Specific Potential Problems

	Threat		
	Probability	Seriousness	Total Score
1. Raw Materials Received			
a. Biphenyl			
1) Variation in quality	60	3	180
a) Moisture contaminated	30	1	30
b) Impurity level	50	9	450
2) Availability	10	10	100
b. Chlorine Snift Gas			
1) Variation in quality	100	9	900
a) Impurity level (Bromine)	100	9	900
b) Sulfuric Acid content	5	9	45
2) Availability	10	10	100
c. $FeCl_3$			
1) Particle size too large or too small	5	5	25
2) Moisture contamination	.5	10	50
3) Availability	10	10	100
d. Lime			
1) Availability	5	10	50
2) Moisture contamination	5	2	10
e. Porocel			
1) Availability	5	10	50
2) Moisture contamination	5	9	45
3) Particle size too large or too small	10	5	50
2. Raw Materials In Storage			
a. Biphenyl			
1) Moisture contamination	10	10	100
2) Storage tank freeze-up	10	3	30

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	Threat Probability	Seriousness	Total
3. Chlorinator Area			
a. $FeCl_3$ Mix Tank			
1) Inadequate catalyst supply to #6 chlorinator	5	10	50
b. Chlorinators			
1) Unstable product	20	10	200
2) Crude 1142 out-of-spec on Sp. Gr.	20	10	200
3) Inadequate biphenyl feed to #6 chlorinator	10	10	100
4) Inadequate temperature control	10	3	30
c. Intermediate Storage Tank			
1) Cannot feed stills or head tank	10	3	30
2) Cannot maintain proper aging temperature	10	6	60
3) HCl emissions	20	8	160
d. Blow Tank			
1) Cannot feed stills at required rate	10	8	80
2) Cannot control level in tank	10	8	80
3) HCl emissions	20	8	160
4) HCl is not removed to desired level	10	2	20
e. Off-gas system			
1) Cannot control off-gas temperature	10	5	50
2) Drowning jet will not handle full HCl load	10	8	80
3) High back pressure	10	9	90
4) Water in HCl off-gas	10	10	100

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		Threat Probability	Seriousness	Total
4.	Stills			
	1) Erosion and/or pluggage of reboiler tubes	30	10	300
	2) Cannot maintain vacuum	10	10	100
	3) Cannot meet forward flow color spec.	10	10	100
	4) Cannot control temperature	10	8	80
5.	Absorbers			
	1) Cannot meet electrical property specs	20	10	200
	2) Cannot feed desired rate thru absorber	10	10	100
	3) Cannot meet free chloride spec	10	10	100
6.	Thermind Furnace			
	1) Coil failure	10	10	100
	2) Cannot provide adequate heat for stills	10	10	100
7.	Housekeeping			
	1) Unable to achieve acceptable level	10	8	80

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Aroclor Expansion (CEA 1800)

Risk Analysis Worksheet

Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
1. Raw Matls. Recd. a. Biphenyl 1) Variation in quality	1. Anniston operation variances. 2. Tank car coil failure	1. Accept risk 2. Sample every car	1. Review quality variation with Anniston	Lab identifies off-spec material
2) Availability	1. Anniston production outage 2. Rail Strike 3. Coil failure in Associated Sales Stg.Tk.	1. Accept Risk 2. Hold Associated Sales & Dept. Stg. Tks. at least 80% full.	1. Transfer Associated Sales Matl. to WGK. 2. Notify Anniston of low Biphenyl level.	Daily Inventory Sheet indicates quantity on hand below 600M#
b. Chlorine Snift Gas 1) Variation in quality	Chlorine Dept. operation variances	1. Monitor bromine content of KCL shipments. 2. Monitor number of DeNora cells on KOH. 3. Sample snift gas chlorine supply weekly.	Raise chlorination temperature to 195°C.	1. High bromine content in KCL 2. High bromine content in Cl_2 gas
2) Availability	Chlorine Dept. outage	1. Accept Risk 2. Obtain priority to use revaporized chlorine.	Accept risk	1. Notification of scheduled chlorine Dept. outage. 2. Low chlorine supply pressure

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Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
3. Chlorinator Area a. $FeCl_3$ Mix Tk. 1. Inadequate catalyst supply to #6 chlorinator	1. System pluggage 2. Circulating pump failure 3. Agitator failure 4. Steam heating system failure 5. Mix tank is empty 6. Catalyst flow controller failure	1. Sightglass provided 2. Motors alarmed 3. Temperature indicated in field 4. Level recorded on panel 5. Catalyst flow timer on panel 6. Catalyst feed valve alarm for abnormal position	1. Accept Risk 2. Manually add catalyst to each chlorinator	Lab identifies unstable product
b. Chlorinators 1) Unstable product	1. Catalyst doesn't carry thru chlors. 2. Inadequate catalyst feed to #6 chlorinator 3. Chlorination temp. too low. 4. High bromine content in chlorine supply. 5. Vapor phase chlorination 6. Sulfuric acid in chlorine supply 7. Circulating pump failure	1. Accept Risk 2. a) Catalyst tank level recorded on panel. b) Catalyst flow timer on panel c) Catalyst feed valve alarm for abnormal position d) Catalyst tank agitator & pump motors alarmed.	1. Spare catalyst addition nozzles provided on each chlorinator. 2. Accept Risk 3. " " 4. Raise chlorination temperature to 195°C 5. Raise overflow level in chlorinators to decrease vapor space. 6. Accept Risk 7. " "	Lab analysis indicates off-spec material.

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Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
b. Chlorinators (Contd.)	8. Technology inadequate to meet corporate goals. 9. Continuous chlorination technology inadequate to meet specification on stability.	2. e) Sightglass in catalyst circulating loop. 3. Chlorinator temperature recorded & alarmed on panel 4. a) Monitor DeNora cells on KoH b) Monitor KCL Bromide Content c) Monitor bromine content of chlorine supply. 5. Accept Risk 6. Brink mist eliminators in chlorine supply line. 7. Motors alarmed. 8. Accept Risk 9. Continuous chlorination demonstrated at Anniston	8. Lab distill crude & analyze results. 9. Initiate PR&D work to improve technology. 10. All the above.	
2) Crude 1142 out of spec on sp.gr.	1. Chlorine feed in each chlorinator too high or too low. 2. Density control system failure on #9 chlorinator	1. Flow recorded on panel. 2. Accept Risk 3. Flow recorded on panel. Low flow alarm.	1. Regulate flow manually 2. Run sp.gr. manually 3. Regulate flow manually 4. Regulate level manually	Operator analysis indicates off-spec material.

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Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
b. Chlorinators (Contd.)	3. Biphenyl feed rate to #6 Chlorinator too high or too low. 4. Level controller failure on #9 chlorinator. 5. Circulating pump failure	4. Intermediate Stg. Tk. level recorded on panel. Hi/Lo level alarm on Int. Stg. #9 Chlor. 5. Motors alarmed. 6. Operator will routinely analyze each chlorinator every two hrs.	5. Accept Risk 6. Have instrumentation system checked for repair. 7. Redesign Sp.Gr. control system if not adequate.	
3) Inadequate Biphenyl feed to #6 chlorinator	1. Biphenyl feed pump failure 2. Line pluggage 3. Flow controller failure 4. Feed tank empty 5. Rate of charging $FeCl_3$ mix & head tanks is too high	1. Motor alarmed 2. Stg. tank temperature recorded on panel 3. Flow indicating controller on panel and at $FeCl_3$ mix & head tanks. Lo flow alarm. 4. Daily inventory.	Use Biphenyl transfer pump to feed #6 chlorinator	Biphenyl flow recorder indicates low/high flow. Lo flow alarms.
4) Inadequate temperature control	1. Circulating pump failure 2. Temperature controller failure 3. Line pluggages 4. Air cooled heat exchanger fan speed too fast or too slow. 5. Too many or too few air cooler louvres attached to controller	1. Motors alarmed 2. Hi/Lo temperature alarms 3. Temperature recorded on panel 4. Two speed fans provided 5. High temperature chlorine shutdown. 6. Low temperature fan shutdown 7. Chlorine flow recorded on panel	1. Adjust number of louvres attached to controller. 2. Change chlorine flow rates 3. Accept Risk	Temperature recorder indicates temperature too high/low.

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Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
b. Chlorinators (Contd.) 4) Inadequate temp. cont.	6. Chlorine flow is too high or too low. 7. Sulfuric acid in Chlorine supply			
4. Stills 1) Erosion and/ or pluggage of reboiler tubes	1. Lime-catalyst slurry at high velocities 2. Tube diameter 3. Circulating pump failure	1. Accept Risk 2. Accept Risk 3. Motor alarmed	1. Set up spare heat exchanger 2. Drill out tubes 3. Set up spare pump 4. Increase pump impeller size	High pluggage frequency Tube failures
2) Cannot maintain vacuum	1. Vacuum jet failure 2. Pressure controller failure. 3. System leaks 4. Receiver level too high or tank is empty 5. Condenser freeze-up 6. Receiver pump packing leakage 7. Vacuum line pluggage 8. High level in catch tanks	1. Spare jet provided 2. Set up spare parts Pressure gauges provided 3. Accept Risk 4. Hi & Lo level alarms provided 5. Sightglass in forward flow line. Forward flow temperature recorded 6. Accept Risk 7. Accept Risk 8. Level gauge provided	1. Change to spare jet 2. Repair controller 3. Repair leaks 4. Isolate problem & resolve 5. Raise cooling water temperature 6. Repack pump 7. Clean-out lines 8. Drain tanks	Vacuum recorder indicates poor vacuum

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Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
3) Cannot meet forward flow color spec.	1. Entrainment separator run back line plugged 2. Inadequate lime in still	1. Sight glass provided 2. Record lime charge. Feed integrator alarm on panel	1. Clean out line 2. Re-lime still Modify re-lime frequency	Lab analysis indicates off-spec product
5. Absorbers 1) Cannot meet electrical property specs.	1. Treating temperature too high 2. Packing is wet 3. Clean-up filter not removing porocel particles 4. In line analyzer malfunctioning 5. Packing is shot	1. Column feed temperature controller backed up with temperature recorder. 2. Analyze packing for moisture prior to column start up 3. Accept Risk 4. Accept Risk 5. In-line analyzer provided	1. Manually control temperature. 2. Dry packing with nitrogen prior to start-up. 3. Modify filter and/or change cartridge micron retention size. Change absorber support screen size 4. Check results in laboratory 5. Change packing	Lab analysis indicates off-spec material
2) Cannot feed desired rate thru absorbers	1. Treating temp. too low-high viscosity 2. Pilot plant scale-up wrong 3. Pumps undersized 4. Packing charge-out time too long. Low on stream time.	1. See #1 above. 2. Accept Risk 3. Accept Risk 4. Absorbers flexibly piped up	1. Raise treating temp. to reduce viscosity. May also need to change electrical property specs. 2. Run more than one absorber at a time 3. Change pumps 4. Install spare absorber	Flow controller indicates below design feed rate Low on stream time

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Potential Problems	Likely Causes	Prevention: Take Preventive Action or Accept Risk	Protection: Set Contingent Action or Accept Risk	Provide for Information: Trigger Contingent
3) Cannot meet free chloride spec.	1. Bad Porocel 2. Clean-up filter leaking thru	1. Accept Risk 2. " "	1. Change packing 2. Change cartridges	Lab analysis indicates off-spec material
6. Therminol Furnace				
1) Coil Failure	1. Flame safeguard system failure 2. Air pockets in coil 3. Therminol degradation products	1. Set up spare coil. 2. Fill system under vacuum 3. Analyze therminol monthly	1. Changeout coil 2. Accept Risk 3. Replace Therminol	Coil leakage Lab analysis indicates off-spec FR-2
2) Cannot provide adequate heat for stills	1. Therminol feed pump failure 2. Low gas pressure 3. Line pluggage 4. Flow controller failure 5. Furnace undersized	1. Motor alarmed. Flow recorded on panel. 2. Low gas pressure shutdown. Pressure gauges in field 3. Low flow alarm 4. Accept Risk 5. " "	1. Changeout pump 2. Notify utilities dept. 3. Isolate problem & resolve 4. Repair controller 5. Install still feed preheater	Cannot obtain 25M#/yr. still rate
7. Housekeeping 1) Unable to achieve acceptable level	1. Processing problems 2. Inadequate workforce	1. All pumps except for one on ground level. Drain pans provided for each pump 2. Trench sewers provided on ground level 3. Ground level curbed & floor sloped to trenches 4. Open structure design 5. Equipment layed-out with housekeeping problems in mind.	1. Accept Risk 2. Modify Facilities	Low ratings in housekeeping inspections

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Potential Problems	Likely Causes	Prevention Take Preventive Action or Accept Risk	Protection Set Contingent Action or Accept Risk	Provide for Information Trigger Contingent
7. Housekeeping (Contd.)		6. Dumpster ramp for changing absorber packing provided 7. Provision made for draining transfer lines, sample points & catch tanks into drums 8. HCl emission sources tied into drowning jet 9. Housekeeping time alloted in work-force study 10. Complete utility stations located at critical points		

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