G EQUIPMENT SPECIFICATION (DATA) SHEETS

All of the following worksheets and specification sheets are available in the online material at http://books.elsevier.com/companions.

1. Design basis data sheet
2. Calculation sheet
3. Problem table algorithm sheet
4. Pump and line calculation sheet
5. Cost of production calculation sheet
6. Economic analysis calculation sheet
7. Failure mode effect analysis sheet
8. Fixed bed reactor data sheet
9. Fluid phase splitter data sheet
10. Fired heater data sheet
11. Shell and tube heat exchanger data sheet
12. Vapor-liquid contacting column data sheet
13. Effluent summary data sheet

Company Name
Address

Project Name
Project Number Sheet 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

DESIGN BASIS

Form XXXXX-YY-ZZ

1 General Information

Owners Name		
Process Unit Name		
Plant Location		
Correspondance Contacts Address Telephone / Fax E-mail		

2 Measurement System

(●) English ( ) Metric

3 Equipment Numbering System

Equipment will be identified by alphabetic prefix as defined here, followed by three-digit serial number unless otherwise indicated

First digit - process section
Second & third digits - equipment count

AC	Air cooler	G	Grinder, mill	PRV	Pressure relief valve
B	Boiler	H	Heater (fired or electric)	R	Reactor
C	Compressor, blower, fan	J	Ejector, jet, turboexpander	SP	Sample point
CT	Cooling tower	M	Motor	T	Storage tank
D	Dryer	ME	Miscellaneous equipment	V	Vessel (including columns)
E	Exchanger	MX	Mixer		
F	Filter, classifier	P	Pump		

4 Primary Products

Product Name Product Grade						
MSDS Form Number						
Production Rate Tons per year Tons per day Other units						
Product Purity (wt%)						
Product shipment mode						
Additional Specifications						

5 Primary Raw Materials

(Attach additional sheets if needed)

Feedstock name Feedstock grade								
MSDS form number								
Feedstock availability Tons per year Tons per day Other units								
Feedstock price ($/lb) (Default: open market price)								
Known feedstock impurities	Name	ppmw	Name	ppmw	Name	ppmw	Name	ppmw
Additional specifications								

6 Site Information

Low ambient temperature (F) High ambient temperature (F) Hight ambient relative humidity (%) Site elevation (ft) Maximum wind loading (mph)	
Other site design requirements	

Company Name Address	Project Name Project Number					Sheet	2	
	REV	DATE	BY	APVD	REV	DATE	BY	APVD
DESIGN BASIS								
Form XXXXX-YY-ZZ								

7 Utility Information

Fuel Gas				
Gas source or operation mode	Nat Gas			
Supply header temperature (F)				
Supply header pressure (psia)				
Net calorific value (BTU/lb)				
Marginal availability (lb/h)				
Marginal fuel cost ($/MMBTU)				
Sulfur content (wppm)				
Nitrogen content (wppm)				
Chlorine content (wppm)				
Gas composition (vol%)				
H2O				
O2				
N2				
CO				
CO2				
H2S				
H2				
CH4				
C2H4				
C2H6				
C3H6				
C3H8				
C4H8				
iC4H10				
nC4H10				
C5H10				
C5+				

Fuel Oil				
Fuel source or operation mode	#2 Heating Oil			
Supply header temperature (F)				
Supply headder pressure (psia)				
Net calorific value (BTU/lb)				
Marginal availability (lb/h)				
Marginal fuel cost ($/MMBTU)				
Fuel viscosity at F				
Fuel viscosity at F				
Flash point (F)				
Pour point (F)				
Sulfur content (wppm)				
Nitrogen content (wppm)				
Ash content (wt %)				

Steam				
Steam header classification	VHP	HP	MP	LP
Operating pressure (psia)				
Operating temperature (F)				
Mechanical design pressure (psia)				
Mechanical design temperature (F)				
Marginal availability (lb/h)				
Marginal cost ($/Mlb)				

Coolants				
Coolant classification	Cooling Tower Water	Once-Through Water	Chilled Water	
Operating pressure (psia)				
Supply temperature (F)				
Maximum return temperature (F)				
Marginal availability (lb/h)				
Marginal cost ($)				
Marginal cost units				

Process Water Feeds				
Water feed stream	Raw Water	Process Water	Boiler Feed Water	Condensate
Supply pressure (psia)				
Supply temperature (F)				
Marginal availability (lb/h)				
Marginal cost ($/1000 gal)				
Total dissolved solids (wt%)				
Hardness as CaCO3 (ppmw)				
Chloride as Cl (ppmw)				
Metallurgy				

Electric power				
Power range (kW)				
Voltage (V)				
Phase				
Frequency (Hz)				
Marginal availability (kW)				
Marginal cost ($/kWh)				

Plant air streams				
Air stream	Plant Air	Instrument Air	Plant Nitrogen	
Header pressure (psia)				
Header temperature (F)				
Moisture (ppmw)				
Marginal availability (lb/h)				
Marginal cost ($/Mscf)				

Company Name Address	Project Name Project Number					Sheet		1 of 1
	REV	DATE	BY	APVD	REV	DATE	BY	APVD
CALCULATION SHEET								
Form XXXXX-YY-ZZ								

Company Name
Address

PROBLEM TABLE ALGORITHM

Form XXXXX-YY-ZZ

Project Name							
Project Number					Sheet		1 of 1
REV	DATE	BY	APVD	REV	DATE	BY	APVD

1. Minimum temperature approach

ΔT_{min} 0 ºC

2. Stream data

Stream No.	Actual temperature (ºC) Source	Actual temperature (ºC) Target	Interval temperature (ºC) Source	Interval temperature (ºC) Target	Heat capacity flow rate *CP* (kW/ºC)	Heat load (kW)
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0

3. Problem table

Interval	Interval temp (ºC)	Interval ΔT (ºC)	Sum *CP*c - sum *CP*h (kW/ºC)	*dH* (kW)	Cascade (kW)	(kW)
	0				0	0
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8						

Company Name
Address

Pump and Line Calculation Sheet

Form XXXXX-YY-ZZ

Project Name				Sheet	1	of	1
Project Number							
REV	DATE	BY	APVD	REV	DATE	BY	APVD

Owner's Name
Plant Location
Case Description

Equipment label			Equipment name		
Plant section					
Process service					
Fluid			Density		kg/m^3
Operating temperature	Normal	°C	Viscosity		$N.s/m^2$
	Min	°C	Normal flow rate		kg/s
	Max	°C	Design flow rate		kg/s

LINE PRESSURE DROP

SUCTION

	Line size			mm
Note		Normal	Max.	Units
u_1	Velocity	#DIV/0!	#DIV/0!	m/s
Δf_1	Friction loss		0.00	kPa/m
L_1	Line length			m
$\Delta f_1 L_1$	Line loss		0.00	kPa
$\rho u_1^2/2$	Entrance loss	#DIV/0!	#DIV/0!	kPa
(40 kPa)	Strainer			kPa
	(1) Sub-total	#DIV/0!	#DIV/0!	kPa
z_1	Static head			m
$\rho g z_1$		0.0	0.0	kPa
	Upstream equipment pressure			kPa
	(2) Sub-total	0.0	0.0	kPa
(2) − (1)	(3) Suction pressure	#DIV/0!		kPa
	(4) Vapor pressure			kPa
(3) − (4)	(5) NPSH available	#DIV/0!	0.0	kPa
(5)/ρg	NPSH available	#DIV/0!	#DIV/0!	m
	NPSH available	#DIV/0!	0.0	m water

DISCHARGE

	Line size			mm
Note	Flow	Normal	Max.	Units
u_2	Velocity	#DIV/0!	#DIV/0!	m/s
Δf_2	Friction loss		0.00	kPa/m
L_2	Line length			m
$\Delta f_2 L_2$	Line loss	0.00	0.00	kPa
	Orifice / Flow meter			kPa
	Control valve			kPa
	Equipment			
S&THX	H 205			kPa
				kPa
				kPa
Total	(6) Dynamic loss	0	0	kPa
z_2	Static head			m
$\rho g z_2$		0.0	0.0	kPa
	Equip. press (max)			kPa
	Contingency	0	0	kPa
	(7) Sub-total	0.0	0.0	kPa
(7) + (6)	Discharge pressure	0.0	0.0	kPa
(3)	Suction pressure	#DIV/0!	0.0	kPa
	(8) Differential pressure	#DIV/0!	0.0	kPa
(8)/ρg	Pump head	#DIV/0!	#DIV/0!	m
	Control valve			
Valve/(6)	% Dyn. loss		#DIV/0!	

PUMP DATA

Pump manufacturer				Driver type	
Catalog No.				Power supply	
Pump flow rate	normal	#DIV/0!	m^3/h	Seal type	
	max.	#DIV/0!	m^3/h	Hydraulic power	#DIV/0! kW
Differential pressure		#DIV/0!	kPa	Rated power	kW
		#DIV/0!	m	Efficiency	%
		#DIV/0!	m water	Suction specific speed	
NPSH required			m		
Pump type				Casing design pressure	kPa
No. of stages				Casing design temperature	°C
Impeller type				Casing type	
Mounting				Casing material	

SKETCH

NOTES

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Company Name
Address
COST OF PRODUCTION

Project Name
Project Number
Sheet 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Capital Cost Basis Year 2006
Units ○ English ◉ Metric
On Stream 8,000 hr/yr 333.33 day/yr

YIELD ESTIMATE

CAPITAL COSTS

	$MM
ISBL Capital Cost	0.000
OSBL Capital Cost	0.000
Engineering Costs	0.000
Contingency	0.000
Total Fixed Capital Cost	0.000
Working Capital	0.000

REVENUES AND RAW MATERIAL COSTS

MASS BALANCE — MB Closure 100%

Key Products	Units	Units/Unit product	Units/yr	Price $/unit	$MM/yr	$/unit main product
Product 1	MT	0	1	0	0.00	0.00
	MT				0.00	0.00
	MT				0.00	0.00
	MT				0.00	0.00
Total Key Product Revenues (REV)	MT	0	1		0.00	0.00
By-products & Waste Streams						
Byproduct 1	MT	0	0	0	0.00	0.00
Byproduct 2	MT	0	0	0	0.00	0.00
Byproduct 3	MT	0	0	0	0.00	0.00
Byproduct 4	MT	0	0	0	0.00	0.00
Off-gas	MT	0	0	0	0.00	0.00
Organic Waste	MT	0	0	0	0.00	0.00
Aqueous Waste	MT	0	0	0	0.00	0.00
	MT				0.00	0.00
	MT				0.00	0.00
Total Byproducts and Wastes (BP)	MT	0	0		0.00	0.00
Raw Materials						
Feed 1	MT	0	1	0	0.00	0.00
Feed 2	MT	0	0	0	0.00	0.00
Feed 3	MT	0	0	0	0.00	0.00
Feed 4	MT	0	0	0	0.00	0.00
	MT				0.00	0.00
	MT				0.00	0.00
	MT				0.00	0.00
Total Raw Materials (RM)		0	1		0.00	0.00
			Gross Margin (GM = REV + BP - RM)		0.00	0.00

CONSUMABLES

	Units	Units/Unit product	Units/yr	Price $/unit	$MM/yr	$/unit product
Solvent 1	kg	0	0	0.00	0.00	0.00
Solvent 2	kg	0	0	0.00	0.00	0.00
Solvent 3	kg	0	0	0.00	0.00	0.00
Acid 1	kg	0	0	0.00	0.00	0.00
Acid 2	kg	0	0	0.00	0.00	0.00
Base 1	kg	0	0	0.00	0.00	0.00
Base 2	kg	0	0	0.00	0.00	0.00
Other	kg	0	0	0.00	0.00	0.00
Other	kg	0	0	0.00	0.00	0.00
Other	kg	0	0	0.00	0.00	0.00
Other	kg	0	0	0.00	0.00	0.00
Total Consumables (CONS)					0.00	0.00

UTILITIES

	Units	Units/Unit product	Units/hr	Price $/unit	$MM/yr	$/unit product
Electric	kWh	0.0	0	0.00	0.000	0.00
HP Steam	MT	0.0	0	0.00	0.000	0.00
MP Steam	MT	0.0	0	0.00	0.000	0.00
LP Steam	MT	0.0	0	0.00	0.000	0.00
Boiler Feed	MT	0.0	0	0.00	0.000	0.00
Condensate	MT	0.0	0	0.00	0.000	0.00
Cooling Water	MT	0.0	0	0.00	0.000	0.00
Fuel Fired	GJ	0.0	0	0.00	0.000	0.00
Total Utilities (UTS)					0.000	0.000
			Variable Cost of Production (VCOP = RM - BP + CONS + UTS)		0.00	0.00

FIXED OPERATING COSTS

			$MM/yr	$/unit product
Labor	4.8	Operators per Shift Position		
Number of shift positions	3	0 $/yr each	0.00	0.00
Supervision		25% of Operating Labor	0.00	0.00
Direct Ovhd.		45% of Labor & Superv.	0.00	0.00
Maintenance		3% of ISBL Investment	0.00	0.00
Overhead Expense				
Plant Overhead		65% of Labor & Maint.	0.00	0.00
Tax & Insurance		2% of Fixed Investment	0.00	0.00
Interest on Debt Financing		0% of Fixed Capital	0.00	0.00
		0% of Working Capital	0.00	0.00
		Fixed Cost of Production (FCOP)	0.00	0.00

ANNUALIZED CAPITAL CHARGES

	$MM	Interest Rate	Life (yr)	ACCR	$MM/yr	$/unit product
Fixed Capital Investment	0.000	15%	15	0.171	0.00	0.00
Royalty Amortization	0.000	15%	10	0.199	0.00	0.00
Inventory Amortization						
Catalyst 1	0.000	15%	3	0.438	0.00	0.00
Catalyst 2	0.000	15%	3	0.438	0.00	0.00
Adsorbent 1	0.000	15%	3	0.438	0.00	0.00
Equipment 1	0.000	15%	5	0.298	0.00	0.00
Equipment 2	0.000	15%	5	0.298	0.00	0.00
				Total Annual Capital Charge	0.00	0.00

SUMMARY

	$MM/yr	$/unit product
Variable Cost of Production	0.00	0.00
Fixed Cost of Production	0.00	0.00
Cash Cost of Production	0.00	0.00
Gross Profit	0.00	0.00
Total Cost of Production	0.00	0.00

Company Name
Address

Project Name
Project Number

Sheet 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

ECONOMIC ANALYSIS

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Capital Cost Basis Year 2006
Units ○ English ◉ Metric
On Stream 8,000 hr/yr 333.33 day/yr

REVENUES AND PRODUCTION COSTS

	$MM/yr
Main product revenue	0.0
Byproduct revenue	
Raw materials cost	
Utilities cost	
Consumables cost	
VCOP	0.0
Salary and overheads	
Maintenance	
Interest	
Royalties	
FCOP	0.0

CAPITAL COSTS

	$MM
ISBL Capital Cost	0.0
OSBL Capital Cost	0.0
Engineering Costs	0.0
Contingency	0.0
Total Fixed Capital Cost	0.0
Working Capital	0.0

CONSTRUCTION SCHEDULE

Year	% FC	% WC	% FCOP	% VCOP
1				
2				
3				
4				
5				
6				
7+				

ECONOMIC ASSUMPTIONS

Cost of equity
Cost of debt
Cost of capital

Debt ratio

Tax rate
Depreciation method
Depreciation period years

CASH FLOW ANALYSIS

All figures in $MM unless indicated

Project year	Cap Ex	Revenue	CCOP	Gr. Profit	Deprcn	Taxbl Inc	Tax Paid	Cash Flow	PV of CF	NPV
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ECONOMIC ANALYSIS

Average cash flow	0.0	$MM/yr	NPV	10 years	0.0	$MM	IRR	10 years	#NUM!
Simple pay-back period	#DIV/0!	yrs		15 years	0.0	$MM		15 years	#NUM!
Return on investment (10 yrs)	#DIV/0!			20 years	0.0	$MM		20 years	#NUM!
Return on investment (15 yrs)	#DIV/0!		NPV to yr	1	0.0	$MM			

NOTES

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Company Name
Address

Project Name
Project Number
Sheet 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

FAILURE MODE EFFECT ANALYSIS

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Process Step or Key Input	Failure Mode	Consequence	Impact SEV	Cause	Frequency O	Current Control	Detection DET	Priority RPN	Action
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	
								0	

Company Name
Address

Project Name
Project Number
Sheet 1 of 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

FIXED BED REACTOR

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Units ○ English ◉ Metric

Equipment label
Equipment name
Plant section
Process service
Design code
Maximum diameter m
Total height m

PROCESS DATA

Bed Number								
Vapor flow direction								
Liquid flow direction								
Top of section	Operating temperature	°C						
	Pressure	bara						
	Vap flow	kg/h						
	Vap density	kg/m3						
	Vap dynamic viscosity	N.s/m2						
	Liq flow	kg/h						
	Liq density	kg/m3						
	Liq dynamic viscosity	N.s/m2						
Bottom of section	Operating temperature	°C						
	Pressure	bara						
	Vap flow	kg/h						
	Vap density	kg/m3						
	Vap dynamic viscosity	N.s/m2						
	Liq flow	kg/h						
	Liq density	kg/m3						
	Liq dynamic viscosity	N.s/m2						
Catalyst type								
Catalyst shape								
Catalyst nominal diameter		mm						
Catalyst bed depth		m						
Catalyst volume		m3						
Catalyst bed bulk density		kg/m3						
Catalyst bed void fraction								
LHSV		/h						
GHSV		/h						
WHSV		/h						

CONSTRUCTION & MATERIALS

Bed Number								
Shell material								
Shell diameter		m						
Shell tangent length		m						
Shell thickness		mm						
Design temperature		°C						
Design pressure		bara						
Test pressure		bara						
Segregation height	overhead	m						
	sump	m						
Pipe branch nominal diameter		mm						
Pipe branch elevation wrt. base of section		m						
Pipe branch nominal diameter		mm						
Pipe branch elevation wrt. base of section		m						
Support grid material								
Support grid elevation wrt. base of section		m						
Distributor type								
Distributor material								
Distributor base elevation wrt. base of section		m						
Demister type								
Demister material								
Demister support grid elevation wrt. base of section		m						
Notes								

Company Name
Address

Project Name
Project Number
Sheet 1 of 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

FLUID PHASE SPLITTER

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Units ◉ English ○ Metric

Equipment label
Equipment name
Plant section
Process service

Design code
Orientation Vertical
Volume ft3

PROCESS DATA

			IN	VAPOR OUT	ORGANIC OUT	AQUEOUS OUT
Stream No.						
Fluid						
Total fluid flow		lb/h				
Total vapor flow		lb/h				
Total liquid flow		lb/h				
Density		lb/cu ft				
Dynamic viscosity		lbm/ft.s				
Specific heat capacity		Btu/lb.F				
Latent heat		Btu/lb				
Normal temperature		°F				
Max temperature		°F				
Min temperature		°F				
Pressure		psia				
Pressure drop allowed		psi				
Pressure drop calculated		psi				
Pipe branch nominal diameter		in				
Flow velocity	(nozzle)	ft/s				
Flow velocity	(interface)	ft/s				

Composition	Component	wt%	wt%	wt%	wt%
	Component	mol%	mol%	mol%	mol%

CONSTRUCTION & MATERIALS

Shell
Material
Head type
Length ft I.D. in Wall thickness in
Aspect ratio
Design pressure at max temp psia Test pressure psia Min internal pressure psia
Baffle material Baffle type Baffle pitch in
Demister material Demister type Demister elevatn wrt. base in
Packing material Packing type Packing dimension in
Interfacial area Vapor / Liquid ft2 Liquid / Liquid ft2

Branches

Inlet 1	Side	Head	Nominal bore	in	CL elevatn wrt. base	in
Inlet 2	Side	Head	Nominal bore	in	CL elevatn wrt. base	in
Inlet 3	Side	Head	Nominal bore	in	CL elevatn wrt. base	in
Outlet 1	Side	Head	Nominal bore	in	CL elevatn wrt. base	in
Outlet 2	Side	Head	Nominal bore	in	CL elevatn wrt. base	in
Outlet 3	Side	Head	Nominal bore	in	CL elevatn wrt. base	in

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Company Name
Address

Project Name
Project Number
Sheet 1 of 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

FURNACE HEATER

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Units ◉ English ○ Metric

Equipment label
Plant section
Process service
Design code
Furnace Duty MMBtu/h

Equipment name
Furnace type
No. of Zones

PROCESS DATA

Zone Name/Number								
Zone Type								
Process Inlet	Stream No.							
	Fluid							
	Total fluid flow	lb/h						
	Total vapor flow	lb/h						
	Total liquid flow	lb/h						
	Fluid vaporized	lb/h						
	Density	lb/cu ft						
	Dynamic viscosity	lbm/ft.s						
	Specific heat capacity	Btu/lb.F						
	Thermal conductivity	Btu.ft/h.ft2.F						
	Latent heat	Btu/lb						
	Normal temperature	°F						
	Max temperature	°F						
	Min temperature	°F						
	Pressure	psia						
	Flow velocity	ft/s						
Process Outlet	Stream No.							
	Fluid							
	Total fluid flow	lb/h						
	Total vapor flow	lb/h						
	Total liquid flow	lb/h						
	Fluid vaporized	lb/h						
	Density	lb/cu ft						
	Dynamic viscosity	lbm/ft.s						
	Specific heat capacity	Btu/lb.F						
	Thermal conductivity	Btu.ft/h.ft2.F						
	Latent heat	Btu/lb						
	Normal temperature	°F						
	Max temperature	°F						
	Min temperature	°F						
	Pressure	psia						
	Flow velocity	ft/s						
Pressure drop allowed		psi						
Pressure drop calculated		psi						
Number of passes								
Process film transfer coefficient		Btu/h.ft2.F						
Fouling coefficient		Btu/h.ft2.F						
Process heat load		Btu/lb						
Heat duty		Btu/h						
Estimated heat loss to surroundings		Btu/h						
Allowed heat flux		Btu/h.ft2						
Fuel	Fuel type							
	Fuel flowrate	lb/h						
	Fuel temperature	°F						
	Fuel pressure	psia						
Air	Air flowrate	lb/h						
	Air temperature	°F						
	Air pressure	psia						
	Air preheat duty	Btu/h						
	Excess air	%						
Flue gas	FG flowrate	lb/h						
	FG temperature in	°F						
	FG temperature out	°F						
	FG moisture	wt%						
	FG dewpoint	°F						
	FG film transfer coeff	Btu/h.ft2.F						
	NOx	ppmw						
	CO	ppmw						
	PM10	ppmw						
Theoretical flame temperature		°F						
Bridgewall temperature		°F						
Max allowable turndown		%						

CONSTRUCTION & MATERIALS

Zone Number								
Zone Type								
Tubes	Material							
	Orientation							
	Count							
	No. of passes							
	Length/pass	ft						
	O.D.	in						
	Total area	ft2						
	Wall thickness	in						
	Design temperature	°F						
	Design pressure	psia						
	Test pressure	psia						
Refractory	Material							
	Sidewall thickness	in						
	Hearth & roof thickness	in						
Casing & Ducting	Material							
	Wall thickness	in						
	Fuel pipe diameter	in						
	Stack diameter	in						
	Stack height	ft						
Burners	Burner type							
	Burner material							
	No. of burners							
	Burner spacing	ft						
	Flame speed	ft/s						
	Flame length	ft						

NOTES

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Company Name
Address

Project Name
Project Number Sheet 1 of 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

SHELL & TUBE HEAT EXCHANGER

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Units ◉ English ○ Metric

Equipment label — Equipment name
Plant section
Process service
Design code — TEMA — Exchanger type
Shells per unit — Series — Parallel
Surface per unit — ft2 — Surface per shell — ft2

DATA PER UNIT

		SHELL SIDE		TUBE SIDE	
		IN	OUT	IN	OUT
Stream No.					
Fluid					
Total fluid flow	lb/h				
Total vapor flow	lb/h				
Total liquid flow	lb/h				
Total steam flow	lb/h				
Fluid vaporized / condensed	lb/h				
Density	lb/cu ft				
Dynamic viscosity	lbm/ft.s				
Specific heat capacity	Btu/lb.F				
Thermal conductivity	Btu.ft/h.ft2.F				
Latent heat	Btu/lb				
Normal temperature	°F				
Max temperature	°F				
Min temperature	°F				
Pressure	psia				
Pressure drop allowed	psi				
Pressure drop calculated	psi				
Flow velocity	ft/s				
Number of passes					
Film transfer coefficient	Btu/h.ft2.F				
Fouling coefficient	Btu/h.ft2.F				
Heat duty	Btu/h				
F_T factor					
Effective mean temperature difference	°F				
Minimum surface required	ft2				

CONSTRUCTION & MATERIALS PER SHELL

Tubes
Material
Count — Pitch — in — Square — Triangular — Welded ☑
Length — ft — O.D. — in — Wall thickness — in
Design pressure at max temp — psia — Test pressure — psia — Max external pressure — psia
Number of tubes blanked

Shell
Material
Length — ft — I.D. — in — Wall thickness — in
Design pressure at max temp — psia — Test pressure — psia — Min internal pressure — psia
Baffle material — Baffle type — Baffle pitch — in
Tubesheet material — Tubesheet thickness — in
Bonnet material — Bonnet type

Branches
Shell side inlet — in N.B. — Shell side outlet — in N.B.
Tube side inlet — in N.B. — Tube side outlet — in N.B.

NOTES

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Company Name
Address

Project Name
Project Number

Sheet 1 of 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

VAPOR LIQUID CONTACTING COLUMN

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Units ○ English ◉ Metric

Equipment label
Plant section
Process service
Design code

Equipment name

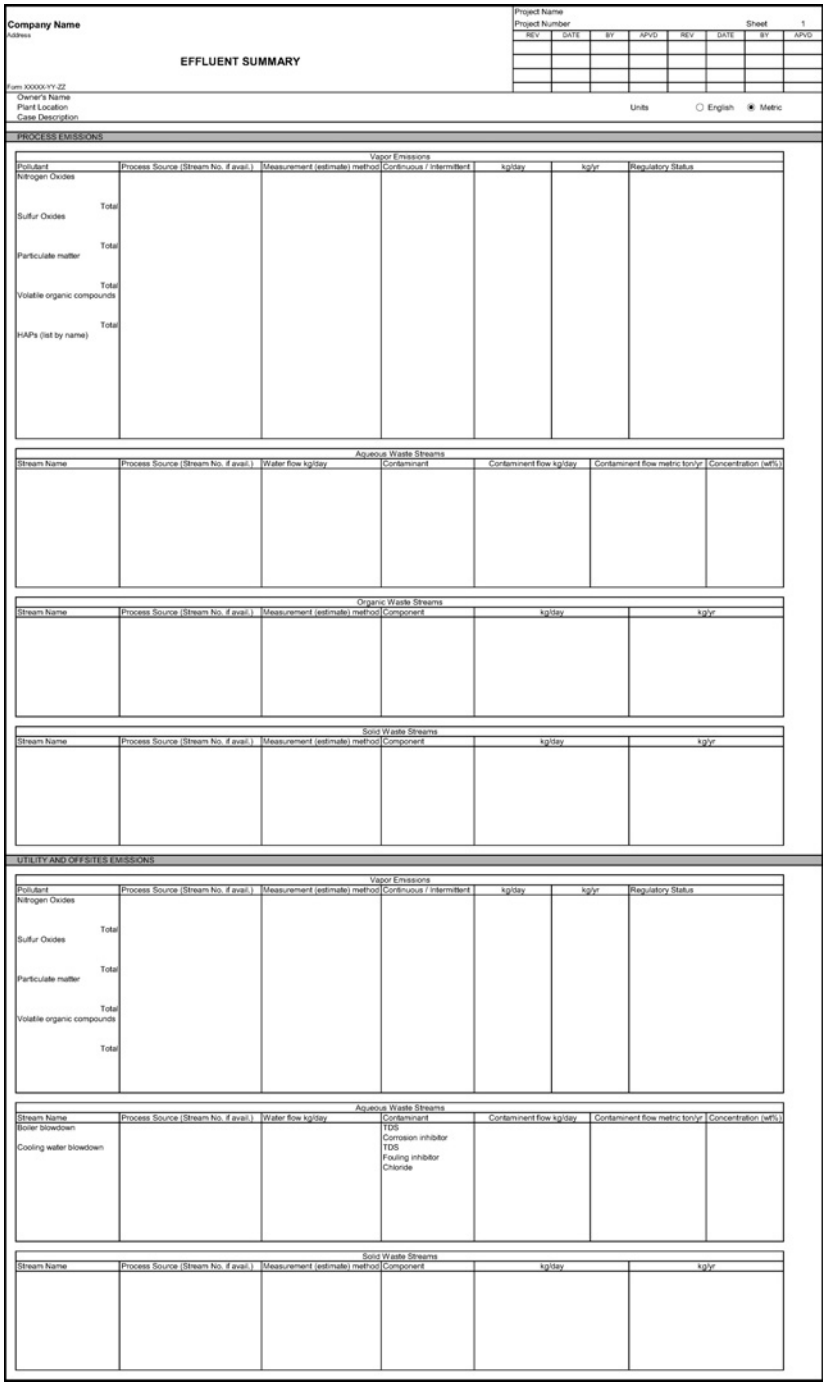
Maximum diameter m Total height m

PROCESS DATA

Column Section								
Tray or Stage Numbers								
Total vapor flow		kg/h						
Total liquid flow		kg/h						
Top of section	Operating temperature	°C						
	Pressure	bara						
	Vap density	kg/m3						
	Vap dynamic viscosity	N.s/m2						
	Liq density	kg/m3						
	Liq dynamic viscosity	N.s/m2						
	Liq surface tension	dyn/cm						
Bottom of section	Operating temperature	°C						
	Pressure	bara						
	Vap density	kg/m3						
	Vap dynamic viscosity	N.s/m2						
	Liq density	kg/m3						
	Liq dynamic viscosity	N.s/m2						
	Liq surface tension	dyn/cm						
Section pressure drop		bar						

CONSTRUCTION & MATERIALS

Column Section								
Tray or Stage Numbers								
Shell material								
Shell diameter		m						
Shell tangent length		m						
Shell thickness		mm						
Design temperature		°C						
Design pressure		bara						
Test pressure		bara						
Segregation height	overhead	m						
	sump	m						
Pipe branch nominal diameter		mm						
Pipe branch elevation wrt. base of section		m						
Pipe branch nominal diameter		mm						
Pipe branch elevation wrt. base of section		m						
Tray type								
Tray material								
No. trays								
No. liquid passes per tray								
No. holes /tray	total							
	active							
Hole size		mm						
Hole pitch		mm						
Hole area / total area		%						
Tray thickness		mm						
Tray spacing		m						
Weir length		m						
Weir height		mm						
Downcomer clearance		mm						
Pressure drop per plate		bar						
Packing type								
Packing material								
Packing size		mm						
Packing height		m						
Support grid material								
Support grid elevation wrt. base of section		m						
Distributor type								
Distributor material								
Distributor base elevation wrt. base of section		m						
Demister type								
Demister material								
Demister support grid elevation wrt. base of section		m						
Notes								



Company Name
Address

Project Name
Project Number
Sheet 1

REV	DATE	BY	APVD	REV	DATE	BY	APVD

EFFLUENT SUMMARY

Form XXXXX-YY-ZZ

Owner's Name
Plant Location
Case Description

Units ○ English ◉ Metric

PROCESS EMISSIONS

Vapor Emissions

Pollutant	Process Source (Stream No. if avail.)	Measurement (estimate) method	Continuous / Intermittent	kg/day	kg/yr	Regulatory Status
Nitrogen Oxides						
Total						
Sulfur Oxides						
Total						
Particulate matter						
Total						
Volatile organic compounds						
Total						
HAPs (list by name)						

Aqueous Waste Streams

Stream Name	Process Source (Stream No. if avail.)	Water flow kg/day	Contaminant	Contaminent flow kg/day	Contaminent flow metric ton/yr	Concentration (wt%)

Organic Waste Streams

Stream Name	Process Source (Stream No. if avail.)	Measurement (estimate) method	Component	kg/day	kg/yr

Solid Waste Streams

Stream Name	Process Source (Stream No. if avail.)	Measurement (estimate) method	Component	kg/day	kg/yr

UTILITY AND OFFSITES EMISSIONS

Vapor Emissions

Pollutant	Process Source (Stream No. if avail.)	Measurement (estimate) method	Continuous / Intermittent	kg/day	kg/yr	Regulatory Status
Nitrogen Oxides						
Total						
Sulfur Oxides						
Total						
Particulate matter						
Total						
Volatile organic compounds						
Total						

Aqueous Waste Streams

Stream Name	Process Source (Stream No. if avail.)	Water flow kg/day	Contaminant	Contaminent flow kg/day	Contaminent flow metric ton/yr	Concentration (wt%)
Boiler blowdown			TDS Corrosion inhibitor			
Cooling water blowdown			TDS Fouling inhibitor Chloride			

Solid Waste Streams

Stream Name	Process Source (Stream No. if avail.)	Measurement (estimate) method	Component	kg/day	kg/yr