Appendix A

A LIST OF ENGINEERING PROCESS FLOW DIAGRAMS AND PROCESS DATA SHEETS

A-1 PROCESS FLOW DIAGRAMS USING VISIO 2002 SOFTWARE

Figure 1-12b Process flow diagram (Feed and fuel desulfurization section).

Figure 1-12c Typical process flow diagram for the production of Methyl Tertiary Butyl Ether (MTBE).

Figure 1-14 Piping and instrumentation diagram for Ammonia plant CO_2 removal.

Figure 1-15 Piping and instrumentation diagram: Ammonia synthesis and refrigeration unit (2).

A-2 PROCESS DATA SHEETS

1. Air cooled heat exchanger process data sheet
2. Centrifugal pump schedule: driver
3. Centrifugal pump schedule: pump
4. Centrifugal pump summary
5. Column schedule
6. Deaerator process data sheet: Deaerated water storage tank
7. Deaerator process data sheet: Deaerator head
8. Drum process data sheet
9. Effluent schedule
10. Equilibrium flash calculation
11. Fabricated equipment schedule
12. Fan/Compressor process duty specification
13. Fractionator calculation summary
14. General services and utilities checklist
15. Hazardous chemical and conditions schedule
16. Heat and mass balances
17. Heat exchanger rating sheet
18. Hydrocarbon dew point calculation
19. Line list schedule
20. Line schedule
21. Line schedule sheet
22. Line summary table
23. Mass balance
24. Mechanical equipment schedule
25. Pipe line list
26. Pipe list
27. Piping process conditions summary
28. Plate heat exchanger data sheet
29. Calculation of pressure drop in fixed catalyst beds
30. Process engineering job analysis summary
31. Pump calculation sheet
32. Pump schedule
33. Relief device philosophy sheet
34. Tank and vessel agitator data sheet
35. Tank process data sheet
36. Tank schedule
37. Tie-in-schedule
38. Tower process data sheet
39. Tray loading summary
40. Trip schedule
41. Utility summary sheet
42. Vessel and tank schedule
43. Vessel and tank summary: driver
44. Vessel schedule
45. Water analysis sheet

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A.K.C. TECHNOLOGY	**AIR COOLED HEAT EXCHANGER PROCESS DATA SHEET**	Document No.	
		Sheet of	Rev.
Job		Item No.(s)	
Item Name		No. Working	Total No. Off

Unless otherwise stated, fluid properties are for mean fluid temperature. For lines 30-36 this is mean from dewpoint to outlet temperatures.

1	**TUBE SIDE DATA**	**UNITS**			**MATERIALS**
2	Fluid Circulated				Tubes
3	Total Fluid Entering (Normal)	kg/h	lb/h		Fins
4	Flow Margin	%	%		Header Boxes
5	Temperature: In/Out	°C	°F		Tubesheets
6	Max. Pressure Drop at Line 4	bar	psi		Stress Relief Yes/as Codes
7	Inlet Pressure: Operat./Design	barg	psig		Radiography Yes/as Codes
8	Normal Heat Load	kW	Btu/h		Sour Service Yes/No
9	Heat Load Margin	%	%		
10	Design Temperature	°C	°F		
11	Corrosion Allowance	mm	in.		
12	Fouling Resistance	m^2 °C/W	°Ft^2h/Btu		
13	Line N.B.: In/Out	mm.	in.		
14	**GAS (AND VAPOR)**				PROCESS CONTROL REQUIREMENTS
15	Flow of Vapor & Gas at Inlet	kg/h	lb/h		Local / Remote Set
16	Molecular Weight: In/Out				Hand / Automatic
17	Thermal Conductivity: In/Out	W/m °C	Btu/h.ft. °F		Adjustable Pitch Fans
18	Specific Heat	kJ/kg °C	Btu/lb. °F		Variable Speed Motor
19	Compressibility Factor				Louvres
20	Viscosity In / Out	cP	lb/ft.h		Air Recirculation
21	**LIQUID IN**				
22	Total Flow of Liquid at Inlet	kg/h	lb/h		
23	Thermal Conductivity: In/Out	W/m °C	Btu/h.ft. °F		
24	Specific Heat	kJ/kg °C	Btu/lb. °F		
25	Density	kg/m^3	lb/ft^3		
26	Viscosity	cP	lb/ft.h		
27	**CONDENSATION**				
28	Fluid Condensed	kg/h	lb/h		
29	Molecular Weight				
30	Thermal Conductivity	W/m °C	Btu/h.ft. °F		
31	Specific Heat	kJ/kg °C	Btu/lb. °F		
32	Density	kg/m^3	lb/ft^3		
33	Viscosity	cP	lb/ft.h		
34	Latent Heat	kJ/kg	Btu/lb		
35	%Condensate Forming Film	%	%		
36	Temps. for Phase Change: In/Out	°C	°F		
37	**COOLING CURVE DATA**				
38	%Heat Load				
39	Condensing Fluid Temp. °C				
40					
41	**AIR SIDE DATA**				
42	Design Inlet Temp. Max/Min	°C	°F		
43	No. of Fans Assumed				
44	Estimated Power per Fan	kW			
45	**SITE DATA**				
46	Altitude				
47	Plot Size Limitations	Length:		Width:	
48	Noise Limits				
49	Atmospheric Contamination				
50					
51	**NOTES**				
52					
53					
54					
55					

	1	Date	2	Date	3	Date	4	Date	5	Date
Description										
Made/Revised by										
Checked by										
Approved Process										
Approved by										

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CENTRIFUGAL PUMP SCHEDULE:
DRIVER

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved Process						
Location			Approved						
Plant									

ITEM No.	TYPE	HP	RPM	ROTATION CW-CCW	ELECTRICAL CHARACTERISTICS	NEMA FRAME	STEAM CONDITIONS		MAKE	MODEL	STEAM RATE	WEIGHT	P.O. No.
							psig	TEMP, °F					

CENTRIFUGAL PUMP SCHEDULE: PUMP

PUMP

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved Process						
Location			Approved						
Plant									

ITEM No.	No. OF UNITS	SERVICE	MAKE	MODEL	TYPE	SIZE CONNECTION		WEIGHT	REFERENCE DRAWINGS	PURCHASE ORDER No.	SEAL TYPE	TYPE COUPLING	FILE REFERENCE
						SUCTION	DISCHARGE						

	CENTRIFUGAL PUMP SUMMARY												
Job No.:				Sheet of	Issue No.:		1	Date	2	Date	3	Date	
Job Name:					Description								
Document No.					Made/Revised by								
Project No.					Checked by								
Client					Approved Process								
Location					Approved								
Plant													
ITEM No.	No. OF UNITS	SERVICE	LIQUID	OPERATING TEMPERATURE °F	SpGr OPER. TEMP.	GPM OPER. TEMP.	$NPSH_A$ ft	DISCHARGE PRESSURE psig	SPEED RPM	BHP PUMP	HP DRIVER	DRIVER TYPE	FILE REFERENCE

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COLUMN SCHEDULE

	Job No.:					Sheet of		Issue No.:		1	Date	2	Date	3	Date		
	Job Name:							Description									
	Document No.							Made/Revised by									
	Project No.							Checked by									
	Client							Approved Process									
	Location							Approved									
	Plant																
1	Item Number																
2	Item Name																
3	Number Required																
4		Units		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
5	Shell Diameter (ID/OD)	mm															
6	Shell Length (T.L. - T.L.)	mm															
7	Overall Shell Length - (T.L. - T.L.)	mm															
8	Base Elevation	mm															
9	Trays – Type																
10	– Number																
11	– Spacing	mm															
12	– Liquid Flow																
13	Packing – Type																
14	– Number of Beds																
15	– Bed Height/Volume	mm/m^3															
16	– Density	kg/m^3															
17	Other Internals																
18																	
19																	
20																	
21	Operating – Pressure																
22	– Temperature																
23	Design – Pressure	barg															
24	– Temperature	°C															
25	Vacuum Design																
26	Material: Shell																
27	Liner																
28	Internals																
29																	
30	Shell Corrosion Allowance	mm															
31	Sour Service																
32	Stress Relieved for Process Reasons																
33	Insulation																
34																	
35																	
36	Notes																
37																	
38																	
39																	
40																	
41																	
42																	
43																	
44																	
45																	

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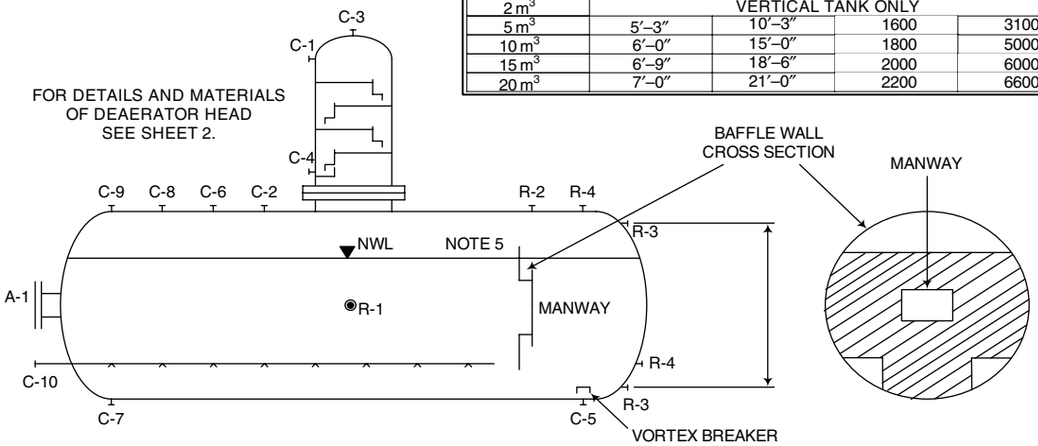
A.K.C. TECHNOLOGY	**DEAERATOR PROCESS DATA SHEET**	Document No.	
		Sheet of	Rev.
Job		Item No.(s)	
Item Name	**DEAERATED WATER STORAGE TANK**	No. Working	Total No. Off

NOTE: * indicates delete as necessary: ** indicates for other than code reason.

STANDARD TANK DIMENSIONS				
TANK	ENGLISH		METRIC	
SIZE	O.D.	LENGTH	O.D.	LENGTH
2 m^3	VERTICAL TANK ONLY			
5 m^3	5′–3″	10′–3″	1600	3100
10 m^3	6′–0″	15′–0″	1800	5000
15 m^3	6′–9″	18′–6″	2000	6000
20 m^3	7′–0″	21′–0″	2200	6600



Shell Diameter (O.D.)					Shell Length: (T.L. - T.L.)				No. Required	
Center Line: *Horizontal										
	Pressure:		Temperature:		Nozzles	Mark No.	Size In		Qty	
	psig	bar g	°F	°C	Inlet	C-1			1	
Operating	3.0	0.237	223	106	Steam In	C-2			1	NOTE 4
Design	10.0	0.73	241	116	Vapour Out	C-3			1	
emergency Vacuum Design: *Yes					Sample Point	C-4			1	
	Material		Corr. Allowance		Liquid Out	C-5			1	
Shell	CS		1/16" (1.6mm)	NOTE	Cond. Out	C-6			1	NOTE 4
Heads	CS		1/16" (1.6MM)	1						
Liner					Vent	C-				
Type of Heads					Drain	C-7			1	
Code:					Steam Out	C-				
Stress Relieve**: Yes					Pressure Relief	C-8			1	
Radiography**: No					Spill Back	C-9			1	
joint Efficiency:					Start Up	C-10			1	NOTE 3
Weight Empty:			Weight Full:							
Is vessel subject to mechanical vibration?				NOTE 2						
Insulation:	Conservation									
*Yes										
NOTES										
1) Corrosion Allowance on Tank Only					Manhole	A-1			1	
2) Water Hammer Only										
3) Sparge Pipe To Have Delavan Type BB Nozzles					Thermocouple	R-1	by Inst. Gp.		1	
and Terminate 1000mm Before Baffle.					Pressure Gauge	R-2			1	
4) Allow for Temp of Desuperheating Steam					Gauge Glass	R-3			2	
or condensate at Inlet Nozzles.					Level Control	R-4			2	Incl.LAHL/LL
5) Normally at 0.67 Dia. Above Base.										
					Min. Base Elevation:				Skirt Length:	
					Material:					

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Description										
Made/Revised by										
Checked by										
Approved Process										
Approved by										

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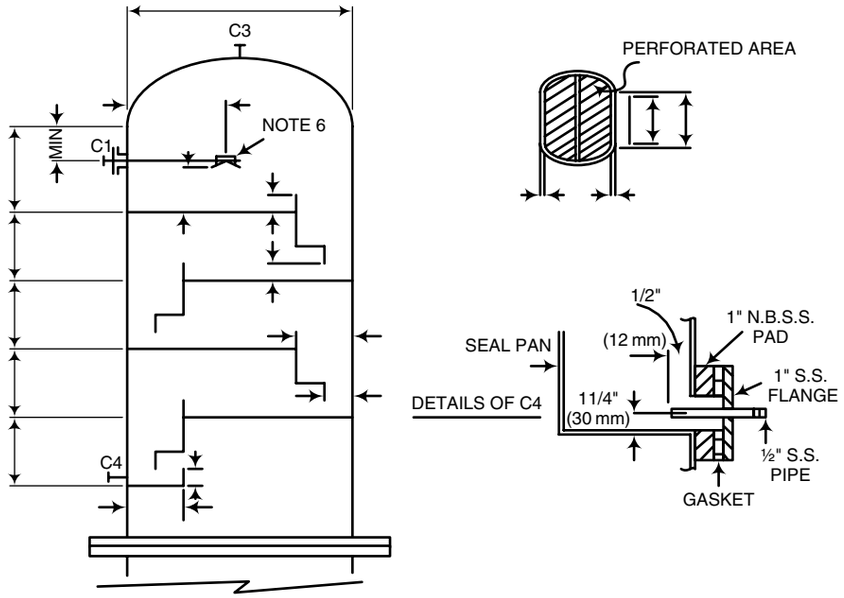
A.K.C. TECHNOLOGY	**DEAERATOR PROCESS DATA SHEET**	Document No.	
		Sheet of	Rev.
Job		Item No.(s)	
Item Name	**DEAERATOR HEAD**	No. Working	Total No. Off



1. DESIGN FOR FULL VACUUM.
   OPERATING TEMPERATURE _____
   OPERATING PRESSURE _____
2. TRAYS TO BE SEALED TO SHELL WITH STEAM QUALITY RUBBER GASKETS.
3. C4 TO BE CAPPED FOR SITE INSTALLATION OF STANDARD SAMPLING EQUIPMENT.
4. HEAD TO BE IN S.S OR COATED M.S. BELOW 120°C MAX. EPOXY RESIN BELOW 180°C MAX. STOVED PHENOLIC RESIN (SAKAPHEN). PROCESS TO ADVICE ON SPECIFICATION & APPLICATION.
5. TRAYS TO BE IN 18/8 S/S. TRIANGULAR PERFORATION. PATTERN TO BE N.GREENING'S___ OR EQUAL.
6. SPRAY NOZZLE TO BE IN 18/8 S/S. SIMILAR TO DELAVAN WATSON S. _____ AND WITHDRAWABLE THROUGH C-1.

NOTE: Bubbling Area Is Any Part Of
Tray Within 4" Distance Of A Hole

NOZZLES	MARK	SIZE	QTY
Water Inlet	C-1		
Vent	C-3		
Sample Point	C-4	STD	1
Perf. Area/Tray			
Bubbling Area/Tray			
No. Of Trays			
Tray Thickness			
Hole Diameter			
Pitch. Approx.			
No. of Holes/Tray			

FLOWS (kg/hr)		
	NORMAL	DESIGN
Water Feed 1		
Water Feed 2		
Water Feed 3		
Heating Steam		
Start-Up Steam		
Vent Steam		
Deaerated Feed Water		

* No. Of Hole Is More Important Than Pitch

	1	Date	2	Date	3	Date	4	Date	5	Date
Description										
Made/Revised by										
Checked by										
Approved Process										
Approved by										

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	A.K.C. TECHNOLOGY	**DRUM PROCESS DATA SHEET**	Doc. No:
			Item No.
		Job:	Sheet of

Distribution:

Item Name:

NOTE: *indicates delete as necessary; **indicates for other than Code reason

25										
26	Shell Diameter (O.D. / I.D.):					Shell Length:			No. Required:	
27	Center+C71 Line: *Horizontal / Vertical									
28		Pressure: g		Temperature: °F /°C		Nozzles	Mark No.	Size	Number	
29	Item Number					Inlet	C-			
30	Operating									
31	Design					Vapor Out	C-			
32	Emergency Vacuum Design: * Yes / No									
33		Material		Corr. Allowance		Liquid Out:	C-			
34	Shell									
35	Heads									
36	Liner					Thermocouple	R-	by Inst. Op.		
37	Type of Heads					Pressure Gauge	R-			
38	Code:					Gauge Glass	R-			
39	Stress Relieve**:		Radiography**:			Level Control	R-			
40	Joint Efficiency:					Safety Valve	R-			
41	Density of Contents:		at	*°F / °C						
42	Weight Empty:		Weight Full:							
43	Is vessel subject to mechanical vibration? *Yes / No					Vent	C-			
44	insulation: Type: *Frost and Personnel Protection / Cold					Drain	C-			
45	*Yes / No / Anticondensation / Heat Conservation					Steam Out	C-			
46	REMARKS:									
47						Manhole	A-			
48										
49										
50										
51										
52										
53						min. Base Elev'n:				
54						Material:				

Issue No.	1	Date	2	Date	3	Date	4	Date
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Checked by								
Approved - Process								
Approved by								

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Job Code:CAPA
Chapter:0capaappA
22-12-2006
5:26p.m.
Page:780
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EFFLUENT SCHEDULE

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	
Job Name:			Description					
Document No.			Made/Revised by					
Project No.			Checked by					
Client			Approved- Process					
Location			Approved					
Plant								

	STREAM NUMBER	EFFLUENT SOURCE	FLUID	TOTAL FLOWRATE tonne/h.	MAIN CONTAMINANTS	CONTAMINANT kg/h. QUANTITY	CONTAMINANT CONCENTRATION	STREAM TEMP. °C.
1								
2								
3								
4								
5								
6								
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10								
11								
12								
13								
14								
15								
16								
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41								
42	Notes:							
43								
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47								
48								

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A.K.C. TECHNOLOGY	**PROCESS DATA SHEET**	Job No.
		Item No.
	Job:	Sheet of

EQUILIBRIUM FLASH CALCULATION (Form 1 of 2)

Temperature: ..... °F
Pressure: ..... psia
Pg: ..... psia

			Assumed $\frac{V}{L}$ =									
	m	K	$K\frac{V}{L}+1$	$\frac{m}{K\frac{V}{L}+1}$	$K\frac{V}{L}+1$	$\frac{m}{K\frac{V}{L}+1}$	$K\frac{V}{L}+1$	$\frac{m}{K\frac{V}{L}+1}$	$K\frac{V}{L}+1$	$\frac{m}{K\frac{V}{L}+1}$	$K\frac{V}{L}+1$	$\frac{m}{K\frac{V}{L}+1}$
H_2 CO CH_4												
CO_2 C_2H_6 C_3H_8												
i-C_4H_{10} n-C_4H_{10} C_2H_4												
C_3H_6 C_6H_6												
		$\sum\frac{m}{K\frac{V}{L}+1}$ =										
		Calculated $\frac{V}{L}$ =										

$$\text{Calculated } \frac{V}{L} = \frac{1}{\sum \frac{m}{K\frac{V}{L}+1}} - 1$$

Issue No.	1	Date	2	Date	3	Date	4	Date	5	Date
Made/Revised by										
Checked by										
Approved - Process										
Approved by										

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A.K.C. TECHNOLOGY	**PROCESS DATA SHEET**	Job No.
		Item No.
	Job:	Sheet of

EQUILIBRIUM FLASH CALCULATION (Form 2 of 2)

Temperature: ..... °F
Pressure: ..... psia
Pg: ..... psia

	MOLES						MOL. FRACTION			
	Feed m		Liquid L_x		Gas V_y		Liquid x		Gas y	
H_2 CO CH_4										
CO_2 C_2H_6 C_3H_8										
i-C_4H_{10} n-C_4H_{10} C_2H_4										
C_3H_6 C_6H_6										

$$L_x = \frac{m}{K\frac{V}{L}+1} \qquad V_y = m - L_x$$

Issue No.	1	Date	2	Date	3	Date	4	Date	5	Date
Made/Revised by										
Checked by										
Approved - Process										
Approved by										

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FABRICATED EQUIPMENT SCHEDULE

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved- Process						
Location			Approved						
Plant									

ITEM No.	No. OFF	DESCRIPTION	DIAMETER (m)	LENGTH (m)	SURFACE (m^2/SHELL)	WEIGHT (tonne/SHELL)	INTERNALS/ H.E. TYPE (See Note 1)	FLUID T = Tube S = Shell	MATERIAL	DESIGN PRESSURE ($kg/cm^2.g$)	CONDITIONS TEMPERATURE (°C)	REMARKS
								T				
								S				
								T				
								S				
								T				
								S				
								T				
								S				
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Notes: 1. H.E. Type Coding - A.C. = Air Cooler; K = Kettle; U.B. = U - Tube Bundle; F.H. = Floating Head; F.T.S. = Fixed Tube Sheet

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A.K.C. TECHNOLOGY	**FAN/COMPRESSOR PROCESS DUTY SPECIFICATION**					Document No.			
						Sheet of		Rev.	
Job						Item No.(s)\			
Item Name						No. Working		Total No. Off	
	OPERATING CONDITIONS PER UNIT								
1		**UNITS**							
2	Operating Case								
3	Mass Flowrate	kg/h	lb/h						
4	Standard Volumetric Flowrate	nm^3/h	std ft^3/h						
5	Volume at Suction	m^3/h	ft^3/h						
6	**INLET CONDITIONS**								
7	Pressure	bara	psia						
8	Temperature	°C	°F						
9	Molecular Weight								
10	Cp/Cv								
11	Compressibility								
12	**DISCHARGE CONDITIONS**								
13	Pressure	bara	psia						
14	Temperature	°C	°F						
15	Cp/Cv								
16	Compressibility								
17	**GAS ANALYSIS**								
18		Mol %	Mol %						
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31	Entrained Liquids/Solids								
32	**PERFORMANCE**								
33	Compression Ratio								
34	Estimated Efficiency	%	%						
35	Estimated Absorbed Power	kW	hp						
36	Recommended Driver Power	kW	hp						
37	**MECHANICAL ARRANGEMENT**								
38	Compressor/Fan Type								
39	Number of Stages			**SKETCH**					
40	Gas to be kept Oil Free	Yes / No							
41									
42	Driver Type								
43									
44	Casing Design Pressure								
45	Design Pressure								
46									
47	Material - Casting								
48	- Impeller								
49									
50	Sour Service	Yes / No							
51	NOTES								
52	1. Cooling medium available:-								
53									
54									
55									

	1	Date	2	Date	3	Date	4	Date	5	Date
Description										
Made/Revised by										
Checked by										
Approved Process										
Approved by										

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A.K.C. TECHNOLOGY

FRACTIONATOR CALCULATION SUMMARY

Job:

Job No:
Item No:
Sheet ____ of _____

Distribution

Item Name:

Operate at ____ psig — Units: Metric / British (delete one)

Fractionation: — Reflux Ratio & No. of Plates:

Ovhd Prod: ____ C < ____ Reflux Ratio: ____ Actual: ____ ; Use ____

Bottoms: ____ C < ____ Rectifying Plates: ____ Theoretical: ____ ; Use ____

Stripping Plates: ____ Theoretical: ____ ; Use ____

	Feed				Net Bottoms						
Component		Mols	Mol %		Mols	Mol %	K $\frac{\text{Ksca } ^{o}C}{\text{psia } ^{o}F}$	KX	Pat ^{o}C ^{o}F	Vapour Pressure	
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

	Net Overheads						Ext. Rflx.	Gross Overheads				
Component		Mols	Mol %	K $\frac{\text{Ksca } ^{o}C}{\text{psia } ^{o}F}$	KX or $\frac{Y}{K}$		Mols	Mols	Mol %	K $\frac{\text{Ksca } ^{o}C}{\text{psia } ^{o}F}$	$\frac{Y}{K}$	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

Thermal Conditions of Feed: — Reboiler Vapour Quantity:

Stream	°API	Sp.Gr. at 15°C at 60°F	Temp. ^{o}C ^{o}F	Sp.Gr. at T°	Sp. Vol. At T° cu. m/kg cu. Ft/lb		Mols/hr	Mol. Wt.	Kg/hr lb/hr
Feed									
Net Bottoms									
Net Overheads									
Gross Overheads									
Gross Bottoms									
Reboiler Vapour									

REMARKS

Issue No.	1	Date	2	Date	3	Date
Made/Revised by						
Checked by						
Approved - Process						
Approved by						

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	GENERAL SERVICES AND UTILITIES CHECKLIST				
Job No.:				Sheet of	PREPARED BY:
Job Name:					
Document No.					DATE:
Project No.					
Client					
Location					
Plant					
SERVICE	SUSTAINED	QUANTITY PEAK	UNIT	OPERATING PRESSURE AND TEMPERATURE	REMARKS
ELECTRICAL 13.8 KV			*KVA		
ELECTRICAL 2300 V			*KVA		
ELECTRICAL 440 V			*KVA		
MISC. LIGHTING, ST. ETC., (110 V)			*KVA		
WELL WATER (CITY)			gpm		
SEA WATER			gpm		
RIVER WATER – PROCESS			gpm		
RIVER WATER – FIRE PROT.			gpm		
FUEL GAS			SCFM		
ODORIZED GAS			SCFM		
COMPRESSED AIR			SCFM		
STEAM			lb/h		
(400 OR 475) Psig			lb/h		
235 Psig			lb/h		
150 Psig			lb/h		
30 Psig			lb/h		
CONDENSATE RETURN			lb/h		
CONDENSATE USAGE			lb/h		
PROCESS TRANSFER AND RAW MATERIALS					
CAUSTIC (–%)			lb/h		
BRINE (–%)			lb/h		
LPG			lb/h		
SITE DEV. (AREA FILL)					
RAIL ROADS					
BLOCK ACCESS ROADS					
SANITARY SEWERS			gpm		
			gpm		
WASTE WATER					

* ASSUME 1 HORSE POWER = 1 KVA

NOTE: ONE COPY OF THIS LIST TO BE GIVEN TO SERVICE AND UTILITY SECTION.

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ΣΩΞ A.K.C. TECHNOLOGY

HAZARDOUS CHEMICAL AND CONDITIONS SCHEDULE

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	
Job Name:			Description					
Document No.			Made/Revised by					
Project No.			Checked by					
Client			Approved Process					
Location			Approved					
Plant								

1	2	3	4	5	6	7	8	9	10	1	12	13
Chemical Hazard	Chemical	Phase	Location in Plant		Fire Hazard							
	Symbol			Toxicity	Flash Point °C		Explosive Limits	% by Volume in Air	Autoignition	Suitable	Protective	Remarks
				(Note 3)	Closed Cup	Open Cup	Upper	Lower	Temp °C	Extinguishing Agents	Equipment	

Note:

1. This Schedule is given without any Legal responsibility on the part of AKC Technology.
2. Column 3: Vapor – V, Liquid – L, Solid – S
3. Toxicity: Denotes Threshold Limit (T.L.) under which it is believed nearly all workers may be exposed day after day without adverse effect. The figures relate to average concentration for a normal working day.
4. Column 11: A – Water, B – Powered Talc, $C – CO_2$, D – Dry Chemical, E – Foam, F – See Remarks
5. Column 12: B.A. – Breathing Apparatus, F.C. – Full Clothing, F.W. – Footware, G.O. – Goggles, G.V. – Gloves, X – See Remarks.

HEAT AND MASS BALANCES

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
			Made/Revised by						
Job Name:			Checked by						
			Approved Process						
			Approved by						

*delete unit as necessary			°API	K	M.W.	FLOWING SpGr	*°F °C	*barg psig	B.P.S.D. at 60°F	FLOWING GPM	Mol %	Mol/h	*kg/h lb/h	*kcal/kg Btu/lb	*106kcal/h 106Btu/h
Stream ↓	Units →?														
1															
2															
3															
4															
5															
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22-12-2006
5:26p.m.
Page:788
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HEAT EXCHANGER RATING SHEET

Document No.

Sheet of Rev.

Items No. (s)

PART 1 - TO BE FILLED IN COMPLETELY

1 Exchanger Name: *

2 Job: * * Location: *

3 Type of Unit: F.T.S.=0; FLTG.HEAD=1; U-TUBE=2; FOR KETTLES ADD 3

4 Hot Side: Either=0; Shell=1; Tubes=2

Arrangement: Horiz = 0; Vert = 1

Units: S.I. 0; Engineering = 1

	Units	S.I.	Engineering	HOT FLUID	COLD FLUID
6	Fluid Circulated	-	-		
7	Total Fluid Entering (Normal)	kg/hr	lb/hr		
8	Flow Margin	%	%		
9	Temperature In/Out	°C	°F		
10	Max Pressure Drop at line 8	bar	psi		
11	Inlet Pressure Operating/Design	barA	psia		
12	Normal Heat Load	kW	Btu/hr		
13	Heat Load Margin	%	%		
14	Design Temperature	°C	°F		
15	Corrosion Allowance	mm	ins		
16	Fouling Resistance	°Cm^2/WI	°F hr ft^2/Btu		
17	Line N.B. In/Out	mm	ins		
18	Part 2				
19	GAS (AD VAPOR) IN	-	-		
20	Flow of Vapor and Gas at Inlet	kg/hr	lb/hr		
21	Code Number	-	-		
22	Molecular Weight	-	-		
23	Thermal Conductivity	W/m °C	Btu/hr ft °F		
24	Specific Heat	kJ/kg °C	Btu/lb °F		
25	Compressibility Factor	-	-		
26	Viscosity	cP	lb/ft hr		
27	LIQUID IN	-	-		
28	Total Flow of Liquid at Inlet	kg/hr	lb/hr		
29	Code Number	-	-		
30	Thermal Conductivity	W/m °C	Btu/hr ft °F		
31	Specific Heat	kJ/kg °C	Btu/lb °F		
32	Density	kg/m^3	lb/ft^3		
33	Viscosity	cP	lb/ft hr		
34	Viscosity at Ave. Temp. other side	cP	lb/ft hr		
35	CONDENSATION AND VAPORIZATION	-	-		
36	Fluid Condensed or Vaporized	kg/hr	lb/hr		
37	Code Number	-	-		
38	Molecular Weight	-	-		
39	Thermal Conductivity	W/m °C	Btu/hr ft °F		
40	Specific Heat	kJ/kg °C	Btu/lb °F		
41	Density (Hot Fluid)	kg/m^3	lb/ft^3		
42	Compressibility Factor (Cold Fluid)	-	-		
43	Viscosity	cP	lb/ft hr		
44	Latent Heat	kJ/kg	Btu/lb		
45	Surface Tension	N/m	lb/ft		
46	Expansion Coefficient	1/ °C	1/ °F		
47	% Condensate Forming Film	%	%		
48	Thermal Conductivity	W/m °C	Btu/hr ft °F		
49	Density	kg/m^3	lb/ft^3		
50	Viscosity	cP	lb/ft hr		
51	Temps for Phase Change Start/Finish	°C	°F		
52	LMTD weighting Factor 'F'	-	-		
53	PART 3				
54	Number of Points in Table Below				

55	% Heat Load	%	%	1	2	3	4	5	6	7	8	9	10
56	Hot Fluid Temperature	°C	°F										
57	Cold Fluid Temperature	°C	°F										

58 PART 4 - CODE NUMBERS TO BE FILLED IN COMPLETELY

	Material for	Description	Code No.	O.D.	Thickness	Length	Passes	Number	Contents Lethal?
60	Tubes								Yes/No
61	Shell								Yes/No
62	Floating Head					Tube Pitch = mm/in.		o Δ □	
63	Channel								
64	Tube Sheets								

NOTES

	Issue No.	1 Date		2 Date		3 Date		4 Date		5 Date		
	Made/Revised by											
	Checked by											
	Approved- Process											
	Approved by											

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	A.K.C. TECHNOLOGY	**HYDROCARBON DEWPOINT CALCULATION**	Job No:
			Item No.
		Job:	Page of

Pressure: ..... psia

Heaviest Compound: PROPANE Convergence Pressure: ..... psia

	y	Tb	LIGHT COMPONENT		HEAVY COMPONENT		ASSUMED TEMPERATURE °F		°F		°F		°F		°F
			FeL	TbFeL	FeH	TbFeH	K	y/K	K	y/K	K	y/K	K	y/K	x
H_2		67	1.000	67.000											
N_2		130	0.0229	2.972	0.105	13.61									
CO		172	0.0046	0.797	0.180	31.00									
CH_4		201	0.0019	0.383	0.244	49.02									
C_2H_4		305			0.548	167.0									
CO_2		330			0.638	210.6									
C_2H_6		332			0.646	214.3									
C_2H_2		340			0.676	229.9									
C_3H_6		406			0.954	387.3									
C_3H_8		416			1.000	416.0									
		1.000													1.000
						Σ y/K									
						x for H_2									
						Σ (yFe_L/K)									
						Σ (yFe_H/K)									
						E.B.PL									
						E.B.PH									
						P_g									

Estimate of Dewpoint: ..... °F

at Estimate Pg of: ..... psia

Issue No.	1	Date	2	Date	3	Date
Made/Revised by						
Checked by						
Approved - Process						
Approved by						

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LINE LIST SCHEDULE

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date	4	Date	5	Date	6	Date
Job Name:			Description											
Document No.			Made/Revised by											
Project No.			Checked by											
Client			Approved Process											
Location			Approved											
Plant														

1 ISS COLUMN DATA CHANGES	2 LINE No.	2A	3 NOM. PIPE SIZE	4 PIPING SPEC.	5 FLUID DENSITY	PHASE	6 LINE FROM	ROUTING TO	7 PLANT CONDITION	8 OPERATING PRESS.	TEMP.	9 DESIGN PRESS.	TEMP.	10 INSULATION CLASS	NOM. THICK	11 FIELD TEST: TEST CLASS	CLASS	PRESS.	CLASS	PRESS.	12 FIELD TEST LIMITED BY	13 CHEMICAL CLEANING	14 REMARKS	14a STRESS CATEGORY	15 ELD DRG. No.	16 ISO. DRG. No.

UNITS: PRESSURE: barg psig $kg/cm^2 g$ TEMPERATURE: °C °F NOMINAL PIPE SIZE in. mm Insulation Thickness in. mm

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LINE SCHEDULE

TITLE:

Job No.:			Sheet of		Issue No.:	1	Date	2	Date	3	Date	
Job Name:					Description							
Document No.					Made/Revised by							
Project No.					Checked by							
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LINE NUMBER	SIZE in.	FROM	TO	LINE CLASS OR CODE	INSULATION CODE	TEST PRESSURE, psig	SPECIAL REMARKS

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Page:793
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LINE SCHEDULE SHEET

Job No.:			Sheet of		Issue No.:	1	Date	2	Date	3	Date	4	Date	5	Date		
Job Name:					Description												
Document No.					Made/Revised by												
Project No.					Checked by												
Client					Approved Process												
Location					Approved by												
Plant																	

LINE NUMBER	FLOW MEDIUM	QUANTITY FLOW, gpm or SCFH	QUANTITY FLOW lb/h	FLUID TEMP. °F	DENSITY lb/ft^3	DENSITY lb/gal	SpGr at 60° F	SpGr AT FLOW TEMPERATURE	EXPANSION COEFFICIENT	CHEMICAL FORMULA	MOL. MW	LINE SIZE	PRESS. DROP/100 ft	EST. LINE LENGTH	LINE PRESS DROP	LINE ORIGIN	LINE TERMINATION

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Page:794
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LINE SUMMARY TABLE

TITLE:

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved Process						
Location			Approved						
Plant									

NUMBER	MATERIAL	FROM	TO	LINE SIZE	OPERATING TEMP. ° F	OPERATING PRESS. psig	TEST PRESS. psig	QUANTITY lb/h	QUANTITY GPM at 60° F	QUANTITY GPM (HOT)	QUANTITY CFS (HOT)	VEL. fps	PRESSURE DROP PER 100 ft psi	PRESSURE DROP TOTAL psi	REMARKS	NO.

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MASS BALANCE

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved Process						
Location			Approved						
Plant									

STREAM NUMBER		▽		▽		▽		▽		▽		▽		▽			
STREAM NAME																	
PHASE																	
TEMPERATURE (° C)																	
	COMPONENT	MOL WT	kg mol/h	Mol %	kg mol/h	Mol %	kg mol/h	Mol %	kg mol/h	Mol %	kg mol/h	Mol %	kg mol/h	Mol %	kg mol/h	Mol %
1	Water																
2	Hydrogen																
3	Nitrogen																
4	Carbon monoxide																
5	Carbon dioxide																
6	Methane																
7	Acetylene																
8	Ethylene																
9	Ethane																
10	Propyne																
11	Propadiene																
12	Propylene																
13	Propane																
14	Isobutane																
15	Isobutene																
16	*n*-Butane																
17	1-Butene																
18	1,3-Butadiene																
19	1-Pentene																
20	neo-Pentane																
21	Isopentane																
22	*n*-Pentane																
23	Toluene																
24	*m*-Xylene																
25	Methanol																
26	MTBE																
27	TBA																
28	DIISO																
29	TOTAL (kg mol/h)																
30																	
31																	
32																	
33																	
34																	
35																	
36																	
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42	Notes:																
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Page:796
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MECHANICAL EQUIPMENT SCHEDULE

Job No.:			Sheet of		Issue No.:		1	Date	2	Date	3	Date	
Job Name:					Description								
Document No.					Made/Revised by								
Project No.					Checked by								
Client					Approved Process								
Location					Approved								
Plant													

ITEM No.	No. OFF	SERVICE DESCRIPTION	FLUID	S.G/M.W	CAPACITY (m^3/h) (Turbine - Te/h)	PRESSURE (kg/cm^2g) IN	PRESSURE (kg/cm^2g) OUT	INLET TEMP. (°C)	$NPSH_A$ (m)	TYPE (see Note 1)	MATERIALS	ABSOLUTE POWER (kW)	SPEED (RPM)/ REMARKS

Notes: 1. Rotary Equipment Type Coding: A = Axial; C = Centrifugal; M = Metering; R = Reciprocating; S = Screw
2. All drives electric motor unless specified otherwise.

	PIPE LINE LIST																
	TITLE:																
Job No.:			Sheet of					Issue No.:	1	Date	2	Date	3	Date			
Job Name:								Description									
Document No.								Made/Revised by									
Project No.								Checked by									
Client								Approved Process									
Location								Approved									
Plant																	

LINE NUMBER	FROM	TO	TEMPERATURE (°F) OPERATING	DESIGN	PRESSURE (psig) OPERATING	DESIGN	VELOCITY ft/s	PRESSURE/100 ft PD/100 ft	FLOW[1]	P&ID NUMBER	

Note: 1. Flow Units: G = gpm; C = acfm; P = lb/h

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	PIPE LIST TITLE:												
Job No.:		Sheet of			Issue No.:	1	Date	2	Date	3	Date		
Job Name:					Description								
Document No.					Made/Revised by								
Project No.					Checked by								
Client					Approved Process								
Location					Approved								
Plant													

LINE NUMBER	FROM	TO	TEMPERATURE (° F) OPERATING	DESIGN	PRESSURE (psig) OPERATING	DESIGN	VELOCITY ft/s	PRESSURE/100 ft PD/100 ft	FLOW[1]	P&ID NUMBER	

NOTE: 1. FLOW UNITS: G = gpm; C = acfm; P = lb/h

PIPING PROCESS CONDITIONS SUMMARY

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved Process						
Location			Approved						
Plant									

INDEX NUMBER	MATERIAL AND COMPOSITION	FLUID SYMBOL	HAZARDOUS MATERIAL CLASSIFICATION	FLUID STATE LIQUID/GAS	MAXIMUM PIPE SIZE in.	MAXIMUM OPERATING TEMPERATURE, °F	CONTINUOUS RANGE PRESSURE, psia	PIPE SPECIFICATION	NOTES

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A.K.C. TECHNOLOGY	**PLATE HEAT EXCHANGER DATA SHEET**	Document No.		
		Sheet of		Rev.
Job		Item No.(s)		
Item Name		No. Working		Total No. Off

	PROCESS DESIGN	UNITS		FLUID 1	FLUID 2	FLUID 3
2	Fluid Circulated	-	-			
3	Total Fluid Entering (Normal)	kg/h	lb/h			
4	Flow Margin	%	%			
5	Inlet Vapor and Gas (&MW)	kg/h	lb/h			
6	Inlet Liquid	kg/h	lb/h			
7	Fluid Vaporized/Condensed (&MW)	kg/h	lb/h			
8	Temperature In/Out	°C	°F			
9	Max. Pressure Drop	bar	psi			
10	Inlet Pressure (Operating)	bar g	psig			
11	Normal Heat Load	kW	Btu/h			
12	Heat Load Margin	%	%			
13	Fouling Resistance	m^2 °C/W	ft^2 °Fh/Btu			
14	FLUID PROPERTIES					
15	Specific Heat	kJ/kg°C	Btu/lb °F			
16	Thermal Conductivity	W/m °C	Btu/hr ft °F			
17	Density	kg/m^3	lb/f^{t3}			
18	Viscosity	cP	lb/hr.ft			
19	Liquid Viscosity (at Temp.)	cP	lb/hr.ft			
20	Latent Heat	kJ/kg	Btu/lb			
21	ENGINEERING DESIGN					
22	Process Design Pressure	bar g	psig			
23	Process Design Temperature	°C	°F			
24	Corrosion Allowance (Header)	mm	in.			
25	Line N.B. In/Out	in	in.			
26	Minimum Flow Passage	mm	in.			
27	Plate Material					
28	Frame Material					
29	Gasket Material					
30	Desgin Code					

31 NOTES

32

33 1. Unless otherwise stated fluid properties are for mean fluid temperatures.

34 2. Sour Service Yes / No

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	1	Date	2	Date	3	Date
Description						
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Approved by						

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Made / Checked / Date		PROCESS DATA SHEET	Job No. / Item No.
	A.K.C. TECHNOLOGY	Job	Sheet of

CALCULATION OF PRESSURE DROP IN FIXED CATALYST BEDS

REQUIRED DATA

VESSEL NO: ----------

SERVICE: ----------

CATALYST:	VOLUME REQUIRED		V		ft^3
	MANUFACTURER & NO.				
	DIMENSIONS				
	EQUIV. PARTICLE DIA.		D_p		ft.
	SHAPE/SIZE FACTOR		S_f		
GAS DATA:	FLOW RATE		W		lb/h
			W^2		$(lb/h)^2$
	MIN. MOLECULAR WEIGHT				
	BED OUTLET PRESSURE		P		psia
	MAX. BED TEMPERATURE				°C
	ABS. TEMPERATURE (°K = °C + 273)		T		K

CALCULATION

$$k_1 = \frac{(T)(S_f)}{(M)(P)} = \text{\_\_\_\_\_} =$$

	SYMBOLS	UNITS	CALCULATION	CASE 1	CASE 2	CASE 3	CASE 4
BED DIAMETER	D	ft					
BED C.S.A.	A	ft^2	$0.7854D^2$				
BED DEPTH	L	ft.	V/A				
SUPERFICIAL MASS FLOW	G	$lb/h.ft^2$	W/A				
MASS FLOW FACTOR	G_f	-					
D_pG		-					
REYNOLDS NO. FACTOR	Re_f	-					
k_2	k_2	-	k_1Re_f				
CLEAN PRESSURE DROP/UNIT DEPTH	ΔP_c	psi/ft.	k_2Gf				
CLEAN OVERALL PRESSURE DROP	ΔP_c	psi	$L\Delta Pc$				
SAFETY/FOULING FACTOR	f	-		1.25/			
FLOW SHEET PRESSURE DROP	ΔP	psi	$f\Delta Pc$				

* IF VALUE OF DpG > 200 (750 FOR RING CATALYSTS) PUT Ref = 1.0
IF VALUE OF DpG < 200 (750 FOR RING CATALYSTS) CALCULATE Re = DpG/μ
(WHERE μ = DYNAMIC VISCOSITY OF GAS, lb/ft.hr)

	1	2	3	4	5	6
Description						
Made/Revised by						
Checked by						
Approved Process						
Approved by						

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A.K.C. TECHNOLOGY	PROCESS ENGINEERING JOB ANALYSIS SUMMARY		
Job Title			
Job No.	Charge No.	Date	
Based Upon Cost Estimated Dated		or Actual Construction Cost	
Summary Prepared By		Information Dated	
Production Basis (lb/day, tonnes/day, lb/month)			

	SERVICE REQUIREMENTS:	UNIT RATE	UNIT RATE/ PRODUCTION BASIS
1	Steam (30 lb)	lb/h	
2	Steam (150 lb)	lb/h	
3	Steam (400 lb)	lb/h	
4	Steam (lb)	lb/h	
5	Treated R.W.	gpm	
6	Untreated R.W.	gpm	
7	Fresh Water	gpm	
8	Sea Water	gpm	
9	Fuel Gas (psi)	cfm (60° F and 1atm)	
10	Air (psi)	cfm (60° F and 1atm)	
11	Power ( )		
12	Horsepower		
13	Condensate	lb/h	
14			
	RAW MATERIALS	UNIT RATE	
1	Chlorine		
2	Hydrogen (%)		
3	Caustic (%)		
4	Salt		
5	Sat. Brine		
6	Natural Gas		
7	Air		
8	Ethylene		
9			
10			
11			
	PRODUCTS AND BY- PRODUCTS	UNIT RATE	
1	Chlorine		
2	HCl (%)		
3	Salt (%)		
4	Caustic (%)		
5	Ammonia (%)		
6	H_2SO_4 (%)		
7	Gas ( )		
8			
9			
10			
11			

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ΣΩΣ A.K.C. TECHNOLOGY		PUMP CALCULATION SHEET			Document No.								
					Sheet of Rev.								
Job					Item No. (s)								
Item Name.					No. Working		Total No. off						
		UNITS		CASE I	CASE II	SKETCH OF PUMP HOOK-UP							
1													
2	Liquid Pumped												
3	Corrosion/Erosion												
4	Due To												
5	Operating Temp. (T)	°C	°F										
6	Specific Gravity at T												
7	Viscosity	cP	cP										
8	Vapor Pressure at T	bara	psia										
9	Normal mass Flowrate	kg/h	lb/h										
10	Normal Vol. Flowrate	m^3/h	gpm										
11	Min. Vol. Flowrate												
12	Design Vol. Flowrate	m^3/h	gpm										
13	SUCTION CONDITION												
14	Pressure at Equipment	barg	psig	+	+								
15	Static Head	bar	psi	+ / –									
16	Total – Lines 14 + 15	bar	psi	+	+								
17	Suction Line ΔP	bar	psi	–	–								
18	Filter/Strainer ΔP	bar	psi	–	–								
19													
20	Total Suction Pressure	barg	psig	+	+								
21	DISCHARGE CONDITION												
22	Pressure at Equipment	barg	psig	+	+								
23	Static Head	bar	psi	+ / –	+ / –								
24													
25	Exchanger ΔP	bar	psi	+	+								
26													
27	Furnace ΔP	bar	psi	+	+								
28	Orifice ΔP	bar	psi	+	+								
29	Control Valve ΔP	bar	psi	+	+								
30													
31	Line ΔP	bar	psi	+	+								
32													
33	Total Discharge Press.	barg	psig	+	+								
34	Differential Pressure	bar	psi										
35	Differential Head	bar	psi										
36	NPSH					NOTES							
37	Total Suction Pressure	bara	psia			1. Pump shut-off head not to exceed……							
38	Vapor Pressure	bara	psia										
39	NPSH – Lines 37 – 38	bara	psia			2. Relief valve on pump discharge to be set at ……							
40	=	m	ft										
41	Safety Margin	m	ft			3. Pump case design pressure……							
42	NPSH – Lines 40–41	m	ft			design temperature……..							
43	Hydraulic Power	kW	Hp										
44	Estimated Efficiency	%	%			4. Sealing/flushing fluid available:							
45	Estimated Abs. Power	kW	Hp										
46	Type of Pump					5. Cooling medium available:							
47	Drive												
48						6. Insulation required:							
49	Material – Casing												
50	– Impeller					7. Start-up/commissioning fluid SG.							
51	– Shaft												
52													
53	Sour Service	Yes/No											
54	HEAD	$m = 10.2 \times bar/SG$		$m = 10 \times kg/cm^2/SG$		$ft = 2.31 \times psi/SG$							
55	VOLUME	$m^3/h \times SG \times 1000 = kg/h$		$igpm \times SG \times 600 = lb/h$									
56	POWER	$kW = m^3/h \times bar/36.0$		$kW = m^3/h \times kg/cm^2/36.71$		$Hp = igpm \times psi/1427$							
57		1	Date	2	Date	3	Date	4	Date	5	Date		
58	Description												
59	Made/Revised by												
60	Checked by												
61	Approved Process												
62	Approved												

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Chapter:0capaappA
22-12-2006
5:26p.m.
Page:804
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	PUMP SCHEDULE																	
	Job No.:					Sheet of			Issue No.:		1	Date	2	Date	3	Date		
	Job Name:								Description									
	Document No.								Made/Revised by									
	Project No.								Checked by									
	Client								Approved- Process									
	Location								Approved									
	Plant																	
1	Item Number.																	
2	Item Name																	
3	Number Off: No. Running /Total Installed																	
4	Preferred Type	Units																
5	Liquid Pumped																	
6	Operating - Temperature	°C	°F															
7	Specific Gravity at Operationg Temperature																	
8	Viscosity at Operating Temperature	cP	lb/ft.h															
9	Vapor Pressure at Operating Temperature	bara	psia															
10	Design Capacity (per pump)	m^3/h	ft^3/h															
11	Normal Capacity (per pump)	m^3/h	ft^3/h															
12	Discharge Pressure	bar g	psig															
13	Suction Pressure	bar g	psig															
14	Differential Head	bar /m	psi/ft															
15	Minimum NPSH Available / Required	m	ft.															
16	Hydraulic Power (per pump)	kW	hp															
17	R.P.M	-	-															
18	Estimated Pump Efficieny	-	-															
19	Estimated Shaft Power (per pump)	kW	hp															
20	Type of Driver	-	-															
21	Driver Rated Power (per pump)	kW	hp															
22	Design Power Consumption (per pump)	kW	hp															
23	Normal Power Consumption (per pump)	kW	hp															
24	Max. Shut-Off Head	bar	psi															
25																		
26	Material: Casing																	
27	Impeller																	
28	Shaft																	
29	Sour Service																	
30	Packing Type / Mechanical Seal Type																	
31																		
32	Services / Utilities																	
33	Cooling Water																	
34	Seal / Flush Fluid	m^3/h	ft^3/h															
35	Quench	m^3/h	ft^3/h															
36	Notes																	
37																		
38																		
39																		
40																		
41																		
42																		
43																		
44																		
45																		

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A.K.C. TECHNOLOGY	RELIEF DEVICE PHILOSOPHY SHEET	DOCUMENT / ITEM REFERENCE			
	EQUIPMENT No.:				
	DATE:	SHEET No.:	OF		
CHECKED BY:	MADE BY:				
DESIGN CODES:	VESSELS	EXCHANGERS	LINES		
OTHER REQUIREMENTS					
BASIS FOR CALCULATION:					
SET PRESSURE, PSIG:	MAX. BACK PRESSURE:	(a) BEFORE RELIEVING		(b) WHILE RELIEVING	
NORMAL CONDITIONS UNDER RELIEF DEVICE:				Calculated	
STATE: TEMPERATURE, °F:	PRESSURE, PSIG:	POSSIBLE CAUSE?	FLUID RELIEVED	RELIEF RATE, lb/h	ORIFICE AREA, in^2.
HAZARDS CONSIDERED					
1. Outlets blocked					
2. Control Valve malfunction					
3. Machine trip/ overspeed/density change					
4. Exchanger tube rupture					
5. Power failure/ Voltage dip					
6. Instrument air failure					
7. Cooling failure					
8. Reflux failure					
9. Abnormal entry of volatile liquid					
10 . Loss of liquid level					
11. Abnormal chemical reaction					
12. Boxed in thermal expansion					
13. External fire					
14. (specify)					
15. (specify)					
16. (specifty)					
SELECTED DESIGN CASE:					
RELIEVED FLUID: STATE	DENSITY / MW:	TEMPERATURE:		Cp/Cv:	
COMPOSITION:				FLASHING:	
RELIEF RATE REQUIRED, lb/h:	ORIFICE SELECTED:	AREA, in^2:		TYPE:	
ACTUAL CAPACITY, lb/h					
REMARKS/SKETCH					

Issue No:	1	Date	2	Date	3	Date	
Description							
Made/Revised by							
Checked by							
Approved- Process							
Approved							

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A.K.C. TECHNOLOGY	**TANK AND VESSEL AGITATOR DATA SHEET** Project Name:		Drawing No: Project No.: sheet …….. Of ……..
	Equipment No:	No. Off:	Associated Vessel/Tank* Item No:
PROCESS DEPT. INFORMATION — PROCESS	1. Largest and smallest charge:		
	2. Components added during mixing:		
	3. Agitator operating while vessel is being filled or product withdrawn? Yes/No*		
	4. If continuous, throughput per hour:		
	5. Process duty: Mixing liquids/Dissolving/Suspensions/Emulsions/Gas absorption/Homogenisation*		
	6. Mixing effect: Violent/Medium/Moderate*		Time available for mixing:
	7. Working Pressure:		Design Pressure:
	8. Working Temperature:		Design Temperature:
	9. Special Remarks:		
PROCESS DEPT. INFORMATION — MIXING	10. Components % by weight:		
	11. Temperature during mixing:		
	12. Specific gravity of components:		
	13. Viscosity of mixing at mixing temperature:		
	14. Specific gravity of product at mixing temperature:		
	15. Size of solid particles:		
	16. Special Remarks:		
DESIGN DEPT . INFORMATION — IMPELLER	17. Type of impeller:		
	18. Number of impellers on shaft:		
	19. Position of impellers:		
	20. Distance between shaft end & vessel:		Bottom bearing:
	21. Preferred impeller speed:		Shaft diameter:
	22. Type of drive: Direct/Vee belt/Fluid*		
	23. Type of seal: Vapor/Packed gland/Mechanical/Easy replacement*		
	24. Method of installation: Assembled in/Assembled out* of vessel		
	25. Entry position:		
	26. Materials of construction:		
	27. Absorbed HP/KW*:		Installed HP/KW*:
	28. Other information:		
DESIGN DEPT . INFORMATION — TANK OR VESSEL	29. Dimensions:		Capacity:
	30. Coils, baffles, etc.:		
	31. Fixing agitator (beams, flanges, etc.):		
	32. If at atmospheric pressure: Closed/Open*		Can stuffing box be greased? Yes/No*
	33. Headroom available above agitator:		
	34. Other information:		
DESIGN DEPT . INFORMATION — ELECT.	35. Agitator installed: Indoors/Outdoors		Motor enclosure:
	36. Electrical specification:		
	37. Any other electrical information:		
DESIGN DEPT . INFORMATION — GENERAL	38. Motor to be included: Yes/No*		
	39. Motor Will/Will not* be sent to manufacturer for assembly and alignment.		
	40. Threads: Unified /*		
	41. All rotating parts must be strictly guarded to BS 1649/ASME		
	42. Fixing bolts supplied by:		
	43. Net weight including motor:		
	44. Witnessed run in air:		
	45. General notes:		

	Date	3	Date	2	Date	1
Description						
Made/Revised by						
Checked by						
Approved Process						
Approved						

NOTE: * Indicates delete as necessary.

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	A.K.C. TECHNOLOGY	**TANK PROCESS DATA SHEET**					Doc. No: Item No. Sheet of			
		Job:								
	Item Name:									
	NOTE: * indicates delete as necessary; ** indicates for other than Code reason									
5										
10										
15										
20										
25										
26	Shell Diameter (O.D. / I.D.):					Shell Length:			No. Required:	
27	Center Line: *Horizontal / Vertical									
28		Pressure: g		Temperature: °F / °C		Nozzles	Mark No.	Size	Number	
29	Item Number					Inlet	C-			
30	Operating									
31	Design					Vapor Out	C-			
32	Emergency Vacuum Design: * Yes / No									
33		Material		Corr. Allowance		Liquid Out:	C-			
34	Shell									
35	Heads									
36	Liner					Thermocouple	R-	by Inst. Op.		
37	Type of Heads					Pressure Gauge	R-			
38	Code:					Gauge Glass	R-			
39	Stress Relieve**: Radiography**:					Level Control	R-			
40	Joint Efficiency:					Safety Valve	R-			
41	Density of Contents: at °F / °C									
42	Weight Empty: Weight Full:									
43	Is vessel subject to mechanical vibration? *Yes / No					Vent	C-			
44	insulation: Type: *Frost and Personnel Protection / Cold					Drain	C-			
45	*Yes / No Anticondensation / Heat Conservation					Steam Out	C-			
46	REMARKS:									
47						Manhole	A-			
48										
49										
50										
51										
52										
53						min. Base Elev'n:		k-Skirt Length		
54						Material:				

Issue No.	1	Date	2	Date	3	Date	4	Date	
Made/Revised by									
Checked by									
Approved - Process									
Approved by									

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	A.K.C. TECHNOLOGY	TANK SCHEDULE										
	Job No.:				Sheet of	Issue No.:	1	Date	2	Date	3	Date
	Job Name:					Description						
	Document No.					Made/Revised by						
	Project No.					Checked by						
	Client					Approved- Process						
	Location					Approved						
	Plant											
1	Item Number.											
2	Item Name											
3	Number Required											
4	Type	Units										
5	Length x Width	mm	in.									
6	Height	mm	in.									
7	Diameter											
8	Minimum Base Elevation	mm	in.									
9	Total Volume	m^3	ft^3									
10	Working Capacity	m^3	ft^3									
11	Internals / Fittings											
12												
13												
14	Operating Pressure	bar g	psig									
15	Operating Temperature	°C	°F									
16	Design Pressure +/ -	bar g	psig									
17	Design Temperature	°C	°F									
18	Vacuum Design											
19	Material: Shell											
20	Liner											
21	Internals											
22												
23	Shell Corrosion Allowance	mm	in.									
24	Sour Service											
25	Stress Relieved for Process Reasons											
26	Insulation											
27												
28												
29												
30	Notes											
31												
32												
33												
34												
35												
36												
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Job Code:CAPA
Chapter:0capaappA
22-12-2006
5:26p.m.
Page:809
Trimsize:8.5in×11in

TIE-IN-SCHEDULE

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:			Description						
Document No.			Made/Revised by						
Project No.			Checked by						
Client			Approved Process						
Location			Approved						
Plant									

TIE-IN NUMBER	SERVICE	DESCRIPTION	EXISTING LINE NUMBER	NEW LINE NUMBER	EXISTING ELD* NUMBER	NEW ELD* NUMBER	REMARKS	TIE-IN NUMBER

*ELD=ENGINEERING LINE DRAWING

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Made by: Date: Checked by:				**TOWER PROCESS DATA SHEET**			Document No.			
				Job			Item No:(s)			
				Item Name			Sheet of			
	Tower Name:									
	NOTE: * indicates delete as necessary; ** indicates for other than code reason									
1				Top	Bottom					
2	Shell Diameters O.D. - I.D.									
3	No. of Trays									
4	Pressure		Operating							
5	*psig		Design							
6	Temperature		Operating							
7	*°F / °C		Design							
8	Material		Shell							
9			Trays							
10			Caps							
11			Liner or Clad							
12	Corrosion -		Shell							
13	Allowance		Heads							
14			Trays							
15	Tray Spacing									
16	Type of Liquid Flow									
17	Type of Trays									
18	Joint Efficiency									
19	Code			Emergency Vac. Design *Yes / No						
20	Stress Relieved **Yes / No			Radiography **Yes / No						
21	Is vessel subject to mechanical vibration *Yes / No									
22	Insulation		Type: *Frost and Personnel Protection / Cold /							
23	*Yes / No		/anticondensation / Heat Conservation /							
24	Min. Base Elevation:				Skirt length:					
25	Weight Empty:				Full:					
26	Nozzles	Mark No.	Size	Number						
27	Feed	C-								
28										
29	Overhead Vpr.	C-								
30	Reflux In	C-								
31										
32	Bottoms	C-								
33	Reboiler Vpr	C-								
34	Reboiler liq	C-								
35										
36										
37	Thermocouple	R-	by inst. Gp.							
38	Level Glass	R-								
39	Press Gauge	R-								
40	Level Control	R-								
41	Safety Valve	R-								
42										
43										
44	Vent	C-								
45	Drain	C-								
46	Steam Out	C-								
47	Manholes	A-								
48	Handholes	A-								
49	Cap Type:			Tray Layout Ref:						
50	NOTES									
51										
52										
53										
54										
55			1	Date	2	Date	3	Date	4	Date
56	Description									
57	Made/Revised by									
58	Checked by									
59	Approved Process									
60	Approved by									

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	A.K.C. TECHNOLOGY	**TRAY LOADING SUMMARY**				Job No.			
						item No.			
		Job:				Sheet of			
	Tower Name:			Type of Tray					
1	Manufacturer					Mfr. Ref:			
2	Pressure at top of Tower	barg	psia						
3	Max. ΔP over Tower	bar	psi			units Used: METRIC/BRITISH (delete one)			
4	No. of Trays			Aboved Feed			Below Feed		
5	Tray location								
6	Tray Number*								
7	Tray Spacing	mm	in.						
8	Tower Internal Diameter I.D.	mm	in.						
9	Vapor to Tray								
10	Temperature	°C	°F						
11	Compressibility								
12	Density	kg/m^3	lb/ft^3						
13	Molecular Weight								
14	Rate	kg/h	lb/h						
15									
16	Liquid from Tray								
17	Temperature	°C	°F						
18	Surface Tension	dynes/cm	lb/ft						
19	Viscosity	cps	lb ft/hr						
20	Density	kg/m^3	lb/ft^3						
21	Rate	kg/h	lb/h						
22	Foaming Tendency **								
23	Number of Passes								
24	Minimum Hole Diameter ***	mm	in.						
25	Minimum DC Residence Time***	secs	s						
26	Maximum Rate as % Design								
27	Minimum Rate as % Design								
28	Design Rate % Flood Rate***								
29									
30	Tray Material								
31	Valve or Cap Material								
32	Corrosion Allowance	mm	in.						
33	Tray Thickness***	mm	in.						
34									
35									
36									
37									
38	NOTES: * Trays are numbered from the bottom of the tower upwardstop of the tower downwards								
39	** Indicate whether 'non', 'moderate', 'high' or 'severe'								
40	*** Data to be supplied by tray manufacturer unless special Process/Client requirement entered here.								
41	REMARKS:								
42									
43									
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55			1	Date	2	Date	3	Date	
56		Description							
57		Made/Revised by							
58		Checked by							
59		Approve - Process							
60		Approved by							

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ΣΩΣ	TRIP SCHEDULE										
Job No.:				Sheet of		Issue No.	1 Date		2 Date		
Job Name:						Decription					
Document No.						Made/Revised by					
Project No.						Checked by					
Client						Approved Process					
Location						Approved					
Plant											

1	2	3	4	5	6	7	8	9	10	11	12
INITIATING VARIABLE	BASIC	PRE-	ALARM	CUT	OUT	FIRST FAULT	INHIBIT	TRIP LINKAGE	ITEM	PRIMARY	REMARKS
	INST. No.	INST. No.	SETTING	INST. No.	SETTING	INDICATION	SWITCH		ACTUATED	PROCESS EFFECT	

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22-12-2006
5:26p.m.
Page:813
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UTILITY SUMMARY SHEET

Job No.:		Sheet of		Issue No.:		1	Date	2	Date	3	Date	4	Date	5	Date	6	Date		
Job Name:				Description															
Document No.				Made/Revised by															
Project No.				Checked by															
Client				Approved- Process															
Location				Approved by															
Plant																			

Item No.	Item Name	NUMBER OFF		ELECTRICITY					STEAM/ CONDENSATE/ BOILER FEEDWATER					COOLING WATER See Note 2				FUEL		COMPRESSED AIR	REMARKS AND OTHER SERVICES
		Inst'd	Work'g	Motor Efficiency %	Per Machine Consumption Shaft	Per Machine Consumption Electrical	Installed Electrical	Total Consumption Electrical HT	Total Consumption Electrical LT	See Note 1											
										P=	*P*=	*P*=	Condensate	BFW	Source	I	Source	II	Absorbed	Fired	P=
										T=	*T*=	*T*=			Flow	ΔT	Flow	ΔT			See Note 1
					kW	kW	kW	kW	kW	kg/h=	kg/h=	kg/h=	kg/h=	kg/h=	m^3/h	°C	m^3/h	°C	kW	kW	nm^3/h

Note 1: State units - *P* is *T* is

Note 2: Cooling water Source I is: Source II is

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Chapter:0capaappA
22-12-2006
5:26p.m.
Page:814
Trimsize:8.5in×11in

VESSEL AND TANK SCHEDULE

Job No.:				Sheet of		Issue No.:		1	Date	2	Date	3	Date	
Job Name:						Description								
Document No.						Made/Revised by								
Project No.						Checked by								
Client						Approved Process								
Location						Approved								
Plant														
ITEM No.	No. UNITS	SERVICE DESCRIPTION	VERTICAL OR HORIZONTAL	DIAMETER	LENGTH	THICKNESS HEAD	THICKNESS SHELL	LINING	INSULATION CODE	TEST PRESSURE, psig	WEIGHT	REFERENCE DRAWING	PURCHASE ORDER TO	P.O. Number

ΣΩΣ A.K.C. TECHNOLOGY

VESSEL AND TANK SUMMARY
Driver

Job No.:		Sheet of	Issue No.:	1	Date	2	Date	3	Date	4	Date	5	Date
Job Name:			Description										
Document No.			Made/Revised by										
Project No.			Checked by										
Client			Approved- Process										
Location			Approved										
Plant													

				CAPACITY		THICKNESS, INCHES			CORROSION ALLOWANCE INCHES	MATERIAL SHELL & HEADS	SADDLE SKIRT SUPPORT	PRESSURE, PSIG			TEMP., °F		CODE	STAMP	REFERENCE DRAWING No.	NOTES
ITEM No.	EQUIPMENT	TYPE	O.D.	HEIGHT or LENGTH.	GALLONS	SHELL	HEAD	SADDLE SKIRT SUPPORT				OPER'N	DESIGN	TEST	OPER'N	DESIGN				

Figure 1-38 Vessel and tank summary

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Chapter:0capaappA
22-12-2006
5:26p.m.
Page:816
Trimsize:8.5in×11in

VESSEL SCHEDULE

Job No.:				Sheet of	Issue No.:	1	Date	2	Date	3	Date
Job Name:					Description						
Document No.					Made/Revised by						
Project No.					Checked by						
Client					Approved- Process						
Location					Approved						
Plant											
1	Item Number.										
2	Item Name										
3	Number Required										
4		Units									
5	Shell Diameter (O.D/I.D.)	mm	in.								
6	Shell Length	mm	in.								
7	Center Line (H/V)										
8	Boot Size	mm	in.								
9	Base Elevation	mm	in.								
10	Internals										
11											
12											
13											
14	Operating Pressure	bar g	psig								
15	Operating Temperature	°C	°F								
16	Design Pressure	bar g	psig								
17	Design Temperature	°C	°F								
18	Vacuum Design										
19	Material: Shell										
20	Liner										
21	Internals										
22											
23	Shell Corrosion Allowance	mm	in.								
24	Sour Service										
25	Stress Relieved for Process Reasons										
26	Insulation										
27											
28											
29											
30	Notes										
31											
32											
33											
34											
35											
36											
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ΣΩΣ A.K.C. TECHNOLOGY		**WATER ANALYSIS SHEET**	Submitted by: Address:		Location: Date:			
	**	Analysis	No. Date:					
		pH Value						
		Suspended Solids	mg/l					
		Total Dissolved Solids	mg/l at 110° C					
		Total Dissolved Solids	mg/l at 180° C					
		Alkalinity to Pp	as mg/l $CaCO_3$					
		Alkalinity to MO	as mg/l $CaCO_3$					
		Sulphate	as mg/l SO_4					
		Chloride	as mg/l Cl					
		Nitrate	as mg/l NO_3					
		Silica	as mg/l SiO_2					
		Phosphate	as mg/l PO_4					
		Total Anions	as mg/l $CaCO_3$					
		Total Hardness	as mg/l $CaCO_3$					
		Calcium	as mg/l Ca					
		Magnesium	as mg/l Mg					
		Sodium*	as mg/l Na					
		Potassium*	as mg/l K					
		Iron	as mg/l Fe					
		Manganese	as mg/l Mn					
		Free and Saline Ammonia	as mg/l NH_3					
		Total Cations	as mg/l $CaCO_3$					
		Free Dissolved CO_2	as mg/l CO_2					
		Dissolved O_2	as mg/l O					
		Color Hazaen Units						
		Turbidity Formazin Units+	FTU APHA					
		Lead	as mg/l Pb					
		Copper	as mg/l Cu					
		Residual Chlorine						
		Flouride	as mg/l F					
		Sulfite	as mg/l SO_3					

NOTES: 1. Please state if units other than milligrams per liter, or different conditions of test, are used.
2. * If Na and/or K form an appreciable amount of total cations, please state Alkalinity to Phenolphthalein (p), Alkalinity to Methyl Orange (MO), and Carbonate Hardness.
3. + DO NOT use Formazin Units as defined by British Standard BS. 2690 Pt. 9.
4. ** Tick if item definitely to be included in analysis.
5. 100 mg/L $CaCO_3$ = 2 milliequivalents/(m val/L).

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