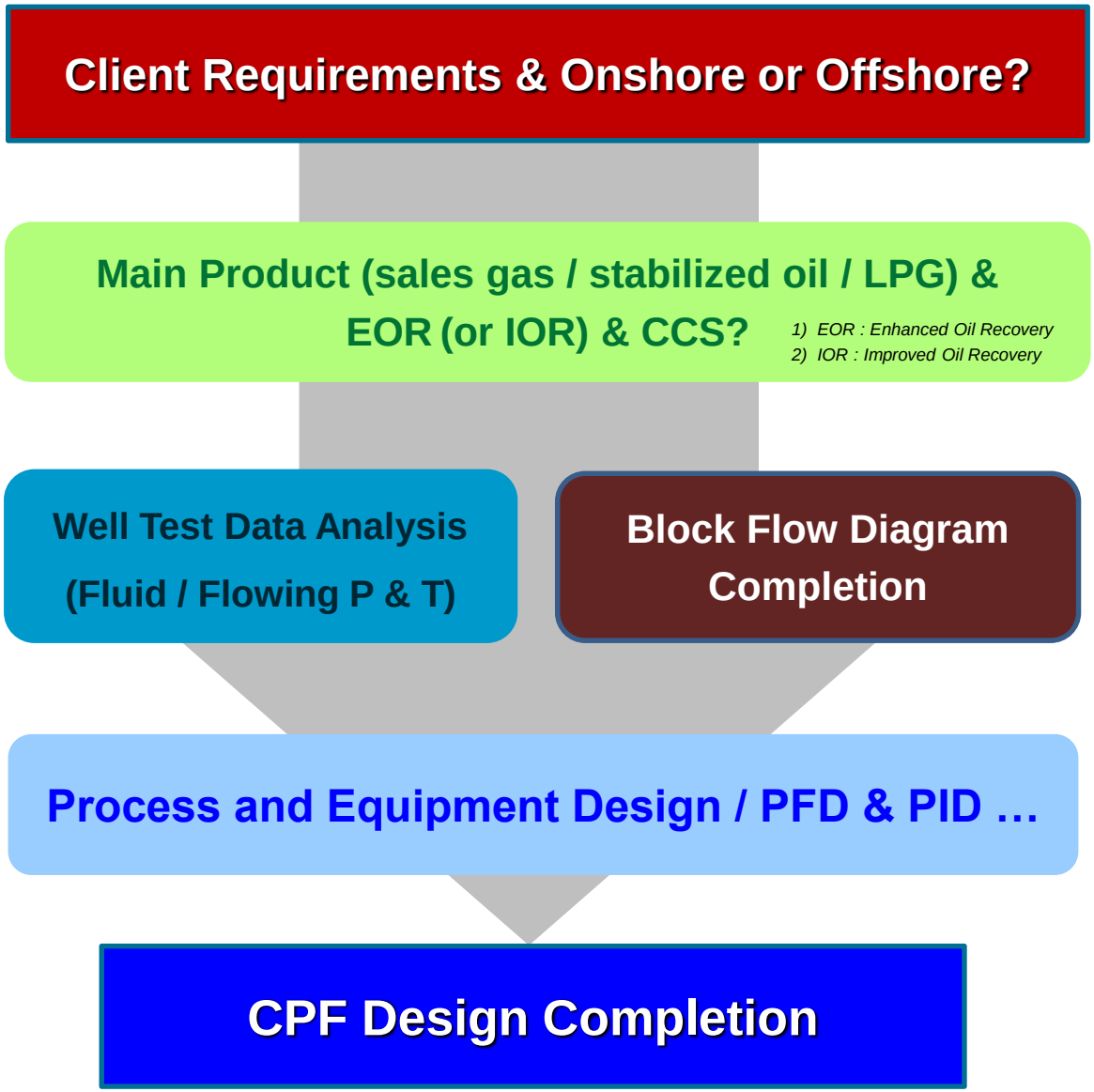
Turbo Expander

NGL Recovery Unit



In the CPF, NGL recovery unit plays a role of LPG extraction from Gas / Condensate

Design approach

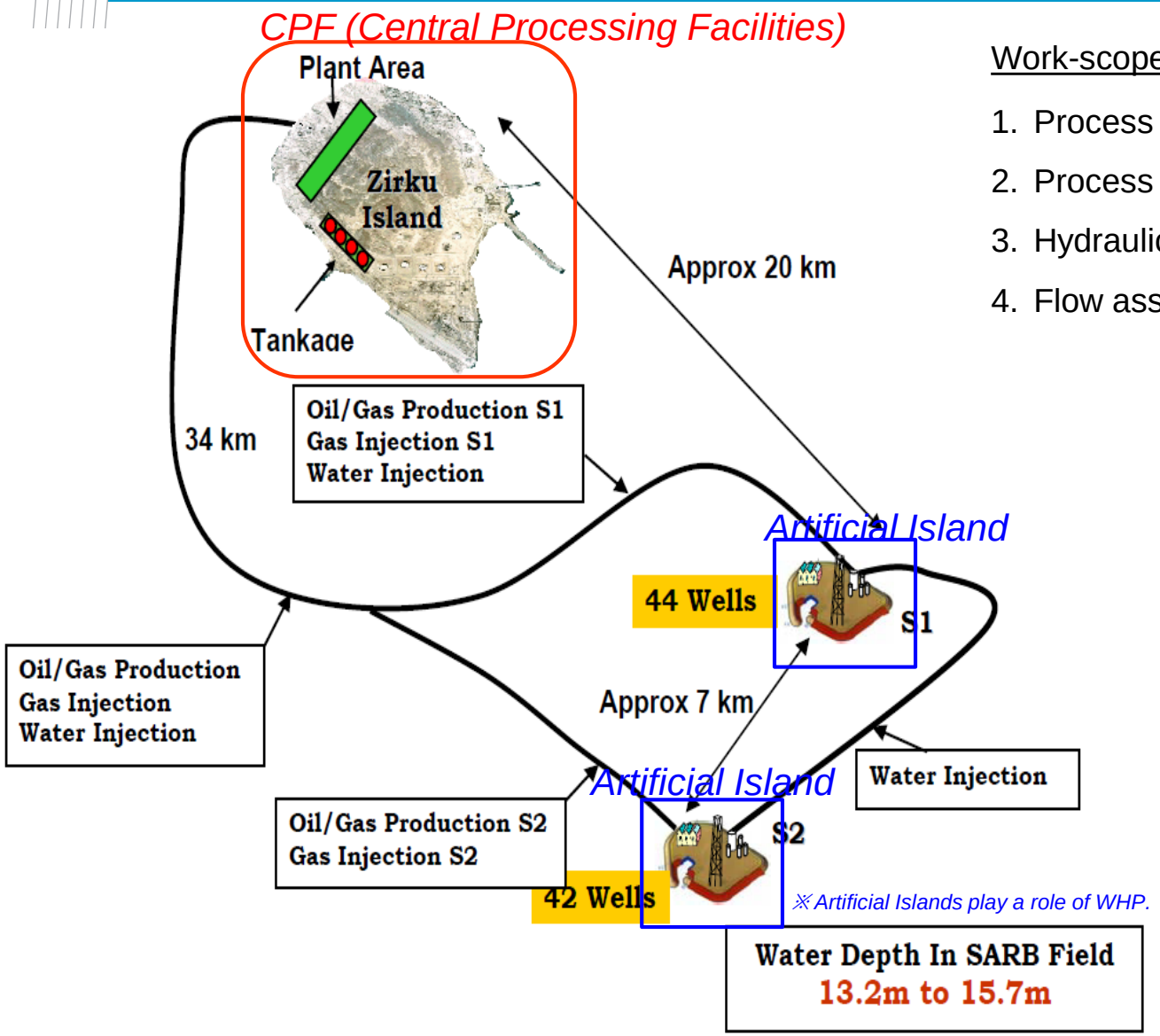


Project Comparison

Project	Reservoir Fluid	Product	IOR [1] / EOR [2]	CCS [3]
SARB-4 (UAE_Abu dhabi)	Oil	Stabilized Oil Reinjection Gas	Y (Gas/Water Injection)	N
TouatGaz (Algeria)	Gas	Sales Gas Stabilized Condensate	N	Y
MIDYAN (Saudi)	Gas	Sales Gas	N	N
AKKAS (Iraq)	Gas	Sales Gas Stabilized Condensate	N	N
RHIP (Oman)	Gas	Sales Gas Stabilized Condensate LPG	Y (SG Injection)	Y [4]

Note 1> IOR means “Improved Oil Recovery” as technology for 2nd and 3rd recovery
2> EOR means “Enhanced Oil Recovery” as technology for 3rd recovery
3> CCS means “Carbon Capture & Storage”
4> RHIP process includes CO_2 EOR facilities for another oil field. CO_2 EOR plays a role of CO_2 storage role as well as enhanced production.

Ex. SARB-4 (Client : ADMO-OPCO / Abu Dahbi)



Work-scope

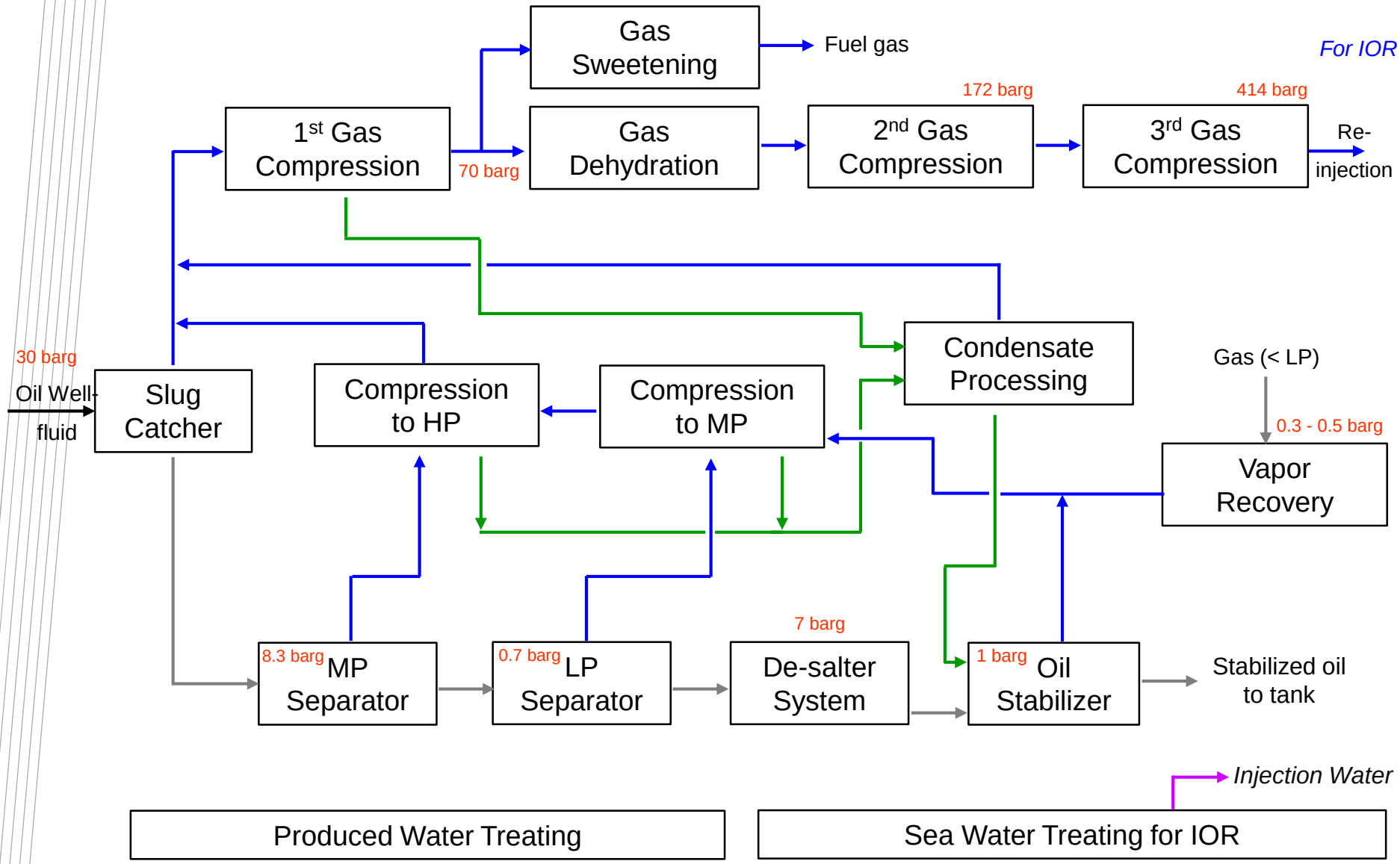
1. Process Design on CPF (Zirku Island)
2. Process Design on Artificial Islands
3. Hydraulics on subsea pipeline
4. Flow assurance on subsea pipelines

Product (CPF)

1. Stabilized oil (200,000 stb/d)
2. Reinjection gas and fuel gas
3. Reinjection water (sea water)

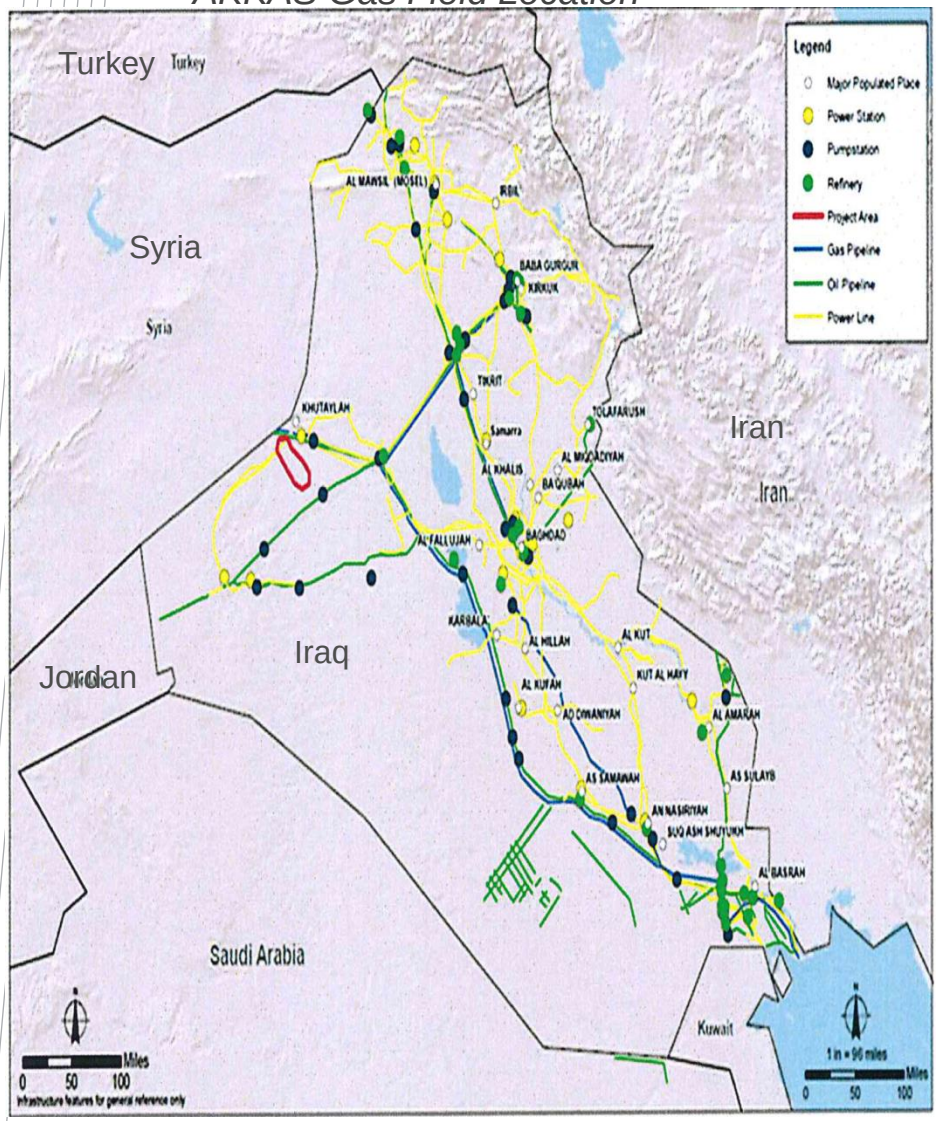
Source : *"Process Description", SARB-4 FEED PKG*

Ex. SARB-4 Project (Client : ADMO-OPCO)

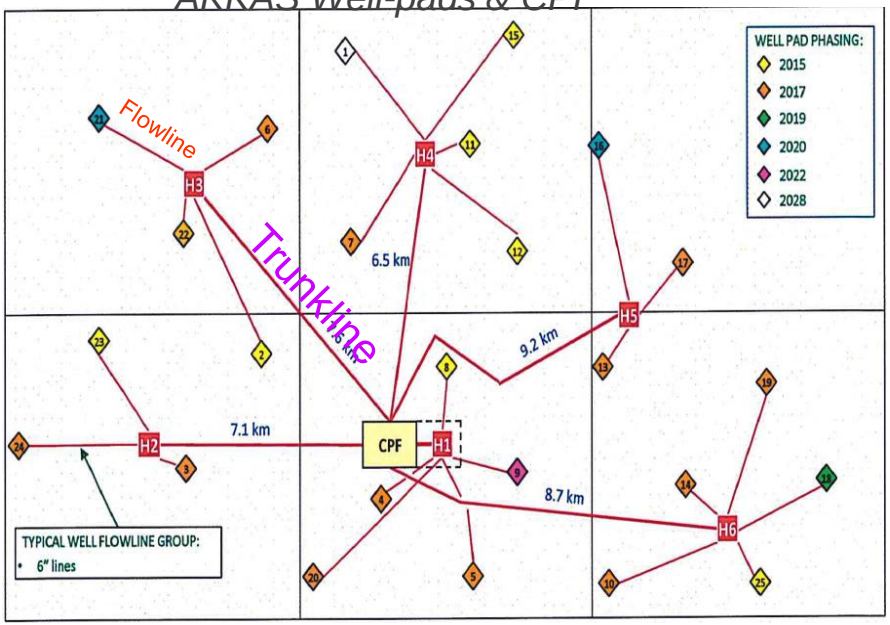


AKKAS Gas Field Project

AKKAS Gas Field Location



AKKAS Well-pads & CPF



Work-scope

1. Process Design on CPF
2. Hydraulics on Flowline / Trunkline / Export PL
3. Flow assurance on Flowline / Trunkline / Export PL

Product (CPF)

1. Sales Gas (480 MMSCFD)
2. LPG (8.3 MBPD)
3. Stabilized Condensate (16.8 MBPD)

Source : *"Gathering System Design Philosophy", P99065-S00-PHIL-U-02, AKKAS CPF FEED Document*

Product Specification

Sales Gas Specification

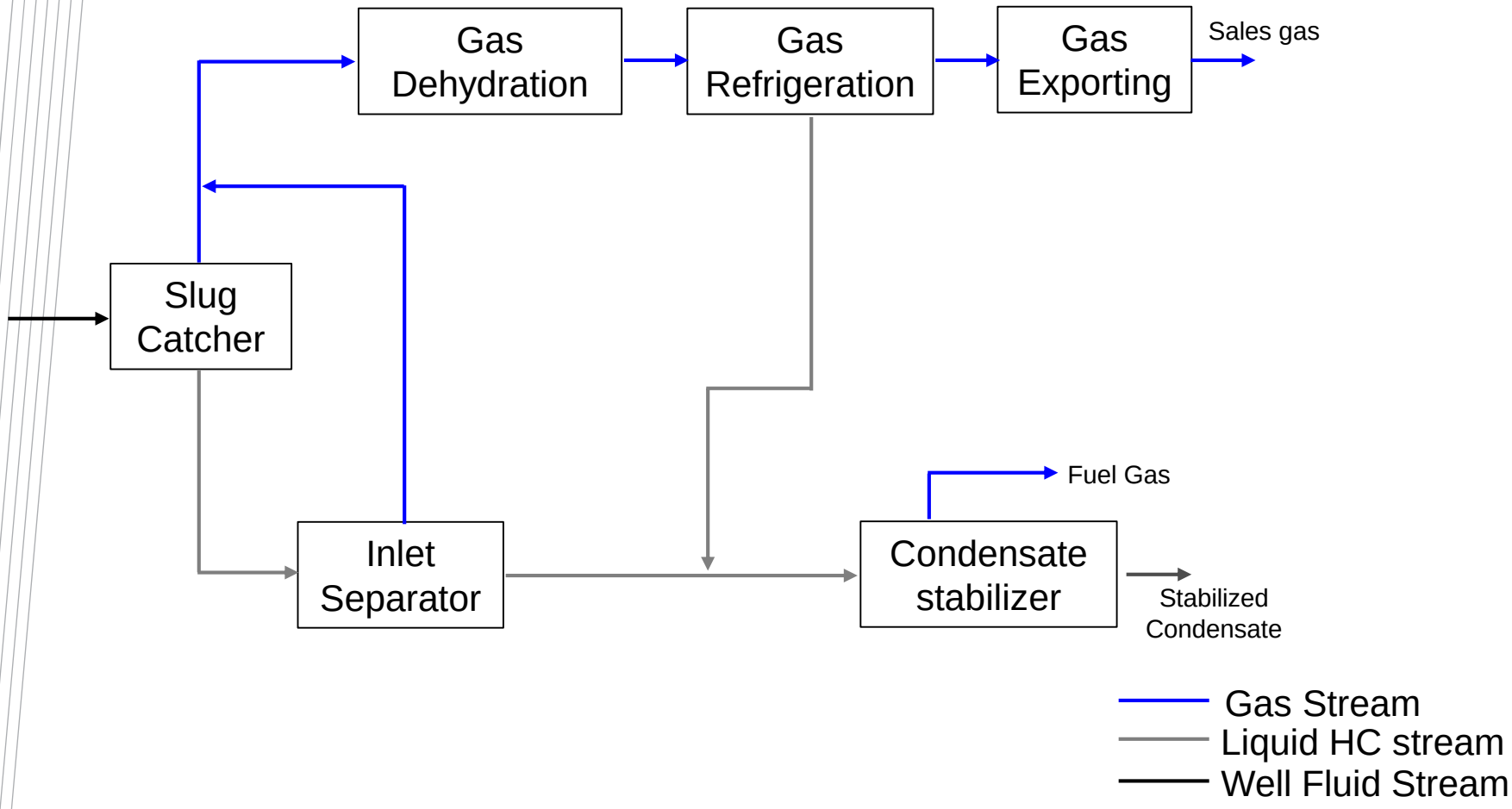
	Unit	Value
Water Dew Point @ 70 barg	^oC	-12
Hydrocarbon Dew Point @ 70 barg	^oC	-8
H_2S Content	ppm	7.5 max
RSH (Mercaptans) Content	ppm	15 max
CO_2 Content	vol %	2.5 max

LPG Specification

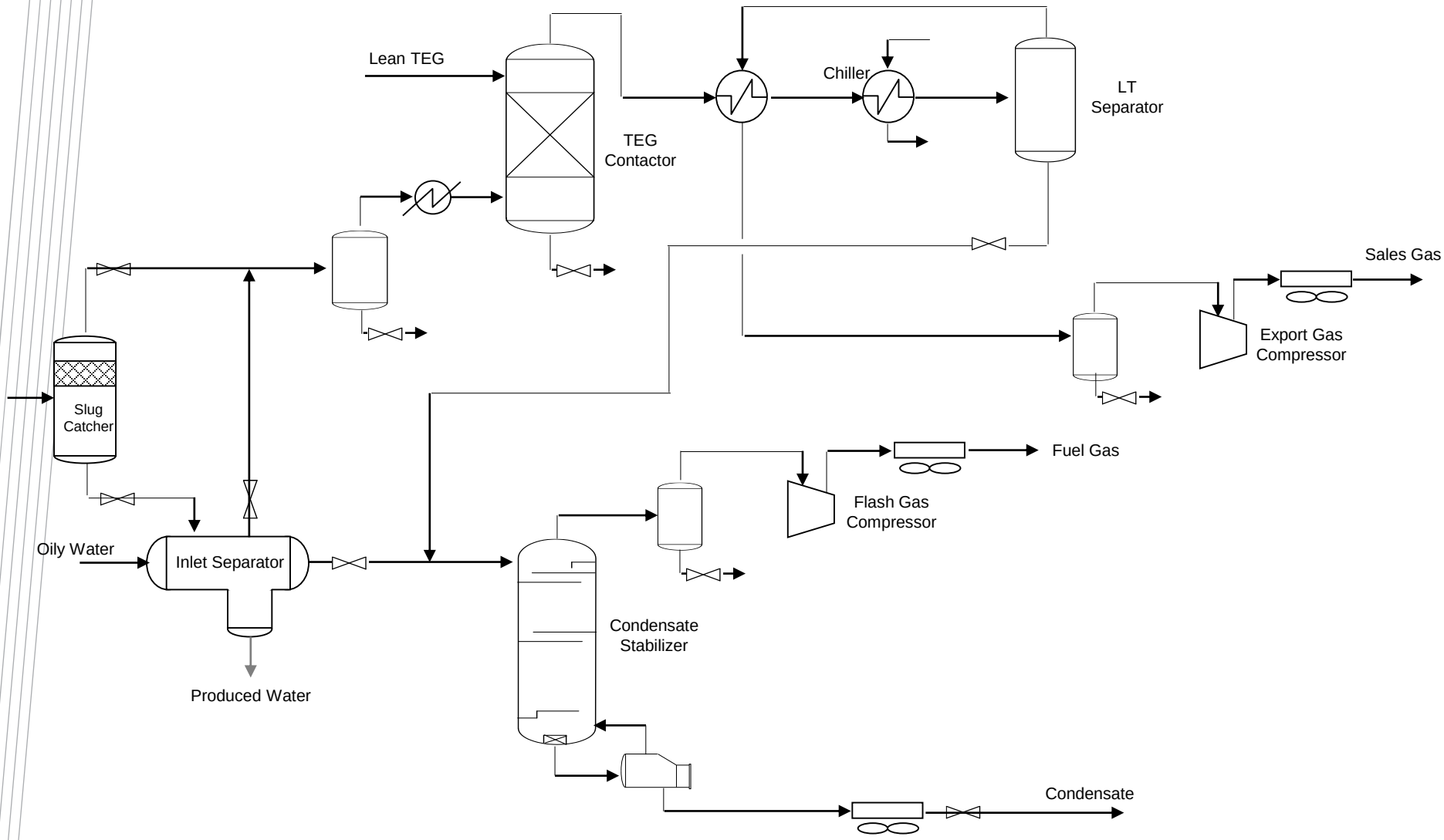
	Unit	Value
RVP (Summer)	kPa	800
RVP (Winter)	kPa	1,000
Ethane	vol %	0.6 max
C_{5+}	vol %	2 max
Sulphur Content	mg/m^3	343 max
Water Content	-	0 (water free)

Stabilized Condensate Specification → 9.6 psia (0.66 bara)

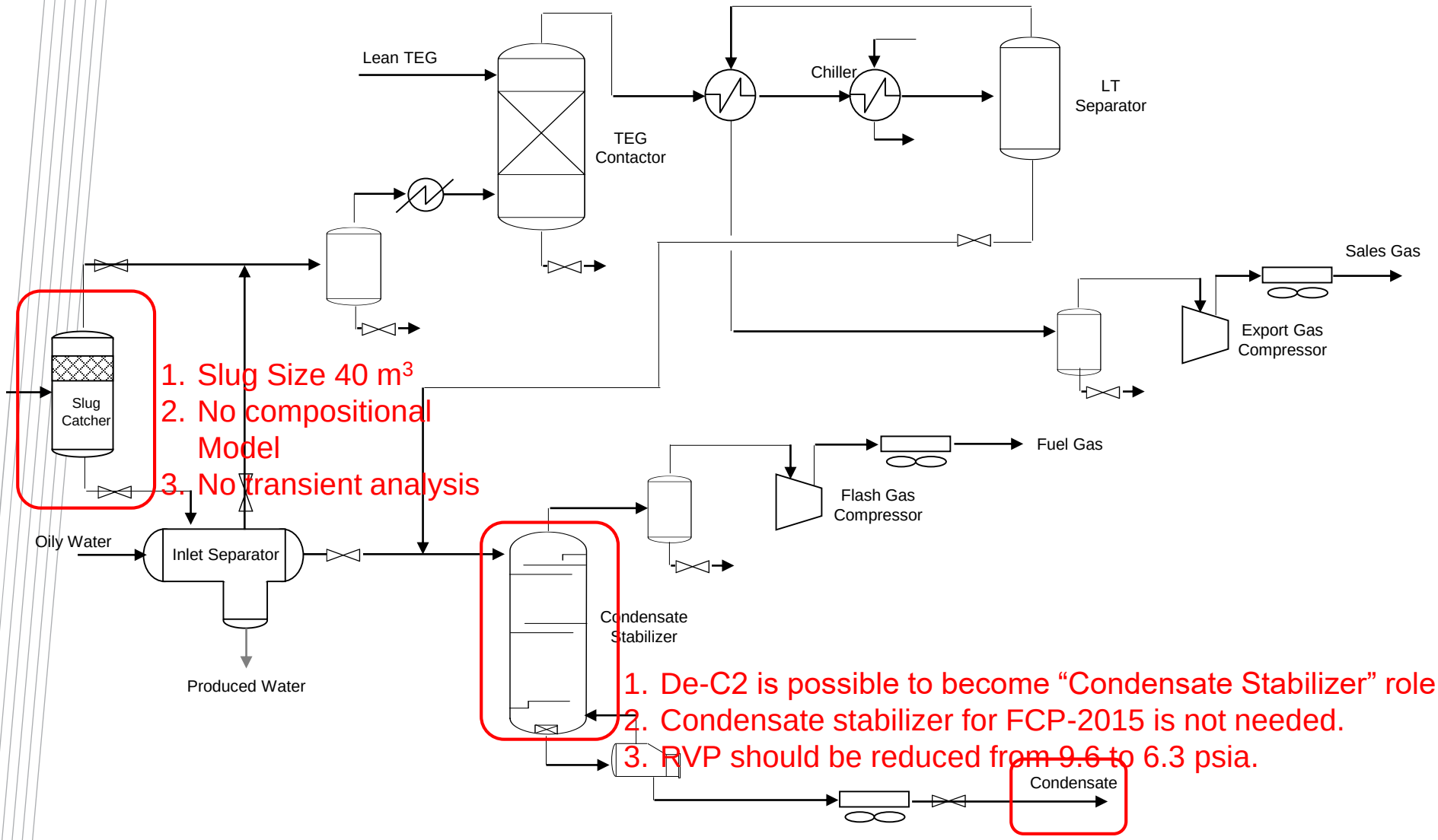
Gas processing concept



FEED Design for FCP-2015



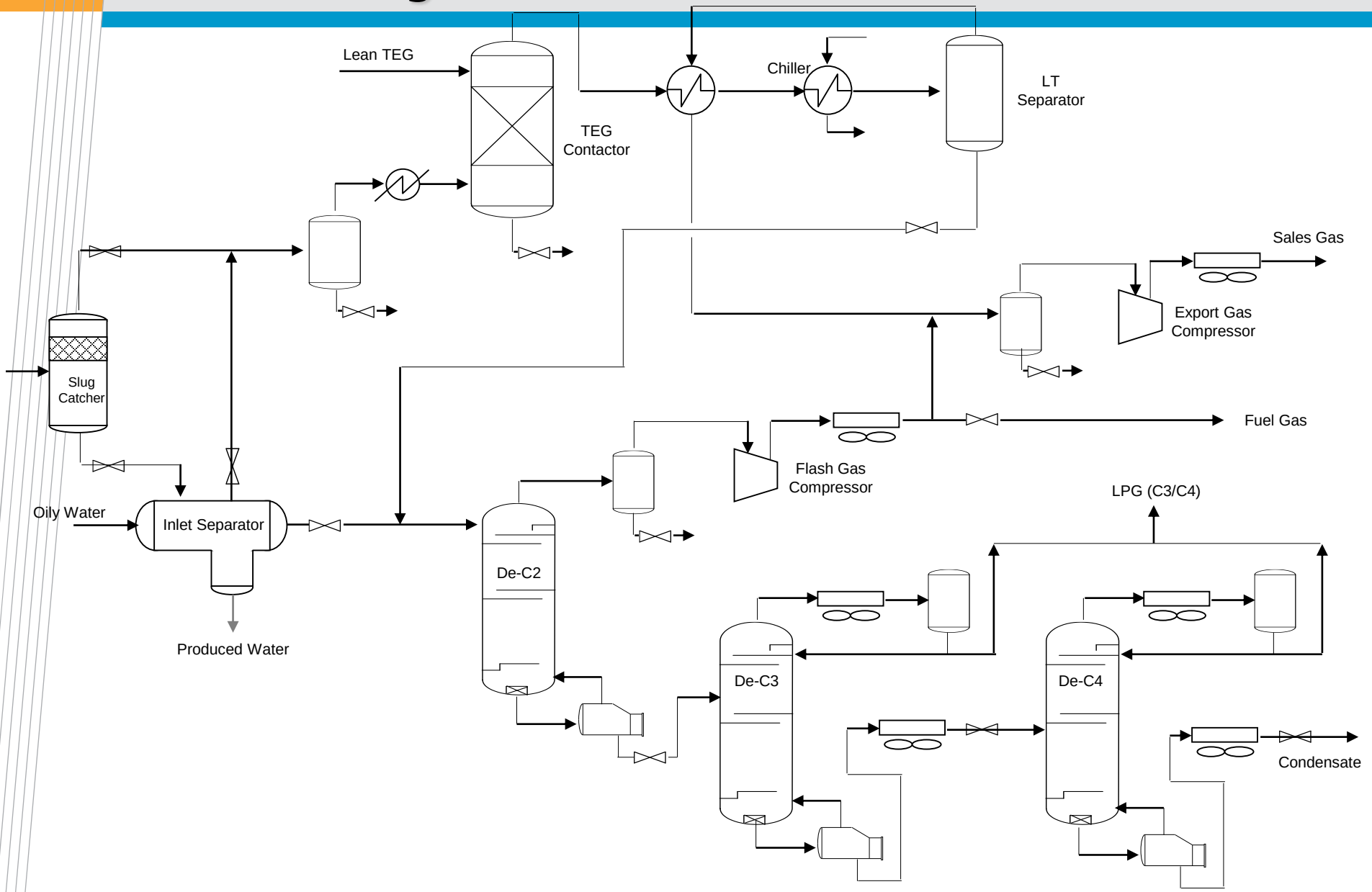
Verification Result for FCP-2015



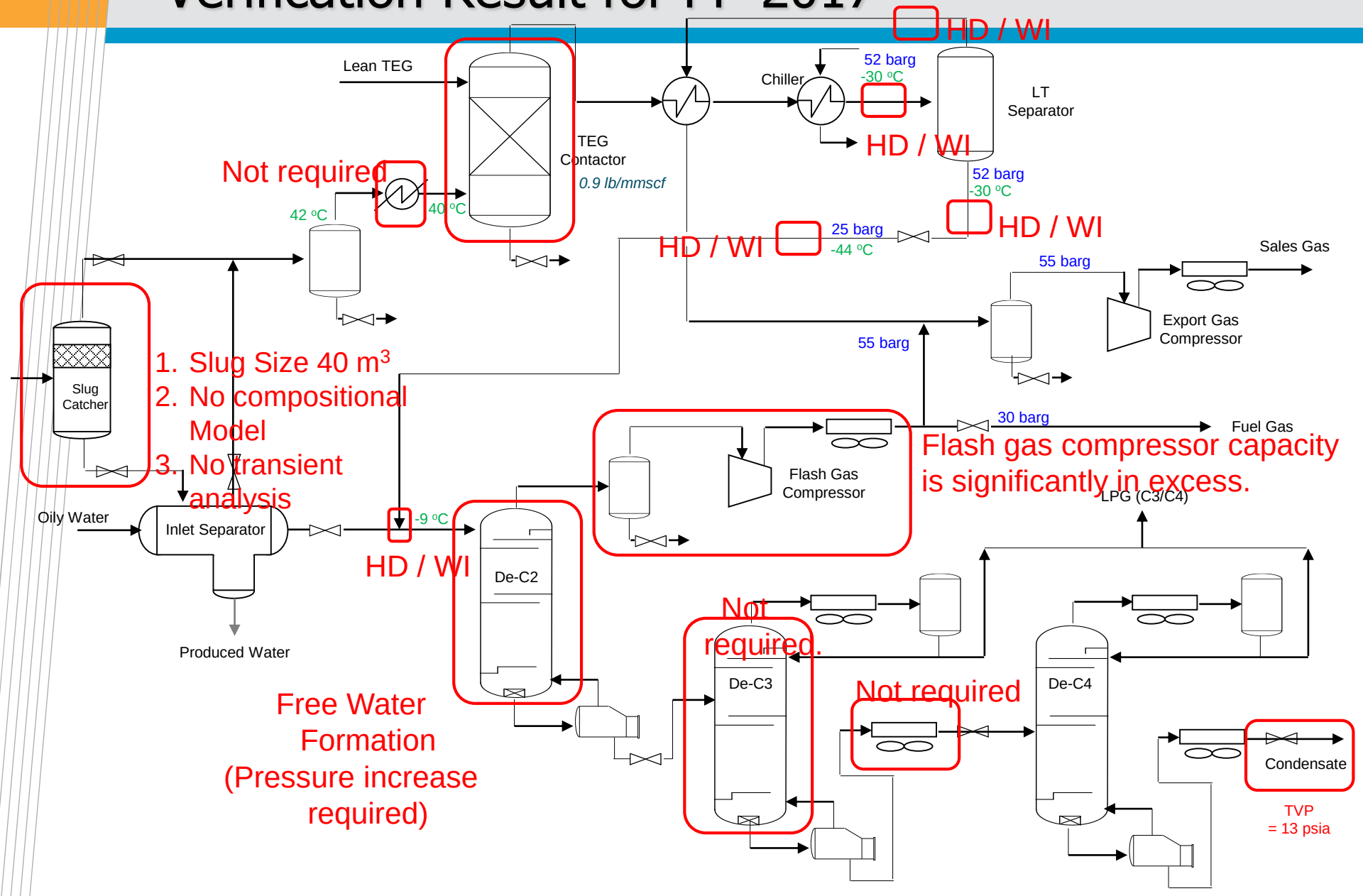
1. Slug Size 40 m^3
2. No compositional Model
3. No transient analysis

1. De-C2 is possible to become “Condensate Stabilizer” role.
2. Condensate stabilizer for FCP-2015 is not needed.
3. RVP should be reduced from 9.6 to 6.3 psia.

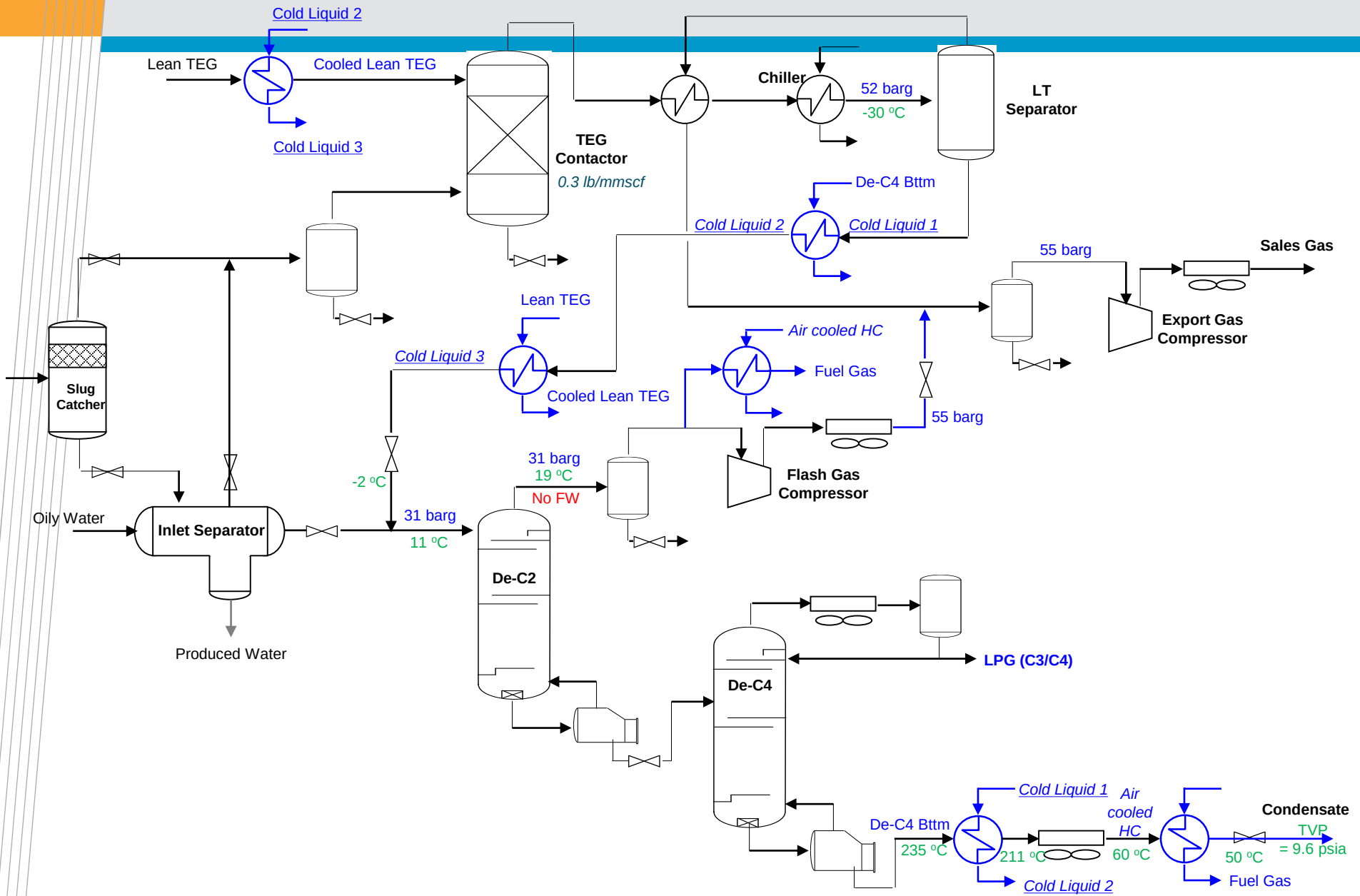
FEED Design for PP-2017



Verification Result for PP-2017



Revised Design (Alternative Case) for PP-2017



Comparison with FEED Design

		Unit	FCP-2015		PP-2017		PP-2030	
			FEED	Alter	FEED	Alter	FEED	Alter
LPG	RVP	[kPa]	-	-	851.8	844.7	815.5	815.5
	C_{2-}	[%]	-	-	0.35	0.37	0.23	0.37
	C_{5+}	[%]	-	-	1.60	1.61	1.57	1.60
	Product Rate[1)]	[t/d]	-	-	567	532	546	525
Stabilized Condensate	RVP	[psia]	9.597	6.300	6.433	6.400	9.796	9.149
	Product Rate	[t/d]	530	526	1,747	1,743	732	717

Note 1) LPG production should be guaranteed as over 500 ton/d at the begging of PP-2017.

However

Comments from the client,

1) LPG RVP unit must be revised from psia to kPa.

2) LPG product must consider C_3/C_4 ratio according to production season.

		Unit	Before the revision	After the revision
LPG	RVP	-	(S) 800 psia (55 bar) (W) 1,000 psia (68 bar)	(S) 800 kPa (W) 1,000 kPa
	C_{2-}	[%]	0.6	0.6
	C_{5+}	[%]	2.0	2.0
	C_3	[%]	No limitation	(S) 30 – 40 (W) 60 – 70
	C_4	[%]	No limitation	(S) 60 – 70 (W) 30 - 40
	C_3/C_4	-	No limitation	(S) 0.43 – 0.67 (W) 1.50 – 2.33

To deal with the requests

For client request (1) : LPG RVP unit must be revised. ((S) 800 psia, (W) 1,000 psia)

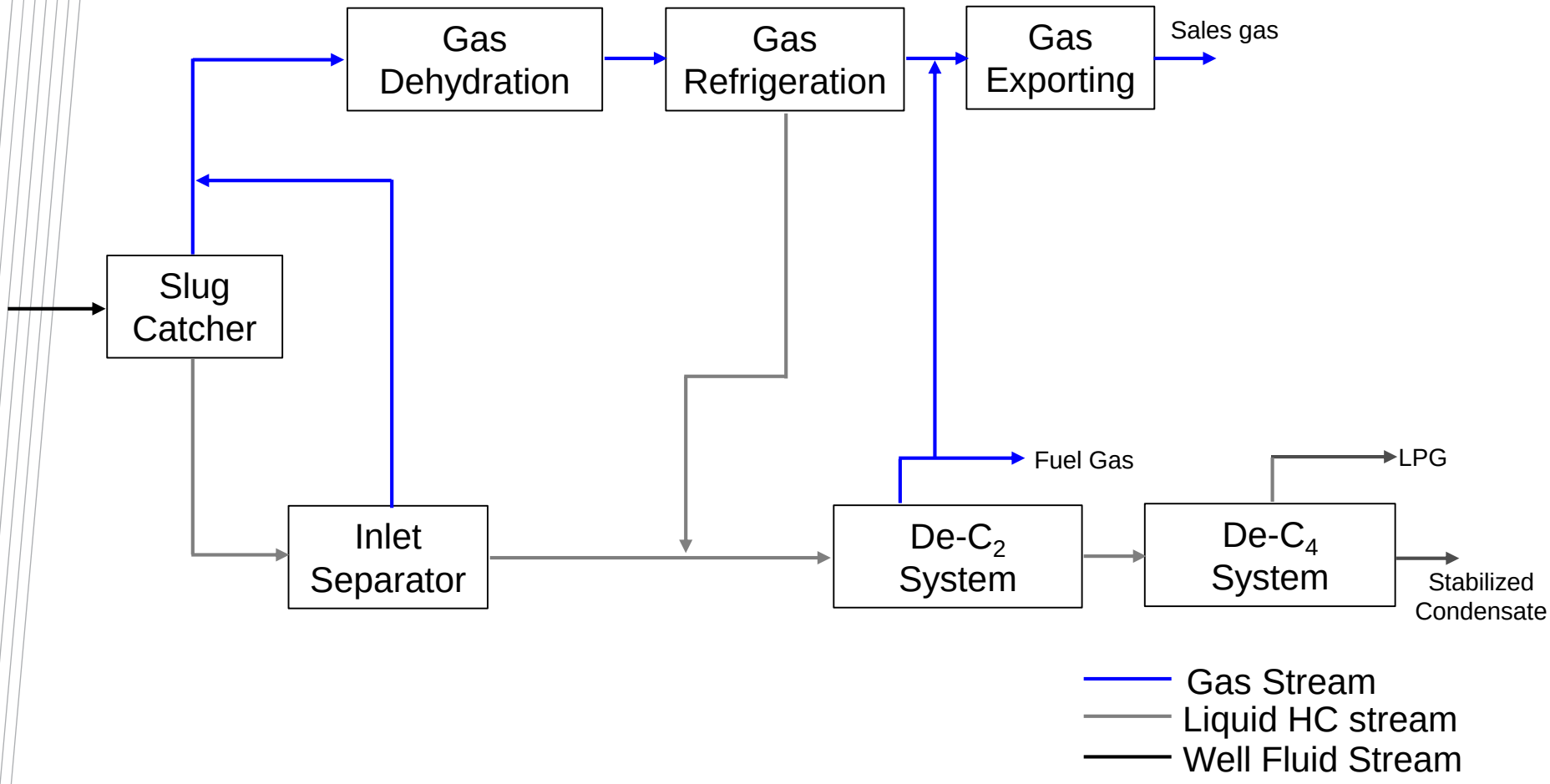
- ➔ *C_{2-} removal in LPG is useless for revised RVP.*
- ➔ *C_3 content in LPG must be reduced for revised RVP.*

For client request (2) : LPG product must consider C_3/C_4 ratio according to production season.

- ➔ *Operation condition and a method for reducing C_3 and increasing C_4 should be devised.*

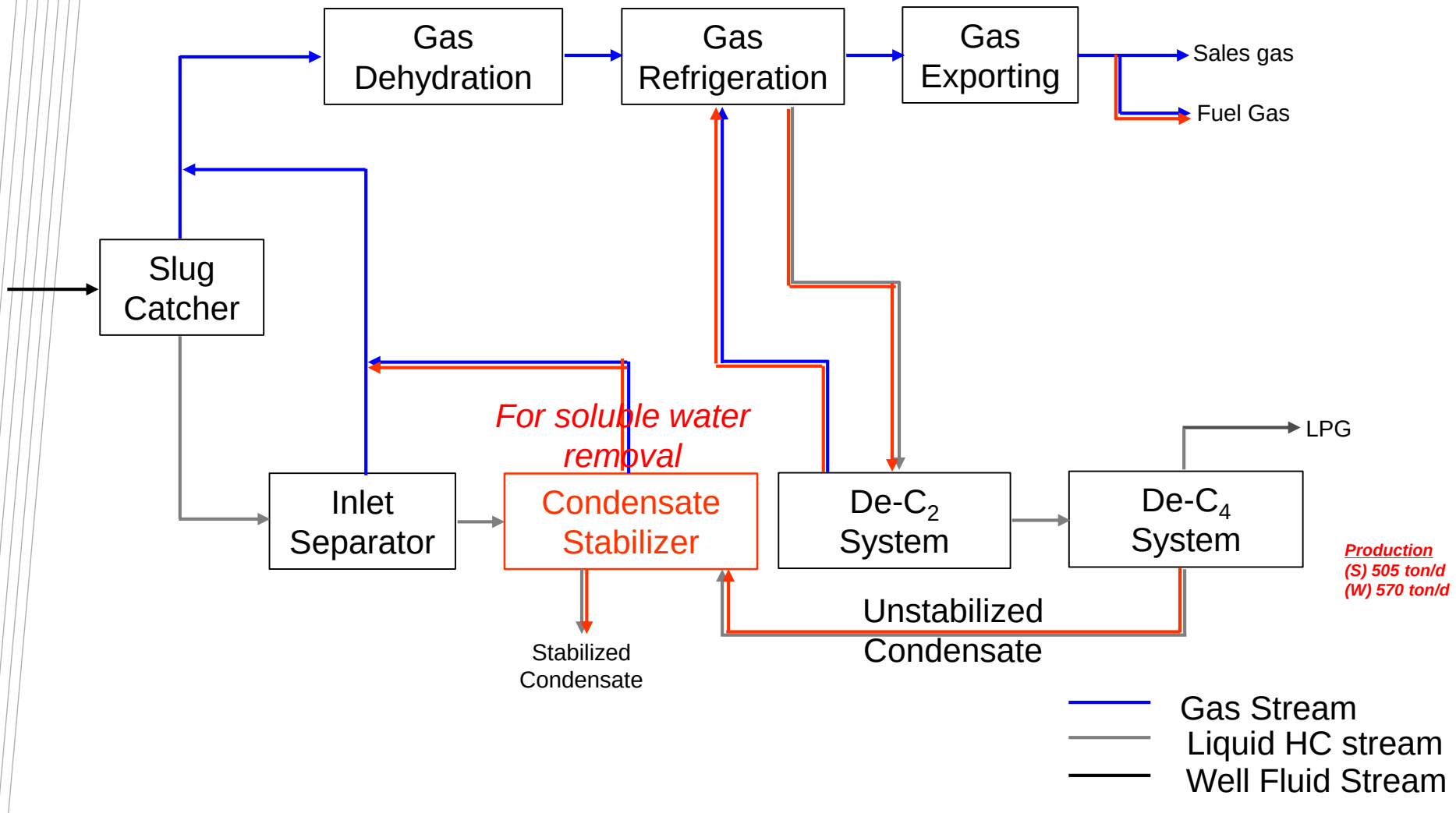
Modification of the process

Before Revision

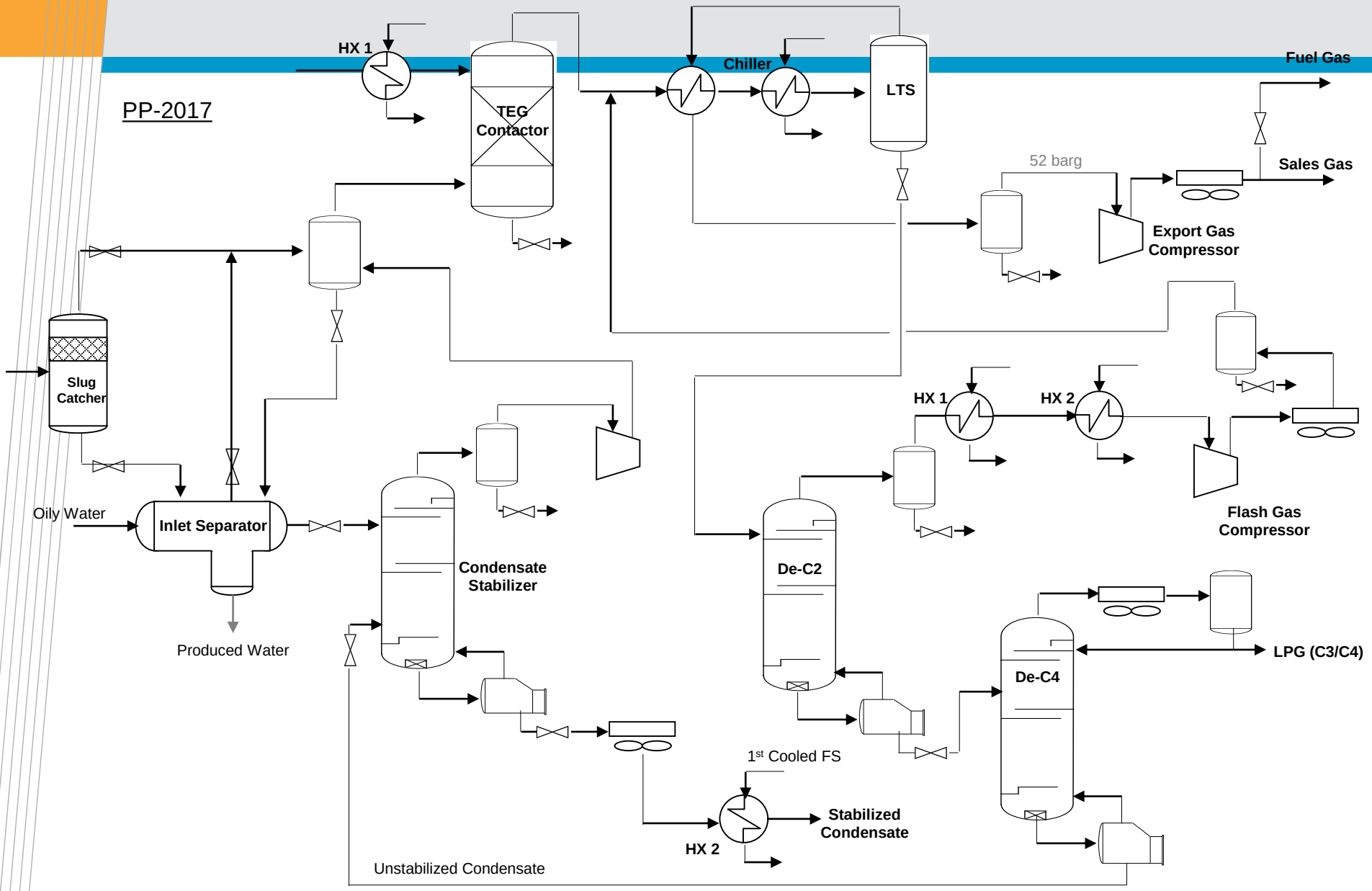


Solution Devised for Client Requests

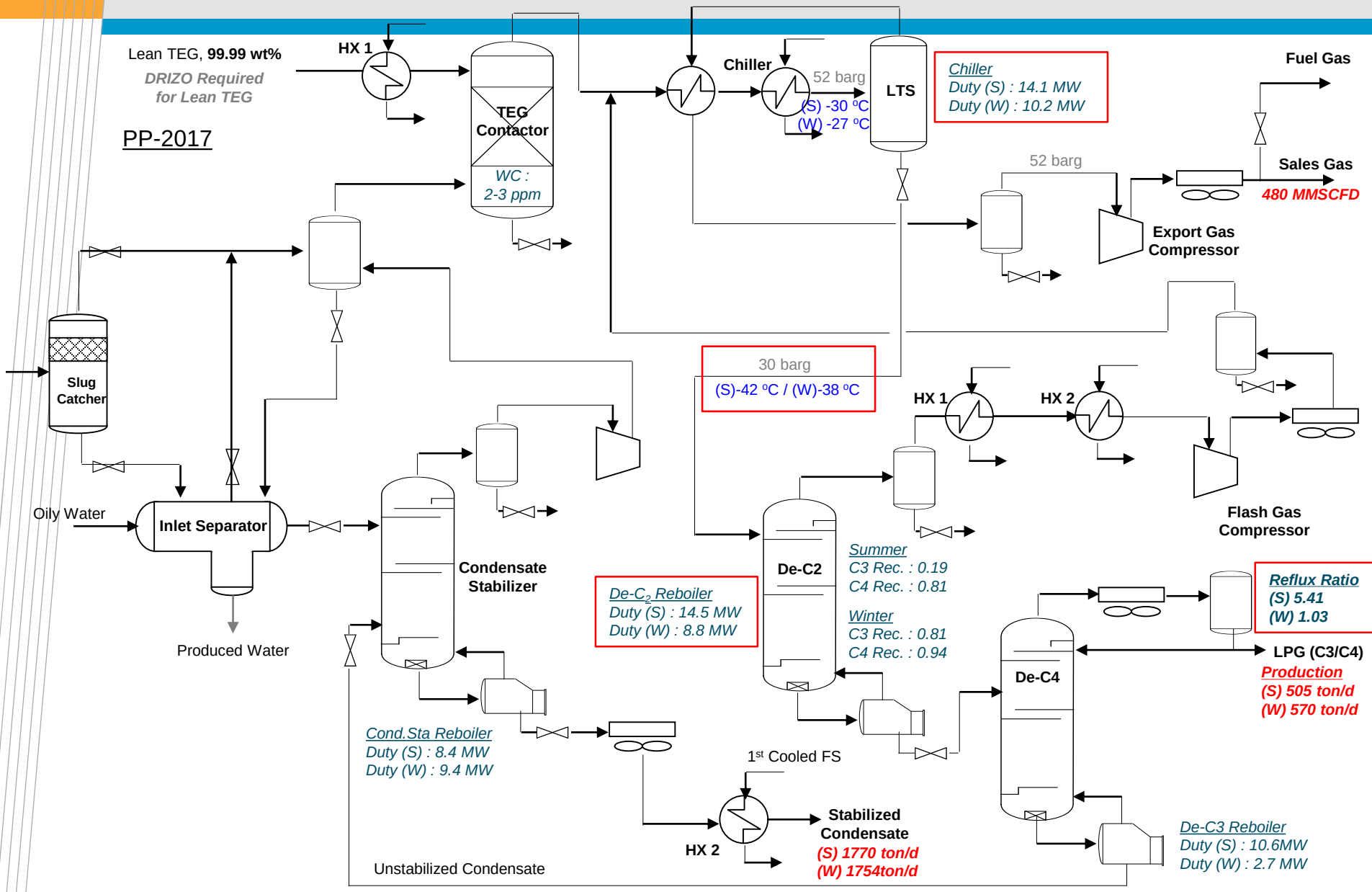
After Revision



Solution Devised for Client Requests



Solution Devised for Client Requests



Products summary

		Unit	Required Spec.	PP-2017	
				FEED	Solution Devised
LPG	RVP	[kPa]	(S) 800 (W) 1,000	851.8	(S) 692 (W) 897
	C_{2-}	[%]	0.6	0.35	(S) About 0.00 (W) 0.35
	C_{5+}	[%]	2	1.60	(S) 1.61 (W) 1.61
	Product Rate 1)	[t/d]	> 500 (@ PP-2017)	567	(S) 505 (W) 570
	C3/C4	-	(S) 0.43 – 0.67 (W) 1.50 – 2.33		(S) 0.66 (W) 1.65
Stabilized Condensate	RVP	[psia]	9.8	6.433	(S) 6.400 (W) 6.400
	Product Rate	[t/d]	-	1,747	(S) 1,770 (W) 1,754

: Devised solution is good to satisfy all requirements

Conclusion

For LPG product spec. (satisfying production rate, C_3/C_4 value, RVP and so on)

- ➔ *De-C_2 inlet fluid should be cooled for higher C_3 and C_4 recovery.*
- ➔ *C_3/C_4 and RVP control can be De-C_2 re-boiler duty control and De-C_3 reflux ratio.*

For stable operation (preventing hydrate, water freezing and free water),

- ➔ *Water content in dehydrated gas should be 2 – 3 ppm (about 0.1 lb/mmscf). (DRIZO)*
- ➔ *Condensate stabilizer should be introduced.*

Thank you!