

## **APPENDIX B**

**Plot plan, utility process flow diagram and heat & mass  
balances for the capture cases**

**Prepared by  
Amec FosterWheeler**

Annalias Clapis, Lucio Boschetti, Chiara Gilardi, Luca Mancuso and  
Mario Castellano

## **B.1 CO<sub>2</sub> capture from base case 1**



UNIT LIST	
UNIT	DESCRIPTION
100	CRUDE DISTILLATION (CDU)
200	SATURATED GAS PLANT (SGP)
250	LPG SWEETENING (LSW)
280	KERO SWEETENING (KSW)
300	NAPHTHA HYDROTREATER (NHT)
350	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
500	CATALYTIC REFORMING (CRF)
600	KERO HDS (KHT)
700	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1100	VACUUM DISTILLATION (VDU)
1500	VISBREAKER UNIT (VBU)
2000	AMINE WASHING AND REGENERATION (ARU)
2100	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
2200	TAIL GAS TREATMENT
2250	SULPHUR LOADING
2300	WASTE WATER TREATMENT (WWT)
2300	API SEPARATOR
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 01-01**

SCALE : 1 / 2500

REV.	DATE	DESCRIPTION	BY	CHK	APP.	P.Y.	S.T.	M.C.S.
COO	9/11/18	FIRST ISSUE						
REV.	DATE	DESCRIPTION	BY	CHK	APP.			

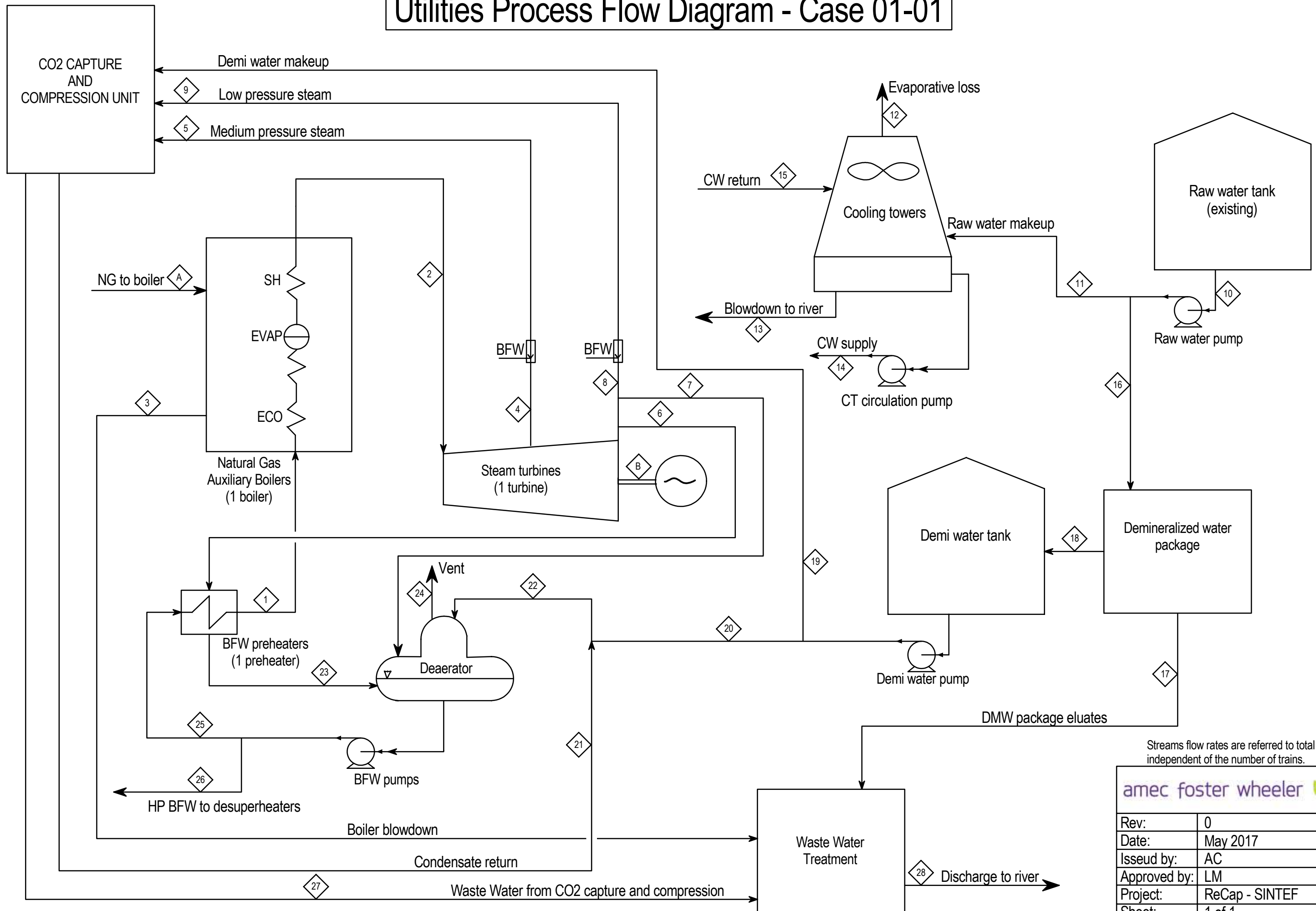
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DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
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BOOKS#A-0000-01-0011		COO	
SHEET 1	OF 1		

BASE CASE 1  
SIMPLE HYDROSKIMMING REFINERY  
100,000 BPSD  
GENERAL PLOT PLAN

# Utilities Process Flow Diagram - Case 01-01



Streams flow rates are referred to total figures, independent of the number of trains.

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Project:	ReCap - SINTEF
Sheet:	1 of 1

Utilities Material Balance

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 01-01	DATE			
HEAT & MATERIAL BALANCE	08/05/2017			

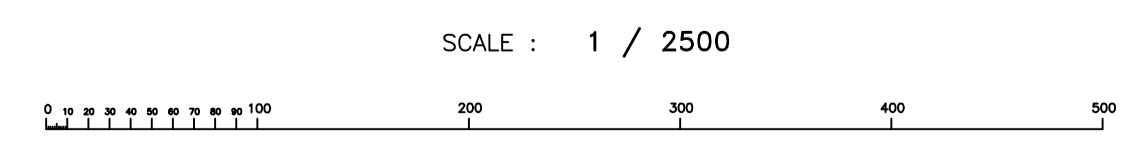
STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	78,300	64.0	162
2	HP SUPERHEATED STEAM FROM BOILER	77,908	45.0	420
3	BOILER BLOWDOWN	391	45.0	257
4	MP STEAM EXTRACTION	4,584	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	4,670	13.0	260
6	LP STEAM TO BFW PREHEATER	8,375	7.0	218
7	LP STEAM TO DEAERATOR	1,059	7.0	218
8	LP STEAM TO EXPORT	63,890	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	64,790	5.5	190
10	RAW WATER FROM TANK	140,621	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	106,925	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	70,345	atm	35
13	COOLING TOWER BLOWDOWN	36,580	atm	30
14	CW SUPPLY	3,939,342	6.0	30
15	CW RETURN	3,939,342	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	33,696	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	3,369	atm	ambient
18	DEMINERALIZED WATER TO TANK	30,327	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	29,636	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	692	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	69,460	9.0	94
22	WATER TO DEAERATOR	70,152	9.0	93
23	CONDENSATE FROM BFW PREHEATER	8,375	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	78,300	65.0	101
26	BFW TO DESUPERHEATERS	986	65.0	101
27	WASTE WATER FROM CO2 CAPTURE AND COMPRESSION	28,186	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	31,946	atm	30
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	4,780	kg/h	
B	ELECTRIC POWER OUTPUT	7,700	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
100	CRUDE DISTILLATION (CDU)
200	SATURATED GAS PLANT (SGP)
250	LPG SWEETENING (LSW)
280	KERO SWEETENING (KSW)
300	NAPHTHA HYDROTREATER (NHT)
350	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
500	CATALYTIC REFORMING (CRF)
600	KERO HDS (KHT)
700	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1100	VACUUM DISTILLATION (VDU)
1500	VISBREAKER UNIT (VBU)
2000	AMINE WASHING AND REGENERATION (ARU)
2100	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
2200	TAIL GAS TREATMENT
2250	SULPHUR LOADING
2300	WASTE WATER TREATMENT (WWT)
2300	API SEPARATOR
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

Post-combustion  
 CO2 capture  
 Case 01-02



REV.	DATE	DESCRIPTION	BY	CHK	APP.	P.Y.	S.T.	M.C.S.
COO	9/11/18	FIRST ISSUE						
REV.	DATE	DESCRIPTION	BY	CHK	APP.			

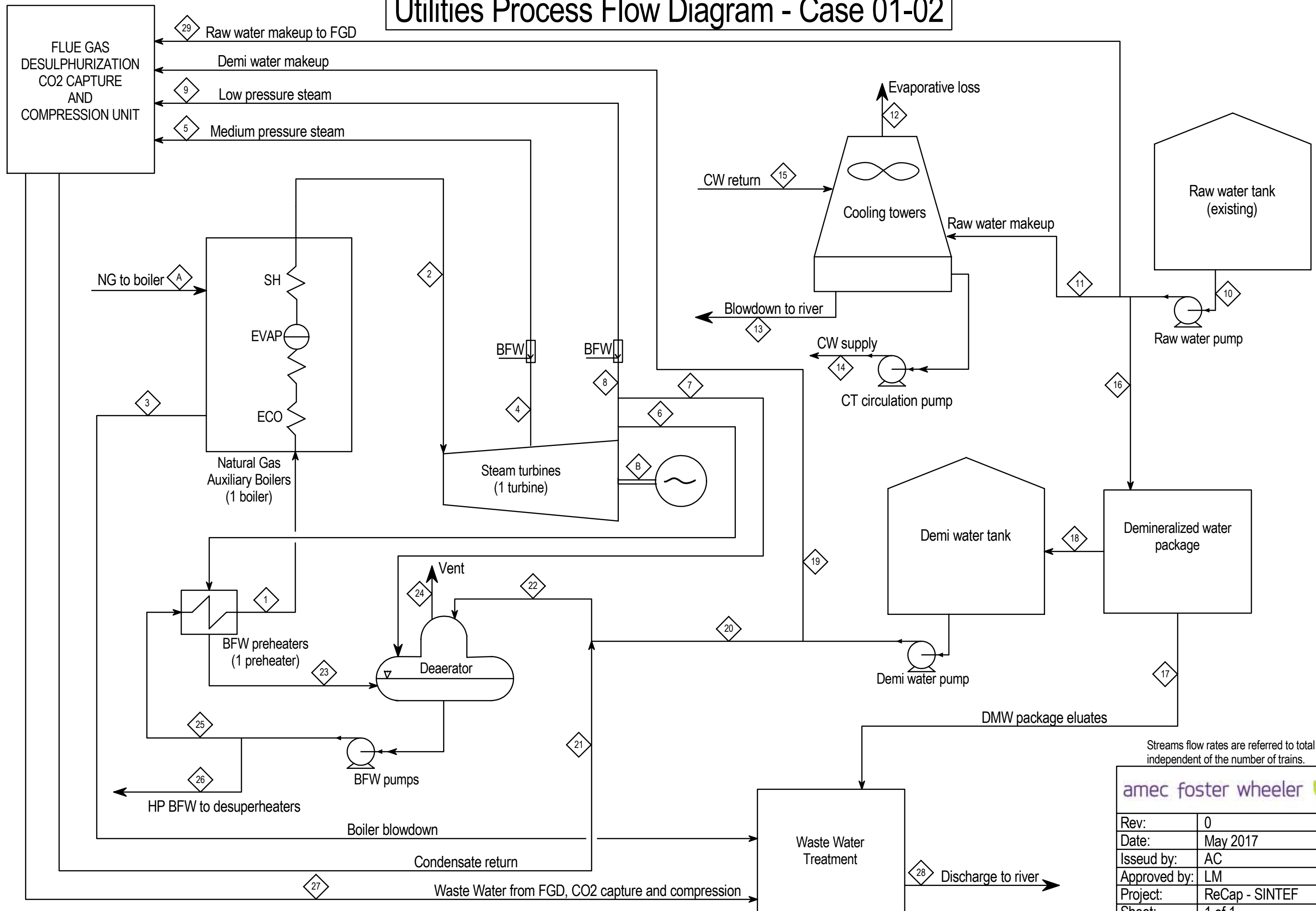
REVISIONS	


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DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PIN DWG N°		REV.	
BOOKS#A-0000-01-0011		COO	
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**BASE CASE 1**  
**SIMPLE HYDROSKIMMING REFINERY**  
**100,000 BPSD**  
**GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 01-02



Streams flow rates are referred to total figures, independent of the number of trains.

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Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 01-02	DATE			
HEAT & MATERIAL BALANCE	08/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	123,856	64.0	162
2	HP SUPERHEATED STEAM FROM BOILER	123,237	45.0	420
3	BOILER BLOWDOWN	619	45.0	257
4	MP STEAM EXTRACTION	7,235	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	7,370	13.0	260
6	LP STEAM TO BFW PREHEATER	13,248	7.0	218
7	LP STEAM TO DEAERATOR	1,491	7.0	218
8	LP STEAM TO EXPORT	101,263	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	102,690	5.5	190
10	RAW WATER FROM TANK	214,967	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	153,488	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	100,979	atm	35
13	COOLING TOWER BLOWDOWN	52,509	atm	30
14	CW SUPPLY	5,654,821	6.0	30
15	CW RETURN	5,654,821	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	53,995	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	5,398	atm	ambient
18	DEMINERALIZED WATER TO TANK	48,597	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	47,678	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	919	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	110,060	9.0	94
22	WATER TO DEAERATOR	110,979	9.0	93
23	CONDENSATE FROM BFW PREHEATER	13,248	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	123,856	65.0	101
26	BFW TO DESUPERHEATERS	1,562	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	37,966	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	43,983	atm	30
29	RAW WATER MAKEUP TO FGD	7,483	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	7,562	kg/h	
B	ELECTRIC POWER OUTPUT	12,180	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains





UNIT LIST	
UNIT	DESCRIPTION
100	CRUDE DISTILLATION (CDU)
200	SATURATED GAS PLANT (SGP)
250	LPG SWEETENING (LSW)
280	KERO SWEETENING (KSW)
300	NAPHTHA HYDROTREATER (NHT)
350	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
500	CATALYTIC REFORMING (CRF)
600	KERO HDS (KHT)
700	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1100	VACUUM DISTILLATION (VDU)
1500	VISBREAKER UNIT (VBU)
2000	AMINE WASHING AND REGENERATION (ARU)
2100	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
2250	TAIL GAS TREATMENT
2300	SULPHUR LOADING
2300	WASTE WATER TREATMENT (WWT)
2300	API SEPARATOR
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

Post-combustion  
 CO2 capture  
 Case 01-03

SCALE : 1 / 2500

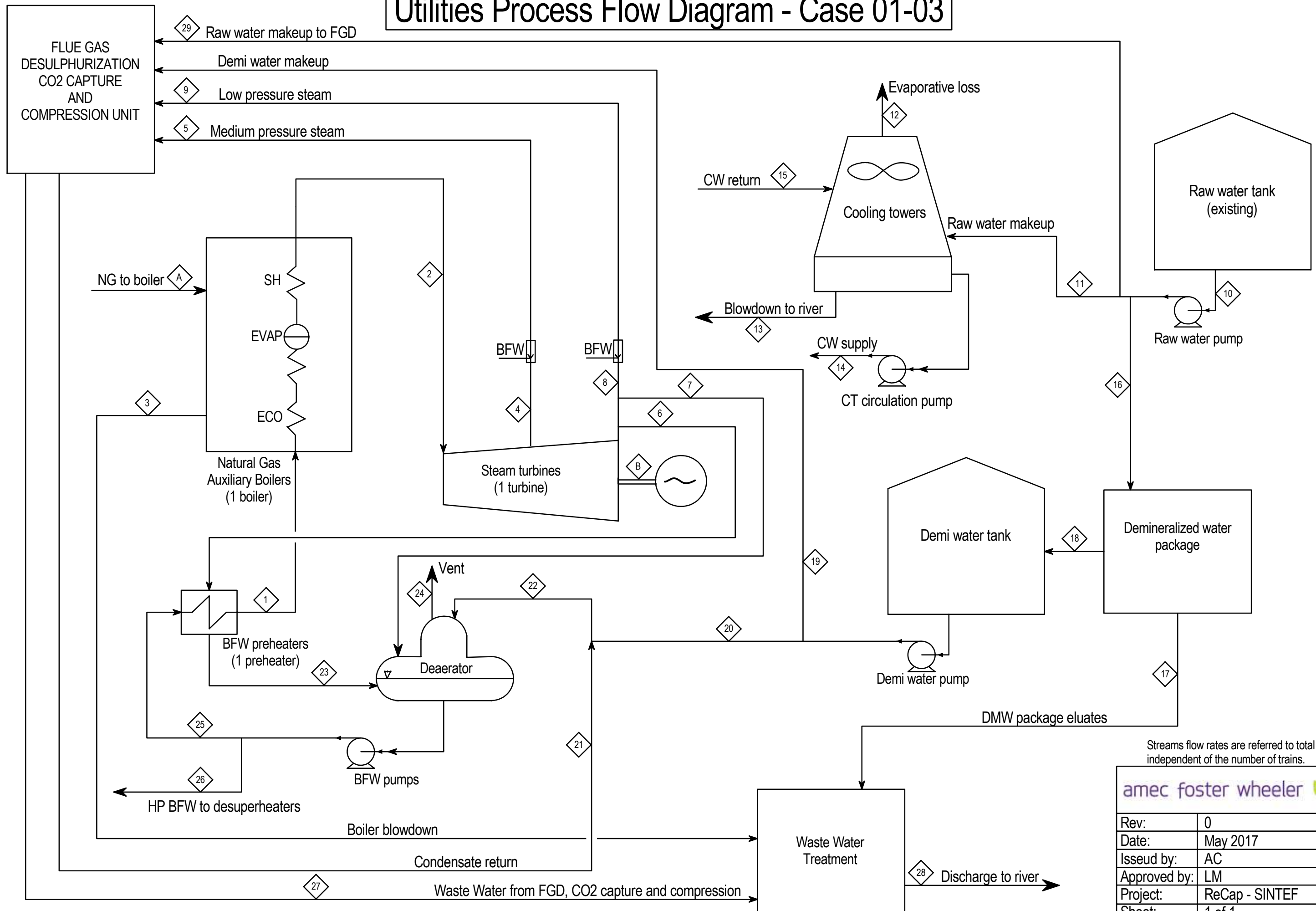
REV.	DATE	DESCRIPTION	BY	CHK	APP.	P.Y.	S.T.	M.C.S.
COO	9/11/18	FIRST ISSUE						
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ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PIN DWG N°		REV.	
BOOKS#A-0000-01-0011		COO	
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**BASE CASE 1**  
**SIMPLE HYDROSKIMMING REFINERY**  
**100,000 BPSD**  
**GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 01-03



Streams flow rates are referred to total figures, independent of the number of trains.

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Rev:	0
Date:	May 2017
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Project:	ReCap - SINTEF
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CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 01-03	DATE			
HEAT & MATERIAL BALANCE	08/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	140,317	64.1	162
2	HP SUPERHEATED STEAM FROM BOILER	139,614	44.5	420
3	BOILER BLOWDOWN	702	44.5	257
4	MP STEAM EXTRACTION	8,197	15.0	294
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	8,360	13.0	260
6	LP STEAM TO BFW PREHEATER	15,036	7.0	220
7	LP STEAM TO DEAERATOR	1,648	7.0	220
8	LP STEAM TO EXPORT	114,734	7.0	220
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	116,550	5.5	190
10	RAW WATER FROM TANK	244,143	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	175,443	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	115,423	atm	35
13	COOLING TOWER BLOWDOWN	60,020	atm	30
14	CW SUPPLY	6,463,702	6.0	30
15	CW RETURN	6,463,702	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	61,216	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	6,120	atm	ambient
18	DEMINERALIZED WATER TO TANK	55,096	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	54,095	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,002	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	124,910	9.0	94
22	WATER TO DEAERATOR	125,912	9.0	93
23	CONDENSATE FROM BFW PREHEATER	15,036	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	140,317	65.0	101
26	BFW TO DESUPERHEATERS	1,978	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	43,751	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	50,572	atm	30
29	RAW WATER MAKEUP TO FGD	7,483	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	8,566	kg/h	
B	ELECTRIC POWER OUTPUT	13,680	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains

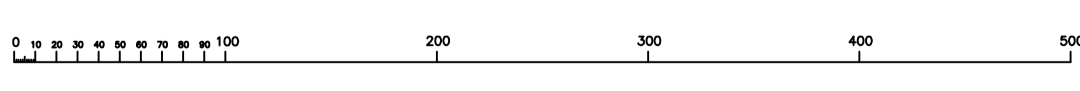
## **B.2 CO<sub>2</sub> capture from base case 2**



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKER (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1500	VISBREAKING UNIT (VBU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
2200B	SULPHUR RECOVERY (SRU)
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
<b>POWER UNITS</b>	
2300A	WASTE WATER TREATMENT (WWT)
2300B	WASTE WATER TREATMENT (WWT)
2500	POWER PLANT (POW)
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 02-01**

SCALE : 1 / 2500



NO.	DATE	DESCRIPTION	BY	CHK	APP.
COO	9/11/19	FIRST ISSUE			
REV.					

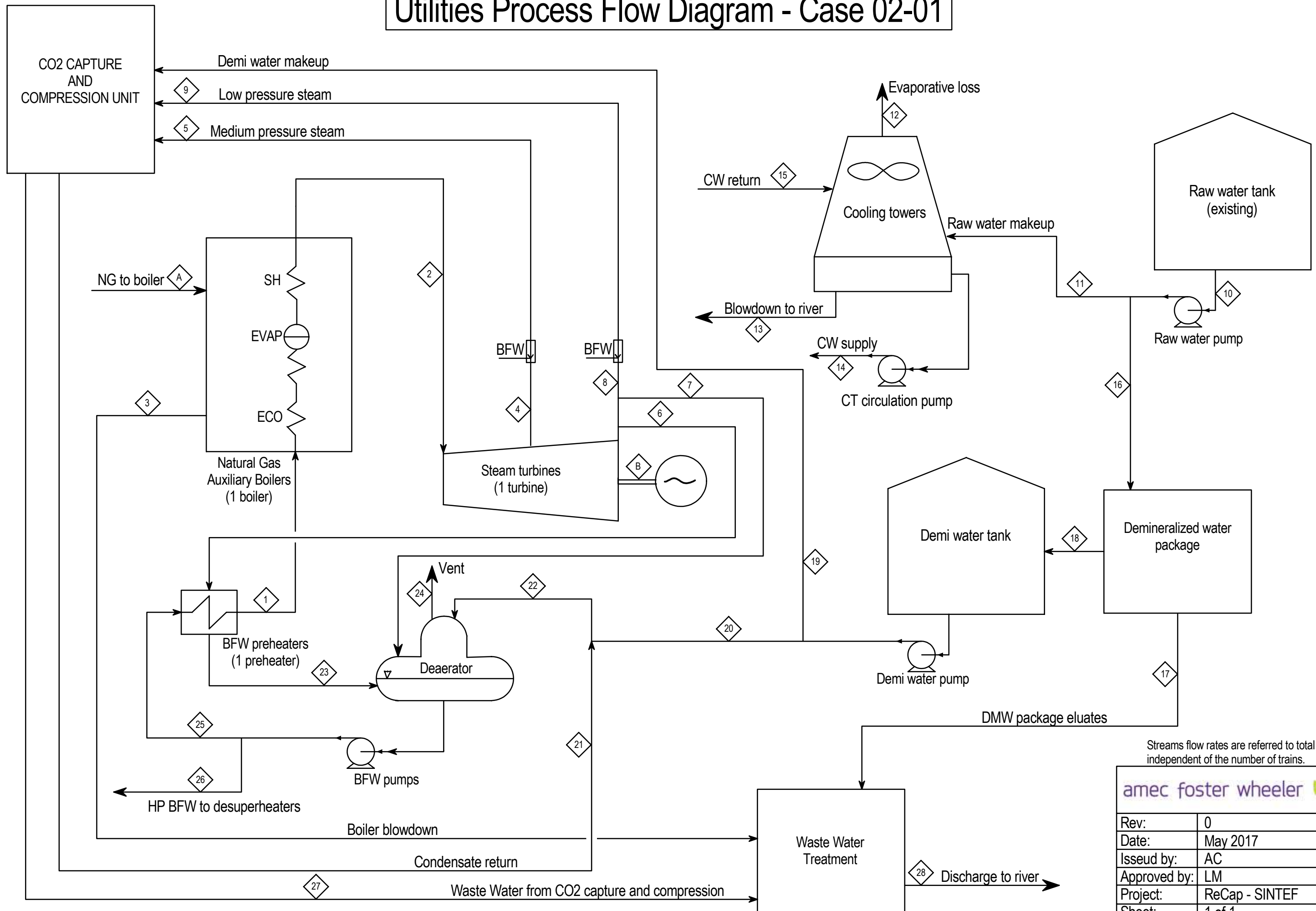
REVISIONS	


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DWG. REV.	DATE	SIGNATURE	
ORDER N°		SUPPLIER	
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PNR DWG N°		REV.	

**BASE CASE 2  
MEDIUM CONVERSION REFINERY  
220,000 BPSD  
GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 02-01



Streams flow rates are referred to total figures, independent of the number of trains.

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Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 02-01	DATE			
HEAT & MATERIAL BALANCE	08/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	173,281	64.0	162
2	HP SUPERHEATED STEAM FROM BOILER	172,415	45.0	420
3	BOILER BLOWDOWN	866	45.0	257
4	MP STEAM EXTRACTION	10,091	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	10,280	13.0	260
6	LP STEAM TO BFW PREHEATER	18,535	7.0	218
7	LP STEAM TO DEAERATOR	1,957	7.0	218
8	LP STEAM TO EXPORT	141,831	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	143,830	5.5	190
10	RAW WATER FROM TANK	304,872	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	229,535	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	151,010	atm	35
13	COOLING TOWER BLOWDOWN	78,525	atm	30
14	CW SUPPLY	8,456,541	6.0	30
15	CW RETURN	8,456,541	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	75,337	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	7,531	atm	ambient
18	DEMINERALIZED WATER TO TANK	67,806	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	66,650	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,156	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	154,120	9.0	94
22	WATER TO DEAERATOR	155,276	9.0	93
23	CONDENSATE FROM BFW PREHEATER	18,535	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	173,281	65.0	101
26	BFW TO DESUPERHEATERS	2,188	65.0	101
27	WASTE WATER FROM CO2 CAPTURE AND COMPRESSION	58,590	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	66,987	atm	30
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	10,579	kg/h	
B	ELECTRIC POWER OUTPUT	17,050	kW	

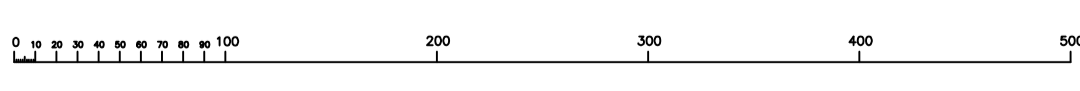
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKER (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1500	VISBREAKING UNIT (VBU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2200B	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
<b>POWER UNITS</b>	
2300A	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2300B	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2500	POWER PLANT (POW)
<b>UTILITY UNITS</b>	
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 02-02**

SCALE : 1 / 2500



NO.	DATE	DESCRIPTION	BY	CHK	APP.
COO	9/11/19	FIRST ISSUE			
REV.					

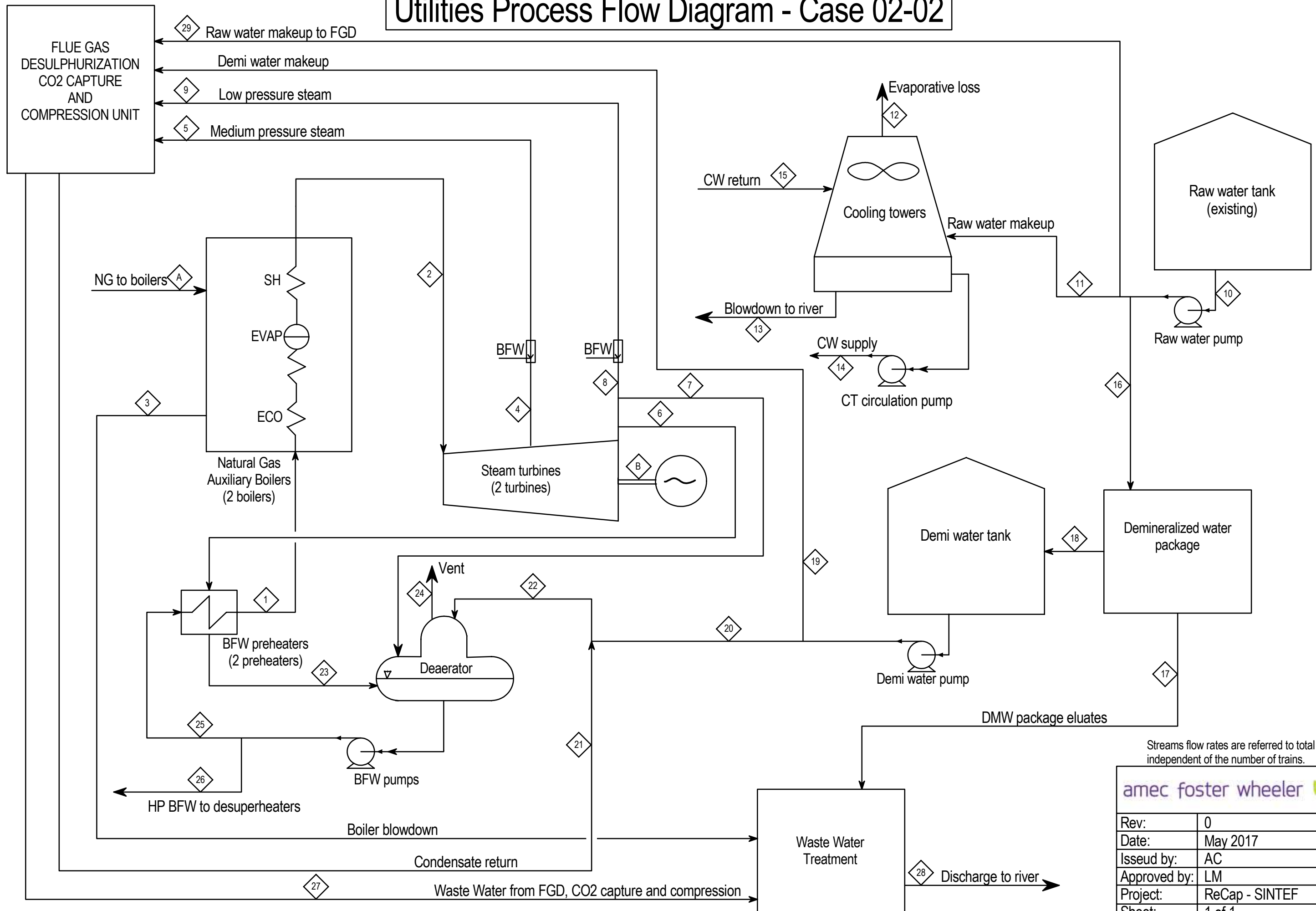
  

amec foster wheeler		APPROVED FOR CONSTRUCTION	
DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PIN DWG N°		REV.	
B00839A-0000-01-0021		COO	
SHEET 1	OF 1		

**BASE CASE 2  
MEDIUM CONVERSION REFINERY  
220,000 BPSD  
GENERAL PLOT PLAN**



# Utilities Process Flow Diagram - Case 02-02



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 02-02	DATE			
HEAT & MATERIAL BALANCE	09/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	254,678	64.0	162
2	HP SUPERHEATED STEAM FROM BOILERS	253,405	45.0	420
3	BOILERS BLOWDOWN	1,273	45.0	257
4	MP STEAM EXTRACTION	14,931	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	15,210	13.0	260
6	LP STEAM TO BFW PREHEATERS	27,242	7.0	218
7	LP STEAM TO DEAERATOR	2,730	7.0	218
8	LP STEAM TO EXPORT	208,502	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	211,440	5.5	190
10	RAW WATER FROM TANK	453,655	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	324,448	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	213,452	atm	35
13	COOLING TOWER BLOWDOWN	110,995	atm	30
14	CW SUPPLY	11,953,335	6.0	30
15	CW RETURN	11,953,335	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	109,434	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	10,940	atm	ambient
18	DEMINERALIZED WATER TO TANK	98,494	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	96,921	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,573	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	226,650	9.0	94
22	WATER TO DEAERATOR	228,223	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	27,242	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	254,678	65.0	101
26	BFW TO DESUPERHEATERS	3,217	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	83,341	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	95,554	atm	30
29	RAW WATER MAKEUP TO FGD	19,773	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	15,549	kg/h	
B	ELECTRIC POWER OUTPUT	25,050	kW	

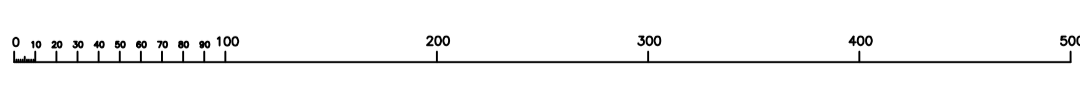
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
PROCESS UNITS	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKER (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1500	VISBREAKING UNIT (VBU)
AUXILIARY UNITS	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2200B	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
POWER UNITS	
2300A	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2300B	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2500	POWER PLANT (POW)
OFF SITES UNITS	
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture**  
  
**Case 02-03**

SCALE : 1 / 2500



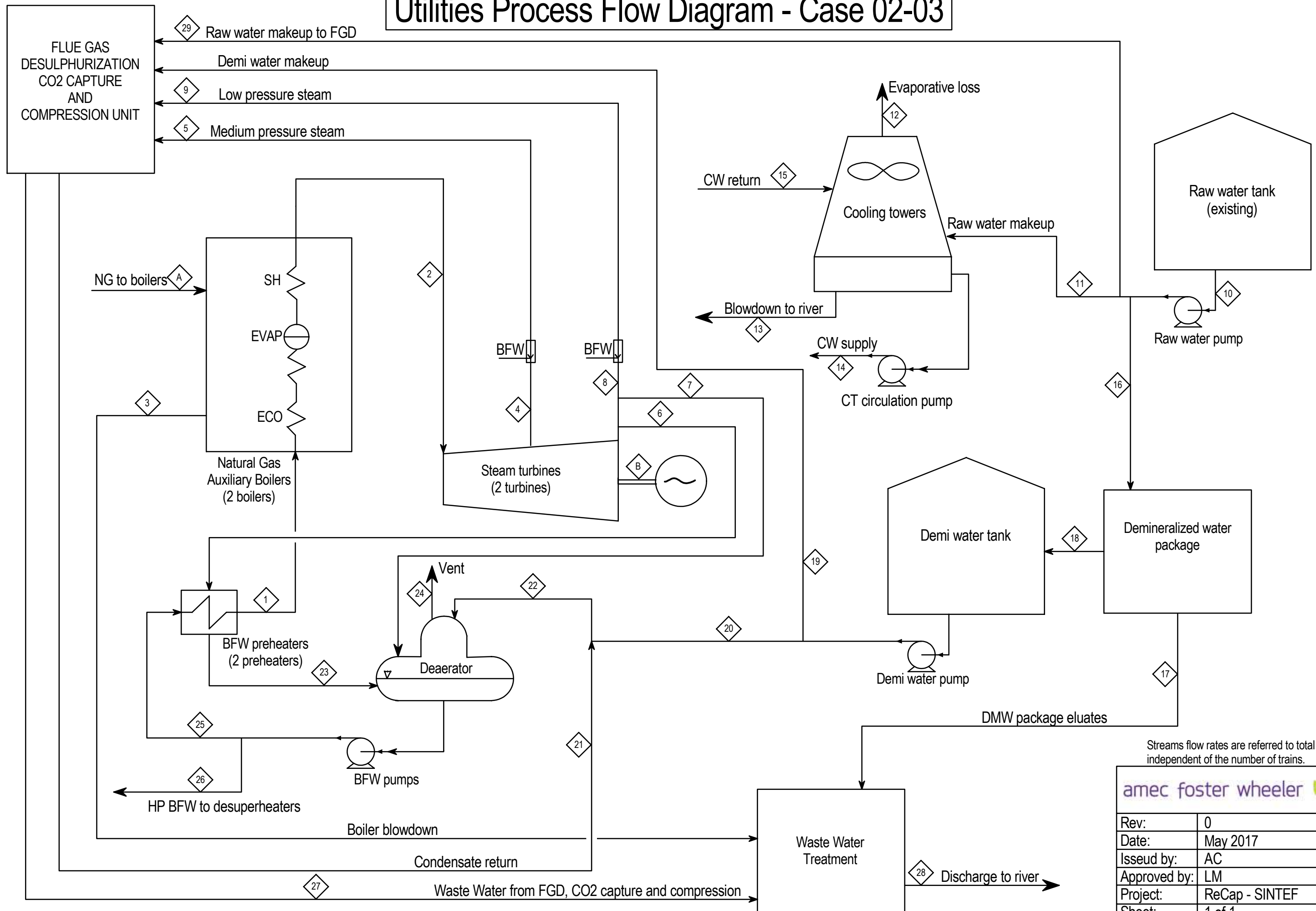
NO.	DATE	DESCRIPTION	BY	CHK	APP.
COO	9/11/19	FIRST ISSUE			
REV.	DATE	DESCRIPTION			


amec foster wheeler		APPROVED FOR CONSTRUCTION	
DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PIN DWG N°		REV.	
B00839A-0000-01-0021		COO	
SHEET 1	OF 1		

**BASE CASE 2**  
**MEDIUM CONVERSION REFINERY**  
**220,000 BPSD**  
**GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 02-03



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 02-03	DATE			
HEAT & MATERIAL BALANCE	09/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	395,416	64.1	162
2	HP SUPERHEATED STEAM FROM BOILERS	393,439	44.4	420
3	BOILERS BLOWDOWN	1,977	44.4	257
4	MP STEAM EXTRACTION	23,264	15.0	294
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	23,730	13.0	260
6	LP STEAM TO BFW PREHEATERS	42,386	7.0	220
7	LP STEAM TO DEAERATOR	4,067	7.0	220
8	LP STEAM TO EXPORT	323,722	7.0	220
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	328,940	5.5	190
10	RAW WATER FROM TANK	687,398	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	480,771	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	316,296	atm	35
13	COOLING TOWER BLOWDOWN	164,474	atm	30
14	CW SUPPLY	17,712,604	6.0	30
15	CW RETURN	17,712,604	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	168,809	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	16,876	atm	ambient
18	DEMINERALIZED WATER TO TANK	151,934	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	149,656	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	2,277	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	352,670	9.0	94
22	WATER TO DEAERATOR	354,947	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	42,386	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	395,416	65.0	101
26	BFW TO DESUPERHEATERS	5,684	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	116,913	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	135,765	atm	30
29	RAW WATER MAKEUP TO FGD	37,818	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	24,140	kg/h	
B	ELECTRIC POWER OUTPUT	38,470	kW	

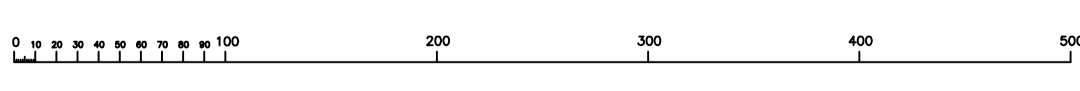
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKER (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1500	VISBREAKING UNIT (VBU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
	TAIL GAS TREATMENT
2200B	SULPHUR RECOVERY (SRU)
	TAIL GAS TREATMENT
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
<b>POWER UNITS</b>	
2300A	WASTE WATER TREATMENT (WWT)
	API SEPARATOR
2300B	WASTE WATER TREATMENT (WWT)
	API SEPARATOR
2500	POWER PLANT (POW)
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 02-04**

SCALE : 1 / 2500



NO.	DATE	DESCRIPTION	BY	CHK	APP.
COO	9/11/19	FIRST ISSUE			
REV.					

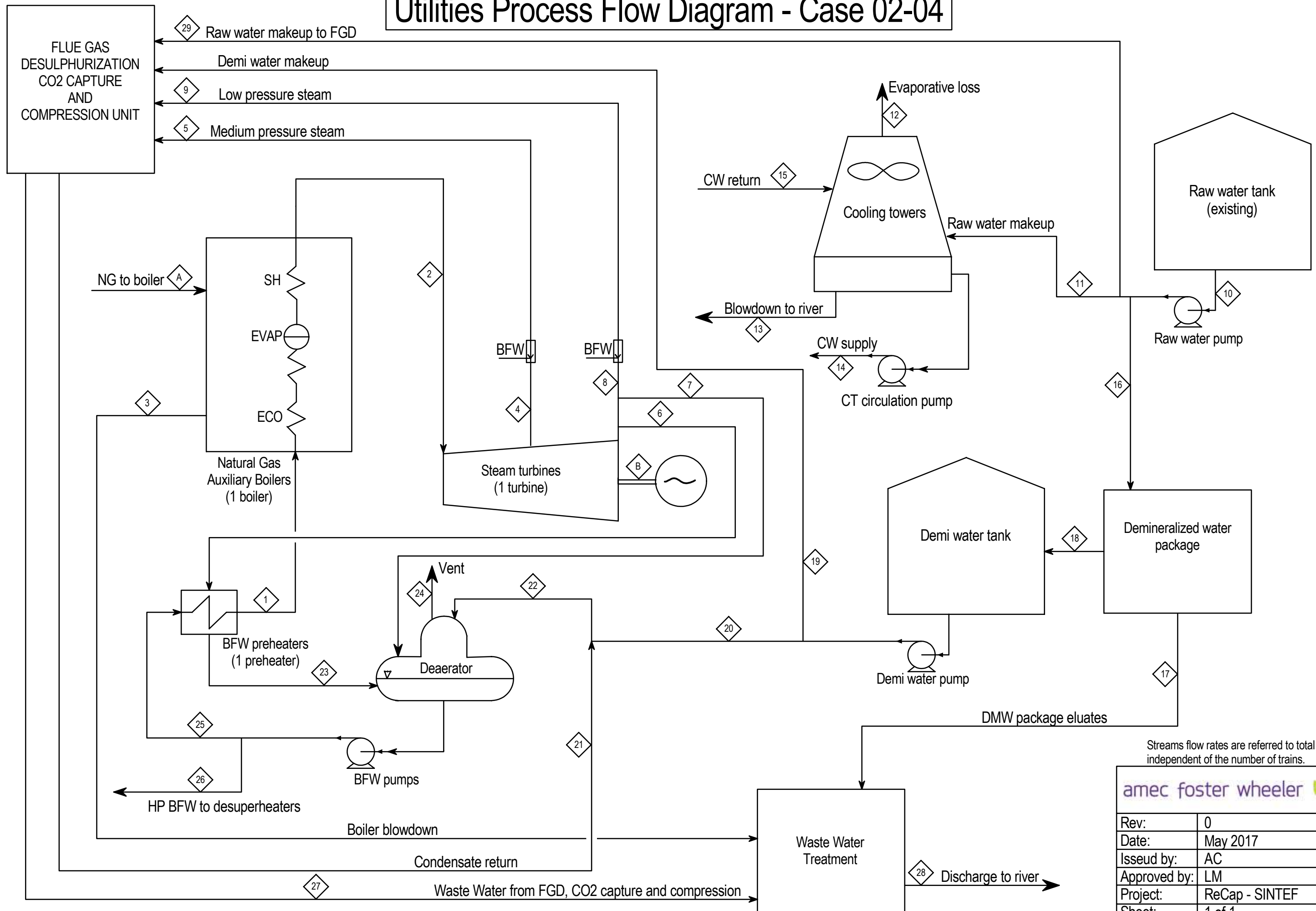
REVISIONS	


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DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PNR DWG N°		REV.	
B00839A-0000-01-0021		COO	
SHEET 1	OF 1		

**BASE CASE 2  
MEDIUM CONVERSION REFINERY  
220,000 BPSD  
GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 02-04



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 02-04	DATE			
HEAT & MATERIAL BALANCE	09/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	188,239	64.0	162
2	HP SUPERHEATED STEAM FROM BOILER	187,298	45.0	420
3	BOILER BLOWDOWN	941	45.0	257
4	MP STEAM EXTRACTION	11,092	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	11,300	13.0	260
6	LP STEAM TO BFW PREHEATER	20,135	7.0	218
7	LP STEAM TO DEAERATOR	2,101	7.0	218
8	LP STEAM TO EXPORT	153,970	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	156,140	5.5	190
10	RAW WATER FROM TANK	333,147	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	215,535	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	141,799	atm	35
13	COOLING TOWER BLOWDOWN	73,736	atm	30
14	CW SUPPLY	7,940,772	6.0	30
15	CW RETURN	7,940,772	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	79,794	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	7,977	atm	ambient
18	DEMINERALIZED WATER TO TANK	71,817	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	70,576	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,241	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	167,440	9.0	94
22	WATER TO DEAERATOR	168,681	9.0	93
23	CONDENSATE FROM BFW PREHEATER	20,135	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	188,239	65.0	101
26	BFW TO DESUPERHEATERS	2,377	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	52,796	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	61,714	atm	30
29	RAW WATER MAKEUP TO FGD	37,818	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	11,493	kg/h	
B	ELECTRIC POWER OUTPUT	18,510	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains



## **B.3 CO<sub>2</sub> capture from base case 3**



UNIT LIST

UNIT	DESCRIPTION
PROCESS UNITS	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1400	DELAYED COKING (DCU)
AUXILIARY UNITS	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2200B	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
2300A	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2300B	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2500	POWER PLANT (POW)
POWER UNITS	
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

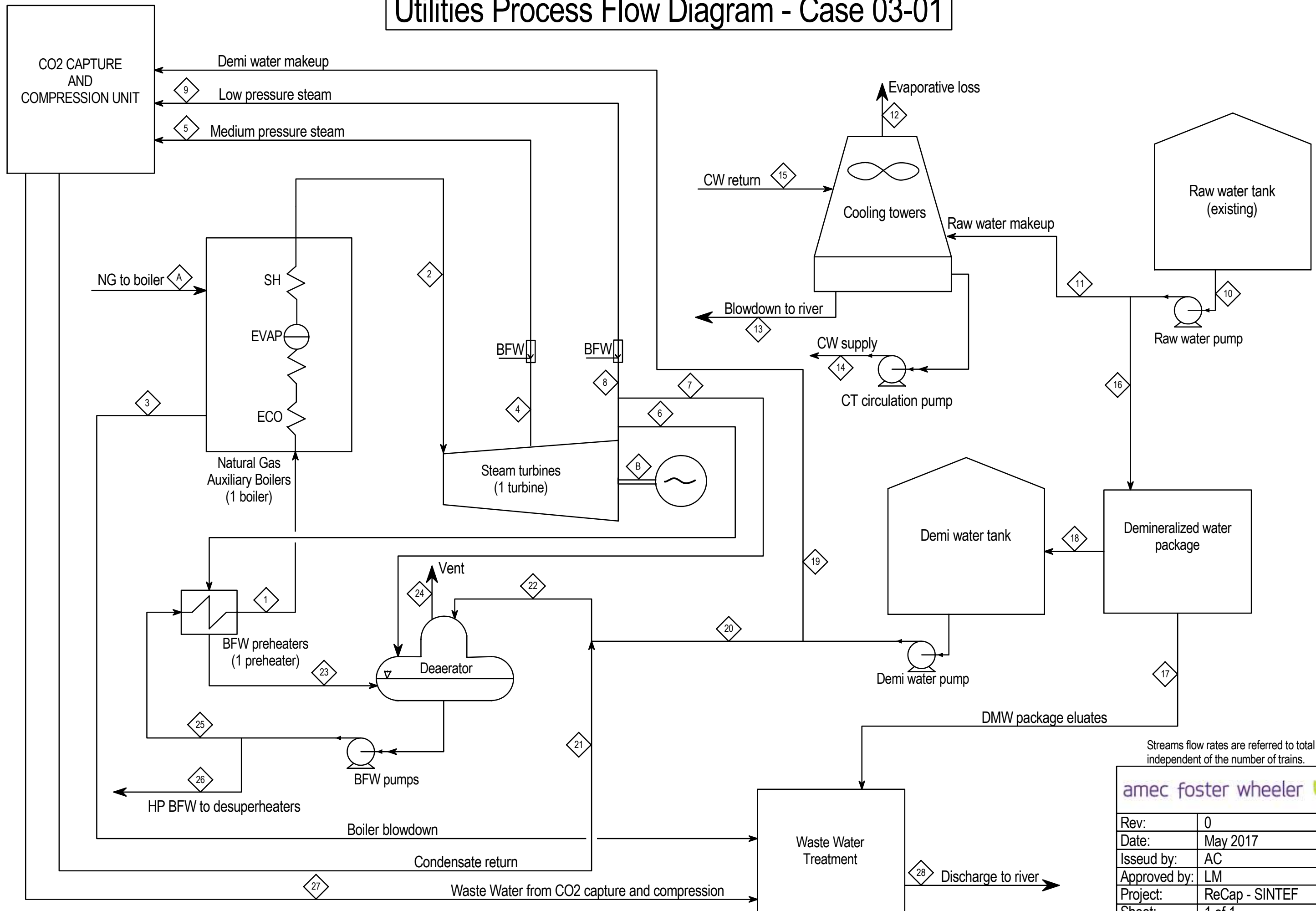
**Post-combustion  
CO2 capture  
Case 03-01**

SCALE : 1 / 2500


COO	9/11/19	FIRST ISSUE		P.Y.	S.T.	M.G.S.
REV.	DATE	DESCRIPTION		BY	CHK	APP.
REVISIONS						
amec foster wheeler				APPROVED FOR CONSTRUCTION		
		DWG. REV.		DATE		
		SIGNATURE				
		ORDER N°				
		SUPPLIER				
		CONTRACT N°		1-BD-0839A		
		CLIENT DWG N°				
		SCALE		1:2500		
		SHEET OF				
		P/N DWG N°		REV.		
		B00839A-0000-01-0031		COO		
		SHEET 1 OF 1				

BASE CASE 3  
HIGH CONVERSION REFINERY  
220,000 BPSD  
GENERAL PLOT PLAN

# Utilities Process Flow Diagram - Case 03-01



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 03-01	DATE			
HEAT & MATERIAL BALANCE	09/05/2017			

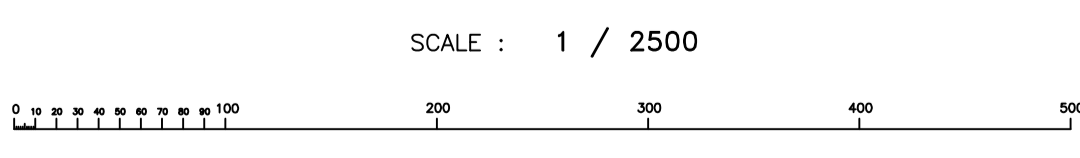
STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	151,863	64.0	162
2	HP SUPERHEATED STEAM FROM BOILER	151,104	45.0	420
3	BOILER BLOWDOWN	759	45.0	257
4	MP STEAM EXTRACTION	8,717	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	8,880	13.0	260
6	LP STEAM TO BFW PREHEATER	16,244	7.0	218
7	LP STEAM TO DEAERATOR	1,756	7.0	218
8	LP STEAM TO EXPORT	124,387	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	126,140	5.5	190
10	RAW WATER FROM TANK	252,798	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	188,499	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	124,013	atm	35
13	COOLING TOWER BLOWDOWN	64,487	atm	30
14	CW SUPPLY	6,944,716	6.0	30
15	CW RETURN	6,944,716	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	64,299	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	6,428	atm	ambient
18	DEMINERALIZED WATER TO TANK	57,871	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	56,812	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,059	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	135,020	9.0	94
22	WATER TO DEAERATOR	136,079	9.0	93
23	CONDENSATE FROM BFW PREHEATER	16,244	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	151,863	65.0	101
26	BFW TO DESUPERHEATERS	1,916	65.0	101
27	WASTE WATER FROM CO2 CAPTURE AND COMPRESSION	41,557	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	48,744	atm	30
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	9,272	kg/h	
B	ELECTRIC POWER OUTPUT	14,940	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains



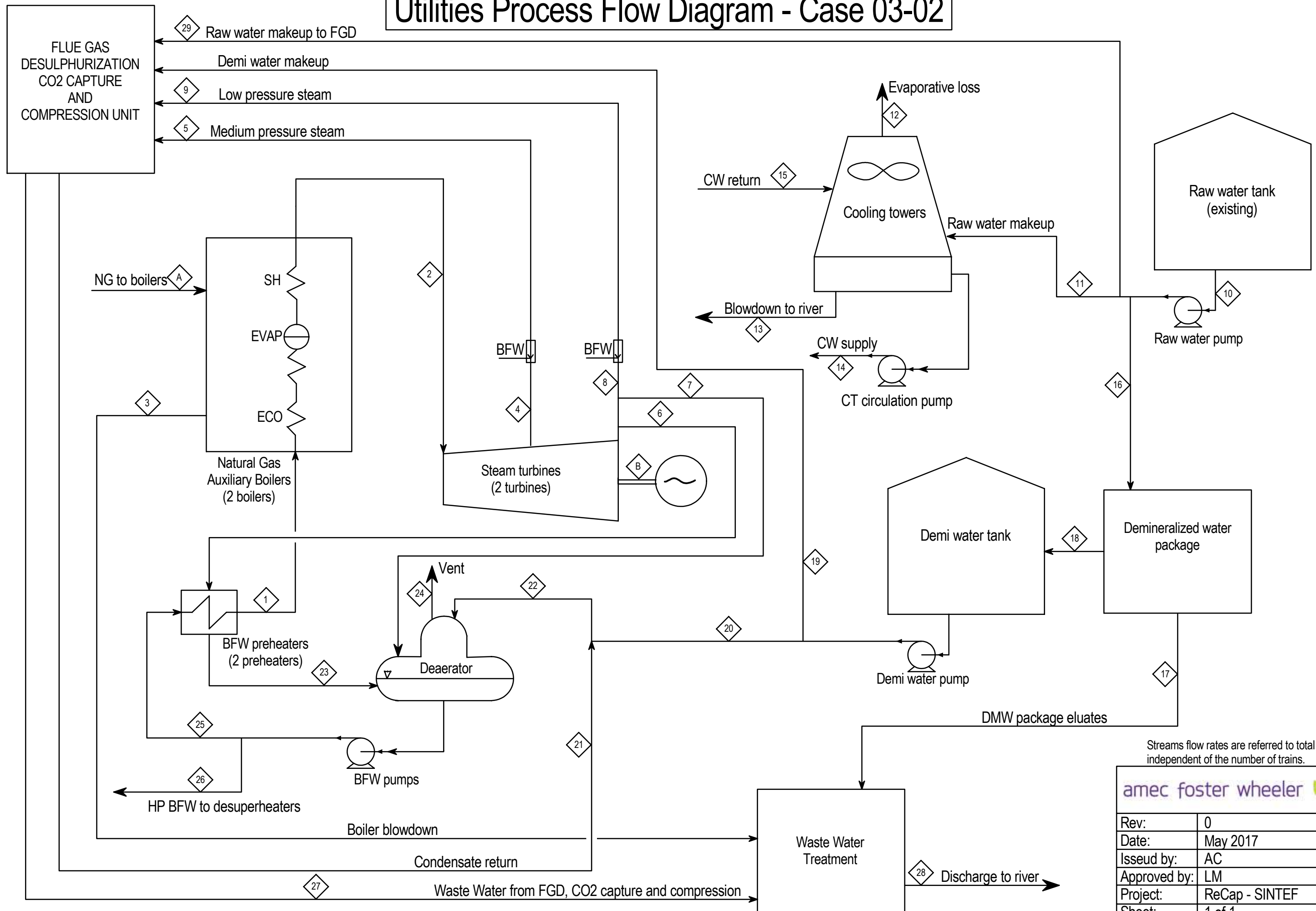
UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
	TAIL GAS TREATMENT
2200B	SULPHUR RECOVERY (SRU)
	TAIL GAS TREATMENT
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
<b>POWER UNITS</b>	
2300A	WASTE WATER TREATMENT (WWT)
	API SEPARATOR
2300B	WASTE WATER TREATMENT (WWT)
	API SEPARATOR
2500	POWER PLANT (POW)
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 03-02**




COO	9/11/19	FIRST ISSUE		P.Y.	S.T.	M.G.S.
REV.	DATE	DESCRIPTION		BY	CHK	APP.
REVISIONS						
amec foster wheeler			APPROVED FOR CONSTRUCTION			
			DWG. REV.	DATE		
			SIGNATURE			
			ORDER N°			
			SUPPLIER			
			CONTRACT N°	1-BD-0839A		
			CLIENT DWG N°			
			SHEET	OF	SCALE	
			PIN DWG N°			1:2500
			SHEET 1	OF 1	REV.	COO
			BASE CASE 3 HIGH CONVERSION REFINERY 220,000 BPSD GENERAL PLOT PLAN			

# Utilities Process Flow Diagram - Case 03-02



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 03-02	DATE			
HEAT & MATERIAL BALANCE	09/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	249,764	64.0	162
2	HP SUPERHEATED STEAM FROM BOILERS	248,516	45.0	420
3	BOILERS BLOWDOWN	1,249	45.0	257
4	MP STEAM EXTRACTION	14,538	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	14,810	13.0	260
6	LP STEAM TO BFW PREHEATERS	26,716	7.0	218
7	LP STEAM TO DEAERATOR	2,683	7.0	218
8	LP STEAM TO EXPORT	204,578	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	207,460	5.5	190
10	RAW WATER FROM TANK	432,333	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	303,316	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	199,550	atm	35
13	COOLING TOWER BLOWDOWN	103,766	atm	30
14	CW SUPPLY	11,174,808	6.0	30
15	CW RETURN	11,174,808	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	105,291	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	10,526	atm	ambient
18	DEMINERALIZED WATER TO TANK	94,765	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	93,216	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,549	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	222,270	9.0	94
22	WATER TO DEAERATOR	223,819	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	26,716	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	249,764	65.0	101
26	BFW TO DESUPERHEATERS	3,155	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	71,539	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	83,314	atm	30
29	RAW WATER MAKEUP TO FGD	23,726	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	15,249	kg/h	
B	ELECTRIC POWER OUTPUT	24,570	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
1200	STEAM REFORMING (SMR)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200A	SULPHUR RECOVERY (SRU)
	TAIL GAS TREATMENT
2200B	SULPHUR RECOVERY (SRU)
	TAIL GAS TREATMENT
2250A	SULPHUR LOADING
2250B	SULPHUR LOADING
<b>POWER UNITS</b>	
2300A	WASTE WATER TREATMENT (WWT)
	API SEPARATOR
2300B	WASTE WATER TREATMENT (WWT)
	API SEPARATOR
2500	POWER PLANT (POW)
3000A	UTILITY UNITS
3000B	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 03-03**

SCALE : 1 / 2500

NO.	DATE	DESCRIPTION	BY	CHK	APP.
COO	9/11/19	FIRST ISSUE			
REV.					

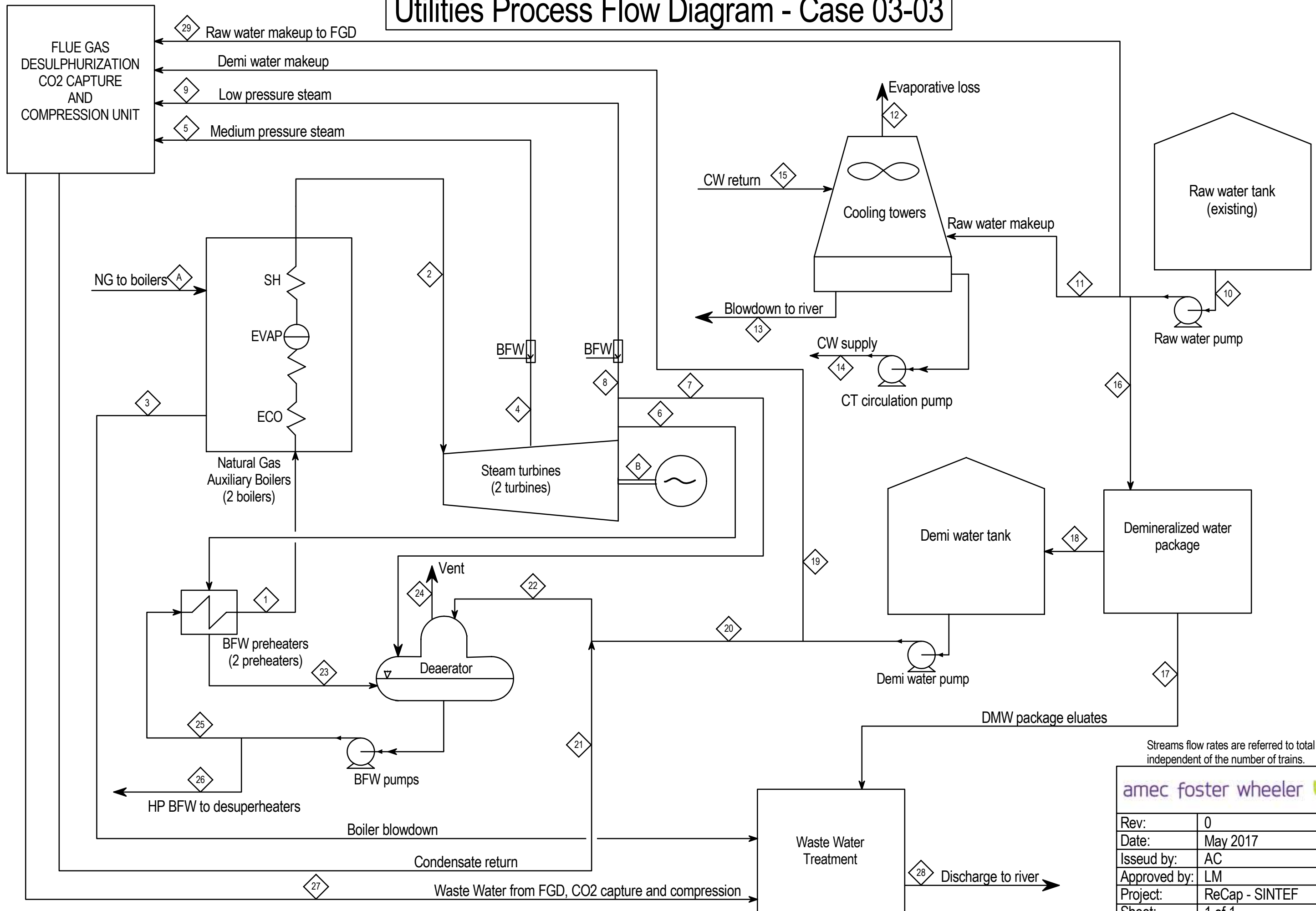
  

amec foster wheeler		APPROVED FOR CONSTRUCTION	
DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT ORG N°		SCALE	
SHEET	OF	1:2500	
PIN DWG N°		REV.	
B00839A-0000-01-0031		COO	
SHEET 1	OF 1		

**BASE CASE 3  
HIGH CONVERSION REFINERY  
220,000 BPSD  
GENERAL PLOT PLAN**



# Utilities Process Flow Diagram - Case 03-03



Streams flow rates are referred to total figures, independent of the number of trains.

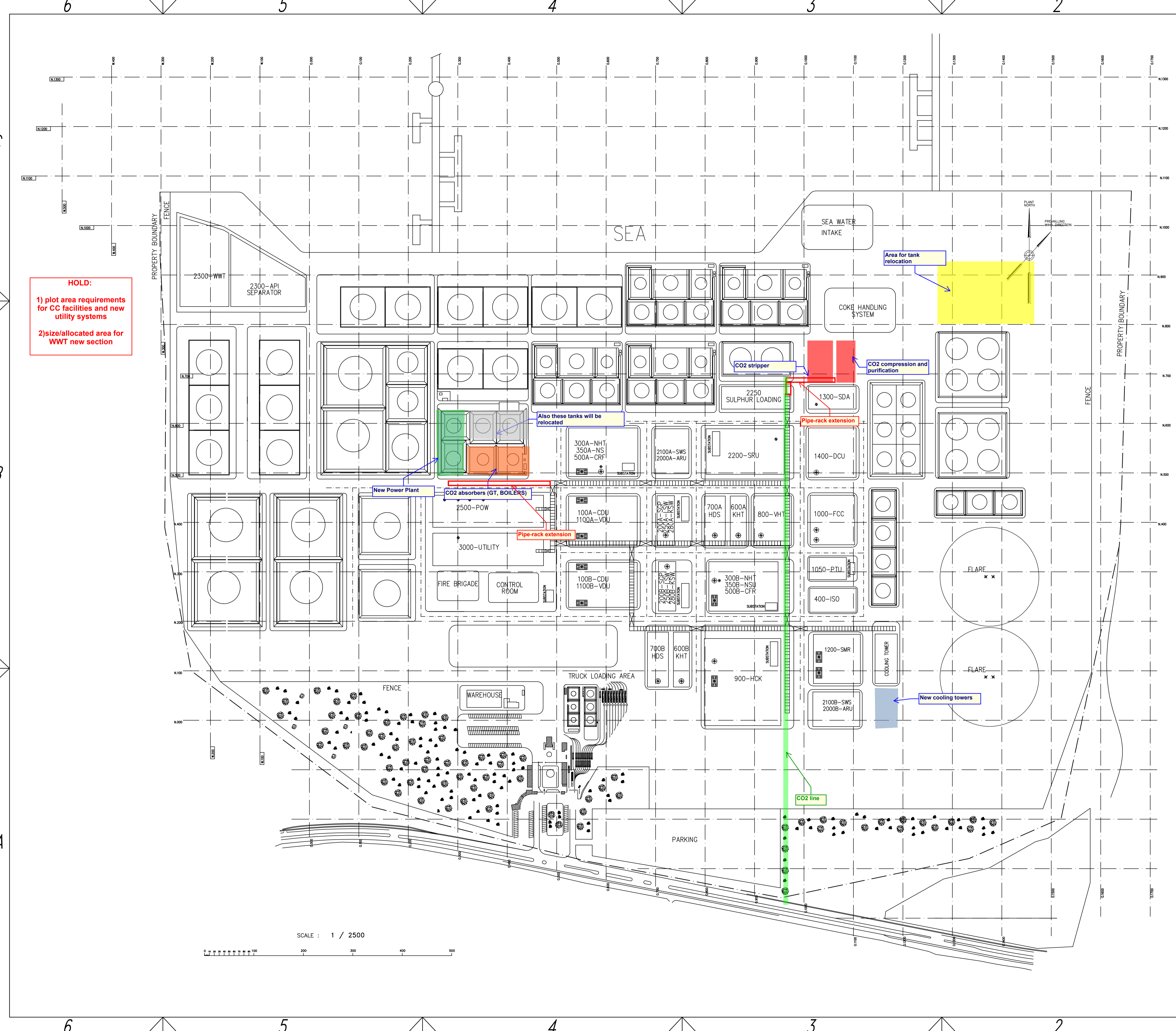
amec foster wheeler 	
Rev:	0
Date:	May 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 03-03	DATE			
HEAT & MATERIAL BALANCE	09/05/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	414,710	64.1	162
2	HP SUPERHEATED STEAM FROM BOILERS	412,636	44.3	420
3	BOILERS BLOWDOWN	2,074	44.3	257
4	MP STEAM EXTRACTION	24,299	15.0	294
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	24,790	13.0	260
6	LP STEAM TO BFW PREHEATERS	44,464	7.0	220
7	LP STEAM TO DEAERATOR	4,250	7.0	220
8	LP STEAM TO EXPORT	339,623	7.0	220
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	345,180	5.5	190
10	RAW WATER FROM TANK	722,217	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	503,491	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	331,244	atm	35
13	COOLING TOWER BLOWDOWN	172,247	atm	30
14	CW SUPPLY	18,549,676	6.0	30
15	CW RETURN	18,549,676	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	175,005	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	17,495	atm	ambient
18	DEMINERALIZED WATER TO TANK	157,510	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	155,136	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	2,374	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	369,970	9.0	94
22	WATER TO DEAERATOR	372,344	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	44,464	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	414,710	65.0	101
26	BFW TO DESUPERHEATERS	6,048	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	110,089	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	129,658	atm	30
29	RAW WATER MAKEUP TO FGD	43,721	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	25,317	kg/h	
B	ELECTRIC POWER OUTPUT	40,300	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains

## **B.4 CO<sub>2</sub> capture from base case 4**



**HOLD:**  
 1) plot area requirements for CC facilities and new utility systems  
 2) size/allocated area for WWT new section

UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
900	VACUUM GASOIL HYDROCRACKING (HCK)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
1200	STEAM REFORMING (SMR)
1300	SOLVENT DEASPHALTING (SDA)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2250	SULPHUR LOADING
<b>POWER UNITS</b>	
2300	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2500	POWER PLANT (POW)
<b>OFF SITES UNITS</b>	
3000	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
 CO2 capture  
 Case 04-01**

SCALE : 1 / 2500



COO	REV	DATE	FIRST ISSUE	DESCRIPTION	P.Y.	S.T.	M.G.S.

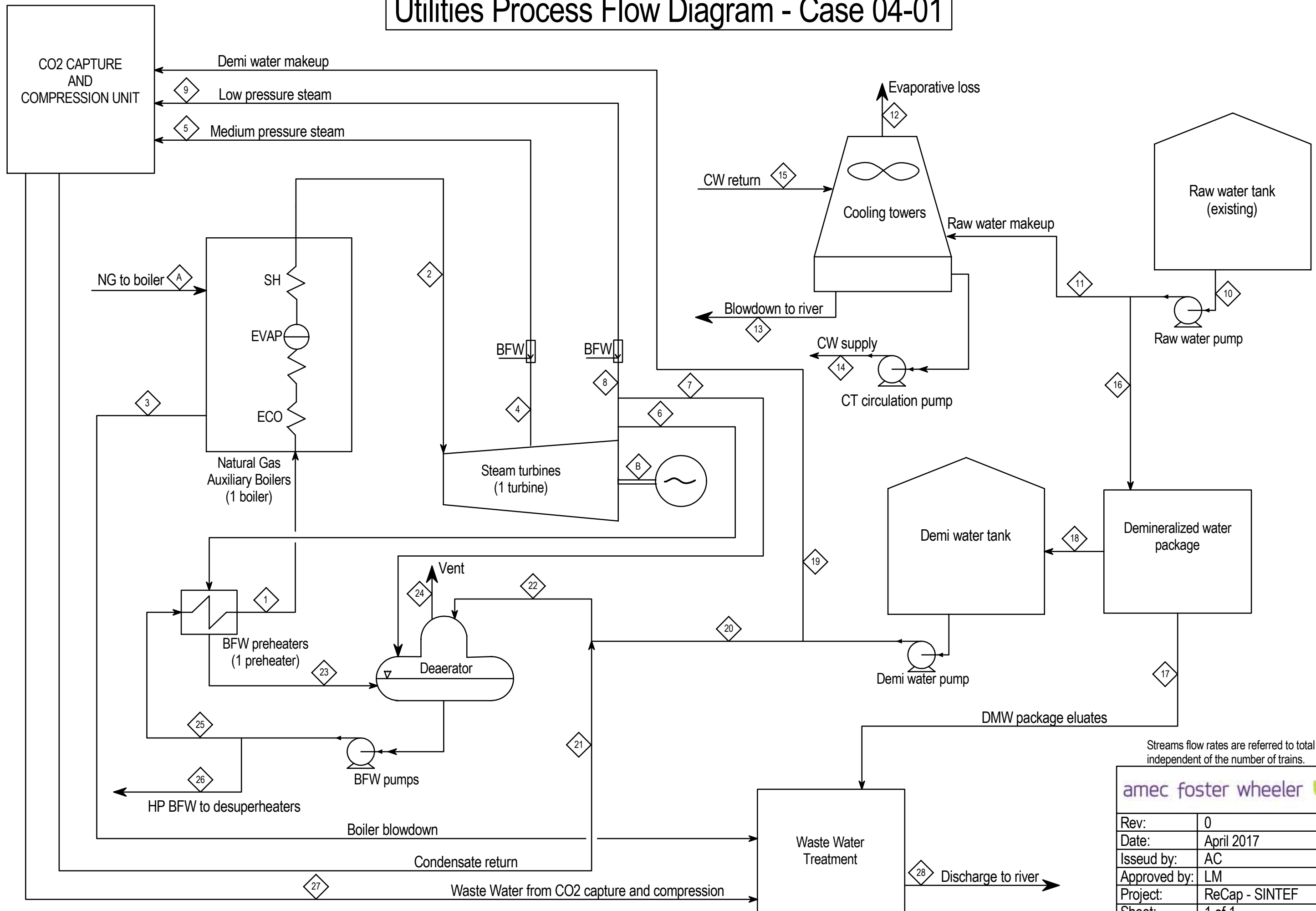
REVISONS	


amec foster wheeler		APPROVED FOR CONSTRUCTION	
DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°		SCALE	
SHEET	OF	1:2500	
PIN DWG N°		REV.	
BOOKS-0000-01-0041		COO	
SHEET 1	OF 1		

BASE CASE 4  
 HIGH CONVERSION REFINERY  
 350,000 BPSD  
 GENERAL PLOT PLAN

# Utilities Process Flow Diagram - Case 04-01



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	April 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 04-01	DATE			
HEAT & MATERIAL BALANCE	26/04/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILER	190,913	64.0	162
2	HP SUPERHEATED STEAM FROM BOILER	189,958	45.0	420
3	BOILER BLOWDOWN	955	45.0	257
4	MP STEAM EXTRACTION	10,680	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	10,880	13.0	260
6	LP STEAM TO BFW PREHEATER	20,421	7.0	218
7	LP STEAM TO DEAERATOR	2,126	7.0	218
8	LP STEAM TO EXPORT	156,731	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	158,940	5.5	190
10	RAW WATER FROM TANK	282,607	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	202,962	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	133,527	atm	35
13	COOLING TOWER BLOWDOWN	69,434	atm	30
14	CW SUPPLY	7,477,533	6.0	30
15	CW RETURN	7,477,533	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	79,645	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	7,962	atm	ambient
18	DEMINERALIZED WATER TO TANK	71,683	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	70,428	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,255	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	169,820	9.0	94
22	WATER TO DEAERATOR	171,075	9.0	93
23	CONDENSATE FROM BFW PREHEATER	20,421	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILER	190,913	65.0	101
26	BFW TO DESUPERHEATERS	2,409	65.0	101
27	WASTE WATER FROM CO2 CAPTURE AND COMPRESSION	27,669	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	36,586	atm	30
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILER	11,656	kg/h	
B	ELECTRIC POWER OUTPUT	18,800	kW	

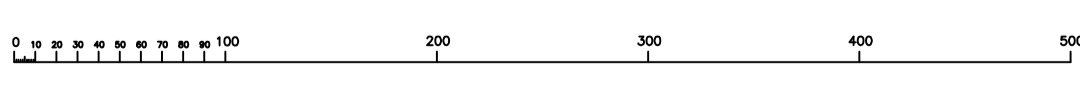
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
900	VACUUM GASOIL HYDROCRACKING (HCK)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
1200	STEAM REFORMING (SMR)
1300	SOLVENT DEASPHALTING (SDA)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2250	SULPHUR LOADING
<b>POWER UNITS</b>	
2300	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 04-02**

SCALE : 1 / 2500



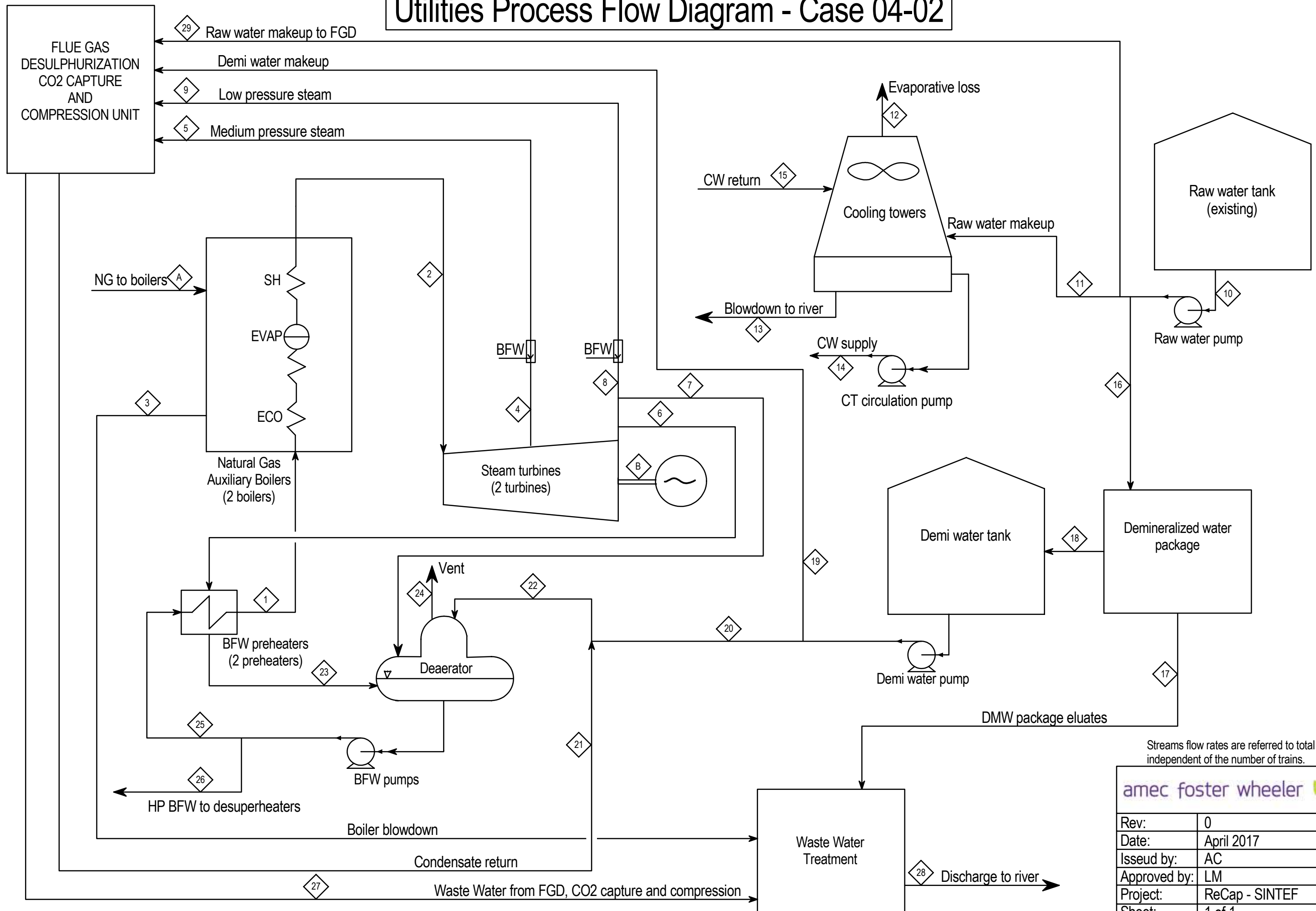
REV.	DATE	DESCRIPTION	BY	CHK	APP.	P.Y.	S.T.	M.G.S.
COO	9/11/19	FIRST ISSUE						
REV.		DESCRIPTION						


amec foster wheeler		APPROVED FOR CONSTRUCTION	
DWG. REV.	DATE	SIGNATURE	
ORDER N°			
SUPPLIER			
CONTRACT N°	1-BD-0839A		
CLIENT DWG N°	SCALE		
SHEET OF	1:2500		
PIN DWG N°	REV.		
BD0839A-0000-01-0041	COO		
SHEET 1 OF 1			

**BASE CASE 4  
HIGH CONVERSION REFINERY  
350,000 BPSD  
GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 04-02



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	April 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1



CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 04-02	DATE			
HEAT & MATERIAL BALANCE	26/04/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	374,626	64.0	162
2	HP SUPERHEATED STEAM FROM BOILERS	372,753	45.0	420
3	BOILERS BLOWDOWN	1,873	45.0	257
4	MP STEAM EXTRACTION	21,458	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	21,860	13.0	260
6	LP STEAM TO BFW PREHEATERS	40,072	7.0	218
7	LP STEAM TO DEAERATORS	3,864	7.0	218
8	LP STEAM TO EXPORT	307,359	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	311,690	5.5	190
10	RAW WATER FROM TANK	611,222	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	418,779	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	275,512	atm	35
13	COOLING TOWER BLOWDOWN	143,266	atm	30
14	CW SUPPLY	15,428,686	6.0	30
15	CW RETURN	15,428,686	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	158,527	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	15,848	atm	ambient
18	DEMINERALIZED WATER TO TANK	142,679	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	140,516	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	2,163	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	333,560	9.0	94
22	WATER TO DEAERATORS	335,723	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	40,072	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	374,626	65.0	101
26	BFW TO DESUPERHEATERS	4,733	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	78,069	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	95,790	atm	30
29	RAW WATER MAKEUP TO FGD	33,916	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	22,872	kg/h	
B	ELECTRIC POWER OUTPUT	36,870	kW	

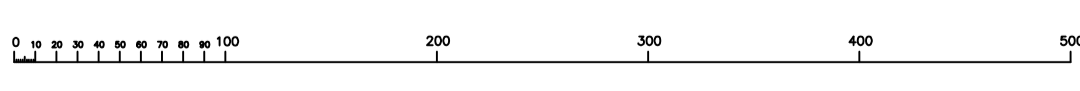
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
900	VACUUM GASOIL HYDROCRACKING (HCK)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
1200	STEAM REFORMING (SMR)
1300	SOLVENT DEASPHALTING (SDA)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
TAIL GAS TREATMENT	
2250	SULPHUR LOADING
<b>POWER UNITS</b>	
2300	WASTE WATER TREATMENT (WWT)
API SEPARATOR	
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 04-03**

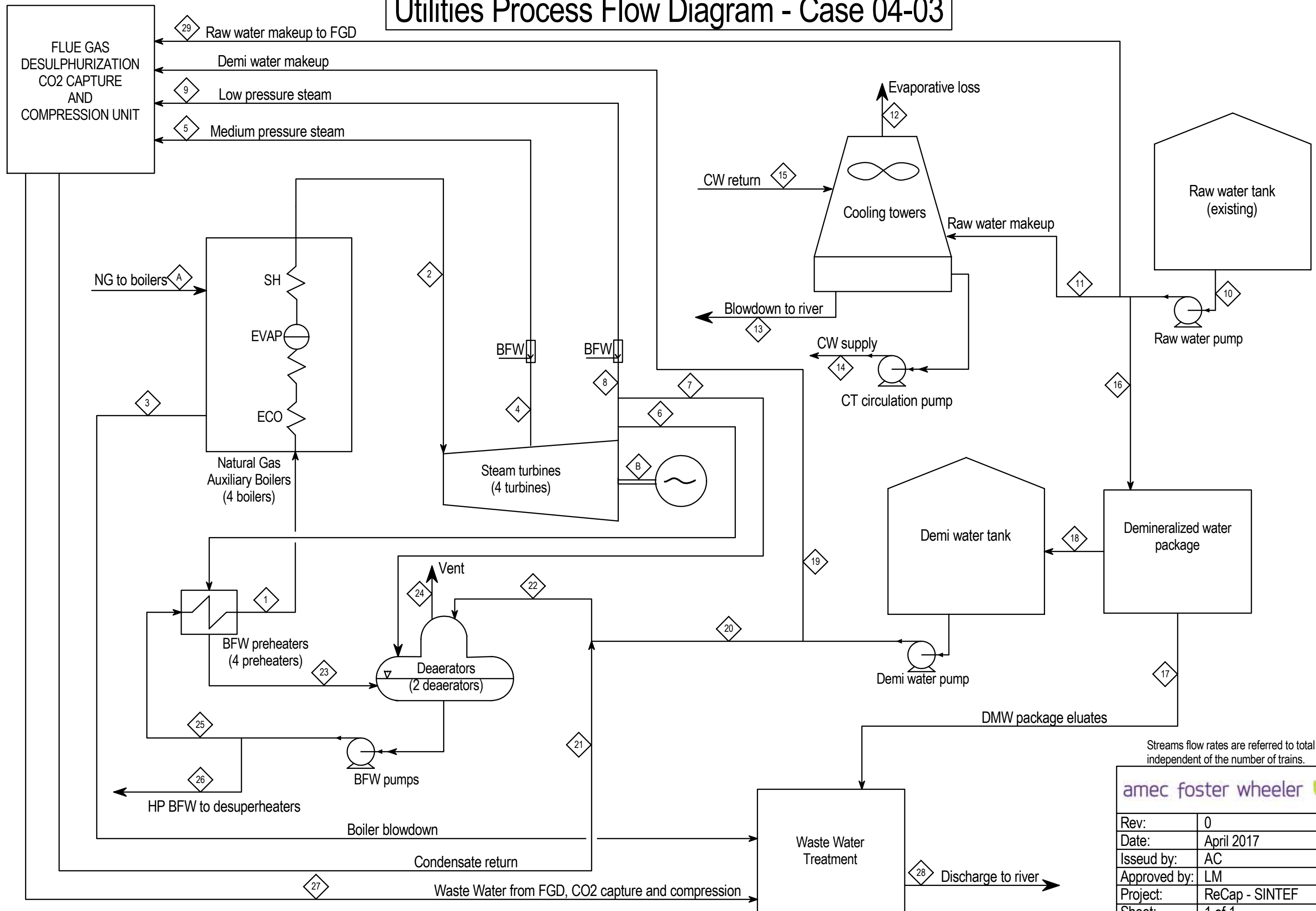
SCALE : 1 / 2500




COO	9/11/19	FIRST ISSUE		P.Y.	S.T.	M.G.S.
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REVISIONS						
amec foster wheeler			APPROVED FOR CONSTRUCTION			
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			SIGNATURE			
			ORDER N°			
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			CLIENT DWG N°			
			SHEET	OF	SCALE	
			PIN DWG N°			1:2500
			SHEET 1	OF 1	REV.	COO
					REV.	COO

BASE CASE 4  
HIGH CONVERSION REFINERY  
350,000 BPSD  
GENERAL PLOT PLAN

# Utilities Process Flow Diagram - Case 04-03



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	April 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 04-03	DATE			
HEAT & MATERIAL BALANCE	26/04/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	683,374	64.2	163
2	HP SUPERHEATED STEAM FROM BOILERS	679,954	43.0	420
3	BOILERS BLOWDOWN	3,417	43.0	255
4	MP STEAM EXTRACTION	40,020	15.0	298
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	40,950	13.0	260
6	LP STEAM TO BFW PREHEATERS	73,591	7.0	226
7	LP STEAM TO DEAERATORS	6,814	7.0	226
8	LP STEAM TO EXPORT	559,532	7.0	226
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	571,330	5.5	190
10	RAW WATER FROM TANK	1,107,513	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	764,359	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	502,868	atm	35
13	COOLING TOWER BLOWDOWN	261,491	atm	30
14	CW SUPPLY	28,160,608	6.0	30
15	CW RETURN	28,160,608	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	285,258	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	28,517	atm	ambient
18	DEMINERALIZED WATER TO TANK	256,741	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	253,024	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	3,717	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	612,280	9.0	94
22	WATER TO DEAERATORS	615,997	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	73,591	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	683,374	65.0	101
26	BFW TO DESUPERHEATERS	12,728	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	144,964	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	176,898	atm	30
29	RAW WATER MAKEUP TO FGD	57,896	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	41,713	kg/h	
B	ELECTRIC POWER OUTPUT	64,720	kW	

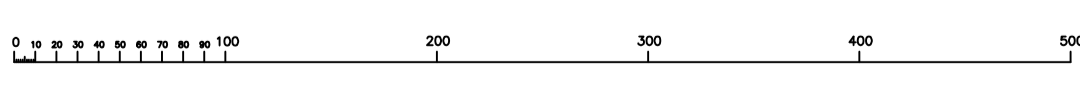
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
900	VACUUM GASOIL HYDROCRACKING (HCK)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
1200	STEAM REFORMING (SMR)
1300	SOLVENT DEASPHALTING (SDA)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
2250	TAIL GAS TREATMENT
2250	SULPHUR LOADING
<b>POWER UNITS</b>	
2300	WASTE WATER TREATMENT (WWT)
2300	API SEPARATOR
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 04-04**

SCALE : 1 / 2500



COO	REV.	DATE	FIRST ISSUE	DESCRIPTION	P.Y.	S.T.	M.G.S.

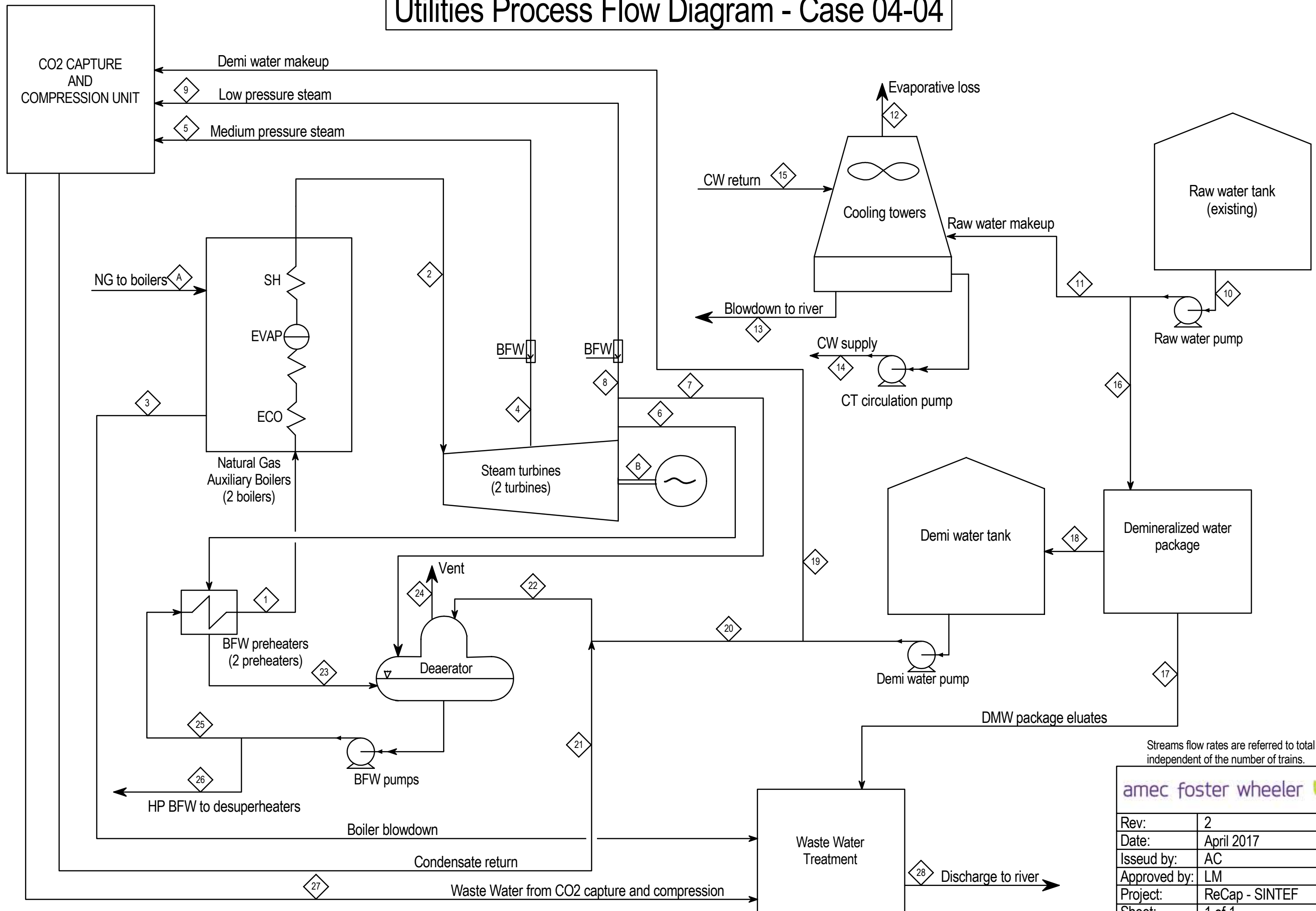
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ORDER N°			
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CONTRACT N°	1-BD-0839A		
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**BASE CASE 4  
HIGH CONVERSION REFINERY  
350,000 BPSD  
GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 04-04



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	2
Date:	April 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	2	AC	LM	LM
Case 04-04	DATE			
HEAT & MATERIAL BALANCE	26/04/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	210,375	64.3	164
2	HP SUPERHEATED STEAM FROM BOILERS	209,322	39.3	420
3	BOILERS BLOWDOWN	1,052	39.3	249
4	MP STEAM EXTRACTION	12,671	15.0	308
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	13,080	13.0	260
6	LP STEAM TO BFW PREHEATERS	22,927	7.0	241
7	LP STEAM TO DEAERATORS	2,327	7.0	241
8	LP STEAM TO EXPORT	171,398	7.0	241
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	177,430	5.5	190
10	RAW WATER FROM TANK	310,728	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	223,507	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	147,044	atm	35
13	COOLING TOWER BLOWDOWN	76,463	atm	30
14	CW SUPPLY	8,234,487	6.0	30
15	CW RETURN	8,234,487	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	87,221	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	8,719	atm	ambient
18	DEMINERALIZED WATER TO TANK	78,502	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	77,150	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	1,352	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	190,510	9.0	94
22	WATER TO DEAERATORS	191,862	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	22,927	6.6	105
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	210,375	65.0	101
26	BFW TO DESUPERHEATERS	6,441	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	35,334	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	45,106	atm	30
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	12,834	kg/h	
B	ELECTRIC POWER OUTPUT	18,330	kW	

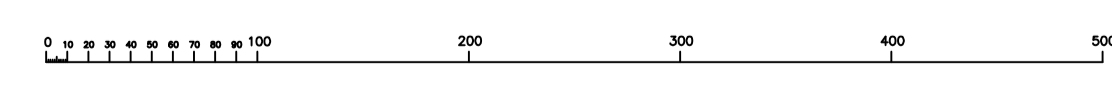
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
900	VACUUM GASOIL HYDROCRACKING (HCK)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
1200	STEAM REFORMING (SMR)
1300	SOLVENT DEASPHALTING (SDA)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
2250	TAIL GAS TREATMENT
2250	SULPHUR LOADING
2300	WASTE WATER TREATMENT (WWT)
2300	API SEPARATOR
<b>POWER UNITS</b>	
2500	POWER PLANT (POW)
3000	UTILITY UNITS
4000	OFF SITES UNITS

Post-combustion  
 CO2 capture  
 Case 04-05

SCALE : 1 / 2500



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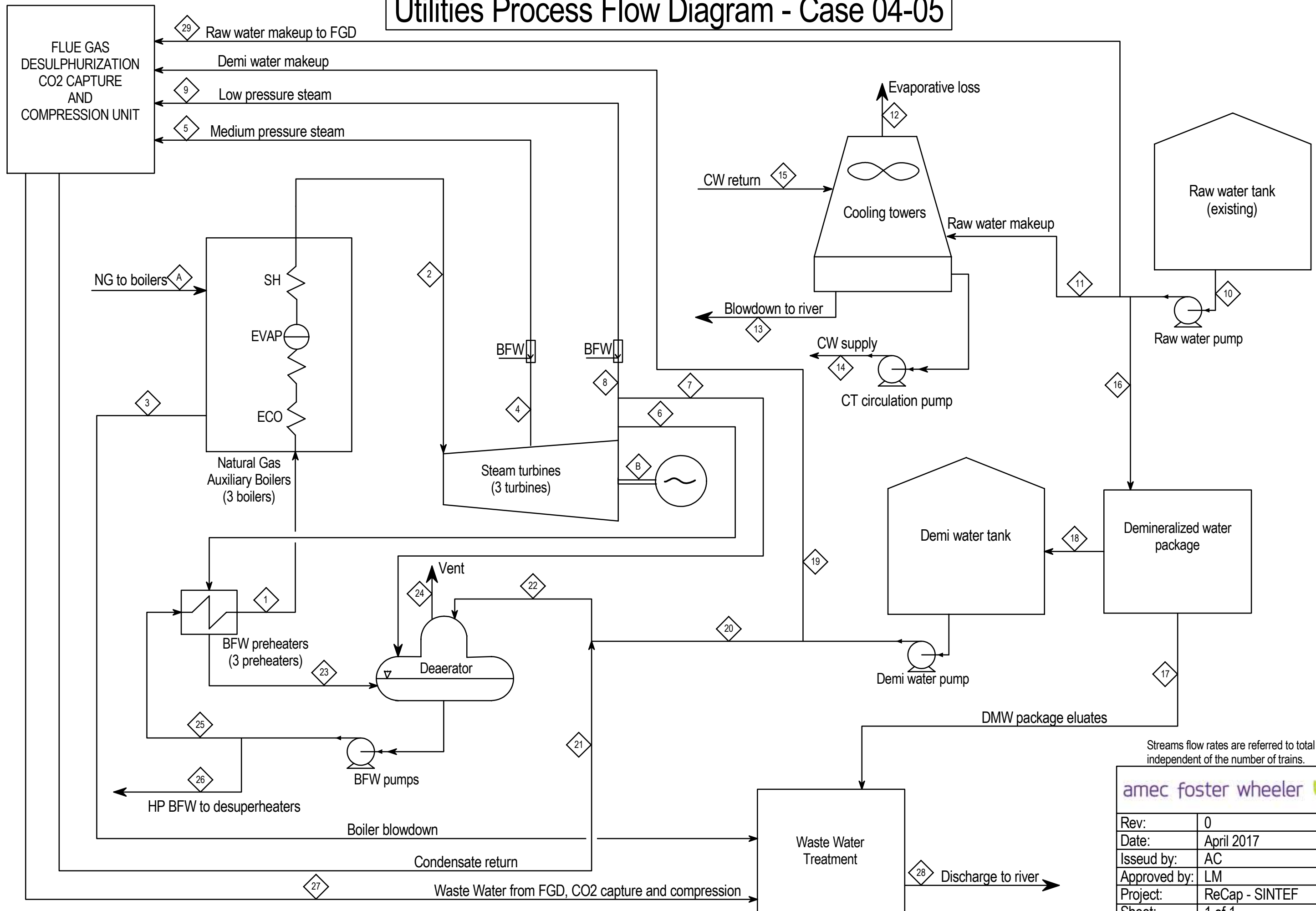
  

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CONTRACT N°	1-BD-0839A		
CLIENT DWG N°	SCALE		
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BASE CASE 4  
 HIGH CONVERSION REFINERY  
 350,000 BPSD  
 GENERAL PLOT PLAN



# Utilities Process Flow Diagram - Case 04-05



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	April 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 04-05	DATE			
HEAT & MATERIAL BALANCE	26/04/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	585,611	64.2	163
2	HP SUPERHEATED STEAM FROM BOILERS	582,683	42.7	420
3	BOILERS BLOWDOWN	2,928	42.7	254
4	MP STEAM EXTRACTION	34,210	15.0	299
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	35,030	13.0	260
6	LP STEAM TO BFW PREHEATERS	63,130	7.0	227
7	LP STEAM TO DEAERATORS	5,888	7.0	227
8	LP STEAM TO EXPORT	479,456	7.0	227
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	490,110	5.5	190
10	RAW WATER FROM TANK	926,571	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	648,568	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	426,690	atm	35
13	COOLING TOWER BLOWDOWN	221,879	atm	30
14	CW SUPPLY	23,894,623	6.0	30
15	CW RETURN	23,894,623	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	244,086	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	24,401	atm	ambient
18	DEMINERALIZED WATER TO TANK	219,685	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	216,457	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	3,228	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	525,140	9.0	94
22	WATER TO DEAERATORS	528,368	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	63,130	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	585,611	65.0	101
26	BFW TO DESUPERHEATERS	11,474	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	116,325	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	143,654	atm	30
29	RAW WATER MAKEUP TO FGD	33,916	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	35,744	kg/h	
B	ELECTRIC POWER OUTPUT	55,110	kW	

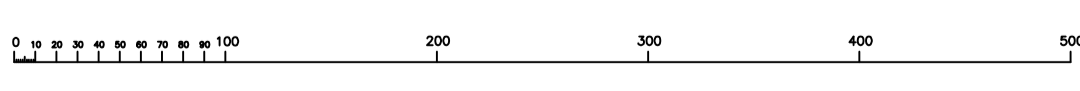
Note: Streams flow rates are referred to total figures, independent of the number of trains



UNIT LIST	
UNIT	DESCRIPTION
<b>PROCESS UNITS</b>	
100A	CRUDE DISTILLATION (CDU)
1100A	VACUUM DISTILLATION (VDU)
100B	CRUDE DISTILLATION (CDU)
1100B	VACUUM DISTILLATION (VDU)
200A	SATURATED GAS PLANT (SGP)
250A	LPG SWEETENING (LSW)
200B	SATURATED GAS PLANT (SGP)
250B	LPG SWEETENING (LSW)
280A	KERO SWEETENING (KSW)
280B	KERO SWEETENING (KSW)
300A	NAPHTHA HYDROTREATER (NHT)
300B	NAPHTHA HYDROTREATER (NHT)
350A	NAPHTHA SPLITTER (NSU)
400	ISOMERIZATION (ISO)
350B	NAPHTHA SPLITTER (NSU)
500A	CATALYTIC REFORMING (CRF)
500B	CATALYTIC REFORMING (CRF)
600A	KERO HDS (KHT)
600B	KERO HDS (KHT)
700A	GASOIL HDS (HDS)
700B	GASOIL HDS (HDS)
800	VACUUM GASOIL HYDROTREATER (VHT)
900	VACUUM GASOIL HYDROCRACKING (HCK)
1000	FLUID CATALYTIC CRACKING (FCC)
1050	FCC GASOLINE POST-TREATMENT UNIT (PTU)
1200	STEAM REFORMING (SMR)
1300	SOLVENT DEASPHALTING (SDA)
1400	DELAYED COKING (DCU)
<b>AUXILIARY UNITS</b>	
2000A	AMINE WASHING AND REGENERATION (ARU)
2000B	AMINE WASHING AND REGENERATION (ARU)
2100A	SOUR WATER STRIPPER (SWS)
2100B	SOUR WATER STRIPPER (SWS)
2200	SULPHUR RECOVERY (SRU)
2250	TAIL GAS TREATMENT
2250	SULPHUR LOADING
<b>POWER UNITS</b>	
2300	WASTE WATER TREATMENT (WWT)
2300	API SEPARATOR
2500	POWER PLANT (POW)
<b>OFF SITES UNITS</b>	
3000	UTILITY UNITS
4000	OFF SITES UNITS

**Post-combustion  
CO2 capture  
Case 04-06**

SCALE : 1 / 2500



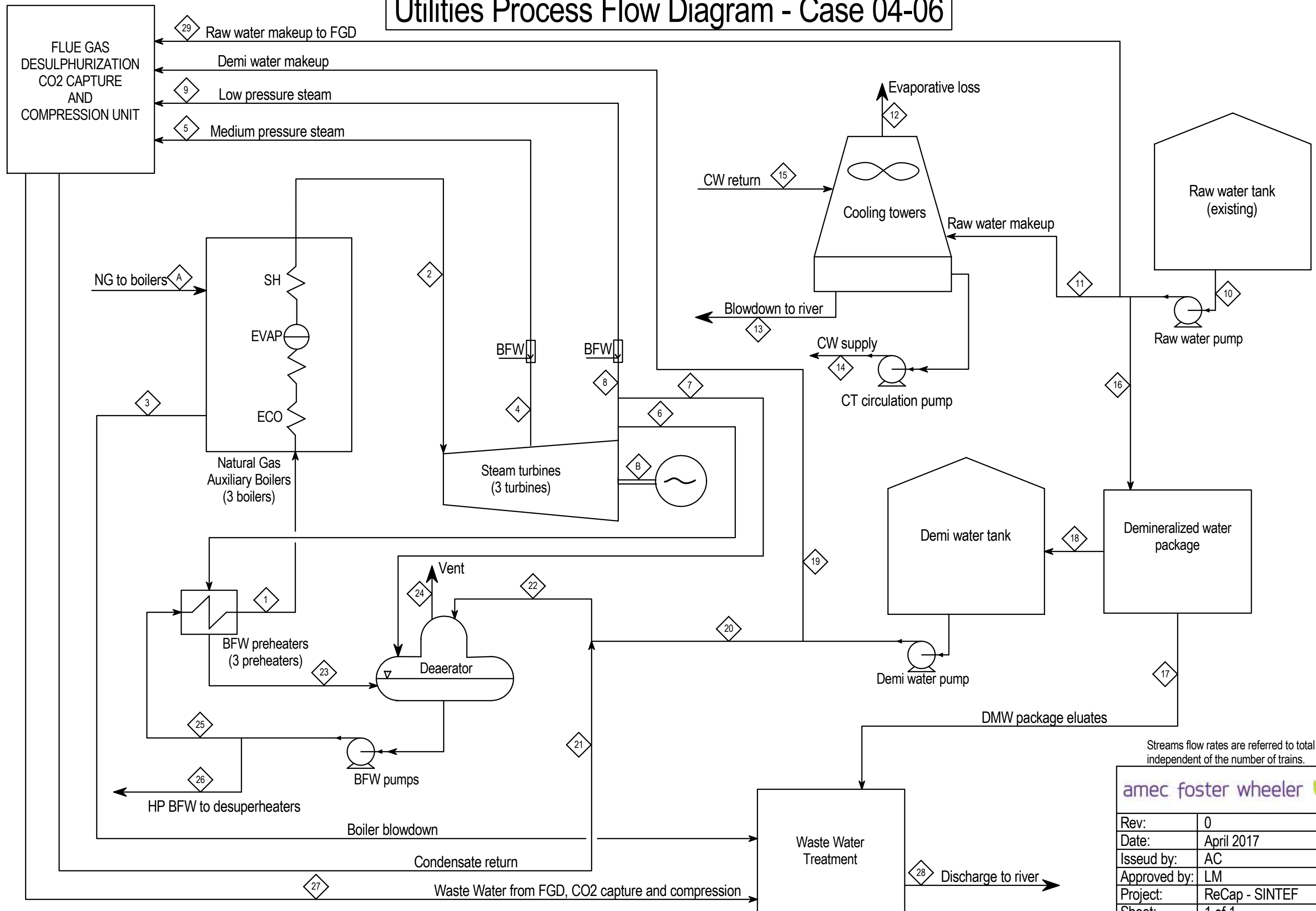
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ORDER N°			
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CONTRACT N°	1-BD-0839A		
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**BASE CASE 4  
HIGH CONVERSION REFINERY  
350,000 BPSD  
GENERAL PLOT PLAN**

# Utilities Process Flow Diagram - Case 04-06



Streams flow rates are referred to total figures, independent of the number of trains.

amec foster wheeler 	
Rev:	0
Date:	April 2017
Issued by:	AC
Approved by:	LM
Project:	ReCap - SINTEF
Sheet:	1 of 1

CLIENT: SINTEF	REV	BY	CHKD	APP
PROJECT: ReCap	0	AC	LM	LM
Case 04-06	DATE			
HEAT & MATERIAL BALANCE	26/04/2017			

STREAM n°	Description	Flow [kg/h]	Pressure [bara]	Temperature [°C]
<b>STEAM CYCLE STREAMS</b>				
1	HOT BFW TO BOILERS	472,450	64.0	162
2	HP SUPERHEATED STEAM FROM BOILERS	470,090	45.0	420
3	BOILERS BLOWDOWN	2,362	45.0	257
4	MP STEAM EXTRACTION	27,289	15.0	293
5	MP STEAM TO CO2 CAPTURE AND COMPRESSION	27,800	13.0	260
6	LP STEAM TO BFW PREHEATERS	50,536	7.0	218
7	LP STEAM TO DEAERATORS	4,792	7.0	218
8	LP STEAM TO EXPORT	387,471	7.0	218
9	LP STEAM TO CO2 CAPTURE AND COMPRESSION	392,930	5.5	190
10	RAW WATER FROM TANK	792,565	atm	ambient
11	RAW WATER MAKEUP TO COOLING TOWERS	533,909	6.5	ambient
12	COOLING TOWER EVAPORATION LOSS	351,256	atm	35
13	COOLING TOWER BLOWDOWN	182,653	atm	30
14	CW SUPPLY	19,670,326	6.0	30
15	CW RETURN	19,670,326	atm	40
16	RAW WATER TO DEMINERALIZED WATER PACKAGE	200,760	6.5	ambient
17	DEMINERALIZED WATER PACKAGE ELUATES	20,070	atm	ambient
18	DEMINERALIZED WATER TO TANK	180,690	atm	ambient
19	DEMI WATER MAKE UP TO CO2 CAPTURE AND COMPRESSION	178,028	9.0	ambient
20	DEMI WATER MAKE UP TO STEAM CYCLE	2,662	9.0	ambient
21	CONDENSATE RETURN FROM CO2 CAPTURE AND COMPRESSION	420,730	9.0	94
22	WATER TO DEAERATORS	423,392	9.0	93
23	CONDENSATE FROM BFW PREHEATERS	50,536	6.5	106
24	DEAERATOR VENT	300	1.0	101
25	COLD BFW TO BOILERS	472,450	65.0	101
26	BFW TO DESUPERHEATERS	5,970	65.0	101
27	WASTE WATER FROM FGD, CO2 CAPTURE AND COMPRESSION	107,764	3.0	35
28	WASTE WATER TREATMENT DISCHARGE	130,196	atm	30
29	RAW WATER MAKEUP TO FGD	57,896	6.5	ambient
<b>OTHER STREAMS</b>				
A	NATURAL GAS TO BOILERS	28,845	kg/h	
B	ELECTRIC POWER OUTPUT	46,480	kW	

Note: Streams flow rates are referred to total figures, independent of the number of trains