Worksheet - Cover Page

Printed: June 21, 2002, 2:53 PM
Company: Safetech
Location: Princeton, NJ
Facility: Princeton
PHA Method: HAZOP
PHA Type: Initial

Process:

File Description:
Chlorine Handling

Date:

Process Description:

Chemicals:

Purpose:

Scope:

Objectives:

Project Notes:

Filters: None

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (1) Chlorine rail car
Drawings: CLC/01-07-66
Parameter: Pressure
Intention: Normal operation is 100 - 150 psig. Target pressure is 125 psig.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
More	Higher Pressure	1. Fire exposure	1.1. Potential overpressurization of rail car resulting in release of chlorine.	1.1.1. Rail cars provided with relief valve. 1.1.2. Rail cars insulated	1	4	4		:No recommendations	
			1.2. Potential rupture of the rail car if the rail car relief valve fails.	1.2.1. Location of rail car minimizes likelihood of exposure.	1	5	5		:No recommendations	
		2. High ambient temperature	2.1. Potential increase in pressure. Not likely to approach rated pressure of rail car.	2.1.1. Rail cars insulated 2.1.2. Location of rail car minimizes likelihood of exposure. 2.1.3. Pressure indicator, PI-1.	5	1	5		:No recommendations	
Less	Lower Pressure	3. Relief valve RV-25 fails open	3.1. Potential exposure of personnel and potential offsite impact	3.1.1. Railcar emergency leak patch kit is available on site. 3.1.2. Pressure indicator, PI-1.	1	4	4		3.1.1. Consider conducting a failure modes and effects analysis (FMEA) of a typical pressure relief valve.	PWP
		4. Empty rail car	4.1. Delay in treating	4.1.1. Rail car is weighed upon receipt	5	3	9		:No further recommendations	
		5. Sudden change in ambient temperature	5.1. Potential for too low flow to the treatment system	5.1.1. Rail cars insulated	5	2	8		:No further recommendations	

Session: (1) 07/02/00 Revision: 0
Node: (1) Chlorine rail car
Drawings: CLC/01-07-66
Parameter: Composition Intention: Chlorine with less than 5 ppm moisture.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Other Than	Other Than Composition	1. Supplier loads rail car with incorrect material	1.1. Consequences will depend upon what other materials could be delivered in rail...	1.1.1. Analysis of shipment by supplier.	3	4	8		1.1.1. Consider changing the SOP to require a certificate of analysis be received with each rail car and...	DSC

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (1) Chlorine rail car
Drawings: CLC/01-07-66
Parameter: Composition Intention: Chlorine with less than 5 ppm moisture.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Other Than (cont.)	Other Than Composition (cont.)	1. Supplier loads rail car with incorrect material (cont.)	...cars.	1.1.1. Analysis of shipment by supplier. (cont.)					...be checked before accepting the rail car.	
As Well As	As Well As Composition (contaminatio n)	2. Rail car padded with incorrect material (e.g. moist air) by supplier	2.1. Moisture with chlorine will cause accelerated corrosion of system piping	2.1.1. Analysis of shipment by supplier.	3	4	8		:No further recommendations	
			2.2. Consequences will depend upon what other materials could be delivered in rail cars	2.2.1. As for 2.1.1	3	4	8		:No further recommendations	

Session: (1) 07/02/00 Revision: 0
Node: (1) Chlorine rail car
Drawings: CLC/01-07-66
Parameter: Level
Intention: Normal railcar liquid level varies between a maximum of 80 % of capacity to as empty as practical.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No	No Level	1. Rail car received empty	1.1. Delay in treating	1.1.1. Rail car is weighed upon receipt	5	4	10		:No recommendations	
		2. Leak in rail car or attached piping	2.1. Potential exposure of personnel and potential offsite impact	2.1.1. Chlorine gas sensors around rail car unloading station	3	4	8		:No recommendations	
				2.1.2. Emergency C kit available for rail car leaks						
More	Higher Level	3. Supplier overloads	3.1. Potential overpressure of rail car due to thermal expansion of material	3.1.1. Rail car weighed upon receipt	3	4	8		3.1.1. *Verify the scales are calibrated correctly	LSS

Worksheet

Session: (1) 07/02/00
Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No	No Flow	1. Control valve CV-32 fails closed	1.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process	1.1.1. Failing closed, or accidentally closing, a single valve will not result in overpressure since line is open to either end 1.1.2. Operator response to a shutdown of the system would be immediate 1.1.3. Limit switch provided on each valve which will indicate the valve is closed 1.1.4. Micromotion flow meter, FTLIQA	4	4	9		:No recommendations	
			1.2. Potential overpressure of Cl_2 piping if liquid-filled, closed piping heats up	1.2.1. All valves (ball valves) in liquid Cl_2 service are provided with a port to vent the ball cavity 1.2.2. Rupture disk discharging to expansion tanks are provided for the section of the piping between - VLIQA and VLIQB - PCVGASC and PCVGASB (downstream of vaporizer) 1.2.3. Pressure transmitters provided on potentially trapped sections of piping between: - VRCA2 and VRCL - VRCB2 and...	3	4	8		:No recommendations	

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No (cont.)	No Flow (cont.)	1. Control valve CV-32 fails closed (cont.)	1.2. Potential overpressure of Cl_2 piping if liquid-filled, closed piping heats up (cont.)	...VRCM - VRCL/M and VLIQA - VLIQB and PCVGASC					:No recommendations (cont.)	
		2. Control system incorrectly activates shutdown for "rupture" condition	2.1. Potential overpressure of Cl_2 piping if liquid filled, closed piping heats up	2.1.1. Rupture disk discharging to expansion tanks are provided for the section of the piping between - VLIQA and VLIQB - PCVGASC and PCVGASB (downstream of vaporizer)	3	4	8		2.1.1. *Investigate the design of the rupture disks and expansion tanks and the pressure setting (375 psig) of the rupture disk	LDS
									2.1.2. *Verify Chlorine Institute requirements for venting valves with design of existing valves	JBS
				2.1.2. Failing closed, or accidentally closing, a single valve will not result in overpressure since line is open to either end						
				2.1.3. Limit switch provided on each valve which will indicate the valve is closed						
				2.1.4. Micromotion flow meter, FTLIQA						
		3. Control valve closes due to incorrect signal or setting	3.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process	3.1.1. Failing closed, or accidentally closing, a single valve will not result in overpressure since line is open to either end	4	4	9		:No further recommendations	
				3.1.2. Operator response to a shutdown of the system would be immediate						

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No (cont.)	No Flow (cont.)	3. Control valve closes due to incorrect signal or setting (cont.)	3.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process (cont.)	3.1.3. Limit switch provided on each valve which will indicate the valve is closed 3.1.4. Micromotion flow meter, FTLIQA					:No further recommendations (cont.)	
		4. Manual block valve is accidentally closed	4.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process	4.1.1. Failing closed, or accidentally closing, a single valve will not result in overpressure since line is open to either end 4.1.2. Operator response to a shutdown of the system would be immediate 4.1.3. Limit switch provided on each valve which will indicate the valve is closed 4.1.4. Micromotion flow meter, FTLIQA	4	4	9		:No further recommendations	
		5. Filter plugged	5.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process	5.1.1. Operator response to a shut down of the system would be immediate 5.1.2. Micromotion flow meter, FTLIQA	4	2	7		:No further recommendations	
		6. Micromotion meter plugged	6.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control...	6.1.1. Operator response to a shut down of the system would be immediate 6.1.2. Pressure...	4	2	7		:No further recommendations	

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No (cont.)	No Flow (cont.)	6. Micromotion meter plugged (cont.)	...system to shut down process	...transmitters before and after the meter					:No further recommendations (cont.)	
		7. Dip pipe (in railcar) plugged	7.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process	7.1.1. Operator response to a shut down of the system would be immediate 7.1.2. Micromotion flow meter, FTLIQA	4	2	7		:No further recommendations	
		8. Excess flow valve closed	8.1. Interruption to production operation due to deviation of Cl_2 flow from setpoint causing control system to shut down process	8.1.1. Failing closed, or accidentally closing, a single valve will not result in overpressure since line is open to either end 8.1.2. Operator response to a shutdown of the system would be immediate 8.1.3. Micromotion flow meter, FTLIQA	4	4	9		:No further recommendations	
		9. Line or flex hose failure	9.1. Release of Cl_2 to the atmosphere	9.1.1. Railcars inspected between each load by supplier 9.1.2. Chlorine gas sensors in the vicinity of the railcar and in the vaporizer building 9.1.3. Pressure along the piping is monitored by control system. If pressure differential exceeds 40-50 psig between 2 transmitters, control system will...	1	4	4		9.1.1. Consider alternatives to the present hanger arrangements to allow total insulating of the piping while minimizing external corrosion of the piping. 9.1.2. Consider whether alternative materials of construction are practical which will provide better internal and external corrosion resistance	LDS TLK

Worksheet

Session: (1) 07/02/00
Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No (cont.)	No Flow (cont.)	9. Line or flex hose failure (cont.)	9.1. Release of Cl_2 to the atmosphere (cont.)	...initiate a "line rupture" shutdown which closes all valves on the liquid Cl_2 piping 9.1.4. Piping pressure tested prior to each campaign 9.1.5. Normal preventive maintenance program for Cl_2 piping is to perform non-destructive testing of wall thickness annually					9.1.2. Consider whether alternative materials of construction are practical which will provide better internal and external corrosion resistance (cont.)	
Less	Less Flow	10. Block valve (VRCG/H, PCVLIQA) to vent scrubber system open or passing	10.1. Potential interruption to production if flow deviates significantly from setpoint	10.1.1. Second block valve, PCVLIQB, on vent line from railcar station would also have to be accidentally open or passing 10.1.2. Position switches provided on all valves leading to the scrubber system from the liquid chlorine lines (VRCG, VRCH, PCVLIQA, PCVLIQB) which indicate if the valve moves off the fully closed position.	4	4	9		:No further recommendations	
			10.2. Potential release to the atmosphere if exceeds scrubber capacity or scrubber not operating	10.2.1. All the valves from the liquid chlorine lines to the scrubber (VRCG, VRCH, PCVLIQA, PCVLIQB) are interlocked closed by the control system when...	1	4	4		:No further recommendations	

Session: (1) 07/02/00
Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Less (cont.)	Less Flow (cont.)	10. Block valve (VRCG/H, PCVLIQA) to vent scrubber system open or passing (cont.)	10.2. Potential release to the atmosphere if exceeds scrubber capacity or scrubber not operating (cont.)	...chlorine is in the system, preventing the operator from accidentally manually opening the valve from the console.					:No further recommendations (cont.)	
		11. Partial pluggage of any component or partially closed valve	11.1. Potential interruption to production if flow deviates significantly from setpoint	11.1.1. Pressure transmitter, PTRCF, on vent line from railcar station would increase if upstream valve(s) passing and downstream closed 11.1.2. Temperature indication, TTLIQA, on vent line to flash pot may indicate lower temperature due flashing of Cl_2 liquid	4	2	7		:No further recommendations	
		12. Leak	12.1. Release of Cl_2 to the atmosphere	12.1.1. Chlorine sensor provided near atmospheric vent from scrubber system 12.1.2. Control valve on Cl_2 gas flow to reactor, FCVGASA, will open to attempt to maintain set flow to reactor	1	4	4		12.1.1. Review the best available means for periodic testing and/or examination of the chlorine liquid piping system to ensure the system integrity	PWP
	More Flow	13. N_2 pressurization valve, VRCC/VRCD, opens during padding of railcar, and manual block on tubing left open, displacing liquid Cl_2 in line with N_2	13.1. Potential erratic flow due to presence of N_2 in system. Potential overchlorination of product due to surge of chlorine ahead of N_2. Impact on product quality. Potential overloading of...	13.1.1. Flow indication and control (FICGASA) on chlorine flow to reactor will throttle to maintain set flow 13.1.2. Position indicators on N_2 valves (VRCC, VRCD) which...	4	4	9		:No recommendations	

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Less (cont.)	More Flow (cont.)	13. N_2 pressurization valve, VRCC/VRCD, opens during padding of railcar, and manual block on tubing left open, displacing liquid Cl_2 in line with N_2 (cont.)	...scrubber	...indicates whenever the valve is off normally closed position.					:No recommendations (cont.)	
		14. Higher than normal pressure in rail car	14.1. Potential erratic flow due to presence of N_2 in system. Potential overchlorination of product due surge of chlorine ahead of N_2. Impact on product quality. Potential overloading of scrubber	14.1.1. Backup manual valve on N_2 line is normally closed except when pressure testing the piping. 14.1.2. Pressure monitoring of pipeline	4	4	9		:No recommendations	
		15. Flow control valve, FCVGASA, opens wide due to incorrect signal or setting	15.1. Potential erratic flow due presence of N_2 in system. Potential overchlorination of product due surge of chlorine ahead of N_2. Impact on product quality. Potential overloading of scrubber	15.1.1. Independent flow indication, FTLIQA, to allow operator to verify flow control reading	4	4	9		:No recommendations	
		16. Sudden clearing of a blockage	16.1. Potential erratic flow due to presence of N_2 in system. Potential overchlorination of product due surge of chlorine ahead of N_2. Impact on product quality. Potential overloading of...	16.1.1. Flow indication and control (FICGASA) on chlorine flow to reactor will throttle to maintain set flow	4	2	7		:No recommendations	

Session: (1) 07/02/00
Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Less (cont.)	More Flow (cont.)	16. Sudden clearing of a blockage (cont.)	...scrubber due to surge of chlorine	16.1.1. Flow indication and control (FICGASA) on chlorine flow to reactor will throttle to maintain set flow (cont.)					:No recommendations (cont.)	
Reverse	Reverse Flow	17. Blockage of the system downstream of the vaporizer	17.1. Vaporization of liquid in vaporizer will increase vaporizer pressure pushing liquid Cl_2 back to rail car	17.1.1. Chlorine line is open back to the rail car preventing excessive pressure buildup 17.1.2. Pressure indication on vaporizer outlet, PTGASA	4	2	7		:No recommendations	
			17.2. No flow, sensed by FICGASA, will initiate a shutdown. Will close VLIQB and open VGASA to vent vaporizer to the scrubber	17.2.1. Flow indicators, FICGASA and FTLIQA, will indicate no flow 17.2.2. Line upstream of VLIQB is open to the railcar	4	2	7		:No recommendations	
		18. Rupture of the N_2 pressurization line at the rail car when padding the rail car	18.1. Release of Cl_2 to atmosphere	18.1.1. Piping downstream of vaporizer is vented to the scrubber thru VGASA 18.1.2. Rupture disk and relief valve on vaporizer , discharging to catch pot T-22, if blockage is between vaporizer and VGASA. Additional capability to manually vent lines thru VGASC or PCVLIQA	1	5	5		:No recommendations	
		19. Failure of liquid chlorine line or flex hose	19.1. Release of Cl_2 to the atmosphere	19.1.1. Piping downstream of vaporizer is vented...	1	5	5		:No recommendations	

Session: (1) 07/02/00
Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Flow
Intention: Flow approximately 1 - 5 lbs/min of liquid chlorine, at 100- 150 psig, from the railcar to the vaporizer.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Reverse (cont.)	Reverse Flow (cont.)	19. Failure of liquid chlorine line or flex hose (cont.)	19.1. Release of Cl_2 to the atmosphere (cont.)	...to the scrubber thru VGASA 19.1.2. Rupture disk and relief valve on vaporizer , discharging to catch pot T-22, if blockage is between vaporizer and VGASA. Additional capability to manually vent lines thru VGASC or PCVLIQA					:No recommendations (cont.)	
Other Than	Other Than Flow	20. Failure of rupture disk on liquid line	20.1. Some flow of chlorine to the expansion tanks	20.1.1. Pressure indicator, PTLIQD, on line to expansion tanks	1	5	5		:No recommendations	
			20.2. Potential loss of expansion capacity if rupture disk released, expansion tanks filled and pressure rise in expansion tanks not observed by operator.	20.2.1. Chlorine gas sensors in the vicinity of the railcar and in the vaporizer building 20.2.2. Pressure along the piping is monitored by control system. If pressure differential exceeds 40-50 psig between 2 transmitters, control system will initiate a "line rupture" shutdown which closes all valves on the liquid Cl_2 piping 20.2.3. Piping pressure tested prior to each campaign	4	5	10		:No recommendations	

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Pressure
Intention: Normal operating pressure is approximately 100-145 psig.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
More	Higher Pressure	1. Fire exposure	1.1. Potential overpressurization of rail car resulting in release of chlorine.	1.1.1. Chlorine line insulated except at hangers 1.1.2. Chlorine line open to railcar and/or vaporizer 1.1.3. Rail cars insulated	1	5	5		:No further recommendations	
			1.2. Potential rupture of the rail car if the rail car relief valve fails.	1.2.1. Rail cars provided with relief valve 1.2.2. Location of rail car minimizes likelihood of exposure 1.2.3. Pressure indicator, PI-1	1	5	5		:No further recommendations	
		2. Steam exposure	2.1. Potential overheating if broken steam line discharges on chlorine line	2.1.1. Chlorine line insulated except at hangers 2.1.2. Chlorine line open to railcar and/or vaporizer 2.1.3. Rail cars insulated	3	4	8		:No recommendations	
		3. High ambient temperature	3.1. Potential increase in pressure. Not likely to approach rated pressure of rail car	3.1.1. Chlorine line insulated except at hangers 3.1.2. Chlorine line open to railcar and/or vaporizer 3.1.3. Rail cars insulated	5	1	5		:No further recommendations	
		4. Change in ambient temperature after padding rail car	4.1. Potential for too low flow to the treatment system	4.1.1. Chlorine line insulated except at hangers 4.1.2. Chlorine...	5	2	8		:No further recommendations	

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Pressure
Intention: Normal operating pressure is approximately 100-145 psig.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
More (cont.)	Higher Pressure (cont.)	4. Change in ambient temperature after padding rail car (cont.)	4.1. Potential for too low flow to the treatment system (cont.)	...line open to railcar and/or vaporizer 4.1.3. Pressure indicator, PI-1 4.1.4. Rail cars insulated					:No further recommendations (cont.)	
Less	Lower Pressure	5. Leak in rail car or relief valve fails open	5.1. Potential exposure of personnel and potential offsite impact	5.1.1. Railcar emergency leak patch kit is available on site 5.1.2. Pressure indicator, PI-1	1	5	5		:No further recommendations	
		6. Empty rail car	6.1. Delay in treating	6.1.1. Rail car weighed upon receipt	4	4	9		:No further recommendations	
		7. Sudden change in ambient temperature	7.1. Potential for too low flow to the treatment system	7.1.1. Rail car weighed upon receipt	4	3	8		:No further recommendations	

Session: (1) 07/02/00 Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Composition Intention: Chlorine to specification

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
As Well As	As Well As Composition	1. Water, or other agents, in line after cleaning	1.1. Potential for accelerated corrosion of the piping	1.1.1. Normal procedure for cleaning includes blowing the system dry with N_2 after cleaning 1.1.2. Training of maintenance personnel working on chlorine system	3	4	8		1.1.1. Consider means of cleaning the chlorine piping system which do not involve the use of water or incompatible materials	LDS
		2. Use of non-compatible materials, such as hydrocarbon-containing greases, during maintenance of...	2.1. Potential reaction possibly causing accelerated corrosion, fire or contaminants affecting product quality	2.1.1. Normal procedure for cleaning includes blowing the system dry with N_2 after cleaning	3	4	8		2.1.1. Consider modifying the training program for maintenance personnel who may work on the chlorine system to include coverage of...	TLK

Worksheet

Session: (1) 07/02/00
Revision: 0
Node: (2) Cl2 liquid to vaporizer
Drawings: CLC/01-07-66
Parameter: Composition
Intention: Chlorine to specification

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
As Well As (cont.)	As Well As Composition (cont.)	...system	2.1. Potential reaction possibly causing accelerated corrosion, fire or contaminants affecting product quality (cont.)	2.1.2. Training of maintenance personnel working on chlorine system					...incompatible materials	

Worksheet

Session: (1) 07/02/00 Revision: 0
Node: (3) Cl2 vaporizer
Drawings: CLC/01-07-66
Parameter: Flow Intention: Vaporize 100-150 pounds per hour. Target is 125.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
No	No Flow	1. Exit valve is in off position	1.1. Overpressurization of vaporizer	1.1.1. Relief valves on vessel	3	4	8		1.1.1. *Verify relief valves undergo periodic testing	LSS
		2. Entrance valve is in off position	2.1. Product down time	2.1.1. None	4	4	9		:No further recommendations	
			2.2. Excessive wear on pumps	2.2.1. Pumps have autoshutoff switches to prevent overheating	3	4	8		:No further recommendations	
As Well As	As Well As Flow	3. N_2 purge stream valve is open	3.1. Impure product	3.1.1. Feed is tested when it is unloaded from rail car	4	4	9		3.1.1. Consider updating SOP to include a valve configuration flow sheet	LSS
		4. Impure Cl_2 feed	4.1. Impure product	4.1.1. Feed is tested when it is unloaded from rail car	4	4	9		:No further recommendations	
			4.2. Side reaction causing exotherm.		3	4	8		:No further recommendations	

Session: (1) 07/02/00 Revision: 0
Node: (3) Cl2 vaporizer
Drawings: CLC/01-07-66
Parameter: Pressure Intention: Vaporizer is intended to operate at 3 atm.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
More	Higher Pressure	1. Exit line from vaporizer plugged	1.1. Failure to provide adequate supply to reactor	1.1.1. Low flow alarm present	4	2	7		:No further recommendations	
			1.2. Pressure build up in vaporizer	1.2.1. Pressure rating on vaporizer exceeds that of the supply tanks	4	2	7		:No further recommendations	
		2. Chlorine supply line has a greater flow rate than designed	2.1. Pressure build up in vaporizer	2.1.1. Pressure rating on vaporizer exceeds that of the supply tanks	3	4	8		:No further recommendations	
Less	Lower Pressure	3. Supply line plugged	3.1. Loss of productivity due to low chlorine supply to reactor	3.1.1. Low flow alarm present.	4	2	7		3.1.1. *Check to see if this has ever been a problem	LSS
		4. Rupture in line exiting the vaporizer	4.1. Release of chlorine to atmosphere	4.1.1. Chlorine gas sensors in the area	1	5	5		4.1.1. Consider installing an automatic chlorine source...	JBS

Worksheet

Session: (1) 07/02/00
Revision: 0
Node: (3) Cl2 vaporizer
Drawings: CLC/01-07-66
Parameter: Pressure
Intention: Vaporizer is intended to operate at 3 atm.

GW	DEVIATION	CAUSES	CONSEQUENCES	SAFEGUARDS	S	L	R	REF#	RECOMMENDATIONS	BY
Less (cont.)	Lower Pressure (cont.)	4. Rupture in line exiting the vaporizer (cont.)	4.1. Release of chlorine to atmosphere (cont.)	4.1.1. Chlorine gas sensors in the area (cont.)					...shutdown if the vaporizer pressure drops below 1.5 atm.	
			4.2. Loss of reactant		4	5	10		:No further recommendations	
		5. Leak in vaporizer	5.1. Release of Cl_2 to atmosphere	5.1.1. Chlorine gas sensors in the area	1	5	5		5.1.1. Consider implementing a periodic check of vaporizer to ensure there are no pressure leaks	LDS

Worksheet - Index

Node 1: Chlorine rail car 1
Parameter: Pressure 1
Parameter: Composition 1
Parameter: Level 2
Node 2: Cl2 liquid to vaporizer 3
Parameter: Flow 3
Parameter: Pressure 12
Parameter: Composition 13
Node 3: Cl2 vaporizer 15
Parameter: Flow 15
Parameter: Pressure 15