AREA 2100 –OVERVIEW

When it is necessary to produce C5 rich material for use in propagators 1 and 2, the flashed hydrolyzate is fed to the screw press where a solid C6-rich stream is separated from the liquid C5- rich stream. Liquid material from the screw press will flow by gravity into the C5 storage tank for further processing.

C5 StorageTank, TS-2108 (DRAWING PIL-PID-2103)

A recirculation loop is provided on the C5 Storage Tank that prevents the tank discharge pump, PT-2108 from dead-heading.

This tank is agitated to keep the contents homogenous and prevent solids from settling out of mixture.

At any time during processing, the vessel contents can be sampled with the sterile sampling valve provided. Steam is provided to the valve to sterilize the interior before the sample is taken.

Speed Control (SIC-2108-04)

The Speed controller controls the speed of the C5 Pump. The speed of the pump is adjusted by the local integrated control panel or by the PLC. This delivers the desired flow rate. The pump is turned on/off based on the level in the tank receiving the discharge of the pump, based on the batching recipe. The speed setting and range values will be determined during commissioning.

Level Indication

The level in the C5 Storage Tank is not controlled but is continuously monitored to prevent overfilling. Level indicator LI-2108-03 will have the following alarms and interlocks:

- On High Level (85%) an alarm will be activated only.
- On Low Level (15% full) an alarm will be activated, the agitator (AG-2108) will be shut down. The agitator can only restart once the level has exceeded 15%.
- On Low Low Level (10% full) an alarm will be activated and an interlock will shut down pumps PM-2108. This is to protect the pumps from damage.

- LI 2108-03, Nozzle K: Tank level.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI 2108-05, Line 2103-04: C5 pump discharge pressure.

- TI 2108-06, Nozzle L: Tank temperature.

- LI 2108-07, Nozzle H: Tank level.

		HYDS-2102-02	HYDS-2103-05	HYDS-2103-06	HYDS-2103-04	HYDS-2103-10	HYDS-2103-11	SL-9302-38	CL-2103-01	Sample Valve
Tank Transfer	C5 Tank Fill	O	C	C	C	C	C	C	C	
	Transfer to Propagator 2A	O	O	C	C	O	C	C	C	
	Transfer to Propagator 2B	O	O	C	C	C	O	C	C	
	Transfer to Prep Tank	O	O	C	O	C	C	C	C	
Other	Sampling									O
	Cleaning Sample Valve							O	O	C

Prep Tank, TS-2109

In the Prep Tank C5 sugars are brought in from the C5 Storage Tank, mixed with UV water, and pH adjusted with aqueous ammonia prior to being pumped to the first and second propagators. This solution can be sterilized en route to the propagators using steam in a plate and frame heat exchanger and then cooled in a second plate and frame heat exchanger that uses cooling water.

A recirculation loop is also provided that runs through both heat exchangers to facilitate heating or cooling any solution.

Antifoam, Trace Metals, and Magnesium Sulfate solution can also be made in the Prep Tank. The Antifoam is pumped in but the Trace Metals and Magnesium Sulfate are added through the hatch in the top of the tank. These components are diluted with UV water before being pumped to the storage tanks.

The tank is on weigh cells to confirm the amount of ingredients added to it.

Steam injection is also provided to the tank for heating any solutions where solubility may be an issue.

At any time during processing, the vessel contents can be sampled with the sterile sampling valve provided. Steam is provided to the valve to sterilize the interior before the sample is taken.

Temperature Control (TIC-2109-08, TIC-2109-11)

There are two temperature control loops: one for the Prep Tank Heater and one for the Prep Tank Cooler. Controller TIC 2109-08 modulates steam valve TV 2109-08 according to the outlet temperature of the heater. Controller TIC 2109-11 modulates cooling water return valve TV 2109-11 according to the outlet temperature of the cooler. Fail positions of the modulating valves are as follows:

- TV 2109-08 – Fail closed
- TV 2109-11 – Fail open

There is a third temperature indicator, TI-2109-02 on the Prep Tank. It only displays locally and does not regulate the temperature of the vessel.

pH Control (AIC-2109-07)

The pH of the Prep Tank contents is controlled with aqueous ammonia. AIC 2109-07 speeds up or slows down pump PM-8502 (SIC 8502-01) based on the pH measurement. The pH levels and pump speed and range will be determined during commissioning.

Pressure / Vacuum Control on Prep Tank (PSV-2109-12, PSV-2109-13)

Two safety valves are provided for the two heat exchangers to protect them from over pressurization if the cold fluid is blocked in. The PSVs are located on the side of the cold fluid:

the process side for the heater and the cooling water side for the cooler. The design conditions and the set points of the protection devices are given below.

- Heat exchangers design pressure – 150 psig
- PSV-2109-12 – 65 psig
- PSV-2109-13 – 65 psig

Pressure Control for Pump PT-2109 (PT 2109-14, PIC-2109-14, PV-2109-14)

The pressure is monitored and controlled continuously on the outlet of pump PT-2109. PIC-2109-14 maintains a constant pressure (within the High and Low Pressures) on the discharge of PT-2109. When all downstream line are closed the pressure transmitter, PT-2109-14 will see a High pressure and modulate PV-2109-14 open. When one of the downstream lines are opened, the pressure transmitter, PT-2109-14 will see a Low Pressure and modulate PV-2109-14 closed. The pressure setting for these devices as follows:

- Low Pressure (45 psig) to be verified during commissioning
- High Pressure (55 psig) to be verified during commission.
- High High Pressure (60 psig) - an alarm will be activated and an interlock will shut down the pump, PT-2109. This is to prevent the pump from dead-heading and damage.

Weight Indication for Prep Tank TS-2109 (WI-2109-10)

The local indicator, WI-2106-10 indicates the weight of the contents of the Prep Tank continuously to prevent overfilling. The weight indicator, WI-2109-10 is also used to determine the weight of the various ingredients that are added to the tank. Besides the pH control, the prep tank filling operation is manual operation, so the operator will turn on and off the pumps feeding the tank manually based on the weight shown on the indicator, WI-2109-10. The manual operation will also include the start/stop of Prep Tank agitator, AG-2109 and the open/close of the manual valve that allows UV water into the tank.

- WI- 2109-10: Prep Tank Weight.

- On High High Weight (90% full) an alarm will be activated and an interlock will shut down pumps PT-2108, PA-8303, and PT-8502.

- On High Weight (85%) an alarm will be activated only.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI 2109-09, Line 9302-37: Incoming steam pressure.

- TI 2109-02, Nozzle A: Tank temperature.

VALVE SEQUENCING – PREP TANK (TS-2109)

		CWS-2104-12	CWS-9202-33	HYDS-2104-01	HYDS-2104-02	HYDS-2104-03	HYDS-2104-04	HYDS-2104-08	HYDS-2104-17	HYDS-2104-05 (after hose)	HYDS-2104-05 (prior to pump)	HYDS-2104-05 (drain)	HYDS-2104-06	HYDS-2104-14	HYDS-2104-13	Nozzle B (Steam Injection)	Nozzle C (Drain)	Nozzle D (Reirculation)	Nozzle G (C5, UV Water)	Nozzle J (Aqua Ammonia)	Nozzle K (Antifoam)	SL-2104-11	SL-9302-37 (prior to throttling valve)	SL-9302-37 (prior to vessel)	Sampling Valve	RCW-9501-31	HYDS-2103-04	UVW-9503-15
Adding Ingredients	Adding Ammonia															C	C	C	C	O	C							
	Adding Antifoam															C	C	C	C	C	O							
	Adding C5															C	C	C	O	C	C						O	C
	Adding UV Water															C	C	C	O	C	C						C	O
Temp. Control	Steam Injection																O						O	O				
	Cooling in HP-2110	O	O																			O						
	Heating in HP-2109																					O	O	C				
	Recirculating									O	O		O	O	O		O	O										
Draining	Pumping to Antifoam Storage Tanks			C	C	C	C	C	O	O	O	C	O	O	O		O											
	Pumping to propagator 1A			C	C	C	O	C	C	O	O	C	O	O	O		O											
	Pumping to propagator 1B			C	C	O	C	C	C	O	O	C	O	O	O		O											
	Pumping to propagator 2A			C	O	C	C	C	C	O	O	C	O	O	O		O											
	Pumping to propagator 2B			O	C	C	C	C	C	O	O	C	O	O	O		O											
	Pumping to Trace Metals to Storage Tanks			C	C	C	C	O	C	O	O	C	O	O	O		O											
Other	Sampling																								O			
	Cleaning with Process Water									O	C	O				C	O	C	C	C	C							

AREA 2200 – FLASH STEAM CONDENSER OVERVIEW

Following the hydrolysis step, the hydrolyzate is flash cooled, which removes a significant amount of water, a portion of the acetic acid, furfural and HMF. It is beneficial to remove these by-products, as they are fermentation inhibitors. The flash steam is condensed and sent to waste water tank via the u-drain. This flash steam is condensed in shell and tube heat exchanger that uses chilled water.

Flash Steam Condenser (DRAWING PIL-PID-2102)

The Flash Steam Condenser (HS-2201) condenses the flash steam from the hydrolysis step using chilled water.

Temperature Control (TIC-2201-06)

TIC-2201-06 modulates chilled water outlet valve TV-2201-06 according to the outlet temperature of the condenser. Fail positions of the modulating valve is as follows:

- TV 2201-06 – Fail open

Pressure Relief on Flash Steam Condenser (PSV-2201-05)

A pressure safety valve is provided for the condenser to protect it from over pressurization if the cold fluid supply is interrupted. The PSV is located on the return side of the cold fluid. This device is set at 100 psig.

Local Indication

The local indicators below are provided for visual verification of process conditions at the condenser. These instruments have no control functions and they do not report data to the PLC.

- PI 2201-02, Line 9202-03: Incoming chilled water pressure.
- TI 2201-03, Line 2102-05: Outgoing chilled water temperature.
- PI 2201-04, Line 2102-05: Outgoing chilled water pressure.

VALVE SEQUENCING – FLASH STEAM CONDENSER (HS-2201)

		CHWS-9202-03	CHWS-2102-05	DGFS-2101-01	CL-2102-08	DGFS-2102-01(after condenser)
Temp. Control						
	Cooling in HP-2201	O	O	O	O	C
Venting						
	Venting Non-Condensibles	O	O	O	O	O

AREA 2300 – OVERVIEW

In the Liquefaction Process, pretreated feedstock is conditioned with cellulase enzyme, cooled and pH adjusted.

In the first step, the Liquefaction Tank, the feedstock is transferred from the screw press transfer conveyor (CV-2106) down a chute. The feedstock is mixed with aqueous ammonia and cellulase enzyme and cooled. The residence time in the tank is controlled at six hours

Sterilized water is sprayed into the feedstock just prior to the Liquefaction Tank. This water is cooled first using chilled water in a plate and frame heat exchanger, HP-2301.

In the second step the liquefied feedstock is pH adjusted in the Hydrolyzate pH Adjustment Tank. The residence time in the tank is controlled at one hour.

Liquefaction Tank (DRAWING PIL-PID-2301)

In the Liquefaction Tank (VS-2301) the feedstock is transferred from the Screw Press Transfer Conveyor (CV-2106) down a chute. Prior to entering the tank, aqueous ammonia is mixed with the cooling water before it is sprayed into the feed stock. The cellulase enzyme is metered in through a nozzle at the top of the tank. The pH of the tank is constantly monitored, and the pH element controls the rate of a pump metering the aqueous ammonia into the feedstock. The level of the tank is controlled to ensure the six-hour residence time in the tank. Cooling water, steam and hot water are all provided to the vessel jacket. The jacket water can also be recirculated through a pump for finer temperature control. This tank can be cleaned in place and steamed in place.

The CIP cycle consists of three phases: pre-rinsing, dilute caustic wash, and final rinse. All are provided at the flowrate and pressure required for the sprayball to clean the tank adequately. See the Area 8200 controls description for further discussion.

The steam-in-place (SIP) cycle also consists of three phases: heat up, hold, and cool down. Heating the tank up is done using 15 psig (250F) steam on the jacket and 30 psig (275F) steam in the vessel. It is critical that the temperature of the steam to the jacket is lower than the steam to the vessel in order to ensure the vessel steam does not become superheated. The flow to the vessel interior is controlled by a temperature control valve (TV 2301-04C) that is throttled according to the temperature in the tank. The flow into the jacket is not throttled. When the tank has reached the temperature set point (275F), the manual steam supply valve to the tank is closed, the vent valve is opened and the SIP Vacuum Pump (PV-3201) reduces the pressure in the tank to approximately 0.5 psia (25 mm Hg). This evacuates all air pockets within the vessel, which would hinder the heat transfer that sterilizes the tank interior. When the pressure set point is reached, the vent is closed and the tank interior is filled with steam again. This procedure is repeated twice to ensure that the maximum amount of air has been evacuated. The steam to jacket remains open the whole time.

At the end of the hold time the manual steam supply valves to both the jacket and tank interior are closed. The valve to the vacuum relief (PSV 2301-05) is opened. If time allows, the vent to the Beer Well (TS-4601) and the drain valve remain closed to allow any remaining condensate to drain and the vessel to cool naturally. If a quicker cool-down is required the valves to the vent and the drain remain closed and UV water is sprayed in through the CIP spray nozzles. As the steam condenses sterile air will relieve the vacuum.

At any time during processing, the vessel contents can be sampled with the sterile sampling valve (SSP 2301-01) provided. Steam is provided to the valve to sterilize the interior before the sample is taken.

Liquefaction Tank Level Controller (LIC-2301-09) Interlocks with the Liquefaction Tank Agitator (AG-2301)

The level in the Liquefaction Tank will be interlocked with the agitator to prevent damage to it:

- When the level in the Liquefaction Tank reaches 15% the agitator will turn on.
- When the level in the Liquefaction Tank goes below 15% the agitator will turn off.

Level Control for VS-2301 (LIC-2301-09)

The level in the Liquefaction Tank (VS-2301) is controlled by varying the speed of the Liquefaction Tank Pump (PT-2301) by sending a signal to SIC-2301-14. Level controller LIC-2301-09 has the following alarms and interlocks:

- On High Level (90%) an alarm will be activated and the speed of PT-2301 will increase through SIC-2301-14.
- On Low Level (15% full) an alarm will be activated, the agitator (AG-2301) will be shut down.
- On Low Low Level (10% full) an alarm will be activated. Pump PT-2301 will not shut down as this is a peristaltic pump that can run dry without damage.

Temperature Control (TIC-2301-04A and TIC-2301-04B)

The temperature in the vessel is controlled by TIC-2301-04A (99 ^{o}F) during the normal processing cycle and by TIC-2301-04B (275 ^{o}F) during the SIP cycle. During the normal cycle, temperature transmitter TT-2301-04 modulates valve TV-2301-04A to regulate the flow of cooling water or hot water. The switch between cooling water and hot water is automated using valves XV 2301-29, XV 2301-30, XV 2301-31 and XV 2301-32. During the SIP cycle temperature transmitter TT-2031-04 modulates valve TV-2301-04C which regulates the flow of steam into the vessel.

Fail positions of the modulating valves are as follows:

- TV 2301-04A – Fail open
- TV 2301-04C – Fail closed

Fail positions of the on/off valves are as follows:

- XV-2301-29 – Fail open
- XV-2301-30 – Fail closed
- XV-2301-31 – Fail closed
- XV-2301-32 – Fail open

TI-2301-18 indicates temperature of the Liquefaction vessel locally.

The Liquefaction Jacket Recirculation Pump (PT-3204) recirculates the contents of the vessel jacket. The speed of this pump can be controlled locally or remotely and is not affected by the temperature of the vessel.

Pressure Indication (PIT-2301-08)

The pressure in the Liquefaction Tank is measured by PIT-2301-08. It is displayed both locally and remotely. This instrument has no controlling function but it is used during the vacuum step of the SIP cycle to turn off the vacuum pump (PV-3201) when the vessel reaches 0.5 psia.

pH Control (AIC-2301-16)

The pH of the hydrolysate slurry is controlled with aqueous ammonia in the Liquefaction Tank. AIC 2301-16 controls the speed of pump PT-8501 (SIC 8501-01) based on the pH measurement.

Current Indicator for AG-2301 (II-2301-07)

The current on the Liquefaction Tank Agitator (AG-2301) motor is monitored to alert operations problems with the agitator motor. The current indicator has high and a low alarms. A high alarm would signal any condition causing overload and the low alarm would signal a failed drive coupling.

Pressure / Vacuum Control on Liquefaction Tank (PSE-2301-22, PSV-2301-05)

Rupture disk PSE-2301-22 and vacuum relief valve PSV 2301-05 are provided to protect the Liquefaction Tank (a pressure vessel) from over pressurization and vacuum damage. Sterile air is provided to the vacuum relief in order to prevent introduction of bacteria into the vessel. A valve is also provided to isolate the tank from the vacuum relief while vacuum is being pulled on the vessel during the SIP cycle. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 50 psig
- Tank design vacuum – Full vacuum
- PSE-2301-22 – pressure setting 40 psig
- PSV-2301-05 – vacuum setting -15” w.c.

Pressure / Vacuum Control on Liquefaction Tank Jacket (PRV-2301-01, PSV-2301-02)

Pressure regulating valve PRV-2301-01 regulates the pressure of steam entering the jacket. It is a self-contained PRV and has a set point of 15 psig.

Pressure relief valve PSV-2301-02 is provided to protect the Liquefaction Tank Jacket from over pressurization. The design conditions and the set points of the protection devices are given below.

- Jacket design pressure – 50 psig
- PSV-2301-02 – pressure setting 45 psig

Pressure Control for Pump PT-2301 (PIT 2301-15)

The pressure is monitored on the outlet of pump PT-2301 continuously, and the pressure is indicated remotely. On High Pressure (120 psig), PT-2301 will be turned off, as this indicates that all valves downstream are closed.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI 2301-03, Line 9302-12: Incoming steam pressure. Verification of pressure after the pressure regulator.
- TI 2301-18, Nozzle T2: Tank temperature. This is a redundant temperature indicator to TT 2301-04
- PI 2301-12, Line 2301-09: Steam pressure. Verification of pressure prior to the tank.

VALVE SEQUENCING – LIQUEFACTION TANK (VS-2301)

		AMX-8501-03: V-02 or V-10	CELU-8303-03: V-13	CIPR-2301-19 (after pump): V-37	CIPR-2301-19 (after tee): V-39	CIPS-2301-15: V-12	CIPS-8202-01: V-09	CL-2301-03: V-30	CL-2301-06: V-33	CWR-2301-02: XV-2301-29	CWR-2301-99: V-19	CWR-3214-11: V-25	CWS-2301-17	CWS-9202-05: XV-3201-32	HW-2301-16: XV-2301-30	HW-9601-16: XV-2301-31	LIQS-2301-04: V-28, V-35	LIQS-2301-05: V-38	LIQS-2301-13: V-40	Nozzle D: V-11	Nozzle Q: V-28	Nozzle R: V-27	Nozzle S: V-26	Nozzle V: V-21	Sampling Valves	SL-2301-09: TV-3201-04C	SL-2301-15: V-15, V-13	SL-9302-12: V-22	UVW-2301-08: V-04 thru V-07	UVW-2301-20: V-08	UVW-2302-08: V-03	VTN-2301-01: V-44
Adding Ingredients	Adding Ammonia	O																			O		C					C			O	O
	Adding Cellulase		O																		O		C					C				O
	Adding Hydrolysate																				O		C					C				O
	Adding UV Water																				O		C					C		O	O	O
	Adding UV Water to tank																C				O	C	C						O			
CIP	CIP-HYDS line (reverse)			C	O													O	C													
	CIP-Tank				O	O	O										O				O	O	C									
SIP	SIP - Heat up							C				C		C		C					O	C	O				O		O			
	SIP - Vacuum Step		C			C	C														C	C	C					O		C		
	SIP - Hold		C			C	C		O												O	O	O						C	C		
Temp. Control	Cooling									O			C	O	C	C					O		C	O	O				C			
	Heating									C			C	C	O						O		C	O	O			C	C				O
	Recirculating Jacket							C			O	O	C											O	O				C				
Draining	Pumping to Ph Adjust Tank			O	C				C								O	O	C	O	O											
	Pumping to Decanter			O	C				C								O	C	O	O	O											
	Sample valve																			O					O							

Liquefaction Cooler (DRAWING PIL-PID-2302)

Prior to its introduction into the Liquefaction tank, the UV water is cooled in the Liquefaction Cooler (HP-2301) using chilled water.

Temperature Control (TIC-2301-19)

The outlet temperature of the UV water is controlled by TIC-2301-19. Temperature transmitter TT-2301-19 modulates valve TV-2301-19 to regulate the flow of chilled water. Fail positions of the modulating valves are as follows:

- TV-2301-19 – Fail open

Local Indication

The local indicators below are provided for visual verification of process conditions at the heat exchanger. These instruments have no control functions and no remote indication.

- TI 2303-01, Line 2302-06: Returning chilled water temperature.
- PI 2303-02, Line 2302-06: Returning chilled water pressure.
- TI 2303-03, Line 9202-34: Incoming chilled water temperature.
- PI 2303-03, Line 9202-34: Incoming chilled water pressure.
- TI 2301-17, Line 9503-07: Incoming UV water temperature.
- PI 2301-20, Line 2302-08: Outgoing UV water pressure.

Pressure Control on Liquefaction Cooler (PSV-2301-21)

Pressure Safety Valve PSV-2301-21 is provided to protect the Liquefaction Cooler from over pressurization if the chilled water is ever blocked in. The pressure setpoint of the PSV is 95 psig.

Hydrolyzate pH Adjustment (DRAWING PIL-PID-2303)

The hydrolyzate slurry is transferred from the Liquefaction Tank VS-2301 to the Hydrolyzate pH Adjustment Tank (VS-2302). The pH of this tank is constantly monitored, and the pH element controls the rate of a pump metering the aqueous ammonia into the slurry. The level of the tank is controlled to ensure the one-hour residence time in the tank. Cooling water, steam and hot water are all provided to the vessel jacket. The jacket water can also be recirculated through a pump for finer temperature control. This tank can be cleaned in place and steamed in place.

The CIP cycle consists of three phases: pre-rinsing, dilute caustic wash, and final rinse. All are provided at the flowrate and pressure required for the sprayball to clean the tank adequately. See the Area 8200 controls description for further discussion.

The steam-in-place (SIP) cycle also consists of three phases: heat up, hold, and cool down. See the SIP write-up in the Liquefaction Tank section.

At any time during processing, the vessel contents can be sampled with the sterile sampling valve provided. Steam is provided to the valve to sterilize the interior before the sample is taken.

Hydrolyzate pH Adjustment Tank Level Controller (LIC-2302-09) Interlocks with the Hydrolyzate pH Adjustment Tank Agitator (AG-2302)

The level in the Hydrolyzate pH Adjustment Tank will be interlocked with the agitator to prevent damage to it:

- When the level in the Hydrolyzate pH Adjustment Tank reaches a level that will cover the lower turbine blade the agitator will turn on.
- When the level in the Hydrolyzate pH Adjustment Tank goes below the level that will not cover the lower turbine blade the agitator will turn off.

Level Control for VS-2302 (LIC-2302-09)

The level in the Hydrolyzate pH Adjustment Tank is controlled by modulating valve LV 2302-09. Level controller LIC-2302-09 will have the following alarms and interlocks:

- On High Level (90%) an alarm will be activated and the speed of PT-2302 will open LV 2302-09.
- On Low Level (15% full) an alarm will be activated, the agitator (AG-2302) will be shut down and LV 2302-09 will open.
- On Low Low Level (10% full) an alarm will be activated.

Temperature Control (TIC-2302-04 and TIC-2302-04B)

The temperature in the vessel is controlled by TIC-2302-04 during the normal processing cycle and by TIC-2302-04B during the SIP cycle. During the normal cycle, TT-2302-04 modulates valve TV-2302-04A to regulate the flow of cooling water or hot water through the jacket. The switch between cooling water and hot water is automated on automated valves XV 2302-29, XV 2302-30, XV 2302-31 and XV 2302-32. During the SIP cycle, TT-2302-04B modulates valve TV-2302-04B, which regulates the flow of steam into the vessel.

Fail positions of the modulating valves are as follows:

- TV-2302-04A – Fail open
- TV-2302-04B – Fail open

Fail positions of the on/off valves are as follows:

- XV-2302-29 – Fail open
- XV-2302-30 – Fail closed
- XV-2302-31 – Fail closed
- XV-2302-32 – Fail open

TI-2302-18 indicates the temperature of the Hydrolyzate pH Adjustment Tank locally.

The Hydrolyzate pH Adjustment Jacket Recirculation Pump (PT-3205) recirculates the contents of the vessel jacket. The speed of this pump can be controlled locally or remotely but is not affected by the temperature of the vessel.

pH Control (AIC-2302-16)

The pH of the hydrolysate slurry is controlled with aqueous ammonia in the Hydrolyzate pH Adjustment Tank. AIC 2302-16 speeds up or slows down pump PT-8503 (SIC 8503-01) based on the pH measurement.

Pressure Indication for VS-2302 (PIT 2302-10)

The pressure on the Hydrolyzate pH Adjustment tank is monitored locally and remotely and is used during the vacuum phase of the SIP cycle. There are no alarms or interlocks on this instrument.

Pressure / Vacuum Control on VS-2302 (PSE-2302-22, PSV-2302-20)

Rupture disk PSE-2302-22 and vacuum relief PSV-2302-20 are provided to protect the Hydrolyzate pH Adjustment Tank (a pressure vessel) from over pressurization and vacuum damage. Sterile air is provided to the vacuum relief in order to prevent introduction of bacteria into the vessel. A valve is also provided to isolate the tank from the vacuum relief while the vessel is being evacuated with the vacuum pump during the SIP cycle. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 50 psig
- Tank design vacuum – Full vacuum
- PSE-2302-22 – pressure setting 40 psig
- PSV-2302-20 – vacuum setting -15” w.c.

Pressure / Vacuum Control on Hydrolyzate pH Adjustment Tank Jacket (PRV-2302-01, PSV-2302-02)

Pressure regulating valve PRV-2302-01 regulates the pressure of steam entering the jacket. It can be adjusted for different pressures.

Pressure relief valve PSV-2302-02 is provided to protect the Liquefaction Tank Jacket from over pressurization. The design conditions and the set points of the protection devices are given below.

- Jacket design pressure – 50 psig
- PSV-2302-02 – pressure setting 45 psig

Pressure Control for PT-2302 (PI-2302-15)

The pressure is continuously monitored on the outlet of pump PT-2302. On High Level (120 psig) pump PT-2302 will be turned off, as this indicates that all valves downstream are closed.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and no remote indication.

- PI-2302-03, Line 2303-01: Returning cooling water pressure.
- PI-2302-05, Line 9202-32: Incoming cooling water pressure.
- PI-2302-07, Line 9302-36: Incoming steam pressure. Verification of pressure after the pressure regulator.
- PI 2302-08, Line 2303-15: Steam pressure. Verification of pressure prior to entering the vessel.
- TI-2302-18, Nozzle Q2: Tank temperature. This is a redundant temperature indicator to TIT-2302-04.

VALVE SEQUENCING – HYDROLYZATE PH ADJUSTMENT TANK (VS-2302)

		AMX-2303-14: V-04	CIPR-2303-08: V-37	CIPS-2303-22: V-02	CIPS-2303-23: V-03	CL-2303-18: V-29	CL-2303-21: V-47	CWR-2303-01: XV-2302-29	CWR-2303-99: V-15	CWR-3214-10: V-24	CWS-9202-32: XV-2302-32	HPV Valve (Jacket vent): V-17	HW-2303-19: Xv-2302-30	HW-9601-14: V-27, XV-2302-31	LIQS - 2303-03 (after pump): V-34	LIQS - 2303-03 (after header): V-42	LIQS - 2303-04: V-44	LIQS - 2303-05: V-39	LIQS - 2303-06: V-40	LIQS - 2303-07: V-43	LIQS - 2303-12: V-35	LIQS-2301-05: V-39	LIQS-2303-02: V-26,V-31	LIQS-2303-12: V-35	Nozzle B (Liquefaction Inlet): V-08	Nozzle G (Vent): V-10	Nozzle J (Aqua Ammonia): V-46	Nozzle K (Sampling Valves)	Nozzle L (Vessel Drain): V-26	Nozzle N (Jacket Inlet): V-25	Nozzle P (Jacket Drain): V-23	Nozzle R (Jacket Outlet): V-16	Nozzle T (Steam): V-22	Nozzle V (Vac. Relief): V-07	Nozzles D1, D2 (CIP Nozzles): V-11, V-09	SL-2303-15: V-22, TV-2302-048	SL-9202-36: V-14	VTN-2303-10: V-49
Adding Ingredients	Adding Ammonia (Liq line)	O																							O	O	C					C			C		O
	Adding Ammonia (Tank)	C																							O	O	O					C			C		O
	Adding Hydrolysate			C	C						O		C	C								O			O	O						C	O		C		O
Temp. Control	Cooling					C		O			O		C	C																O		O		O			C	
	Heating					C		C			C		O	O												O				O		O		O		C	C	O
	Recirculating Jacket					C			O																	O				O				O		C	C	O
Draining	Pumping to Prop 3A		C				C								O	O	C	C	C	C	C		O			O			O					O		C		O
	Pumping to Prop 3B		C				C								O	C	O	C	C	C	C		O			O			O					O		C		O
	Pumping to Fermentor A		C				C								O	C	C	O	C	C	C		O			O			O					O		C		O
	Pumping to Fermentor B		C				C								O	C	C	C	O	C	C		O			O			O					O		C		O
	Pumping to Fermentor C		C				C								O	C	C	C	C	O	C		O			O			O					O		C		O
	Pumping to CIP Return Filter		O				C								O	C	C	C	C	C	C		O			O			O					O		C		O
	Pumping to Liq. Tank		C				C								O	C	C	C	C	C	O		O			O			O					O		C		O
CIP	CIP - Liquefaction Line (Forwards)	C	O	C	O										C							C		C	O				O						C			
	CIP - Liquefaction Line Backwards			O	C																	C													C			
	CIP - Tank	C	O	C	C			C	C	C	C	C	C	C	C								C	C	C	O	C	C	O	C	C	C	C	O	O	C	C	O
SIP	SIP - Heat up							C	C	C	C	C	C	C											C	O	C	C	O	O	C	O	O	C	C	O	O	O
	SIP - Hold							C	C	C	C	C	C	C											C	C	C	C	O	O	C	O	O	C	C		O	C
	SIP - Vacuum Step							C	C		C		C	C											C	O			C	O		O		C	C		O	C
	Sampling																											O									

Area 3200 –Overview

Propagators 1 A & B, 2A & B, 3A & B

Propagation begins at a set number of hours before the organism is required by fermentation.

Propagation is carried out in a propagation train of three vessels where each is 10 times larger than the previous. The propagator 1's are 8 gallons working volume, propagator 2's are 80 gallons working volume, and the propagator 3's are 800 gallons working volume.

Temperature and pH are monitored throughout the propagation to assess the process conditions. Propagators 1, 2, and 3 are kept at 98.6 °F with cooling water, hot water and steam provided to a jacket on the vessels. The temperature measurement on the propagator controls the cooling and hot water flow to the jacket during normal processing and controls steam flow to the jacket during the SIP cycle.

Many phases of the Propagator 1 batch cycle are controlled manually. These include all CIP cycles (tank and lines), addition of ingredients (excluding acid and base), addition of inoculum from any vessel or through septum, jacket water recirculation, draining/pump-out, all phases of SIP cycle excluding temperature regulation during Hold phase.
Batch Sequencing of the Propagators

The propagators follow a fed-batch sequence as follows:

Step 1. Start with a clean, sterile vessel and transfer line.

Step 2. Fill the propagation vessel to half of the working volume with hydrolyzate and 3/8 of the working volume with UV water.

Step 3. Add magnesium sulfate and trace metals. Antifoam or other ingredients can also be added at this time.

Step 4. Utilizing the hot water and cooling water provided to the jacket, bring the vessel contents to 98.6^{o}F.

Step 5. Utilizing the acid and base provided, bring the vessel contents to a pH of 6.5.

Step 6. Add inoculum. In the first propagator, the inoculum is normally added through a sterile septum. Normally, in subsequent propagators, this is the organism pitched from the previous propagation. However, this system is designed so that any vessel can also provide the inoculum organism to any other vessel.

Step 7. Sterile air is supplied to an internal sparger to aid in propagation if necessary.

Step 8. The organism will generate carbon dioxide. A vent to the Beer Well will be open during the propagation. The Beer Well is then vented to the CO2 scrubber. This system prevents any release of organisms to the atmosphere.

Step 9. The batch ends after 24 hours at which time the contents can be pitched into the next propagator or the fermentor.

Step 10. The next propagator in line has already gone through steps 1-5 above and is ready for its step 6 from the previous propagator.

Step 11. A pump is used to empty propagator 1 into propagator 2. Sterile air is used to transfer propagators 2 and 3.

Step 12. The next step is to CIP the propagator, the transfer lines and the vent line. Pump PT-3201 is used to pump the CIP fluid from Propagator 1A & 1B back to the CIP system. A hose connection and a portable pump are used for the other propagators.

Step 13. Steam sterilizes the propagator at 30 psig, 275°F. Steam is added directly into the propagator through a nozzle separate from the normal drain. The steam will condense and will be drained at the bottom of the propagation broth transfer line to a drain. Steam on the vessel jacket can be used to preheat the vessel and maintain the temperature setpoint.

Step 14. Propagator is ready to start over with step 1.

Propagator 1A & 1B Controls (DRAWINGS PIL-PID-3201 & PIL-PID-3209)

Propagator 1A & 1B Level Indication (LI-3201A-03, LI-3201B-03)

Level indicators LI-3201A-03 and LI-3201B-03 will have the following alarms and interlocks:

On High Level (90% full) an alarm will be activated.

On Low Level (15% full) an alarm will be activated, and Propagator 1A or 1B Agitator (AG-3201A or AG-3201B) will be shut down.

Level Switch for Foam Detection (LSH-3201A-04, LSH-3201B-04)

High level switches, LSH-3201A-04 & LSH-3201B-04, are provided for foam detection. When a high level is detected, an alarm will sound in the PLC signaling the operator to add antifoam.

Temperature Control (TIC-3201A-10, TIC-3201B-10)

The temperatures in the vessels are controlled by TIC-3201A-10 and TIC-3201B-10 during both the normal processing cycle and the SIP cycle. TIT-3201A-10 & TIT-3201B-10 are mounted on the propagator and send a signal to TIC-3201A-10 and TIC-3201B-10, respectively. During the normal cycle, TIC-3201A-10 modulates valve TV-3201A-10A and TIC-3201B-10 modulates valve TV-3201B-10A to regulate the flow of cooling water or hot water. The switch between cooling water and hot water is automated with on/off valves (XV-3201A-29, 30, 31, 32 & XV-3201B-29, 30, 31, 32) on the hot and cold water inlets and outlets.

During the SIP cycle, TIC-3201A-10 modulates valve TV-3201A-10B and TIC-3201B-10 modulates valve TV-3201B-10B which regulates the flow of steam into the vessel. There is no throttling valve for the steam flow to the jacket.

Fail positions of the modulating valves are as follows:

- TV-3201A-10A & TV-3201B-10A – Fail open
- TV-3201A-10B & TV-3201B-10B – Fail closed

Temperature Indication (TI-3201A-27, TI-3201B-27)

TI-3201A-27 and TI-3201B-27 display the temperature in the propagators locally and do not regulate the temperature of the vessels.

Pressure Indication (PI-3201A-33, PI-3201B-33)

The pressure in Propagators 1A & 1B is measured by PIT-3201A-33 and PIT-3201B-33 and is displayed both locally and remotely. These instruments have no controlling function but are used during the vacuum step of the SIP cycle.

pH Control (AI-3201A-01, AI-3201B-01)

The pH of the propagation broth is controlled with phosphoric acid and the base in the Base B system. AI-3201A-01 pulses open either XV-3201A-23 (Base B) or XV-3201A-24 (acid) and AI-3201B-01 pulses open either XV-3201B-23 (Base B) or XV-3201B-24 (acid) according to the pH measurements in the vessel.

Current Indicator for AG-3201A and AG-3201B (II-3201A-06, II-3201B-06)

The currents on the AG-3201A and AG-3201B motors are monitored to alert operations problems with the agitator motor. The current indicators have high and a low alarms. A high alarm would signal any condition causing overload and the low alarm would signal a failed drive coupling.

Sterile Air Pressure Control (PRV 3201A-25, FI 3201A-26, PRV 3201B-25, FI 3201B-26)

The pressure and flowrate of the sterile air into the spargers are controlled by pressure regulating valves, PRV 3201A-25 and PRV 3201B-25, and rotameters, FI 3201A-26 and FI 3201B-26. PRV 3201A-25 and PRV 3201B-25 can be adjusted for different pressure. The flowrate can be manually adjusted using FI 3201A-26 or FI 3201B-26. Both of the instruments are local only and do not report any data to the DCS.

Steam Pressure Control (PRV 3201A-13, PRV 3201B-13)

The pressure of the steam into the vessel jackets is controlled by pressure regulating valves, PRV 3201A-13 and PRV 3201B-13, which can be adjusted for different pressure.

Pressure / Vacuum Control on Propagators 1A & 1B (PSE-3201A-28, PSV-3201A-07, PSE-3201B-28, PSV-3201B-07)

Rupture disk PSE-3201A-28 and PSE-3201B-28 and vacuum relief valve PSV 3201A-07 and PSV 3201B-07 are provided to protect Propagators 1A & 1B (pressure vessels) from over pressurization and vacuum damage. Sterile air is provided to the vacuum relief in order to prevent introduction of bacteria into the vessel. A valve is also provided to isolate the tank from the vacuum relief while vacuum is being applied to the vessel during the SIP cycle. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 50 psig
- Tank design vacuum – Full vacuum
- PSE-3201A-28, PSE-3201B-28 – pressure setting - 40 psig
- PSV-3201A-07, PSV-3201B-07 – vacuum setting -15” w.c.

Pressure / Vacuum Control on Propagators 1A & 1B Jackets (PSV-3201A-11, PSV-3201B-11)

Pressure relief valves PSV 3201A-11and PSV 3201B-11 are provided to protect the jackets on Propagators 1A and 1B from over pressurization. These PSVs will vent to the atmosphere. The design conditions and the set points of the protection devices are given below.

- Jacket pressure – 50 psig
- PSV-3201A-11, PSV-3201B-11 – pressure setting - 45 psig

Pressure Control for Pump PT-3201 (PIT 3201A-22)

The pressure is monitored continuously on the outlet of Propagator 1A Pump (PT-3201). On High Level pump PT-3201 will be turned off, as this indicates that all valves downstream are closed.

Local Indication

The local indicators listed below are provided for visual verification of process conditions at the propagator. These instruments have no control functions and they do not report data to the DCS.

- PI 3201A-08, PI 3201B-08: Sterile air pressure. Verification of air pressure prior to vessel pressurization, vacuum relief or air sparging.
- TI 3201A-12, TI 3201B-12: Jacket water outlet temperature. Verification of Cooling or Hot water temperature after the jacket.
- PI 3201A-15, PI 3201B-15: Incoming steam pressure. Verification of pressure after the pressure regulator.
- PI 3201A-16, PI 3201B-16: Jacket water inlet pressure. Verification of Cooling or Hot water pressure prior to the jacket.
- TI 3201A-17, TI 3201B-17: Jacket water inlet temperature. Verification of Cooling or Hot water temperature prior to the jacket.
- PI 3201A-20, PI 3201B-20: Steam pressure. Verification of pressure pressure prior to the tank.
- TI 3201A-27, TI 3201B-27: Tank temperature. These are redundant temperature indicators to TIT 3201A-10 and TIT 3201B-10.

VALVE SEQUENCING – PROPAGATOR 1A (VS-3201A)

		AF-3201-08: V-07	AF-9402-10: V-12, V-15, V-20	CIP (Nozzle E): V-25	CIPR-3201-10: V-35	CIPS-3201-14: V-08	CIPS-8202-02: V-25	CWR-3201-13: XV-3201A-29	CWR-3201-30: V-44	CWR-3214-02: V-23	Drain (Nozzle L): V-27	HW-3201-24: XV-3201A-30	HYDS-2104-04: V-11	Process Inlet (Nozzle Q): V-19	PROP-3201-07 (Prior to pump): V-32	PROP-3201-16 (1st, by Pump): V-34	PROP-3201-16 (2nd, after branches): V-38	JACKET OUTLET (Nozzle J2)	CL-3201-19 (prior to trap): V-31	CL-3201-22 (prior to trap): V-30	PROP-3201-23: V-37	PROP-3203-38: V-05	PROP-3204-38: V-04	PROP-3205-34: V-01	PROP-3206-34: V-02	PROP-3207-34: V-03	PROP-3209-16: V-38	Sample Valve (Nozzle N)	SL-3201-06: TV-3201A-10B, V-28	SL-9302-11: V-42	Sparger (Nozzle P): V-20	Steam Inlet (Nozzle K): V-28	UVW-9503-06: V-14	Vacuum relief (Nozzle A): V-24	Valve 3201A-23 (Base inlet)	Valve 3201A-24 (Acid inlet)	Valve 3201A-29 (Cooling water outlet)	Valve 3201A-30 (Hot water outlet)	Valve 3201A-31 (Hot water inlet)	Valve 3201A-32 (Cooling water inlet)	Vent (Nozzle F): V-26	VTP-3201-04: V-49
Adding Ingredients	Adding HYDS		O				C				C		O													C		C		C	O	C					O	O
	Adding base		O				C				C		C													O		C		C	O	C					O	O
	Adding Acid		O				C				C		C													C		C		C	C	C	O	O				O	O
	Adding UV water												C	O																		O	O	C	C					
	Pitching from 2A	C		C			C							C	O	O	O				C						C	C		C	C								
	Pitching from 2B	C		C			C							C	O	O	C				O						C	C		C	C								
	Pitching from Prop 3A		O	C							O			C	O	C			C			O	C	C	C	C	C	C	C	C	C	O					O	O
	Pitching from Prop 3B		O	C							O			C	O	C			C			C	O	C	C	C	C	C	C	C	C	O					O	O
	Pitching from Ferm A		O	C							O			C	O	C			C			C	C	O	C	C	C	C	C	C	C	O					O	O
	Pitching from Ferm B		O	C							O			C	O	C			C			C	C	C	O	C	C	C	C	C	C	O					O	O
	Pitching from Ferm C		O	C							O			C	O	C			C			C	C	C	C	O	C	C	C	C	C	O					O	O
Temp. Control	Heating							O				C						O		C												O			C	O	O	C		
	Cooling							O				C						O		C												O			O	C	C	O		
	Recirculating jacket								O	O								O		C												O							
Pumping Out	Pumping to 2A	C	O	C	C		C				O			C	O	O	O		C		C						C	C	C		C	C		O				O	O
	Pumping to 2B	C	O	C	C		C				O			C	O	O	C		C		O						C	C	C		C	C		O				O	O
	Pumping from 1B to 2B				C										C	O	C				O						O												
	Pumping from 1B to 2A				C										C	O	O				C						O												
Clean In Place (CIP)	CIP - Sparger	C	O	C	O	O	C				O			C		O	C		C		C						C	C		C	O	C		O				O	
	CIP - Vent line	C		C	O	C	O				O				O	O	C		C		C							C	C			C		O				O	C
	CIP - Tank	C	O	O	O	C	C				O			C	O	O	C		C		C						C	C	C		C	C		O				O	O
	Returning CIP from Prop 1B				O										C	O	C				C						O												
Steam in Place (SIP)	SIP - Pre Heat	C					C	C	C	C								O		O									C	O			O				C	C	O	O
	SIP - Heat up	C		C			C				C			C														C	C		C	O		O				O	O
	SIP - Vacuum Step	C		C			C				C			C														C	O		C	C		C				O	C
	SIP - Hold			C							O			C	C				O									C			C	O		C				C	
Other	Sparging	C	O			C	C				C																		C		O	C		O				O	O
	Sampling																											O						O						

Propagators 2A & 2B Controls (DRAWINGS PIL-PID-3202 & PIL-PID-3210)

Propagators 2A & 2B Level Indication (LI-3202A-03, LI-3202B-03)

Level indicators LI-3202A-03 and LI-3202B-03 will have the following alarms and interlocks:

On High Level (90% full) an alarm will be activated.

On Low Level (15% full) an alarm will be activated, and Propagators 2A & 2B Agitators (AG-3202A & AG-3202B) will be shut down.

Level Switches for Foam Detection (LSH-3202A-04, LSH-3202B-04)

High level switches, LSH-3202A-04 and LSH-3202B-04, are provided for foam detection. When a high level is detected an alarm will pulse either valve XV 3202A-27 or XV 3202B-27 to add antifoam.

Temperature Control (TIC-3202A-10, TIC-3202B-10)

The temperature in the vessels is controlled by TIC-3202A-10 and TIC-3202B-10 during both the normal processing cycle and the SIP cycle. TIT-3202A-10 and TIT-3202B-10 mounted on the propagators send a signal to TIC-3202A-10 and TIC-3202B-10, respectively. During the normal cycle, TIC-3202A-10 modulates valve TV-3202A-10A and TIC-3202B-10 modulates valve TV-3202B-10A to regulate the flow of cooling water or hot water. The switch between cooling water and hot water is automated with on/off valves (XV-3202A-29, 30, 31, 32 & XV-3202B-29, 30, 31, 32) on the hot and cold water inlet and outlets.

During the SIP cycle, TIC-3202A-10 modulates valve TV-3202A-10B and TIC-3202B-10 modulates valve TV-3202B-10B to regulate the flow of steam into the vessel. There is no throttling valve for the steam flow to the jacket.

Fail positions of the modulating valves are as follows:

- TV-3202A-10A, TV-3202B-10A – Fail open
- TV-3202A-10B, TV-3202B-10B – Fail closed

Temperature Indication (TI-3202A-02, TI-3202B-02)

TI-3202A-02 and TI-3202B-02 display the temperature in the propagators locally and do not regulate the temperature of the vessel.

Pressure Indication (PI-3202A-33, PI-3202B-33)

The pressure in Propagators 2A & 2B is measured by PIT-3202A-33 and PIT-3202B-33 and is displayed both locally and remotely. These instruments have no controlling function, but are used during the vacuum step of the SIP cycle.

pH Control (AI-3202A-01, AI-3202B-01)

The pH of the propagation broth is controlled with phosphoric acid and base in the Base B system. AI-3202A-01 pulses open either XV-3202A-23 (Base B) or XV-3202A-24 (acid) and AI-3202B-01 pulses opens either XV-3202B-23 (Base B) or XV-3202B-24 (acid) according to the pH measurement in their respective vessels.

Current Indicator for AG-3202A & AG-3202B (II-3202A-06, II-3202B-06)

The current on the AG-3202A and AG-3202B motors is monitored to alert operations problems with the agitator motor. The current indicator has high and a low alarms. A high alarm would signal any condition causing overload and the low alarm would signal a failed drive coupling.

Sterile Air Pressure Control (PRV 3202A-25, FI 3202A-26, PRV 3202B-25, FI 3202B-26)

The pressure and flowrate of the sterile air into the spargers are controlled by pressure regulating valves, PRV 3202A-25 and PRV 3202B-25, and rotameters, FI 3202A-26 and FI 3202B-26. PRV 3202A-25 and PRV 3202B-25 can be adjusted for different pressure. The flowrate can be manually adjusted using FI 3202A-26 or FI 3202B-26. Both flow instruments are local only and do not report any data to the DCS.

Steam Pressure Control (PRV 3202A-13, PRV 3202B-13)

The pressure of the steam into the vessel jackets is controlled by pressure regulating valves PRV 3202A-13 and PRV 3202B-13 which can be adjusted for different pressures.

Pressure / Vacuum Control on Propagators 2A & 2B (PSE-3202A-28, PSV-3202A-07, PSE-3202B-28, PSV-3202B-07)

Rupture disks PSE-3202A-28 and PSE-3202B-28 and vacuum relief valve PSV 3202A-07 and PSV 3202B-07 are provided to protect Propagators 2A & 2B (pressure vessels) from over pressurization and vacuum damage. Sterile air is provided to the vacuum relief in order to prevent introduction of bacteria into the vessel. A valve is also provided to isolate the tank from the vacuum relief while vacuum is being applied to the vessel during the SIP cycle. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 50 psig
- Tank design vacuum – Full vacuum
- PSE-3202A-28, PSE-3202B-28 – pressure setting - 40 psig
- PSV-3202A-07, PSV-3202B-07 – vacuum setting -15” w.c.

Pressure / Vacuum Control on Propagators 2A & 2B Jackets (PSV-3202A-11, PSV-3202B-11)

Pressure relief valves PSV 3202A-11 and PSV 3202B-11 are provided to protect the jackets on Propagators 2A & 2B from over pressurization. This PSV will vent to the atmosphere. The design conditions and the set points of the protection devices are given below.

- Jacket pressure – 50 psig
- PSV-3202A-11, PSV-3202B-11 – pressure setting - 45 psig

Local Indication

The local indicators listed below are provided for visual verification of process conditions at the propagator. These instruments have no control functions and they do not report data to the DCS.

- PI 3202A-08, PI 3202B-08: Sterile air pressure. Verification of air pressure prior to vessel pressurization, vacuum relief or air sparging.
- TI 3202A-12, TI 3202B-12: Jacket water outlet temperature. Verification of Cooling or Hot water temperature after the jacket.
- PI 3202A-15, PI 3202B-15: Incoming steam pressure. Verification of pressure after the pressure regulator.
- PI 3202A-16, PI 3202B-16: Jacket water inlet pressure. Verification of Cooling or Hot water pressure prior to the jacket.
- TI 3202A-17, TI 3202B-17: Jacket water inlet temperature. Verification of Cooling or Hot water temperature prior to the jacket.
- PI 3202A-20, PI 3202B-20: Steam pressure. Verification of pressure prior to the tank.
- TI 3202A-02, TI 3202B-02: Tank temperature. These are redundant temperature indicators to TIT 3201A-10 and TIT 3201B-10.
- PI-3202A-22, PI-3202B-22: Outlet line pressure. Verification of flow.

VALVE SEQUENCING – PROPAGATORS 2A & 2B & 2B (VS-3202A, VS-3202B)

		AF-3202-11: V-38	AF-9402-09: V-10, V-14	CIPS-3202-07: V-11	CIPS-3202-09: V-03	CIPS-3202-10: V-04	CIPS-3202-16: V-35	CIPS-3202-17: V-44	CL-3202-19: V-20	CL-3202-24: V-15	CWR-3214-08: V-17	CWR-3202-29: V-33	HYDS-2103-10: V-02	HYDS-2104-02: V-01	Nozzle A: V-42	Nozzle E: V-41, V-39	Nozzle F: V-40	Nozzle K: V-25	Nozzle L: V-24	Nozzle P	Nozzle Q	Nozzle X: XV-3202A-23	Nozzle Y: V-13	PROP-3201-16 (btn 3202-09 & 3202-10): V-05	PROP-3201-16 (prior to 3202-20): V-22	PROP-3202-20 (after 3202-30): V-28	PROP-3202-20 (btn 3201-16 & 3202-15): V-21	PROP-3202-30: V-27	Sample Valve	SL-3202-01: V-37	SL-9302-10: V-34	UVW-9503-11: V-06	VTP-3202-02: V-36	XV 3202A-23	XV 3202A-24	XV 3202A-27 (Antifoam)	XV 3202A-29 (Cooling Water outlet)	XV 3202A-30 (Hot Water outlet)	XV 3202A-31 (Hot Water inlet)	XV 3202A-32 (Cooling Water inlet)
Adding Ingredients	Adding Acid	C					C								O	C	O	C	C				O							C				O					
	Adding Antifoam	C					C								O	C	O	C	C											C	C			O			O				
	Adding Base B	C					C								O	C	O	C	C			O								C	C			O	O						
	Adding C5 from C5 storage	C					C	C					O	C	O	C	O	C	C		O									C				O							
	Adding C5 from prep Tank	C					C	C					C	O	O	C	O	C	C		O										C				O							
	Adding UV Water	C				C	C								O	C	O	C	O					C	O		O			C		O		O							
	Pitching from 1A	C			C	C	C								O	C	O	C	O					O	O		O		C	C		C		O							
	Pitching from 3A	C		C	C	C	C	C	C						O	C	O	C	O	C	C	C	C		C	O	O	C	C	C			O			C				
	Pitching from 3B	C		C	C	C	C	C	C						O	C	O	C	O	C	C	C	C		C	C	O	O	C	C			O			C				
Temperature Control	Cooling (Jacket)									C					O																C					O	C	C	O
	Heating (Jacket)									C																										C	O	O	C
	Recirculating jacket									C	O	O																			C								
Draining	Pitching from 2A to 1A	O			C	C	C								O	C	O	C	O	C	C	C	C	O	O		O		C	C		C	C			C				
	Draining from 2A to 3A								C						O	C	C	C	O	C	C	C	C		C	O	O	C	C							C				
	Draining from 2A to 3B								C						O	C	C	C	O	C	C	C	C		C	C	O	O	C							C				
	Pressurizing from 2A to 3A	O					C		C						O	C	O	C	O	C	C	C	C		C	O	O	C	C	C			C			C				
	Pressurizing from 2A to 3B	O					C		C						O	C	O	C	O	C	C	C	C		C	C	O	O	C	C			C			C				
Cleaning in Place (CIP)	CIP 3A line (reverse)								C										C						C	O	C	O												
	CIP 3B line (reverse)								C										C						C	O	C	O												
	CIP Hyds line (forward)	C	C		C	C	C	O					C	C	O	C	O	C	O		O	C	C			O	C	C	C	C			O			C				
	CIP Prop 1A line (forward)			C	C	O	C	C								C			C					C	O	O	O	C				C							
	CIP Sparger	C	C	O	C	C	C	C							O	C	O	C	O	O	C	C	C			O	C	C		C			O							
	CIP Tank	C		C	C	C	C	C							O	O	O	C	O	C	C	C	C			O	C	C	C	C			O			C				
	CIP Vent Line	C		C	C	C	O	C							O	C	O	C	O	C	C	C	C			O	C	C	C	C			C			C				
Steam in Place (SIP)	SIP Hold								O						C	C	C	O	O	C	C	C	C		C	C	O	C	C							C				
	SIP Preheat									O	C																				O							C	C	C	C
	SIP Vacuum	C					C								C	C	O	C	C	C	C	C	C						C	O			C			C				
Other	Pitching from 3A to 1A				C	C			C															O	O	O	C	C				C							
	Pitching from 3B to 1A				C	C			C															O	O	C	C	O				C							
	Sampling								O						C	C	C	O	O	C	C	C	C		C	C	O	C	C							C				
	Sparging	C	O				C								O	C	O	C	C	O	C	C	C						C	C			O			C				

Propagators 3A & 3B Controls (DRAWINGS PIL-PID-3203, PIL-PID-3204)

Propagators 3A & 3B Level Indication (LI-3203A-03, LI-3203B-03)

Level controllers LI-3203A-03 and LI-3203B-03 will have the following alarms and interlocks:

On High Level (90% full) the high level alarm is activated
On Low Level (15% full) the low level alarm is activated and the agitators (AG-3203A, AG-3203B) are shut down.

Level Switches for Foam Detection (LSH-3203A-04, LSH-3203B-04)

High level switches LSH-3203A-04 and LSH-3203B-04 are provided for foam detection. When a high level is detected an alarm will pulse either valve XV 3203A-27 or XV 3203B-27 to add antifoam.

Temperature Control (TIC-3203A-10, TIC-3203B-10)

The temperature in the vessels is controlled by TIC-3203A-10 and TIC-3203B-10 during both the normal processing cycle and by the SIP cycle. During the normal cycle, temperature transmitter TIT 3203A-10 sends a signal to TIC-3203A-10 to modulate valve TV 3203A-10A and TIT 3203B-10 sends a signal to TIC-3203B-10 to modulate valve TV 3203B-10A to regulate the flow of cooling water or hot water. The switch between cooling water and hot water is automated with on/off valves (XV-3203A-29, 30, 31, 32 & XV-3203B-29, 30, 31, 32)on the hot and cold water inlet and outlets.

During the SIP cycle, temperature transmitter TIT 3203A-10 sends a signal to TIC-3203A-10 to modulate valve TV 3203A-10B and TIT 3203B-10 sends a signal to TIC-3203B-10 to modulate valve TV 3203B-10B to regulate the flow of steam into the vessel. There is no throttling valve for the steam flow to the jacket. Fail positions of the modulating valves are as follows:

- TV 3203A-10A, TV 3203B-10A – Fail open
- TV 3203A-10B, TV 3203B-10B – Fail closed

Propagators 3A & 3B Temperature Indication (TI-3203A-18, TI-3203B-18)

TI-3203A-18 and TI-3203B-18 provide local indication of the temperatures in Propagators 3A & 3B. They do not regulate the temperatures of the vessels.

Propagators 3A & 3B Pressure Indication (PI-3203A-33, PI-3203B-33)

The pressures in Propagators 3A & 3B are measured by PIT-3203A-33 and PIT-3203B-33. It is displayed both locally and remotely. This instrument has no controlling function but it is used during the vacuum step of the SIP cycle.

Propagators 3A & 3B pH Control (AI-3203A-01, AI-3203B-01)

The pH of the propagation broth is controlled by the addition of either phosphoric acid, or the base in the Base B system or lime slurry. AI-3203A-01 pulses open either XV 3203A-23 (Base B and Lime Slurry) or XV 3203A-24 (acid) and AI-3203B-01 pulses open either XV 3203B-23 (Base B and Lime Slurry) or XV 3203B-24 (acid) according to the pH measurement.

Current Indicator for Agitators AG-3203A and AG-3203B (II-3203A-06, II-3203B-06)

The currents on the AG-3203A and AG-3203B motors are monitored to alert operations problems with the agitator motors. The current indicators have high and a low alarms. A high alarm would signal any condition causing overload and the low alarm would signal a failed drive coupling.

Sterile Air Pressure & Flow Control (PRV-3203A-25, FI-3203A-26, PRV-3203B-25, FI-3203B-26)

The pressure and flowrate of the sterile air into the sparger are controlled with pressure regulating valves PRV-3203A-25 and PRV-3203B-25 and rotameters FI-3203A-26 and FI-3203B-26. PRV-3203A-25 and PRV-3203B-25 can be adjusted for different pressures. The flowrate can be manually adjusted by using FI-3203A-26 and FI-3203B-26. All of the instruments are local only and do not report any data to the PLC.

Steam Pressure Control (PRV 3203A-13, PRV 3203B-13)

The pressures of the steam into the vessel jackets are controlled by pressure regulating valves, PRV 3203A-13 and PRV 3203B-13 which can be adjusted for different pressure.

Pressure / Vacuum Control on Propagators 3A & 3B (PSE-3203A-34, PSV-3203A-07, PSE-3203B-34, PSV-3203B-07)

Rupture disks PSE-3203A-34 and PSE-3203B-34 and vacuum relief valves PSV-3201A-07and PSV-3201B-07 are provided to protect Propagators 3A & 3B (pressure vessels) from over pressurization and vacuum damage. Sterile air is provided to the vacuum relief valve to prevent introduction of bacteria into the vessel. A valve is also provided to isolate the tank from vacuum relief while vacuum is being applied to the vessel during the SIP cycle. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 50 psig
- Tank design vacuum – Full vacuum
- PSE-3203A-34, PSE-3203B-34 – pressure setting 40 psig
- PSV-3203A-07, PSV-3203B-07 – vacuum setting -15” w.c.

Pressure / Vacuum Control on Propagators 3A & 3B Jackets (PSV-3203A-11, PSV-3203B-11)

Pressure relief valves PSV 3203A-11 and PSV 3203B-11 are provided to protect the jackets on Propagators 3A & 3B from over pressurization. These PSVs will vent to the atmosphere. The design conditions and the set points of the protection devices are given below.

- Jacket pressure – 50 psig
- PSV-3203A-11, PSV-3203B-11 – pressure setting - 45 psig

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions, and they do not report data to the DCS.

- PI-3203A-08, PI-3203B-08: Sterile air pressure. Verification of air pressure prior to vessel pressurization, vacuum relief or air sparging.
- TI-3203A-12, TI-3203B-12: Jacket water outlet temperature. Verification of Cooling or Hot water temperature after the jacket.
- PI-3203A-15, PI-3203B-15: Incoming steam pressure. Verification of pressure after the pressure regulator.
- PI-3203A-16, PI-3203B-16: Jacket water inlet pressure. Verification of Cooling or Hot water pressure prior to the jacket.
- TI-3203A-17, TI-3203B-17: Jacket water inlet temperature. Verification of Cooling or Hot water temperature prior to the jacket.
- TI 3203A-18, TI 3203B-18: Tank temperature. This is a redundant temperature indicator to TIT 3203A-10
- PI 3203A-20, PI 3203B-20: Steam supply to vessel. Verification of supply pressure.
- PI 3203A-22, PI 3203B-22: Outlet line pressure. Verification of flow.

VALVE SEQUENCING – PROPAGATORS 3A & 3B & 3B (VS-3203A, VS-3203B)

	AF-3203-11: V-12	AF-9402-06: V-11	BASE-8502-12: V-58	CIPS-3203-05: V-01	CIPS-3203-06: V-02	CIPS-3203-07: V-05	CIPS-3203-08: V-06	CIPS-3203-43: V-61	CIPS-3203-40: V-08	CIPS-8202-04: V-57	CL-3203-29: V-27	CL-3203-29 (Prior to Drain): V-28	CWS-3203-34: V-50	CWR-3214-01: V-25	LIQS-2303-03: V-03	LMS-8403-08: V-59	Nozzle A (Vacuum Relief): V-15	Nozzle AA: XV-3203A-27	Nozzle B: V-17	Nozzle F: V-52	Nozzle K: V-35	Nozzle L: V-34	Nozzle P: V-19	Nozzle Q: V-16	Nozzle S: V-18	Nozzle X: XV-3203A-23	Nozzle Y: V-62	Nozzles E1, E2: V-53, V-54	NUTR-3211-20: V-17	NUTR-3211-29: V-18	PROP-3202-20: V-07	CL-3203-18: V-29	CL-3203-18 (prior to Drain): V-30	PROP-3203-19: V-42	PROP-3203-19 (after 3210-22): V-40	PROP-3203-19 (btn 3203-21 & 3210-22): V-33	PROP-3203-21: V-41	PROP-3203-22: V-38	PROP-3203-38: V-36	PROP-3210-30: V-09	PROP-3210-30 (Prior to 3203-19): V-26	Sample Valve	SL-3203-01: V-55	SL-9302-09: V-48	UVW-9503-08: V-04	VTP-3203-02: V-56	XV 3203A-29 (Cooling water)	XV 3203A-30 (Hot water)	XV 3203A-31 (Hot water)	XV 3203A-32 (Cooling water)
Adding Acid	C	O						C		C							O		C	O	C	C		C	C	C	O	C													C			O				
Adding Antifoam	C									C							O	O			C	C																				C			O				
Adding Base B	C	O	O					C		C						C	O		C	O	C	C		C	C	O	C	C													C			O				
Adding Lime Slurry	C	O	C					C		C						O	O		C	O	C	C		C	C	O	C	C													C			O				
Adding MgSO4	C									C							O				C	C			O					O											C			O				
Adding Trace Metals	C									C							O		O		C	C							O													C			O				
Adding UV Water	C	O			C			C							C		O	C	C	O	C	C		O	C	C	C	C																O	O			
CIP Ferm A line (reverse)																						C									C		O	C	C	O	C			C								
CIP Ferm B line (reverse)																																	O	C		O													
CIP Ferm C line (reverse)																																	C	O	C	O	C												
CIP Hyds line (forward)	C	O		C	O	C	C	C	C	C					C		O	C	C	O	C	O	C	O	C	C	C	C						O	O	O	C	C						C	O				
CIP Hyds line (reverse)				O	C	C	C	C	C	C					C		O											C																				
CIP Prop 2A line (forward)				C	C	C	O	C	C	C												C						C	C		C			O	O	O	C	C		C	O						
CIP Prop 2A line (reverse)				C	C	O	C	C	C	C																		C			C																
CIP Prop 2B line (reverse)				C	C	C	C	C	O	C																		C											C								
CIP Sparger	C	C		C	C	C	C	O	C	C							O	C	C	O	C	O	O	C	C	C	C	C						O	O	O	C	C				C			O				
CIP Tank	C	O		C	C	C	C	C	C	C							O	C	C	O	C	O	C	C	C	C	C	O						O	O	O	C	C				C			O				
CIP Vent Line	C	O		C	C	C	C	C	C	O							O		C	O	C	O		C	C	C	C	C						O	O	O	C	C				C			C				
Cooling (Jacket)		O						C			C						O																										C			O	C	C	O
Draining from 3A to Ferm A		O						C									O	C	C	C	C	O	C	C	C	C	C	C				C		O	O	O	C	C	C		C							
Draining from 3A to Ferm B		O						C									O	C	C	C	C	O	C	C	C	C	C	C				C		O	C	O	O	C	C		C							
Draining from 3A to Ferm C		O						C									O	C	C	C	C	O	C	C	C	C	C	C				C			C	O		O	C		C							
Filling	C	O		C	C			C		C					O		O		C	O	C	C		O	C	C	C	C													C		C	O				
Heating (Jacket)		O						C		C	C						O			O																					C	C		O	C	O	O	C
Pitching from Ferm A	C	O						C		C							O	C	C	O	C	O	C	C	C	C	C	C				C		O	O	O	C	C	C		C		C			O				
Pitching from Ferm A to Prop 2A						C	C																								O	C		O	O	O	C	C	C	C	O							
Pitching from Ferm A to Prop 2B							C		C																						O	C		O	O	O	C	C	C	C	O							
Pitching from Ferm B	C	O						C		C							O	C	C	O	C	O	C	C	C	C	C	C				C		O	C	O	O	C	C		C		C			O				
Pitching from Ferm B to Prop 2A						C	C																								O	C		O	C	O	O	C	C	C	O							
Pitching from Ferm B to Prop 2B						C	C																								O	C		O	C	O	O	C	C	C	O							
Pitching from Ferm C	C	O						C		C							O	C	C	O	C	O	C	C	C	C	C	C						O		C		O	C		C		C			O				
Pitching from Ferm C to Prop 2A						C	C																								O	C		O		C		O	C	C	O							

	AF-3203-11: V-12	AF-9402-06: V-11	BASE-8502-12: V-58	CIPS-3203-05: V-01	CIPS-3203-06: V-02	CIPS-3203-07: V-05	CIPS-3203-08: V-06	CIPS-3203-43: V-61	CIPS-3203-40: V-08	CIPS-8202-04: V-57	CL-3203-29: V-27	CL-3203-29 (Prior to Drain): V-28	CWS-3203-34: V-50	CWR-3214-01: V-25	LIQS-2303-03: V-03	LMS-8403-08: V-59	Nozzle A (Vacuum Relief): V-15	Nozzle AA: XV-3203A-27	Nozzle B: V-17	Nozzle F: V-52	Nozzle K: V-35	Nozzle L: V-34	Nozzle P: V-19	Nozzle Q: V-16	Nozzle S: V-18	Nozzle X: XV-3203A-23	Nozzle Y: V-62	Nozzles E1, E2: V-53, V-54	NUTR-3211-20: V-17	NUTR-3211-29: V-18	PROP-3202-20: V-07	CL-3203-18: V-29	CL-3203-18 (prior to Drain): V-30	PROP-3203-19: V-42	PROP-3203-19 (after 3210-22): V-40	PROP-3203-19 (btn 3203-21 & 3210-22): V-33	PROP-3203-21: V-41	PROP-3203-22: V-38	PROP-3203-38: V-36	PROP-3210-30: V-09	PROP-3210-30 (Prior to 3203-19): V-26	Sample Valve	SL-3203-01: V-55	SL-9302-09: V-48	UVW-9503-08: V-04	VTP-3203-02: V-56	XV 3203A-29 (Cooling water)	XV 3203A-30 (Hot water)	XV 3203A-31 (Hot water)	XV 3203A-32 (Cooling water)
Pitching from Ferm C to Prop 2B							C		C																					C	C		O					C									
Pitching from Prop 2A	C	O				C	C	C		C							O			O											C		C					O			C		O				
Pitching from Prop 2A	C	O					C	C	C	C							O			O		O								C	C		C					O	O		C		C	O			
Pressurizing from 3A to Ferm A	O	O						C		C							O	C	C	O	C	O	C	C	C	C	C	C				C		O	O	O	C	C	C		C						
Pressurizing from 3A to Ferm B	O	O						C		C							O	C	C	O	C	O	C	C	C	C	C	C				C		O	C	O	O	C	C		C		C				
Pressurizing from 3A to Ferm C	O	O						C		C							O	C	C	O	C	O	C	C	C	C	C	C				C			C	O		O	C		C		C				
Recirculating jacket											C		O	O			O																										C					
Sampling																																										O						
SIP Hold																	C	C	C	C	O	O	C	C	C	C	C	C				O	C														
SIP Preheat	C	O								C	O	C	C	C			O			O	C																				C	O		O	C	C	C	C
SIP Vacuum																	C	C	C	O	C	C	C	C	C	C	C	C													O						
Sparging	C	O						C		C							O	C	C	O	C	C	O	C	C	C	C	C													C			O			

Fermentors A, B & C Controls (DRAWINGS PIL-PID-3205, PIL-PID-3206, PIL-PID-3207)

Fermentors A, B & C Level Indication (LI-3204A-03, LI-3204B-03, LI-3204C-03)

Level controllers LI-3204A-03, LI-3204B-03, and LI-3204C-03 will have the following alarms and interlocks:

On High Level (90% full) the high level alarm is activated
On Low Level (15% full) the low level alarm is activated and the agitators (AG-3204A, AG-3204B, AG-3204C) is shut down.

Level Switches for Foam Detection (LSH-3204A-04, LSH-3204B-04, LSH-3204C-04)

High level Switches LSH-3204A-04, LSH-3204B-04, and LSH-3204C-04 are provided for foam detection. When high level is detected LAH-3204A-04, LAH-3204B-04 and LAH-3204C-04 will pulse valves XV 3204A-27, XV 3204B-27, and XV 3204C-27, respectively, to add antifoam.

Temperature Control (TIC-3204A-10, TIC-3204B-10, TIC-3204C-10)

The temperature in the vessels is controlled by TIC-3204A-10, TIC-3204B-10, or TIC-3204C-10 during both the normal processing cycle and by the SIP cycle. During the normal cycle, the temperature transmitters (TIT-3204A-10, TIT-3204B-10, TIT-3204C-10) sends a signal to the temperature controllers (TIC-3204A-10, TIC-3204B-10, TIC-3204C-10) to modulate the temperature control valves (TV-3204A-10A, TV-3204B-10A, TV-3204C-10A) to regulate the flow of either cooling water or hot water. The switch between cooling water and hot water is automated with on/off valves (XV-3204A-29, 30, 31, 32, XV-3204B-29, 30, 31, 32 & XV-3204C-29, 30, 31, 32) on the hot and cold water inlet and outlets.

During the SIP cycle, the temperature transmitters (TIT-3204A-10, TIT-3204B-10, TIT-3204C-10) send a signal to the temperature controllers (TIC-3204A-10, TIC-3204B-10, TIC-3204C-10) which modulates the temperature control valves (TV-3204A-10B, TV-3204C-10B, TV-3204B-10B) to regulate the flow of steam into the vessel. There is no throttling valve for the steam flow to the jackets. Fail positions of the modulating valves are as follows:

- TV 3204A-10A, TV 3204B-10A, TV 3204C-10A – Fail open
- TV 3204A-10B, TV 3204B-10B, TV 3204C-10B – Fail closed

Fermentors A, B & C Temperature Indication (TI-3204A-18, TI-3204B-18, TI-3204C-18)

TI-3204A-18, TI-3204B-18, and TI-3204C-18 provide local indication of the temperature in Fermentors A, B & C. They do not regulate the temperature of the vessel.

Pressure Indication (PIT-3204A-33, PIT-3204B-33, PIT-3204C-33)

The pressure in Fermentors A, B & C is measured by PIT-3204A-33, PIT-3204B-33, and PIT-3204C-33. It is displayed both locally and remotely. This instrument has no controlling function, but it is used during the vacuum step of the SIP cycle.

pH Control (AI-3204A-01, AI-3204B-01, AI-3204C-01)

The pH of the propagation broth is controlled by adding phosphoric acid, and either lime slurry or the base in the Base B system. The switch between lime slurry and Base B is manual. Both are added throguh the same nozzle on the propagator.

The pH indicator (AI 3204A-01, AI 3204B-01, AI 3204C-01) pulses open either the actuated base valve (XV 3204A-23, XV 3204B-23, XV 3204C-23) or the actuated acid valve (XV 3204A-24, XV 3204B-24, XV 3204C-24) according to the pH measurement. There are two pH elements provided. Both feed to the same transmitter.

Current Indicator for Agitators AG-3204A, AG-3204B, AG-3204C (II-3204A-06, II-3204B-06, II-3204C-06)

The currents on the AG-3204A, AG-3204B, AG-3204C motors are monitored to alert operations problems with the agitator motor. The current indicator has high and a low alarms. A high alarm would signal any condition causing overload and the low alarm would signal a failed drive coupling.

Sterile Air Pressure & Flow Control (PRV 3204A-25, FI 3204A-26, PRV 3204B-25, FI 3204B-26, PRV 3204C-25, FI 3204C-26)

The pressure and flowrate of the sterile air into the spargers are controlled with pressure regulating valves (PRV-3204A-25, PRV-3204B-25, PRV-3204C-25) and rotameters (FI-3204A-26, FI-3204B-26, FI-3204C-26). The pressure regulating valves can be adjusted for different pressures. The flowrate can be manually adjusted by using the rotameters. All of the instruments are local only and do not report any data to the PLC.

Steam Pressure Control (PRV 3204A-13, PRV 3204B-13, PRV 3204C-13)

The pressures of the steam into the vessel jacket are controlled by pressure regulating valves (PRV 3204A-13, PRV 3204B-13, PRV 3204C-13) which can be adjusted for different pressures.

Pressure / Vacuum Control on Fermentors A, B & C (PSE-3204A-34, PSV-3204A-07, PSE-3204B-34, PSV-3204B-07, PSE-3204C-34, PSV-3204C-07)

Rupture disks (PSE-3204A-34, PSE-3204B-34, PSE-3204C-34) and vacuum relief valves (PSV-3204A-07, PSV-3204B-07, PSV-3204C-07) are provided to protect Fermentors A, B & C (pressure vessels) from over pressurization and vacuum damage. Sterile air is provided to the vacuum relief valves to prevent introduction of bacteria into the vessels. A valves are also provided to isolate the tanks from vacuum relief while vacuum is being applied to the vessels during the SIP cycle. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 50 psig
- Tank design vacuum – Full vacuum
- PSE-3204A-34, PSE-3204B-34, PSE-3204C-34 – pressure setting 40 psig

- PSV-3204A-07, PSV-3204B-07, PSV-3204C-07 – vacuum setting -15" w.c.

Pressure / Vacuum Control on Fermentors A, B & C Jackets (PSV-3204A-11, PSV-3204B-11, PSV-3204C-11)

Pressure relief valves (PSV 3204A-11, PSV 3204B-11, PSV 3204C-11) are provided to protect the jackets on Fermentors A, B & C from over pressurization. These PSVs will vent to the atmosphere. The design conditions and the set points of the protection devices are given below.

- Jacket pressure – 50 psig
- PSV-3204A-11, PSV-3204B-11, PSV-3204C-11 – pressure setting - 45 psig

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI-3204A-08, PI-3204B-08, PI-3204C-08: Sterile air pressure2. Verification of air pressures prior to vessel pressurization, vacuum relief, or air sparging.
- TI-3204A-12, TI-3204B-12, TI-3204C-12: Jacket water outlet temperatures. Verification of Cooling or Hot water temperatures after the jackets.
- PI-3204A-15, PI-3204B-15, PI-3204C-15: Incoming steam pressures. Verification of pressures after the pressure regulators.
- PI-3204A-16, PI-3204B-16, PI-3204C-16: Jacket water inlet pressures. Verification of Cooling or Hot water pressures prior to the jackets.
- TI-3204A-17, TI-3204B-17, TI-3204C-17: Jacket water inlet temperatures. Verification of Cooling or Hot water temperatures prior to the jackets.
- TI-3204A-18, TI-3204B-18, TI-3204C-18: Tank temperatures. These are redundant temperature indicators to indicating transmitters TIT-3204A-10, TIT-3204B-10, TIT-3204C-10.
- PI-3204A-20, PI-3204B-20, PI-3204C-20: Inlet steam pressures. Verification of steam pressures prior to entering vessels.
- PI 3204A-22, PI-3204B-22, PI-3204C-22: Outlet line pressures. Trouble shooting pumps PC-3204A, PC-3204B, and PC-3204C.

VALVE SEQUENCING – FERMENTORS A, B & C (VS-3204A, VS-3204B, VS-3204C)

		AF-3204-08	AF-9402-04: V-21	BASE-8502-03: V-13	BEER-3205-18 (btn 3205-34 & 3203-19): V-31	BEER-3205-18 (Prior to pump): V-35	BEER-3205-19 (after pump): V-38	BEER-3205-19 (after 3205-23): V-42	BEER-3205-20: V-40	CIPR-3205-23: V-41	CIPS-3205-05: V-02	CIPS-3205-07: V-15	CIPS-3205-10: V-10	CIPS-3205-11: V-03	CIPS-3205-12: V-05	CIPS-3205-13: V-07	CIPS-3205-26: V-20	CIPS-8202-06: V-57	CL-3205-30: V-32	CWR-3205-08	CWR-3205-37: V-52	CWR-3214-05: V-26	LIQS-2303-05: V-04	LMS-8403-10: V-14	Nozzle A (Vacuum Relief): V-18	Nozzle C (MgSO4): XV-3204A-36	Nozzle F (vent): V-19	Nozzle J (Base): XV-3204A-23	Nozzle L (Steam): V-33	Nozzle N (Drain): V-30	Nozzle S (Liq Slurry): XV-3204A-37	Nozzle U (Acid): XV-3204A-24	Nozzle Z (Trace Metals): XV-3204A-35	Nozzlec CC (Hose Connection): V-23	Nozzles D1, D2 (CIP): V-15, V-16	Nozzles R1, R2 (Spargers): XV-3204A-39, 38	PROP-3203-19 (btn 3205-12 & 3205-13): V-06	PROP-3203-19 (prior to 3205-18): V-29	PROP-3204-19: V-11	PROP-3205-34: V-34	Sample Valve	SL-3205-01: V-56	SL-9302-05: V-51	UVW-9503-12: V-09	VTP-3205-02: V-58	XV 3204A-24	XV 3204A-23	XV 3204A-27	XV 3204A-29	XV 3204A-30	XV 3204A-31	XV 3204A-32
Adding Ingredients	Adding Acid	C																C						O				C	C		O						C	C			O					
	Adding Antifoam	C																C						O		O		C	C								C	C			O					
	Adding Base B	C		O										C		C	C	C						C	O	C	O	C	C		C		C	C			C	C			O		O			
	Adding inoculum from 3A	C			O	C									C	C		C	C						O		O		C	O						O		C	C			O					
	Adding inoculum from 3B	C			O	C									C	C		C	C						O		O		C	O						C	O	O	C	C			O					
	Adding Lime Slurry	C		C										C		C	C	C						O	O		O	C	C		C		C	C			C						O		O			
	Adding Liquefaction Slurry	C									C			C		C	C	C					O		O		O		C	C	O			C	C			C	C					O					
	Adding MgSO4	C												C		C	C	C						O	O	O	C	C	C		C	C	C	C			C	C					O					
	Adding Trace Metals	C												C		C	C	C						O	C	O		C	C			O	C	C			C	C					O					
	Adding UV Water	C			O	C								C		C	C	C	C						O		O		C	O				C			O		C	C	C		O	O					
Temp. Control	Cooling (Jacket)																		C						O																C			O	C	C	O
	Heating (Jacket)	C																C		C					O		O													C	C		O			C	O	O	C
	Recirculating jacket																			C	O	O			O															C								
Draining	Draining to Beerwell	C			O	O	O	O	C	C										C					O	C	C	C	C	O	C	C	C	C	C	C		C		C	C					C					
	Pressurizing from Ferm to 3A	O			O	C								C	C	C	C	C	C						O	C	O	C	C	O	C	C	C	C	C	C	O	O	C	C	C	C		C	C			C					
	Pressurizing from Ferm to 3B	O			O	C								C	C	C	C	C	C						O	C	O	C	C	O	C	C	C	C	C	C	C	O	O	C	C	C		C	C			C					
	Pressurizing from Ferm to 1A	O			C							C		C		C	C	C							O	C	O	C	C	O	C	C	C	C	C	C	C		C	O	C	C		C	C								
Clean In Place (CIP)	CIP LIQS line (forward)	C			O	O	O	C	C	O	O			O				C	C					C		O	C	O	C	C	O	O	C	C	C				C		C	C					C					
	CIP LIQs line (reverse)										O							C						C																C										
	CIP Prop 1A line											O						C																C						C									
	CIP Prop 3A line (forward)				C	O	O	C	C	O						O		C	C						O											C	O			C			C							
	CIP Prop 3A line (reverse)														O			C																		C													
	CIP Prop 3B line (reverse)												O					C																				C											
	CIP Sparger	C	C		O	O	O	C	C		O		C		C	C	O	C	C						O		O		C	O					O		C		C	C	C			O					
	CIP Tank	C			O	O	O	C	C	O								C	C						O	C	O	C	C	O		C	C	C	O			C		C	C	C			O					
	CIP Vent Line	C			O	O	O	C		O	C		C	C	C	C	C	O	C						O	C	O	C	C	O	C	C	C	C	C	C		C		C	C	C			C					
Steam in Place (SIP)	SIP Hold				O	C													O						C	C	C	C	O	O	C	C	C	C	C	C		C		C	C					C					
	SIP Preheat	C																C		O																					O					C	C	C	C
	SIP Temperature Ramp-up	C																C							C	O	C	O	C	C	C	C	C	C	C					C	C			O			C				
	SIP Vacuum	C																C						C	C	O	C	C	C	C	C	C	C	C	C					C	O			C			C				
Other	Sampling																								O																	O								
	Sparging	C	O														C	C							O											O						C			O					

Ingredient Addition Overview

The system is designed for the addition of trace metals, magnesium sulfate, and antifoam from small, individual tanks during propagation and fermentation. The trace metal solution and the magnesium sulfate solution are mixed in the Prep Tank (TS-2109) and pumped into their respective storage tanks (TS-3206, TS-3207). These storage tanks are agitated. The solutions are then transferred to smaller, individual storage tanks.

Each propagator and fermentor has a small tank for trace metals and a small tank for magnesium sulfate. The purpose of the smaller tanks is to pre-measure the ingredient solution and ensure the correct amount is added during the batch. The transfer from the larger storage tanks to the smaller individual tanks is done by gravity and is controlled manually by the operator.

The antifoam solution is mixed in the Prep Tank and pumped directly to the individual storage tanks.

The solutions are transferred to the propagators and fermentors using peristaltic pumps. There is one peristaltic pump for the fermentors and one for Propagators 3A & 3B. Each peristaltic pump has two heads, one for each solution. There is also a peristaltic pump for Propagators 2A & 2B that pumps antifoam only. The speed of the peristaltic pumps can be controlled locally or remotely. All valves are controlled manually.

Trace Metals Storage & Transfer Controls (Drawing PIL-PID-3211)

Pressure Control for Pump PT-3202 (PI-3202-01, PI-3202-04)

The pressure is monitored continuously on the outlets of the both heads of Trace Metals Pump 1 (PT-3202). On High Pressure, pump PT-3202 will be turned off, as this indicates that all valves downstream are closed.

Pressure Control for Pump PT-3203 (PI 3203-01, PI 3203-04)

The pressure is monitored continuously on the outlets of the both heads of Trace Metals Pump 2 (PT-3203). On High Pressure, pump PT-3203 will be turned off, as this indicates that all valves downstream are closed.

Antifoam Storage & Transfer Controls (Drawing PIL-PID-3213)

Pressure Control for Pump PT-3210, PT-3214, PT-3215 (PI 3210-02, PI-3214-02, PI-3215-02)

The pressure is monitored continuously on the outlet of the three Antifoam Pumps (PT-3210, PT-3214, PT-3215). On High Pressure, pumps PT-3210, PT-3214, and PT-3215 will be turned off respectively, as this indicates that all valves downstream are closed.

VALVE SEQUENCING – INGREDIENT ADDITION

		PID-3208						PID-3211																												PID-3213																	
		TS-3206, Nozzle C: V-07	TS-3207, Nozzle C: V-10	TS-3206 Drain: V-08	TS-3207 Drain: V-11	NUTR-3208-02: V-12	NUTR-3208-06: V-09	NUTR-3208-06 (Prior to TS-3201): V-02	NUTR-3208-02 (Prior to TS-3202): V-03	NUTR-3208-06 (Prior to TS-3203): V-04	NUTR-3208-02 (Prior to TS-3204): V-05	NUTR-3211-05: V-06, V-24	NUTR-3211-06:V-07, V-20	NUTR-3211-07: V-09, V-10	NUTR-3211-08: V-08, V-15	NUTR-3211-11: V-16	NUTR-3211-12: V-18	NUTR-3211-13: V-19	NUTR-3211-14: V-12	NUTR-3211-15: V-13	NUTR-3211-16: V-14	NUTR-3211-20: V-22	NUTR-3211-21: V-23	NUTR-3211-28: V-27	NUTR-3211-29: V-26										ANTF-3213-01: V-02	ANTF-3213-03: V-03	ANTF-3213-05: V-05, V-13, V-14	ANTF-3213-06: V-16	ANTF-3213-08: V-06, V-07, V-08	ANTF-3213-09: V-11	ANTF-3213-16: V-04, V-18	ANTF-3213-19: V-01	ANTF-3213-22: V-19	ANTF-3213-23: V-20	ANTF-3213-25: V-09	ANTF-3213-26: V-15			
Filling Storage Tanks	Filling TS-3201, (Trace Metals)	O		C			O	O		C		C																																						
	Filling TS-3202, (MSGO4)		O		C	O			O		C		C																																					
	Filling TS-3203, (Trace Metals)	O		C			O	C		O					C																																		
	Filling TS-3204, (MSGO4)		O		C	O			C		O			C																																			
	Filling TS-3213, (Antifoam)																																				O	C	C				C									
	Filling TS-3215, (Antifoam)																																				C	O			C			C							
	Filling TS-3218, (Antifoam)																																				C	C					C	O							
Pumping out	Pumping Trace Metals to Prop 3A											O	C										C	O																										
	Pumping Trace Metals to Prop 3B											O	C										O	C																										
	Pumping Trace Metals to Fermentors A													C	O	O	C	C																															
	Pumping Trace Metals to Fermentor B													C	O	C	O	C																															
	Pumping Trace Metals to Fermentor C													C	O	C	C	O																															
	Pumping MgSO4 to Prop 3A											C	O									O	C																										
	Pumping MgSO4 to Prop 3B											C	O									C	O																										
	Pumping MgSO4 to Fermentors A													O	C				O	C	C																												
	Pumping MgSO4 to Fermentor B													O	C				C	O	C																												
	Pumping MgSO4 to Fermentor C													O	C				C	C	O																												
	Pumping Antifoam to Prop 2A																																										O		O	C					
	Pumping Antifoam to Prop 2B																																										O		C	O					
	Pumping Antifoam to Prop 3A																																									O	C						O	
	Pumping Antifoam to Prop 3B																																									O	O						C	
	Pumping Antifoam to Fermentors A																																											O	O				C	
	Pumping Antifoam to Fermentor B																																											O	C				C	
	Pumping Antifoam to Fermentor C																																											O	C				O	
Draining	Draining TS-3206	O		O			C																																											
	Draining TS-3207		O		O	C																																												

SIP Vacuum Pump Overview (Drawing PIL-PID-3208)

The SIP Vacuum Pump (PV-3201) is used to during the steam in place (SIP) cycle to assist in evacuating all air from the vessel. Air pockets can impede the heat transfer of the steam and reduce the effectiveness of the sterilization.

During the SIP cycle, the vessel is first filled with steam. The steam port is then closed, and the vacuum pump draws the vessel contents out and sends them to the CO2 Scrubber. This is repeated two more times, which should evacuate 99.99% of the air.

Cooling water is provided to the liquid ring vacuum pump.

Vacuum Pump Controls (Drawing PIL-PID-3208)

Local Indication

The only control on the vacuum pump, besides motor controls, is a local one. This instrument has no control function and does not report data to the PLC.

- PI 3201-21, Line 3208-09: Pressure indicator. Verification of steam pressure prior to the vacuum pump.

Valve Sequencing
There are manual valves on the inlet and outlet cooling water lines. Both of these must be open for the pump to run.

Vessel Jacket Pumps Overview

Pumps are provided to circulate the jacket water on the Liquefaction Tank, the Hydrolyzate pH Adjustment Tank, the Propagators, and Fermentors. The Fermentor Jacket Pumps are centrifugal, and the others are peristaltic. There are no control functions on the vessels that control the speed of these pumps. All adjustments are manual.

Vessel Jacket Pumps Controls (Drawing PIL-PID-3214)

Pressure Control for Pumps PT-3204, PT-3205, PT-3211, PT-3212, PT-3213 (PI 3204-01, PI 3205-01, PI 3211-01, PI 3211-03, PI 3212-01, PI 3212-03, PI 3213-01, PI 3213-03)

The pressure is monitored continuously on the outlets of pumps PT-3204, PT-3205, PT-3211, PT-3212, and PT-3213. On High Pressure, these pumps will be turned off, as this indicates that all valves downstream are closed.

Local Indication

The local indicators below are provided for visual verification of process conditions. These instruments have no control functions and they do not report data to the PLC.

- PI-3214-01: Pressure Indication. Verification of pressure at the discharge of pump PC-3216. Used for troubleshooting.
- PI-3214-03: Pressure Indication. Verification of pressure at the discharge of pump PC-3215. Used for troubleshooting.
- PI-3214-04: Pressure Indication. Verification of pressure at the discharge of pump PC-3214. Used for troubleshooting.

Valve Sequencing

There are manual valves on the inlet and outlet of each pump. These must be open for the pump to run.

AREA 4600 –OVERVIEW

BEER WELL (DRAWING PIL-PID-4601)

The Beer Well (TS-4601) is the transition point from the batch process to the continuous one (i.e., Distillation). When a fermentation batch is complete it is transferred to the beer well and the fermentor is CIP'd. The beer well is the collection point of several streams. These streams include:

- Scrubber liquid from the CO2 scrubber
- CO2 vents from the fermentors, propagators, liquefaction tank and hydrolyzate pH adjustment tank.
- Rupture disk discharge from the fermentors, propagators, liquefaction tank and hydrolyzate pH adjustment tank.

The beer well can be CIP'd using CIP spray nozzles if necessary.

Pressure / Vacuum Control on Beer Well (PSV-4601-03 and PSE-4601-01)

To protect the Beer Well (an atmospheric API-650 tank) from pressure and vacuum damage a two part protection system is in place. PSV-4601-03 is a conservation vent and provides normal pressure / vacuum relief. PSE-4601-01 is a combination pressure / vacuum emergency manway vent, it is the final line of protection. The design conditions and the set points of the protection devices are given below.

- Tank design pressure – 1 psig
- Tank design vacuum – 6" WC
- PSE-4601-01 – pressure setting +15" WC
- PSV-4601-03 – pressure setting +15" WC
- PSV-4601-03 – vacuum setting -2"WC

Level Indication for Beer Well (LIT-4601-05)

The level in the Beer Well is not controlled but is continuously monitored to prevent overfilling. Level indicator LIT-4601-05 will have the following alarms and interlocks:

- On High High Level (90% full) the alarm for this condition is activated by a high level alarm (LSHH-4601-04) and pump PC-4601 will be turned on.
- On High Level (85%) an alarm will be activated only.
- On Low Level (15% full) an alarm will be activated, the agitator (AG-4601) will be shut down . The agitator can only restart once the level has exceeded 15%.
- On Low Low Level (10% full) an alarm will be activated and an interlock will shut down pumps PC-4601. This is to protect the pumps from cavitation damage.

Local Indication

The local indicators below are provided for visual verification of process conditions. These instruments have no control functions and they do not report data to the PLC.

- PI 4601-08, Line 4601-08: Process pressure. Verification of pressure after the pump and troubleshooting.
- TI 4601-09, Line 4601-08: Process temperature. Verification of temperature at tank discharge.
- FI 4601-10, Line 4601-08: Process flowrate. Verification of flowrate after the pump.

VALVE SEQUENCING – BEER WELL(TK-4601)

	BEER-3205-19: V-12	BEER-3206-19: V-13	BEER-3207-19: V-14	BEER-4601-03: V-27	BEER-4601-04: V-28	BEER-4601-07: V-43	BEER-4601-08: V-38, V-32	BEER-4601-12: V-31	BEER-4601-13: V-42	CIPR-4601-10: V-29	CIPS-4601-09: V-19, V-18	CIPS-8202-10: V-20	ETHW-7201-04: V-16	PROP-4601-11: V-17	VTN-2301-01	VTN-2303-10: V-03	VTP-3201-04: V-04	VTP-3202-02: V-06	VTP-3203-02: V-08	VTP-3204-02: V-09	VTP-3205-02	VTP-3206-02	VTP-3207-02	VTP-3209-04: V-01	VTP-3210-02: V-05
Pumping from Fermentor A	O																								
Pumping from Fermentor B		O																							
Pumping from Fermentor C			O																						
Pumping from Scrubber													O												
Pumping to Column					O	O	O	C	C	C															
Pumping to Decanter					C	O	O	O	C	C															
Draining to air diaphragm pump							C		O																
Venting from Fermentor A																					O				
Venting from Fermentor B																						O			
Venting from Fermentor C																							O		
Venting from Hydrolyzate pH Adjust Tank																O									
Venting from Liq Tank															O										
Venting from Prop 1A																	O								
Venting from Prop 1B																								O	
Venting from Prop 2A																		O							
Venting from Prop 2B																									O
Venting from Prop 3A																			O						
Venting from Prop 3B																				O					
CIP	C	C	C	C	C	O	O	C	C	O	O	O	C	C	C	C	C	C	C	C	C	C	C	C	C
Recirculating				O	C	O	O		C	C															

AREA 4900 –OVERVIEW

In the Area 4900 Insoluble lignin and phosphates are removed from the stripping column bottoms stream by decanting. The decant is completed using a decanting centrifuge which removes the lignin cake and calcium phosphates which is collected and either land filled or sold for its fuel value. Area 4900 also serves to remove the solids from two process streams in the event there are upsets in the process or operations chooses to not fully process the biomass. These two points are after liquefaction and prior to distillation. The stream prior to distillation contains organisms the must be destroyed prior to disposal. This is accomplished useing a direct steam injection Pick heater. The filtrate from the decanting centrifuge is sent to drain, which makes if way to the Waste Water tank via the sump pumps.

Decanter, CF-4901

The Decanter package system is controlled by its own PLC. The only output signal from the decanter PLC is a speed signal that starts the Decanter Feed Pump, PP-4901. The remainder of the controls, motor speeds, temperature, vibration, are controlled internal the decanter by its PLC.

Decanter Feed Tank, TS-4901

This tank serves as a retention point prior to decanting. It is agitated to keep the contents homogenous and prevent solids from settling. The tank is fitted with a manually controlled air diaphragm pump to deliver the contents of the tank to the decanter at a desired flow.

Flow Controller (FIC-4901-04) & Speed Controller (SIC-4901-05)

The flow to the decanter is measured and controls the speed of the Decanter Feed Pump, PP-4901, from an output speed control from the Plant PLC. The flow data and speed will report to the plant PLC using the following instruments.

- FE 4901-04: Flow to Decanter (Flow range from 5 to 6.6 gpm).
- SIC 4901-05: Speed of Decanter. (Speed range to be determined during commissioning)

The pump start/stop is interlocked with the Decanter speed, and will not be able to start until the bowl was reached its maximum speed of 5500 rpm.

Temperature Control, HS-4601(TIC-4601-12)

The temperature of the beer stream out of the Beer Well, TS-4601 must reach at least 140 ^{o}F prior to delivery to the Decanter Feed Tank, TS-4901. This is accomplished using a direct steam injection Beer Pick Heater, HS-4601, with a temperature control loop, TIC-4601-12. When beer is delivered to TS-4901, TIC-4601-12 modulates valve TV-4601-12 to add low pressure steam to the stream based on the desired exist temperature communicated by TT-4601-12.

Fail positions of the modulating valves are as follows:

- TV-4601-12 – Fail open

Level Indication

The level indicator, LI-4901-03 is provided for verification of level in the tank. This device provides for alarm and interlock functions for PP-4901 and AG-4901 and will report data to the PLC. Alarm and interlock functions as follows:

- On High High Level (90%) the alarm for this condition is activated for operations to turn off feed pumps
- On High Level (85%) the alarm is activated for warning only.
- On Low Level (15%) and alarm is activated, the agitator AG-4901 will shut down. The agitator can only restart once the level has exceeded 15%.
- On Low Low Level (10%) an alarm will be activated and an interlock with will shut down pump PP-4901 to prevent pump damage.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- TI 4901-02, Nozzle E: Tank temperature.
- PI 4901-06: Pressure on Feed to Decanter.
- FI 4901-07: Flush Water Flow rate to Decanter.
- PI 4601-13: Inlet Steam Pressure to Beer Pick Heater.

		BEER-4601-12, V-13	LIQS-2301-13	BMS-4602-01	BMS-4901-01: V-02, V-04	BMS-4901-03: V-05, V-07	RCW-9501-27: V-08	BMS-4901-04: V-09, V-11	SL9302-15, V12
Tank Transfer	Tank Fill from Beerwell	O	C	C	C	C	C	C	O
	Tank Fill from Liquefaction	C	O	C	C	C	C	C	C
	Tank Fill from Distillation	C	C	O	C	C	C	C	C
	Transfer to Decanter	C	C	C	O	O	C	O	C
Other	Decanter Rinse	C	C	C	C	C	O	O	C

AREA 7200 –OVERVIEW

In the Area 7200, Carbon dioxide vented from the beer well is first scrubbed in a water scrubber, which recovers most of the ethanol. The scrubbing liquid is pumped to the beer well. The "cleaned" carbon dioxide is then vented to a second scrubber, which uses a bleach solution as the scrubbing liquid. These scrubbers function as the vapor containment system for the microorganism. The spent bleach solution is sent to waste treatment and the clean carbon dioxide to the atmosphere.

CO2 Scrubber, SC-7201 (DRAWING PIL-PID-7201)

This scrubber serves to remove the ethanol and other volatile organic compounds (VOCs) from the fermentation vent system. It has one spray nozzle section at the top of the scrubber with a flow controlled water system. The level controller serves to control the level in the scrubber by purging the excess liquid level in the bottom (ethanol rich) back to the beer well. The scrubber vent line is fitted with a relief devise, PSE-7201-14 to prevent over pressure of the scrubber systems.

Flow Controller (FIC-7201-09)

The flow of the recycle water to the scrubber is controlled to the vendor recommended set point (1 – 3 gpm) to obtain optimum scrubbing efficiency. The flow data will be reported to the PLC. The flow loop utilizes the following instruments:

- FE- 7201-09: Flow of fresh water to the scrubber.
- FV-7201-09: Flow control valve for FE-7201-09, Fail Close.

Level Controller (LIC-7201-05)

The liquid level in the scrubber is controlled to the vendor recommended level to avoid flooding in the scrubber. This purges the ethanol rich steam back to the beer well. The level data will be reported to the PLC. The level loop utilizes the following instruments:

- LT- 7201-05, Scrubber level.
- LV-7201-05, Level control valve, Fail Close.

Level Controller, LIC-7201-05, provides for the following alarms and interlocks:

- On High High Level (90%) and alarm will be activated and close FV-7201-09
- On High Level (85%) an alarm will be activated and start to modulate FV-7201-09 to 25% open and open LV-7201-05 to 100%
- On Low Level (15%) an alarm will be activated and modulate FV-7201-09 to 100% open and close LV-7201-05.
- On Low Low Level (10%) an alarm will be activated and shut down pump PC-7201 to protect the pump from damage.

Temperature and Pressure Indication

The transmitters below are provided for visual verification of process conditions at the scrubber. These instruments have no control functions but report data to the PLC using the following instruments:

- TT 7201-04, Scrubber Bottoms temperature.
- PT 7201-01: Pressure in the Scrubber at top.
- PT 7201-02: Pressure in the Scrubber, midway.
- PT 7201-03: Pressure in the Scrubber at bottom.

Pressure Indication

The indicators below are provided for visual verification of process conditions at the scrubber. These instruments have no control functions and do not report data to the PLC using the following instruments:

- PI 7201-07, CO2 Scrubber Fan inlet pressure
- PI 7201-08, CO2 Scrubber Fan outlet pressure.

		CO2-7201-01	ETHW-7201-02	ETHW-7201-03	ETHW-7201-04	RCW-9501-10	CO2-7201-06			
CO2 Scrubber	Normal Operation	O	O	O	O	O	O			
	Start-up	C	O	O	C	O	O			
	Shut down	O	O	O	O	C	O			
Other										

Bleach Scrubber, SC-7203 (DRAWING PIL-PID-7202)

This scrubber serves to destroy any air bourne GMO that may have escaped the fermentation vent system. It has a single spray nozzle at the top of the scrubber. This nozzle has a flow controlled pump around that introduces bleach into the pump suction. The pump around system on the scrubber also serves to control the level in the scrubber by purging the excess liquid in the bottom and send it to the waste water tank.

Flow Controller (FIC-7203-09)

The flow of the recirculated scrubber bottoms is controlled to the vendor recommended set point (1 -3 gpm) to obtain optimum scrubbing efficiency. The flow data will be reported to the PLC. The flow loop will utilize the following instruments:

- FE- 7203-09: Flow of scrubber bottoms recirculated back to the scrubber.
- FV-7203-09: Flow control valve for FE-7201-09, Fail Open.
- SIC-7203-06: Locally adjusted pump speed.

Pressure Indication

The indicators below are provided for visual verification of process conditions at the scrubber. These instruments have no control functions but report data to the PLC using the following instruments.

- PT 7203-01: Pressure in the Scrubber at top.
- PT 7203-02: Pressure in the Scrubber, midway.
- PT 7203-03: Pressure in the Scrubber at bottom.
- PI 7203-12: Pump discharge pressure (local indication only)

Level Controller (LIC-7203-05)

The liquid level in the scrubber is controlled to the vendor recommended level (75%) to avoid flooding in the scrubber. This purges the excess level to the waste water tank. The level data will be reported to the PLC. The level loop utilizes the following instruments.

- LT- 7203-05, Scrubber level.
- LV-7203-05, Level control valve, Fail Close.

Level Controller, LIC-7203-05, provides for the following alarms and interlocks:

- On High High Level (90%) and alarm will be activated
- On High Level (85%) an alarm will be activated and open LV-7203-05 to 100%
- On Low Level (15%) an alarm will be activated and close LV-7203-05.
- On Low Low Level (10%) an alarm will be activated and shut down pump PC-7203 to protect the pump from damage.

		CO2-7201-07	BASE-7202-01	BASE-7202-02	BASE-7202-03	VTC-7202-04	BLEACH HOSE			
Bleach Scrubber	Normal Operation	O	O	O	O	O	O			
	Start-up	C	O	O	C	O	O			
	Shut down	O	O	C	O	C	C			
Other										

AREA 8000 –OVERVIEW

PHOSPHORIC ACID (DRAWINGS PIL-PID-8101, PIL-PID-8102)

Dilute Phosphoric Acid is used primarily to convert the hemicellulose portion of the feedstock to soluble sugars in the pretreatment area, but is also used in the process to lower pH. The acid is delivered in concentrated form in totes, and is diluted with water in a mix tank on load cells. The diluted acid is then delivered to the transfer tank, where it is metered into the process as needed.

Flow Control and Speed Control (FIC-8101-01, SIC-8101-02 and FIC-8101-04)

The required concentration of phosphoric acid is obtained by a ratio of flow of concentrated acid to recycled water (approximately 80 gallon of water to 1 gallon of concentrated acid). The concentrated acid flow is adjusted by speed of the Concentrated Phosphoric Acid Metering Pump and the flow of the water is adjusted by the flow control valve modulation (the speed set points and speed ranges to be determined during commissioning). The flow data will be reported to the PLC. The flow and speed loops utilize the following instruments:

- FE- 8101-01: Flow of recycled water.
- FV-8101-01: Flow control valve for FE-8101-01, Fail Open.
- FE- 8101-04: Flow of concentrated acid.
- SIC-8101-02: Concentrated Acid Metering Pump speed.

Phosphoric Acid Mix Tank, TS-8101

The Phosphoric Acid Mix Tank is used to batch a volume of desired dilute acid solution by mixing Concentrated Acid with Water. This batch is then transferred to the Phosphoric Acid Hold Tank where a known concentration of dilute acid can be metered into the process. This concentration is key to the success of the Pretreatment system, so three methods of mixing can be programmed into the control system using the installed instrumentation: flow control (outlined above), conductivity, and weight.

Note: The conductivity could be programmed into the control system to indicate the desired concentration of acid. The weight of the tank contents could also be used to obtain the desired concentration of acid by batching a calculated amount of concentrated acid, then adding the water to obtain the Dilute Acid concentration needed.

For the weight method, the operator will have manually control PM-8101 and FV-8101 and use the weigh cells on TS-8101 to obtain the desired concentration. TS-8101 has a volume of 800 gallons, which translates to approx. 6840 lbs of diluted acid. The operator will manually add approximately 6680 lbs of water by manually opening FV-8101 until the that weight is obtain from WI-8101-08, and then close FV-8101. PM-8101 is then started at 50% speed and will continue to run until a total of 6840 lbs is indicated on WI-8101-08. The operator can also use CI-8101-05 to stop PM-8101 once the desire pH is reached.

Local Indication

The instruments below are provided for visual verification of process conditions at the tank. These instruments have no control functions and will report data to the PLC or have local indication only.

- LI 8101-06, Nozzle J: Tank Level.
- CE 8101-05, Nozzle U: Conductivity of Dilute Acid Solution (Local and PLC).
- WI 8101-08: Weight of Tank Contents (Local and PLC).
- PI 8102-04: Pump Discharge pressure (Local only).
- PI 8101-03: Pump Discharge pressure (Local only).

LI-8101-06 will have the following alarms and interlocks:

- On High High Level (90% full) the alarm for this condition is activated and pump PM-8101 will be turned off.
- On High Level (85%) an alarm will be activated only.
- On Low Level (15% full) an alarm will be activated, the agitator (AG-8101) will be shut down . The agitator can only restart once the level has exceeded 15%.
- On Low Low Level (10% full) an alarm will be activated. PA-8102 will have to be turned off to prevent pump damage.

Phosphoric Acid Hold Tank, TS-8102

The Phosphoric Acid Hold Tank is used to meter a known concentration of dilute acid into the process. The dilute acid is used in the Pretreatment and Fermentation Areas.

Speed Control (SIC-8104-01)

The Phosphoric Acid Metering Pump 2 will receive a production rate signal and the speed of the pump is adjusted to deliver the amount of acid needed. The approximate flow required will be about 14 gallons per hour, so the speed range and set point will have to be determine during commissioning. The speed data will report to the PLC using the following instrument.

- SIC 8104-01: Pump Speed.

Speed Control (SIC-8103-01)

The Phosphoric Acid Metering Pump 1 is used to adjust the pH in the propagators and fermentors in case the base addition is over shot. This is basically a manual addition in which the operator pulses the valve at the usage point to lower the pH. The pump is delivers dilute acid to a recirculating loop to keep constant pressure in the header. The pump speed should be set for approximately 75% of full speed to maintain a constant pressure in the header (to be confirmed during commissioning). Along with the pump speed, PRV-8103-03 should be set at approximately 15 psig (also to be confirmed during commissioning). The speed data will report to the PLC using the following instrument.

- SIC 8103-01: Pump Speed.

Local Indication

The instruments below are provided for visual verification of process conditions at the tank. These instruments have no control functions and will report data to the PLC or have local indication only.
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- LI 8102-02, Nozzle J: Tank Level (PLC only).
- CE 8102-03, Nozzle U: Conductivity of Dilute Acid Solution (Local and PLC).
- PI 8103-02: Pump Discharge pressure (Local only).

CIP SYSTEM

See Area 8200 Controls description for the CIP system.

ANTIFOAM (DRAWING PIL-PID-8302)

Antifoam is used in fermentation and propagation to reduce foaming caused by vessel fill and air sparging. The antifoam is delivered in drums, where it is pumped from a weight station to the Prep Tank prior to being used in the process.

Antifoam Weigh Scale, WS-8303

The Antifoam Weigh Scale is used to deliver a quantity of antifoam to the Prep Tank. The weight data is reported to the PLC using the following instrument. The full weight and empty weight will have to be determined during commissioning.

- WI 8303-01: Antifoam drum Weight.

CELLULASE AND BETA GLUCONASE (DRAWING PIL-PID-8303)

Cellulase and Beta Gluconase are enzymes that are used in the process to aid in the conversion of the cellulose portion of the feed stock into glucose. Both enzymes are delivered to the site in totes, where they are directly metered into the Liquefaction tank.

Speed and Flow Control (SIC-8305-01, FIC-8305-03)

The Beta Gluconase Metering Pump will deliver a continuous flow to the Liquefaction Tank. The pump receives a flow signal from the pump discharge and adjusts the speed of the motor to

obtain the desired flow. The speed and flow data is reported to the PLC using the following instruments. The speed range and set points will be determined during commissioning.

- SIC 8305-01: Pump Speed.
- FT 8305-03: Beta Gluconase Flow.

Speed and Flow Control (SIC-8304-01, FIC-8304-03)

The Cellulase Metering Pump will deliver a continuous flow to the Liquefaction Tank. The pump receives a flow signal from the pump discharge and adjusts the speed of the motor to obtain the desired flow. The speed and flow data are reported to the PLC using the following instruments. The speed range and set points will be determined during commissioning.

- SIC 8304-01: Pump Speed.
- FT 8304-03: Cellulase Flow.

SLAKE LIME (DRAWING PIL-PID-8403)

Slake Lime is used in the process to raise the pH. Lime bags are delivered to site, where they are slaked with water in the Lime Slurry Tank. The slurry is then delivered the users to adjust the pH via branches off a recirculating loop.

Lime Slurry Tank, TS-8403

The agitated Lime Slurry Tank is used to batch a volume of Slaked Lime. This batch is then delivered to the usage point via a recirculating header. A calculated number of lime bags are manually added (very slowly) to the tank from the top hatch (with agitator running), after recycled water has been added to obtain the desired solids percent of slaked lime.

Local Indication

The instruments below are provided for visual verification of process conditions at the tank. These instruments have no control functions and will report data to the PLC or have local indication only.

- LI 8403-03, Nozzle J: Tank Level (PLC only).
- SIC 8403-02: Agitator Speed (PLC only).
- FE 8403-01: Water flow to Tank (PLC only).

LI-8403-03 will have the following interlocks and alarms:

- On High High Level (90% full) the alarm for this condition is activated, and the operator will have to manually shut off the water supply.
- On High Level (85%) an alarm will be activated only.
- On Low Level (15% full) an alarm will be activated, the agitator (AG-8403) will be shut down . The agitator can only restart once the level has exceeded 15%.
- On Low Low Level (10% full) an alarm will be activated and an interlock will shut down pumps PC-8403. This is to protect the pumps from cavitation damage.

Pressure Control (PIC-8403-05)

The Slaked Lime recirculating header Pressure Controller maintains a constant pressure of 35 psig (to be confirmed during commissioning) in the line by modulating PV-8403-05. The pressure data will be reported to the PLC. The pressure loop utilizes the following instruments:

- PT-8403-05: Slaked Lime Header Pressure.
- PV-8403-05: Pressure valve, Fail Close.

AQUEOUS AMMONIA AND BASE "B" (DRAWINGS PIL-PID- 8301, -8501, -8502)

Aqueous ammonia and Base B are used in the process to raise the pH. They can be delivered to the site in either drums or totes. They are unloaded from the delivered vessels on a weigh scale, where the appropriate quantity is delivered to designated totes prior to being metered to the final usage points.

Weight Scales (WT-8301-01, WT-8302-01)

The instruments below are provided for visual verification of process conditions at the drums. These instruments have no control functions and will report data to the PLC. The full weight and empty weight will have to be determined during commissioning.

- WT-8301-01: Acid Drum Weight.
- WT-8302-01: Base Drum Weight.

Speed Control (SIC-8501-01)

The Aqueous Ammonia Metering Pump #1 will receive a pH signal from the Liquefaction Tank pH controller, AIC-2301-16 and the speed of the pump is adjusted to deliver the amount of Aqueous Ammonia needed. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8501-01: Pump Speed.

Speed Control (SIC-8502-01)

The Aqueous Ammonia Metering Pump #2 will receive a pH signal from the Prep Tank pH controller, AIC-2109-07 and the speed of the pump is adjusted to deliver the amount of Aqueous Ammonia needed. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8502-01: Pump Speed.

Speed Control (SIC-8503-01)

The Aqueous Ammonia Metering Pump #3 will receive a pH signal from the Hydrolysate pH Adjust Tank pH controller, AIC-2302-16 and the speed of the pump is adjusted to deliver the amount of Aqueous Ammonia needed. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8503-01: Pump Speed.

Speed Control (SIC-8504-01)

The Base B Metering Pump #1 will deliver the amount of Base B needed for pH adjustment in Fermentor A. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8504-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8504-01: Pump Speed.

Speed Control (SIC-8505-01)

The Base B Metering Pump #2 will deliver the amount of Base B needed for pH adjustment in Fermentor B. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8505-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8505-01: Pump Speed.

Speed Control (SIC-8506-01)

The Base B Metering Pump #3 will deliver the amount of Base B needed for pH adjustment in Fermentor C. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8506-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8506-01: Pump Speed.

Speed Control (SIC-8507-01)

The Base B Metering Pump #4 will deliver the amount of Base B needed for pH adjustment in Propagator 2A. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8507-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8507-01: Pump Speed.

Speed Control (SIC-8508-01)

The Base B Metering Pump #5 will deliver the amount of Base B needed for pH adjustment in Propagator 2B. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8508-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8508-01: Pump Speed.

Speed Control (SIC-8509-01)

The Base B Metering Pump #6 will deliver the amount of Base B needed for pH adjustment in Propagator 1A. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8509-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8509-01: Pump Speed.

Speed Control (SIC-8510-01)

The Base B Metering Pump #7 will deliver the amount of Base B needed for pH adjustment in Propagator 3A. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8510-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8510-01: Pump Speed.

Speed Control (SIC-8511-01)

The Base B Metering Pump #8 will deliver the amount of Base B needed for pH adjustment in Propagator 3B. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8511-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8511-01: Pump Speed.

Speed Control (SIC-8512-01)

The Base B Metering Pump #9 will deliver the amount of Base B needed for pH adjustment in Propagator 1B. This is a manual addition performed by the operator using a manual valve at the usage point. The pump speed is manually adjusted to a specific speed determined from field testing. To prevent pump deadhead, a pressure safety valve, PSV-8512-02, is installed on the pump discharge to recirculate the Base B back to the tote when Base B is not required at the usage point. The speed data is reported to the PLC using the following instrument. The speed range and set points will be determined during commissioning.

- SIC 8512-01: Pump Speed.

AREA 8200 –OVERVIEW

CLEAN IN PLACE (CIP) SYSTEM (DRAWINGS PIL-PID-8201, PIL-PID-8202)

The CIP system consists of two 3,100 gal tanks: a Rinse tank, TS-8202 and a Dilute Caustic tank, TS-8203. The Rinse tank is used first to flush out the tanks or piping of hydrolyzate or propagation broth. The used Rinse water is sent to the drain. Caustic at 3% and 180°F is used to clean the tanks and lines. The caustic solution is filtered and reused. A final rinse of UV sterilized water is used to flush out the residual caustic in the lines. UV water is provided from the UV Water tank and pump (Area 9500).

There are two CIP pumps, PC-8202 and PC-8203. Both are used for recirculation as well as pumping to the users. The CIP supply pumps are sized for 125 gpm. Only one large user or two smaller users can utilize the CIP system at a time. The two users must use the same CIP sequence (i.e. both are rinsed at the same time).

The Dilute Caustic and Rinse Tank temperatures will be controlled by small heat exchangers on the recirculation loops. Steam will be used to heat the solution and will control off of temperature in the tank.

The CIP is returned to the CIP system either by distribution pumps already in place, CIP return pumps, or a portable diaphragm pump in conjunction with hose connections.

The CIP return lines will have flow and conductivity meters that are used to detect when the CIP has made a full loop. For example, when the pre-rinse makes a complete loop, the return flowmeter will start to show flow. Then when the caustic CIP has made a full loop, the conductivity meter will start to show a higher conductivity, and finally, when the final rinse has removed the residual caustic, the conductivity meter will drop back down.

After the pre-rinse cleaning, the pre-rinse solution will go to drain. The caustic solution is always saved in the caustic CIP tank. Caustic strength is made up as needed. After the final rinse, the slightly caustic UV rinse water will be transferred directly to the Rinse tank for use as the next pre-rinse.

Level Indication for Dilute Caustic Tank (TS-8202) and Rinse Tank (TS-8203), (LT-8202-03, LT-8203-03)

The level in the tanks is controlled and continuously monitored to prevent overfilling. Level controllers LIC-8202-03 and LIC-8203-03 will have the following alarms and interlocks:

- On High Level (85%) an alarm will be activated only
- On Low Level (10% full) an alarm will be activated, the agitator (AG-8202, AG-8203) and the pump (PC-8202, PC-8203) will be shut down . The agitator can only restart once the level has exceeded 15%.

Level Control for Dilute Caustic Tank (TS-8202) and Rinse Tank (TS-8203)

The tanks are protected from overfilling with overflow lines that go straight to Waste Water Sump #2.

Temperature Control (TIC-8202-01 and TIC-8203-01)

The temperatures of the CIP solutions in the tanks are controlled by two different loops: TIC-8202-01 for the CIP Dilute Caustic Heater and TIC-8203-01 for the CIP Rinse Heater. Loop TIC-8202-01 modulates valve TV 8202-01 on the steam line based on the temperature in the Dilute Caustic Tank. Loop TIC-8203-01 modulates valve TV 8203-01 on the steam line based on the temperature in the Rinse Tank. Fail positions of the modulating valves are as follows:

- TV 8202-01 – Fail closed
- TV 8203-01 – Fail closed

Pressure Control on the CIP Dilute Caustic Heater and CIP Rinse Heater (PSV-8202-05 and PSV-8203-05)

Pressure relief valves are provided on the cold sides of the CIP Dilute Caustic Heater and the CIP Rinse Heater to protect them from pressure in case the solution on the cold side is blocked in while the steam continues to run. The setpoint is 150 psig on both PSVs.

Differential Pressure on CIP Filter FL-8202 (DPI-8202-08)

A differential pressure indicator will be provided with the backwashing CIP Return Filter. When the difference in pressures between the inlet and outlet of the filter reaches a certain setpoint, the filter will go into backwashing mode.

Conductivity and Flow Measurement on CIP Return Line (CI-8202-09, FI 8202-10)

The conductivity and flowrate measurements are taken on the return line upstream of the CIP Return Filter. They have no control function but serve to detect when the CIP has made a full loop. For example, when the pre-rinse makes a complete loop, the return flowmeter will start to show flow. Then when the caustic CIP has made a full loop, the conductivity meter will start to show a higher conductivity, and finally, when the final rinse has removed the residual caustic, the conductivity meter indication will drop back down.

Local Indication

The local indicators below are provided for visual verification of process conditions. These instruments have no control functions and they do not report data to the PLC.

- PI 8202-04,: Line 9302-03: Steam pressure. Verification of steam pressure prior to the CIP Dilute Caustic Heater.
- PI 8203-04, Line 8201-15: Steam pressure. Verification of steam pressure prior to the CIP Rinse Heater.
- PI 8202-06, Line 8201-09: Process pressure. Verification of pressure downstream of the CIP Dilute Caustic Pump.
- PI 8203-06, Line 8201-16: Process pressure. Verification of pressure downstream of the CIP Rinse Pump.

VALVE SEQUENCING – CIP SYSTEM (TS-8202 & TS-8203)

	CIPR-2301-19: V-18 (8202)	CIPR-2303-08: V-24 (8202)	CIPR-3201-10: V-17 (8202)	CIPR-3205-23: V-19 (8202)	CIPR-3206-23: V-20 (8202)	CIPR-3207-23: V-21 (8202)	CIPR-4601-10: V-22 (8202)	CIPR-8201-01: V-31	CIPR-8201-03: V-30	CIPR-8201-11 (tee to drain): V-11	CIPR-8201-12 (tee to drain): V-25	CIPR-8201-02: V-04	CIPR-8202-12 (after filter): V-13 (8202)	CIPR-8202-17: V-15 (8202)	CIPR-8202-19: V-16 (8202)	CIPR-XXXX-XX: V-14 (8202)	CIPS-8201-08: V-27 (8202)	CIPS-8201-09 (after pump)	CIPS-8201-09 (after recirc branch): V-13	CIPS-8201-11: V-10	CIPS-8201-11 (drain hose connection): V-17	CIPS-8201-12: V-26	CIPS-8201-13: V-21	CIPS-8201-16 (after pump)	CIPS-8201-16 (after rcirc branch): V-20	CIPS-8202-01: V-01 (8202)	CIPS-8202-02: V-02 (8202)	CIPS-8202-03: V-03 (8202)	CIPS-8202-04	CIPS-8202-05	CIPS-8202-06: V-04 (8202)	CIPS-8202-07: V-05 (8202)	CIPS-8202-08: V-06 (8202)	CIPS-8202-10: V-07 (8202)	CIPS-8202-11: V-08 (8202)	CIPS-8202-14: V-09 (8202)	CIPS-8202-15	CIPS-8202-18: V-10 (8202)	CL-8201-05: V-09	CL-8201-18: V-24	SL-8201-15: V-08	SL-9302-03: V-07	UVW-9503-16: V-12	NAOH-8301-03: V-02	ACID-8301-02: V-01
Draining Dilute Caustic Tank										O								C		O																								
Draining Rinse Tank											O											O		C																				
Heating with HP-8202																																							O				
Heating with HP-8203																																								O	O			
Pumping UV Water to Liq. Tank																		C						C		O	C	C	C	C	C	C	C	C	C	C	C	C	C				O		
Pumping UV Water to Prop 1A																		C						C		C	O	C	C	C	C	C	C	C	C	C	C	C	C				O		
Pumping UV Water to Prop 2A																		C						C		C	C	O	C	C	C	C	C	C	C	C	C	C	C				O		
Pumping UV Water to Prop 3A																		C						C		C	C	C	O	C	C	C	C	C	C	C	C	C	C				O		
Pumping UV Water to Prop 3B																		C						C		C	C	C	C	O	C	C	C	C	C	C	C	C	C				O		
Pumping UV Water to Ferm A																		C						C		C	C	C	C	C	O	C	C	C	C	C	C	C	C				O		
Pumping UV Water to Ferm B																		C						C		C	C	C	C	C	C	O	C	C	C	C	C	C	C				O		
Pumping UV Water to Ferm C																		C						C		C	C	C	C	C	C	C	O	C	C	C	C	C	C				O		
Pumping UV Water to Beer Well																		C						C		C	C	C	C	C	C	C	C	O	C	C	C	C	C				O		
Pumping UV Water to D&D																		C						C		C	C	C	C	C	C	C	C	C	O	C	C	C	C				O		
Pumping UV Water to Prop 1B																		C						C		C	C	C	C	C	C	C	C	C	C	O	C	C	C				O		
Pumping UV Water to Prop 2B																		C						C		C	C	C	C	C	C	C	C	C	C	C	O	C	C				O		
Pumping UV Water to pH Adjust Tank																		C						C		C	C	C	C	C	C	C	C	C	C	C	C	O	C				O		
Pumping out of Rinse tank to										C												O	C	O		O	C	C	C	C	C	C	C	C	C	C	C	C	C				C		

	CIPR-2301-19: V-18 (8202)	CIPR-2303-08: V-24 (8202)	CIPR-3201-10: V-17 (8202)	CIPR-3205-23: V-19 (8202)	CIPR-3206-23: V-20 (8202)	CIPR-3207-23: V-21 (8202)	CIPR-4601-10: V-22 (8202)	CIPR-8201-01: V-31	CIPR-8201-03: V-30	CIPR-8201-11 (tee to drain): V-11	CIPR-8201-12 (tee to drain): V-25	CIPR-8201-02: V-04	CIPR-8202-12 (after filter): V-13 (8202)	CIPR-8202-17: V-15 (8202)	CIPR-8202-19: V-16 (8202)	CIPR-XXXX-XX: V-14 (8202)	CIPS-8201-08: V-27 (8202)	CIPS-8201-09 (after pump)	CIPS-8201-09 (after recirc branch): V-13	CIPS-8201-11: V-10	CIPS-8201-11 (drain hose connection): V-17	CIPS-8201-12: V-26	CIPS-8201-13: V-21	CIPS-8201-16 (after pump)	CIPS-8201-16 (after rcirc branch): V-20	CIPS-8202-01: V-01 (8202)	CIPS-8202-02: V-02 (8202)	CIPS-8202-03: V-03 (8202)	CIPS-8202-04	CIPS-8202-05	CIPS-8202-06: V-04 (8202)	CIPS-8202-07: V-05 (8202)	CIPS-8202-08: V-06 (8202)	CIPS-8202-10: V-07 (8202)	CIPS-8202-11: V-08 (8202)	CIPS-8202-14: V-09 (8202)	CIPS-8202-15	CIPS-8202-18: V-10 (8202)	CL-8201-05: V-09	CL-8201-18: V-24	SL-8201-15: V-08	SL-9302-03: V-07	UVW-9503-16: V-12	NAOH-8301-03: V-02	ACID-8301-02: V-01
Liq. Tank																																												
Pumping out of Rinse tank to Prop 1A											C											O	C	O		C	O	C	C	C	C	C	C	C	C	C	C					C		
Pumping out of Rinse tank to Prop 2A											C											O	C	O		C	C	O	C	C	C	C	C	C	C	C	C					C		
Pumping out of Rinse tank to Prop 3A											C											O	C	O		C	C	C	O	C	C	C	C	C	C	C	C					C		
Pumping out of Rinse tank to Prop 3B											C											O	C	O		C	C	C	C	O	C	C	C	C	C	C	C					C		
Pumping out of Rinse tank to Ferm A											C											O	C	O		C	C	C	C	C	O	C	C	C	C	C	C					C		
Pumping out of Rinse tank to Ferm B											C											O	C	O		C	C	C	C	C	C	O	C	C	C	C	C					C		
Pumping out of Rinse tank to Ferm C											C											O	C	O		C	C	C	C	C	C	C	O	C	C	C	C					C		
Pumping out of Rinse tank to Beer Well											C											O	C	O		C	C	C	C	C	C	C	C	O	C	C	C					C		
Pumping out of Rinse tank to D&D											C											O	C	O		C	C	C	C	C	C	C	C	C	O	C	C					C		
Pumping out of Rinse tank to Prop 1B											C											O	C	O		C	C	C	C	C	C	C	C	C	C	O	C					C		
Pumping out of Rinse tank to Prop 2B											C											O	C	O		C	C	C	C	C	C	C	C	C	C	C	O					C		
Pumping out of Rinse tank to pH Adjust Tank											C											O	C	O		C	C	C	C	C	C	C	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Liq. Tank										C								O		O						O	C	C	C	C	C	C	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Prop 1A										C								O		O						C	O	C	C	C	C	C	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Prop 2A										C								O		O						C	C	O	C	C	C	C	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Prop 3A										C								O		O						C	C	C	O	C	C	C	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Prop 3B										C								O		O						C	C	C	C	O	C	C	C	C	C	C	C					C		

	CIPR-2301-19: V-18 (8202)	CIPR-2303-08: V-24 (8202)	CIPR-3201-10: V-17 (8202)	CIPR-3205-23: V-19 (8202)	CIPR-3206-23: V-20 (8202)	CIPR-3207-23: V-21 (8202)	CIPR-4601-10: V-22 (8202)	CIPR-8201-01: V-31	CIPR-8201-03: V-30	CIPR-8201-11 (tee to drain): V-11	CIPR-8201-12 (tee to drain): V-25	CIPR-8201-02: V-04	CIPR-8202-12 (after filter): V-13 (8202)	CIPR-8202-17: V-15 (8202)	CIPR-8202-19: V-16 (8202)	CIPR-XXXX-XX: V-14 (8202)	CIPS-8201-08: V-27 (8202)	CIPS-8201-09 (after pump)	CIPS-8201-09 (after recirc branch): V-13	CIPS-8201-11: V-10	CIPS-8201-11 (drain hose connection): V-17	CIPS-8201-12: V-26	CIPS-8201-13: V-21	CIPS-8201-16 (after pump)	CIPS-8201-16 (after rcirc branch): V-20	CIPS-8202-01: V-01 (8202)	CIPS-8202-02: V-02 (8202)	CIPS-8202-03: V-03 (8202)	CIPS-8202-04	CIPS-8202-05	CIPS-8202-06: V-04 (8202)	CIPS-8202-07: V-05 (8202)	CIPS-8202-08: V-06 (8202)	CIPS-8202-10: V-07 (8202)	CIPS-8202-11: V-08 (8202)	CIPS-8202-14: V-09 (8202)	CIPS-8202-15	CIPS-8202-18: V-10 (8202)	CL-8201-05: V-09	CL-8201-18: V-24	SL-8201-15: V-08	SL-9302-03: V-07	UVW-9503-16: V-12	NAOH-8301-03: V-02	ACID-8301-02: V-01
Pumping out of Dilute Caustic tank to Ferm A										C								O		O					C	C	C	C	C	O	C	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Ferm B										C								O		O					C	C	C	C	C	C	O	C	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Ferm C										C								O		O					C	C	C	C	C	C	C	O	C	C	C	C					C		
Pumping out of Dilute Caustic tank to Beer Well										C								O		O					C	C	C	C	C	C	C	C	O	C	C	C					C		
Pumping out of Dilute Caustic tank to D&D										C								O		O					C	C	C	C	C	C	C	C	C	O	C	C					C		
Pumping out of Dilute Caustic tank to Prop 1B										C								O		O					C	C	C	C	C	C	C	C	C	C	O	C					C		
Pumping out of Dilute Caustic tank to Prop 2B										C								O		O					C	C	C	C	C	C	C	C	C	C	C	O					C		
Pumping out of Dilute Caustic tank to pH Adjust Tank										C								O		O					C	C	C	C	C	C	C	C	C	C	C	C	O				C		
Recirculating Dilute Caustic tank										C								O	C	O	C																							
Recirculating Rinse Tank											C						O					O	O	O	C																			
Adding base to Dilute Caustic Tank																																											O	C
Adding acid to Dilute Caustic Tank																																										C	O
Returning to Dilute Caustic Tank from Hose Connection	C	C	C	C	C	C	C	C	C			O	O	O	O	C																										
Returning to Dilute Caustic Tank from Prop 1A	C	C	O	C	C	C	C	C	C			O	O	O	C	C																										
Returning to Dilute Caustic Tank from Liq Tank Pump	O	C	C	C	C	C	C	C	C			O	O	O	C	C																										
Returning to Dilute Caustic Tank from Ferm A	C	C	C	O	C	C	C	C	C			O	O	O	C	C																										
Returning to Dilute Caustic Tank from Ferm B	C	C	C	C	O	C	C	C	C			O	O	O	C	C																										
Returning to Dilute Caustic Tank from Ferm C	C	C	C	C	C	O	C	C	C			O	O	O	C	C																										

	CIPR-2301-19: V-18 (8202)	CIPR-2303-08: V-24 (8202)	CIPR-3201-10: V-17 (8202)	CIPR-3205-23: V-19 (8202)	CIPR-3206-23: V-20 (8202)	CIPR-3207-23: V-21 (8202)	CIPR-4601-10: V-22 (8202)	CIPR-8201-01: V-31	CIPR-8201-03: V-30	CIPR-8201-11 (tee to drain): V-11	CIPR-8201-12 (tee to drain): V-25	CIPR-8201-02: V-04	CIPR-8202-12 (after filter): V-13 (8202)	CIPR-8202-17: V-15 (8202)	CIPR-8202-19: V-16 (8202)	CIPR-XXXX-XX: V-14 (8202)	CIPS-8201-08: V-27 (8202)	CIPS-8201-09 (after pump)	CIPS-8201-09 (after recirc branch): V-13	CIPS-8201-11: V-10	CIPS-8201-11 (drain hose connection): V-17	CIPS-8201-12: V-26	CIPS-8201-13: V-21	CIPS-8201-16 (after pump)	CIPS-8201-16 (after rcirc branch): V-20	CIPS-8202-01: V-01 (8202)	CIPS-8202-02: V-02 (8202)	CIPS-8202-03: V-03 (8202)	CIPS-8202-04	CIPS-8202-05	CIPS-8202-06: V-04 (8202)	CIPS-8202-07: V-05 (8202)	CIPS-8202-08: V-06 (8202)	CIPS-8202-10: V-07 (8202)	CIPS-8202-11: V-08 (8202)	CIPS-8202-14: V-09 (8202)	CIPS-8202-15	CIPS-8202-18: V-10 (8202)	CL-8201-05: V-09	CL-8201-18: V-24	SL-8201-15: V-08	SL-9302-03: V-07	UVW-9503-16: V-12	NAOH-8301-03: V-02	ACID-8301-02: V-01
Returning to Dilute Caustic Tank from Beer Preheater	C	C	C	C	C	C	O	C	C			O	O	O	C	C																												
Returning to Dilute Caustic Tank from D&D	C	C	C	C	C	C	C	C	C			O	O	O	C	O																												
Returning to Dilute Caustic Tank from pH Adjust Tank	C	O	C	C	C	C	C	C	C			O	O	O	C	C																												
Returning to Rinse Tank from hose connection	C	C	C	C	C	C	C	C	O			C	O	O	O	C																												
Returning to Rinse Tank from Prop 1A	C	C	O	C	C	C	C	C	O			C	O	O	C	C																												
Returning to Rinse Tank from Liq Tank Pump	O	C	C	C	C	C	C	C	O			C	O	O	C	C																												
Returning to Rinse Tank from Ferm A	C	C	C	O	C	C	C	C	O			C	O	O	C	C																												
Returning to Rinse Tank from Ferm B	C	C	C	C	O	C	C	C	O			C	O	O	C	C																												
Returning to Rinse Tank from Ferm C	C	C	C	C	C	O	C	C	O			C	O	O	C	C																												
Returning to Rinse Tank from Beer Preheater	C	C	C	C	C	C	O	C	O			C	O	O	C	C																												
Returning to Rinse Tank from D&D	C	C	C	C	C	C	C	C	O			C	O	O	C	O																												
Returning to Rinse Tank from pH Adjust Tank	C	O	C	C	C	C	C	C	O			C	O	O	C	C																												
Returning to Drain from hose connection	C	C	C	C	C	C	C	O	C			C	O	O	O	C																												
Returning to Drain from Prop 1A	C	C	O	C	C	C	C	O	C			C	O	O	C	C																												
Returning to Drain from Liq Tank Pump	O	C	C	C	C	C	C	O	C			C	O	O	C	C																												
Returning to Drain from Ferm A	C	C	C	O	C	C	C	O	C			C	O	O	C	C																												
Returning to Drain from Ferm B	C	C	C	C	O	C	C	O	C			C	O	O	C	C																												
Returning to Drain from Ferm C	C	C	C	C	C	O	C	O	C			C	O	O	C	C																												

	CIPR-2301-19: V-18 (8202)	CIPR-2303-08: V-24 (8202)	CIPR-3201-10: V-17 (8202)	CIPR-3205-23: V-19 (8202)	CIPR-3206-23: V-20 (8202)	CIPR-3207-23: V-21 (8202)	CIPR-4601-10: V-22 (8202)	CIPR-8201-01: V-31	CIPR-8201-03: V-30	CIPR-8201-11 (tee to drain): V-11	CIPR-8201-12 (tee to drain): V-25	CIPR-8201-02: V-04	CIPR-8202-12 (after filter): V-13 (8202)	CIPR-8202-17: V-15 (8202)	CIPR-8202-19: V-16 (8202)	CIPR-XXXX-XX: V-14 (8202)	CIPS-8201-08: V-27 (8202)	CIPS-8201-09 (after pump)	CIPS-8201-09 (after recirc branch): V-13	CIPS-8201-11: V-10	CIPS-8201-11 (drain hose connection): V-17	CIPS-8201-12: V-26	CIPS-8201-13: V-21	CIPS-8201-16 (after pump)	CIPS-8201-16 (after rcirc branch): V-20	CIPS-8202-01: V-01 (8202)	CIPS-8202-02: V-02 (8202)	CIPS-8202-03: V-03 (8202)	CIPS-8202-04	CIPS-8202-05	CIPS-8202-06: V-04 (8202)	CIPS-8202-07: V-05 (8202)	CIPS-8202-08: V-06 (8202)	CIPS-8202-10: V-07 (8202)	CIPS-8202-11: V-08 (8202)	CIPS-8202-14: V-09 (8202)	CIPS-8202-15	CIPS-8202-18: V-10 (8202)	CL-8201-05: V-09	CL-8201-18: V-24	SL-8201-15: V-08	SL-9302-03: V-07	UVW-9503-16: V-12	NAOH-8301-03: V-02	ACID-8301-02: V-01
Returning to Drain from Beer Preheater	C	C	C	C	C	C	O	O	C			C	O	O	C	C																													
Returning to Drain from D&D	C	C	C	C	C	C	C	O	C			C	O	O	C	O																													
Returning to Drain from pH Adjust Tank	C	O	C	C	C	C	C	O	C			C	O	O	C	C																													

AREA 9200 – COOLING WATER SYSTEM OVERVIEW

The Cooling Water System consists of a refrigeration plant package, a heat exchanger, a cooling water tank and pump. Plant recycle water is pumped through the Refrigeration Plant Package (PK-9201) to produce chilled water at 45°F. The chilled water passes through the plate and frame Cooling Water Heat Exchanger (HS-9202) and cools plant recycle water to 85°F to serve as cooling water for the plant.

A portion of the chilled water is used in the Liquefaction Cooler HP-2301 and the Flash Steam Condenser HS-2201, which is part of the packaged Pretreatment System. The chilled water that returns from these users is recycled back through the refrigeration plant.

Cooling water from the cooling water heat exchanger flows to various cooling water users throughout the plant and returns to the Cooling Water Tank (TS-9202). From there, the Cooling Water Pump (PC-9202) pumps it back through the Cooling Water Heat Exchanger. Recycled water is used to maintain a constant level in the Cooling Water Tank.

REFRIGERATION PLANT PACKAGE PK-9201 (DRAWING PIL-PID-9201)

The Refrigeration Plant Package (PK-9201) is a vendor-supplied package system consisting of an Air Separator (VS-9201), a Chiller (CH-9201), a Chilled Water Expansion Tank (TS-9201), a Chilled Water Pump (PC-9201) and a Chiller Heat Exchanger (HS-9201). The plant PLC will control this package through an I/O panel provided with the package.

Chiller Control for CH-9201-M

The Chiller motor is equipped with a VSD to control the speed of the motor, thereby controlling the outlet chilled water temperature. The VSD is controlled through the PLC by SIC-9201-05. Temperature in the chilled water discharge line is measured by TT-9202-01 (Dwg. PIL-PID-9202), which sends a signal to TIC-9202-01 in the PLC (Loop PIL-TIC-9202-01). TIC-9202-01 sends a signal through the PLC to SIC-9201-05, which controls the speed of the compressor motor, or turn individual compressors off or on as required to meet the temperature set point.

COOLING WATER SUPPLY (PIL-PID-9202)

Cooling Water Temperature Control (Loop TIC-9202-04)

Temperature transmitter TT-9202-04 measures the temperature of cooling water leaving the Cooling Water Heat Exchanger HS-9201 and sends a signal to TIC-9202-04. TV-9202-04 regulates the flowrate of chilled water through the Cooling Water Heat Exchanger, thereby maintaining the cooling water at a constant temperature.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI-9201-01, Line 9201-02: chilled water return to Refrigeration Package PK-9201.
- PI-9202-02, Line 9201-01: the chilled water inlet line to the Cooling Water Heat Exchanger HS-9202

Temperature Indication (Loop TI-9202-03)

Temperature in the cooling water inlet to the Cooling Water Heat Exchanger is measured by TT-9202-03 and is indicated in the PLC by TI-9202-03.

COOLING WATER RETURN (DRAWING PIL-PID-9203)

Cooling Water Tank Level (Loop LIC 9202-06)

LT-9202-06 measures the level in the Cooling Water Tank (TS-9202) and transmits a signal to LIC-9202-06 in the PLC, which modulates LV-9202-06, thereby controlling the flow rate of recycle water into the tank.

Pressure Control in Cooling Water Pump Discharge Line

PRV-9202-10 located in the recycle line to the Cooling Water Tank maintains a constant pressure in the pump discharge line, which feeds the Cooling Water Heat Exchanger. It is set to fail closed.

Cooling Water Flow Indication (Loop FI-9202-08)

FE-9202-08, an orifice type flow meter, measures the flow rate of cooling water in the Cooling Water Pump discharge to the process. FT-9202-08 sends a signal to FI-9202-08, which indicates the flow rate in the PLC.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI-9202-09, Line 9203-02: PC-9202 Pump discharge line.

PLC Indication

The listed indicators below are provided for visual verification of steam pressure conditions at the electric boiler, and pressure reducing stations.

- PIC-9301-01: Low pressure steam pressure indicating controller, local, and reportable data to the control Room PLC.
- PIC-9301-02: 60 psig station steam pressure indicating controller, local, and reportable data to the control Room PLC.
- Condensate tank high high level alarm LAHH-9301-05 reportable to PLC control Room.
- Condensate tank level indicating controller LIC-9301-06 local, and signal to PLC control Room.

VALVE FAILURE MODE

STEAM PRESURE CONTROL VALVE	PV-9301-01	O
STEAM PRESURE CONTROL VALVE	PV-9301-02	O
CONDENSATE LEVEL CONTROL VALVE	LV-9301-06	C

AREA 9300 – STEAM SUPPLY SYSTEM OVERVIEW

(DRAWING PIL-PID-9301, PIL-PID-9302)

The plant steam supply system consists of 150 PSIG saturated steam which is supplied from Buckeye, and an electric steam boiler (PK-9301) which will supply 225 PSIG saturated steam.

The Buckeye steam supply will be reduced to 60 PSIG through the pressure indicating controller PIC-9301-02. This steam will supply the hot water heater (HP-9601), Waste water heat exchanger (HP-9601), Waste water heater (HS-9502), CIP area heater, Beer stripper Re-boiler, HP-4601) and beer preheater#1 (HP-4601), stripper column (C-4601),Rectifier Re-boiler (HS-4604), sterilizing filter (FL-9403), and other process users requiring 60 PSIG steam.

PIC-9301-02 will reduce the 150 PSIG steam to 60PSIG through control valve PV-9301-02 based on the signal from the pressure transmitter PT-9301-02. In line PSV-9301-06 is set at slightly higher value to insure proper protection for the equipment and process downstream.

A branch line from the 60 PSIG Saturated steam will feed the 30 PSIG pressure reducing station, which is comprised of PIC-9301-01, Pressure transmitter PT-9301-01, and pressure reducing control valve PV-9301-01. This low pressure steam is to feed the fermentors, Propagators, liquefaction tank VS-3202B, Hydrolysate pH adjustment tank VS-2302, and area 2100.

The 30 PSIG reducing station includes Pressure safety relief valve PSV-9301-07 to protect equipment downstream from any sudden pressure increase over 30 PSIG. The PSV will be set slightly above the 30 PSIG required for this part of the process.

The Electric boiler (PK-9301) will use recycled water from recycle water tank VS-9301 as makeup which will feed the boiler feed water tank along with any condensate return. The boiler feed pump which is part of the feed water system will proportion the required water to the electric boiler. The water treatment chemicals for the boiler will be added to the feed water tank as required to prevent corrosion or scaling of the water side of the boiler.

Condensate return will be directed to the condensate receiver VS-9302, and Boiler feed water tank. Excess condensate will be pumped to the process water tank TS-9501.

The condensate tank pump is controlled via liquid level control LIC-9301-06. This controller will receive the signal from level transmitter LT-9301-06. When level in the receiver is high the level controller will open valve LV-9301-06, activate pump PC-9302 and pump the condensate to the boiler feed water tank which is part of electric boiler package (PK-9301). When the boiler feed water tank is full, the water will be directed to the process water tank TS-9501. When level in tank VS-9301 recedes, the pump will stop, and valve LV-9301-06 closes.

The vendor package will include the pressure control package enabling the operator to set the boiler discharge pressure to a set point of about 250 psig or lower. The boiler will run in auto mode once the feed water tank is filled and ready to deliver water to the boiler based on boiler steam pressure demand.

AREA 9400 – COMPRESSED AIR SYSTEM OVERVIEW

The Compressed Air System consists of dual air-cooled type air compressors, which will provide compressed air at a nominal pressure of 100 psig for use in plant instrumentation and provides compressed air at a nominal pressure of 20 psig for use as sparging air in process vessels. One is operational, and one is on standby at all times. It also includes aftercoolers, filters, air receiver, instrument air dryer and afterfilter.

The process compressed air passes through the Sterilizing Filter (FL-9403) prior to being used in the process vessels.

COMPRESSED AIR PACKAGE (DRAWING PIL-PID-9401)

The Compressed Air Package is a vendor-supplied package system that includes dual air-cooled Air Compressors (AC-9401A / B). Each compressor is followed by an air-cooled Aftercooler (HS-9401A / B) and an Aftercooler Filter (FL-9401C / D). Compressed air then flows to Air Receiver 1 (VS-9401), through the Instrument Air Prefilter (FL-9401A) and is then dried in the Instrument Air Dryer (DR-9401). Prior to proceeding to the plant for use as instrument air, the air is filtered again in the Instrument Air Afterfilter (FL-9401B).

The plant PLC system will control this package through an I/O panel provided with the package.

Pressure Differential Indication for FL-9401A / B

Differential pressures across Instrument Air Prefilter FL-9401A and Instrument Air Prefilter FL-9401-B are indicated in the PLC by PDI-9401-05 and PDI-9401-06, respectively, from signals from pressure differential transmitters provided by the compressor package supplier.

Pressure Reduction (PRV-9402-07)

Compressed air from the Instrument Compressed Air Package may be used as Process Air in the event of a failure of the Process Compressed Air Package. PRV-9402-07 is installed in the connecting line from the instrument Compressed Air Package discharge to the Process Compressed Air Package discharge to reduce the pressure for use as Process air. It is set to fail closed.

COMPRESSED – STERILE AIR DISTRIBUTION (DRAWING PIL-PID-9402)

Pressure Indication for FL-9403

Pressure in Sterilizing Filter FL-9403 is indicated in the PLC by PI-9403-04 from a signal provided by PT-9403-04.

Temperature in Discharge of FL-9403

Temperature in the discharge line for Sterilizing Filter FL-9403 is indicated in the PLC by TI-9403-03 from a signal provided by TT-9403-03.

AREA 9500 – PROCESS WATER, WASTE WATER AND STERILIZED WATER SYSTEMS OVERVIEW

The Process & Recycled Water System consists of a storage tank to collect recycled process water and makeup water, a pump to distribute the process water to the plant and a heat exchanger to keep the tank contents at a constant temperature.

The Waste Water System consists of sump pumps to collect process waste water from floor drains and pump it to a storage tank, a pump to pump the waste water to the mill's wastewater treatment system and a heat exchanger to heat the wastewater prior to going to the mill.

The UV Sterilized Water System consists of a storage tank, a pump to deliver sterilized water to users in the plant and two UV sterilizers in series to sterilize the water.

PROCESS & RECYCLED WATER SYSTEM (DRAWING PIL-PID-9501)

The Process Water Tank (TS-9501) collects clean condensate from the pilot plant and makeup water from the mill's service water to be reused as process water in the pilot plant. The tank has a capacity of 5,875 gallons and is of FRP construction.

The Process Water Pump (PC-9501) pumps process water to process water users in the pilot plant. It also recycles process water to the Process Water Tank through the Process Water Cooler (HD-9501), which maintains the tank contents at 115° F.

The Seal Water Filter (FL-9502) filters the process water for use as seal water in the Pretreatment System.

Process Water Tank Level Control (Loop No. PIL-LIC-9501-01)

LT-9501-01 measures the level in the Process Water Tank and sends a signal to LIC-9501-01 in the PLC, which modulates LV-9501-01 in the service water inlet line to maintain a constant level in the tank. LV-9501-01 is set to fail closed.

Process Water Tank Temperature Control (Loop No. PIL-TIC-9501-03)

TT-9501-03 measures the temperature in the Process Water Tank recycle line and sends a signal to TIC-9501-03 in the PLC, which modulates TV-9501-03 in the cooling water return line from the Process Water Cooler (HP-9501). TV-9501-03 is set to fail open.

Pressure Control in Process Water Tank Recycle Line

PRV-9501-05, a back pressure regulator with an external pressure tap, maintains back pressure in the Process Water Tank recycle line that tees off the discharge of the Process Water Pump. It is set to fail closed.

Pressure Indication in the Process Water Pump Discharge

Pressure is indicated locally in the Process Water Pump discharge by PI-9501-04.

Pressure Indication Before and After FL-9502

Pressure is indicated locally before and after the Seal Water Filter (FL-9502) by PI-9502-09 and PI-9502-08, respectively.

Pressure Relief in Cooling Water Inlet Line to HS-9501

PSV-9501-06 provides pressure relief in the cooling water inlet line to the Process Water Cooler (HS-9501). It is set to open at 60 PSIG.

WASTE WATER SYSTEM (DRAWING PIL-PID-9502)

The Waste Water Tank (TS-9502) collects waste water from the pilot plant and CIP sumps.
The tank has a capacity of 10,600 gallons and is of FRP construction.
Waste water is then pumped from the tank via pump PC-9502 through heat exchanger HS-9502 to waste water treatment plant

Waste Water Tank Level Transmitter (LT-9502-01)

The level is measured in the tank level and the transmitter LT-9502-01 sends a signal to the PLC for indication, and alarming.
Low-Low alarm will trigger at 10%
High alarm will trigger at 90%
High-High alarm will trigger at 95%

Waste Water Flow Control (Loop No. FIC-9502-04)

Waste water flow is measured via FE-9502-04, and reading is transmitted by FT-9502-04 to control FIC-9502-04 in the PLC. The controller then sends a control signal to actuate valve FV-9502-04 to adjust the waste water flow to the heat exchanger HS-9502 prior to discharge to wastewater treatment plant.
PSV9502-07 is installed in line 9502-08 and to relief at 150 PSIG to protect the heat exchanger.

Waste Water Temperature Control(Loop No. TIC-9502-08)

TT 9502-08 measures the temperature in the waste water line leaving waste water heat exchanger HS-9502 and sends a signal to TIC-9502-08 in the PLC. It modulates TV-9502-08 to regulate the flow of steam into the waste water pick heater, thereby controlling the temperature of the waste water going to the treatment plant at 180° F.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI-9502-03, Line 9502-04: Waste Water Pump discharge
- PI-9502-09, Line 9301-05: the steam inlet line to the Waste Water Pick Heater HS-9502.
- PI-9504-02, Line 9502-01: Sump Pump PC-9504 discharge.

- PI-9505-02, Line 9502-05: Sump Pump PC-9505 discharge.

UV STERILIZING WATER SYSTEM (PIL-PID-9503)

The UV water storage tank is filled with process water from pump PC-9501. The UV water is pumped via pump PC-9503 through UV sterilizers X-9501, 9502 to meet propagators and fermentors' process requirements. Self regulated PRV-9503-05 is set to relieve UV water back to the tank TS-9503 whenever user equipment is not requiring water flow, or in case of sudden downstream valve closures.

UV Water Tank Level Control (loop No. 9503-01)

LT-9503-01 measures the level in the UV water storage tank and sends a signal to LIC-9503-01 in the PLC. It in turn, modulates LV-9503-01 in the process water inlet line to tank TS-9503 to maintain a constant level in the tank. LV-9503-01 is set to fail closed.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI-9503-04, Line 9503-02: UV water Pump Discharge.

AREA 9600 – HOT WATER SYSTEM OVERVIEW

The purpose of the Hot Water System is to heat process water to be used for heating process vessels, including the propagators and fermentors. The system consists of a hot water tank, pump and heat exchanger and associated piping and instrumentation and controls.

HOT WATER SYSTEM (DRAWING PIL-PID-9601)

The Hot Water Tank (TS-9601) receives water that is returned from the heating / cooling jackets of the Liquefaction Tank, the Hydrolyzate pH Adjustment Tank and all the Propagators and Fermentors. Process water is used as makeup water for the tank.

The Hot Water Pump (PC-9601) pumps process water through the Hot Water Heater (HP-9601), a plate-and-frame heat exchanger, where it is heated with 60-psig steam to be reused in the process.

Hot Water Tank Level Control (Loop No. PIL-LIC-9601-01)

LT-9601-01 measures the level in the Hot Water Tank and sends a signal to LIC-9601-01 in the PLC. It, in turn, modulates LV-9601-01 in the process water inlet line to maintain a constant level in the tank. LV-9601-01 is set to fail closed.

Hot Water Temperature Control (Loop No. PIL-TIC-9601-03)

TIT-9601-03 measures the temperature in the hot water outlet from the Hot Water Heater and sends a signal to TIC-9601-03 in the PLC. It modulates TV-9601-03 to regulate the flow of steam into the Hot Water Heater, thereby controlling the temperature of the hot water going to the process, and providing local indication.

Pressure Control in Hot Water Tank Recycle Line

PRV-9601-02, a back pressure regulator with an external pressure tap, maintains back pressure in the Hot Water Tank recycle line that tees off the discharge of the Hot Water Pump. It is set to fail closed.

Local Indication

The local indicators below are provided for visual verification of process conditions at the tank. These instruments have no control functions and they do not report data to the PLC.

- PI-9601-04, Line 9601-22: Process Water Pump discharge

AREA 9700 – POTABLE WATER DISTRIBUTION SYSTEM OVERVIEW

The purpose of the Potable Water Distribution System is to store potable water obtained from the mill and to distribute it to users throughout the pilot plant. The system consists of a storage tank, a pump, safety shower / eyewash stations and associated instrumentation and piping.

POTABLE WATER SYSTEM DISTRIBUTION (DRAWING PIL-PID-9701)

The Potable Water Tank (TS-9701) receives potable water from the mill. It has a capacity of 500 gallons, and it is of FRP construction. The Potable Water Booster Pump (PC-9701) delivers potable water to the potable water users in the pilot plant building, to the modular office building and to the safety shower / eyewash stations. These stations will have flow switches (FS9701-05, -07, -08, -11, -13,-15) which will alarm in the PLC to indicate when a safety shower or eyewash has been used.

The stations are located in the following areas:

- CIP
- Laboratory
- Fermentation
- Pretreatment
- D& D (on hold)

Potable Water Tank Level Control (Loop No. PIL-LIC-9701-01)

LIT-9701-01 measures the level in the Hot Water Tank, indicates it locally and sends a signal to LIC-9701-01 in the PLC. It, in turn, modulates LV-9701-01 in the potable water inlet line to maintain a constant level in the tank. LV-9701-01 is set to fail closed.

Pressure Indication in the Potable Water Distribution System (Loop No. PIL-PI-9701-14)

PIT-9701-14 measures pressure in the potable water distribution piping, indicates it locally and sends a signal to PI-9701-14 in the PLC, where it indicates the pressure but does not alarm.

Pressure Control in Potable Water Tank Recycle Line

PRV-9701-15, a self-contained pressure regulator, is located in the Potable Water Tank recycle line that tees off the discharge of the Potable Water Booster Pump and maintains a pressure of 100 psig in the potable water distribution system.

Local Indication

The local indicator below provides visual verification of process conditions at the tank. This instrument has no control function and does not report data to the PLC.

- PI-9701-03, Line 9701-06: PC-9701 Pump discharge line.