

THE BAMBINO® 2000psi and THE TRANSFORMER® 2000psi Botanical Oil Extraction System Operation Manual



FAILURE TO FOLLOW THE SET UP AND OPERATION PROCEDURE PROVIDED IN WITHIN
THIS MANUAL MAY VOID THE EXTRACTION SYSTEM'S WARRANTY

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1. Critical Safety Overview



Throughout these instructions, this symbol is used to indicate that the instructions are critically important to your safety and the safety of your system. Failure to follow the instructions as written can result in a rapid release of high pressure CO₂ potentially causing equipment or personnel damage.



Subcritical and Supercritical CO₂ systems operate under high pressure. Operators must be fully trained and familiar with the system. Failure to operate the system can result in equipment damage and/or bodily injury.



Subcritical and Supercritical CO₂ systems use large amounts of CO₂ during operation. Ensure that system is installed in a well-ventilated area to prevent buildup of CO₂ which can cause asphyxiation. Use of a CO₂ monitor is strongly recommended.



Opening a vessel under pressure can result in a rapid release of pressure and ejection of the material inside the vessel. **DO NOT ATTEMPT TO OPEN A VESSEL UNDER PRESSURE!** Always make sure a vent path for the vessel is opened and the corresponding pressure gauge reads zero prior to loosening the vessel hammer unions.



Subcritical and Supercritical CO₂ systems are designed to operate indoors. Extreme temperatures (below 60°F and above 80°F) will negatively impact the functionality of the system. The environmental temperature range is for the system, chiller, pump and CO₂ bottles.



Only use Propylene Glycol and distilled water in the chiller and cooling system. Never use Deionized Water in the chiller or cooling system.



Extraction system components can weigh in excess of 2000 lbs and need to be moved carefully. Never attempt to move system pieces without the proper equipment, failure to do so could result in serious injury or death.



Always wear safety glasses when operating and servicing the system.

2. System Operation

The following operating instructions are for The Bambino® i.2000psi and The Transformer® 2000psi CO₂ based Botanical Oil Extraction systems. Instructions manuals for the Thermo-Fisher chiller and Diaphragm Compressor are supplied separately. Failure to follow the instructions provided below may void the warranty of the extraction system and its components.

2.1. The Transformer® System Overview



Figure 1. System Components of The Transformer®

2.2. Automation Overview

- 2.2.1. The Human Machine Interface (HMI) is a 10" color touch screen. Almost all of the inputs, outputs and human/machine interactions are managed through the HMI.
- 2.2.2. The HMI has two functions: 1) to provide information and 2) to accept inputs from the operator. Description of some of the interaction is here:
 - 2.2.2.1. If a display value or message is colored orange, an operator must take action before moving forward.

- 2.2.2.1.1. Orange indicates that an operator activity is required before the Start button can be depressed. Messages highlighted orange are indicative of a scheduled maintenance interval being reached.
- 2.2.2.2. Red messages indicate that a component of the system has either failed to reach the minimum operating pressures or temperatures, or that it exceeded the programmed operating limits. Red messages are typically reserved for alarms that could potentially shut down the machine if the condition causing the alarm is not returned to normal.
 - 2.2.2.2.1. Red messages may require user acknowledgement or may simply disappear when an abnormal condition returns to normal parameters. If a button appears, user intervention will be required.
 - 2.2.2.3. Yellow messages will typically be displayed on a button that has to be pressed to acknowledge that the operator has read the message before it disappears.
- 2.2.3. Any variables or messages that need to be (or can be) controlled by the operator are graphically raised to illustrate that the “message” is a button. An example of the different graphical representations is shown in Figure 2.

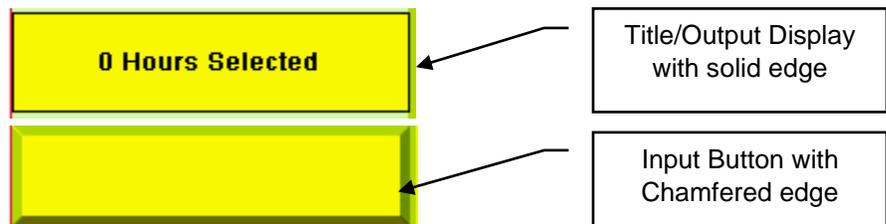


Figure 2. Indicator vs. Button

- 2.2.4. The controller has safety interlocks programmed into it. These safety interlocks prevent unsafe operations from occurring by monitoring the system parameters and by removing unsafe action/input control buttons from the HMI. When buttons appear to be missing from the home screen, it is because the system is performing an operation that would be unsafe in combination with the missing button/action.
- 2.2.5. The HMI will provide message pop ups (in yellow boxes) to instruct the operator what steps are required next in order in to complete any action selected. Most message pop ups are also acknowledgement buttons that must be pressed before any further action can be taken.
- 2.2.6. The primary operating valves on the Apeks system are air actuated valves controlled by the systems controller. In the event of an air compressor failure or a power failure all air actuated valves will return to their normal resting state. Valves 0 and 17B will be normally open and all others will be closed.
- 2.2.7. Each air actuated valve has an indicator on the top to inform the operator which valves are open and which ones are closed. The indicator lines correspond with the flow direction. Figure 3 illustrates both and open and closed valve. Note that it does not matter which way the air actuator is oriented, rather the direction of CO₂ flow is important.

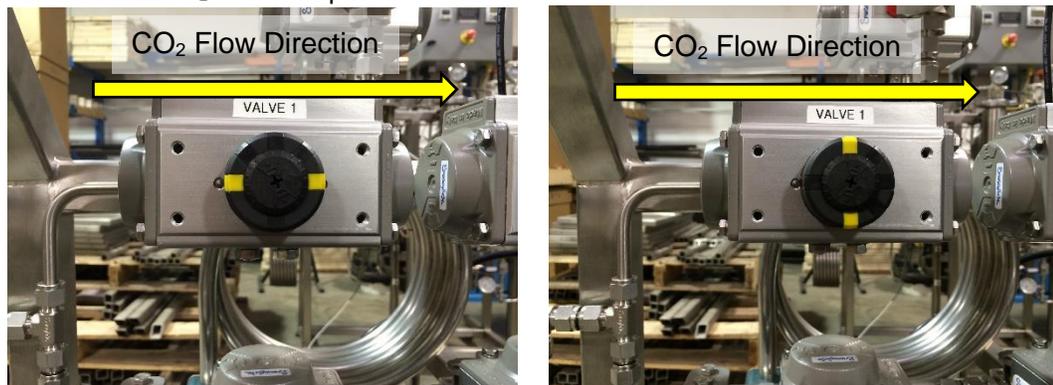


Figure 3. a) Valve 1 in the open position, b) Valve 1 in the closed position

2.3. Screen Shots

2.3.1. Home Screen

The home screen is where all pressures, temperatures, run times, and access to other screens are located. This is where you will enter your parameters and start your extractions.

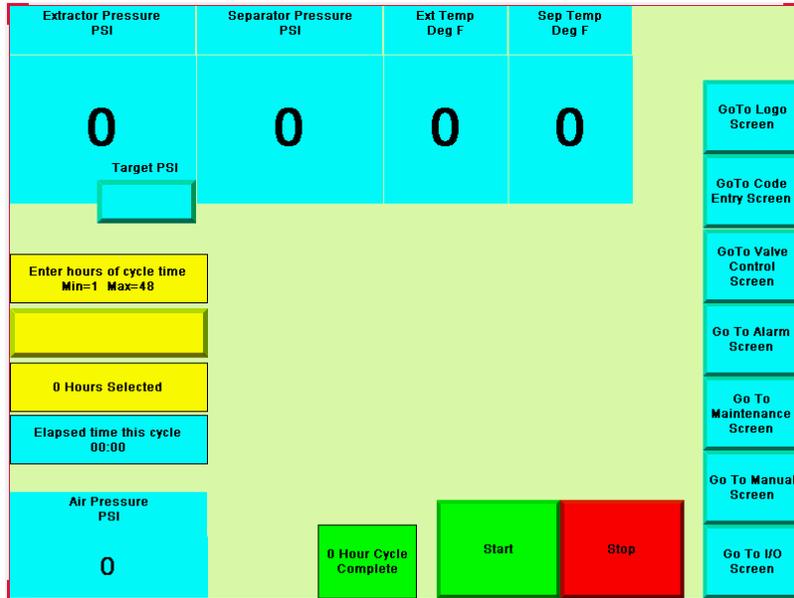


Figure 4. Home Screen single system

2.3.2. Manual Screen

The manual screen is used quite often, and is where to go to perform any operations other than normal operation such as clearing a clogged orifice, recovering CO₂ before the entered run time is complete, opening the extractor vessel, or changing a CO₂ bottle.

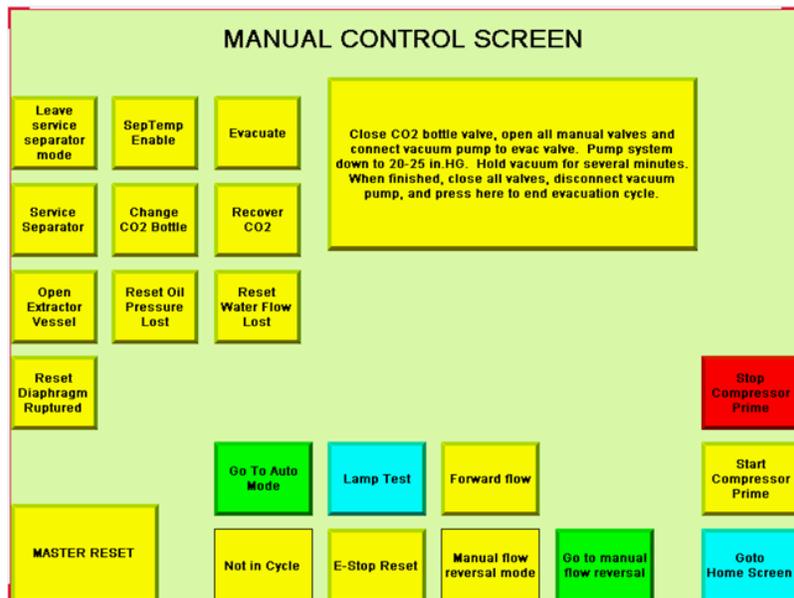


Figure 5. Manual Screen

On the manual screen, there's a button to switch between automatic flow reversal and manual flow reversal. When in manual flow reversal mode, the operator can press a button to switch the flow direction at any time during the run.

When in automatic flow reversal, the machine will only change flow direction when a new extraction is started, meaning that forward flow at the beginning will remain forward flow until the next run. The next run will be reverse flow and will remain reverse flow for the entire run.

2.3.3. Maintenance Screen

The Maintenance screen is where you will go to monitor run times on your system and pump for scheduling and maintenance.

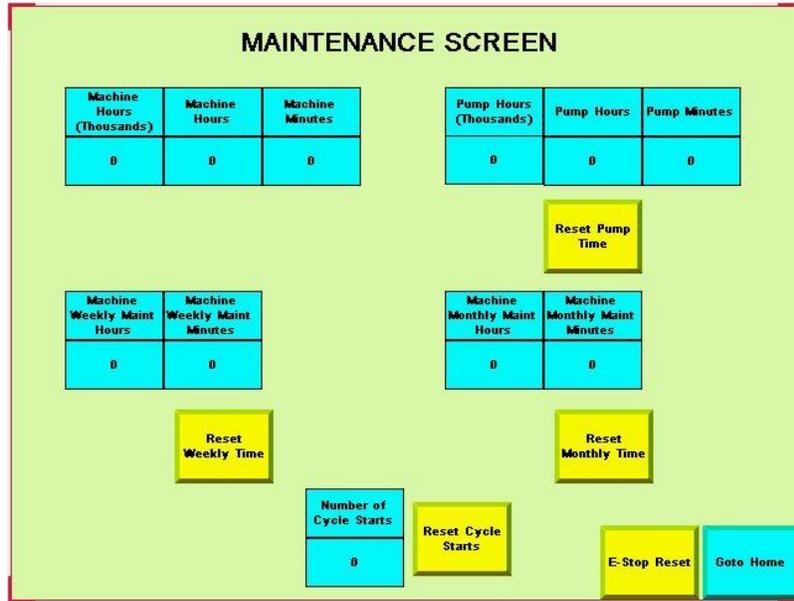


Figure 6. Maintenance Screen

2.3.4. Logo Screen

The Logo Screen shows the system software revision number which is located in the bottom left of this screen. The reason for the logo screen is to hide any potentially secret parameters on the home screen.



Figure 7. Logo Screen

2.3.5. I/O (Input/Output) Status Screen

The I/O screen is used for troubleshooting. On this screen, you can monitor which valves are supposed to be open and closed, if the pump is on or off, and if the light on top of the machine is green or red. There are also indicators showing thermocouple raw input data as well as air and CO₂ pressures in PSI.

I/O STATUS SCREEN						
E-Stop Not OK	Pump Output Off	Valve 5 closed	Valve 11 closed	Separator Temp Deg F	Separator Pressure PSI	Pump Outlet Pressure PSI
Overload OK	Valve 0 Open	Valve 6 closed	Valve 12 closed	0	0	0
Pump Aux Off	Valve 1 closed	Spare	Valve 13 closed	Air Pressure PSI	Extractor Pressure PSI	Bottle Pressure PSI
Pump Leak Detect Switch Tripped	Valve 2 closed	Valve 8 closed	Valve 17 Closed	0	0	0
Oil Press SW Off	Spare	Green light off	Valve 18 Normal Flow	Separator Temp Deg C	Separator Pressure BAR	Pump Outlet Pressure BAR
Water Flow SW Off	Valve 4 closed	Red light off	Valve 19 Normal Flow	0	.0	.0
Pump Leak Detect Switch Activated <7 Days			Valve 20 Closed	Air Pressure BAR	Extractor Pressure BAR	Bottle Pressure BAR
Pressure Testing				.0	0	.0
E-Stop Reset						

Goto Home Screen

Figure 8. I/O Status Screen

2.3.6. Alarm Screen

The Alarm screen is used for troubleshooting, and where navigation to text messaging screen is located. When the system faults for any reason, it is recorded on the alarm screen. A lot of times the fault you see on the home screen may have been caused by a series of faults. By looking at the alarm screen you can see all the previous faults in the order that they occurred.

Alarm Message	Occurrence Time	Occurrence Date	Acknowledge Time	Acknowledge Date
Alarm Message	Occurrence Time	Occurrence Date	Ack Time	Ack Date

▲
▼
E-Stop Reset
Go To Message Selection
Go To Home

Figure 9. Alarm Screen

2.4. Pre-Cleaning

- 2.4.1. The Apeks system is constructed from 304 and 316 stainless steel and can be cleaned with any cleaner that is compatible with both stainless steel and your extracted product. Alcohol (200 proof) works well for most applications.
- 2.4.2. The system should be cleaned to the appropriate level (determined by your application and corresponding regulations) prior to processing each batch of botanical material.
 - 2.4.2.1. Apeks takes great care to clean all systems prior to shipping, however, it is the user's responsibility to ensure that the system meets their required level of cleanliness before processing material.

2.5. Depressurizing System after Recovery

- 2.5.1. After completion of recovery, Valve 4 (4A and 4B for dual vessel) will open to relieve residual extractor pressure. A yellow acknowledge button will appear in the home screen.
- 2.5.2. Follow directions in order:
 - 2.5.2.1. Close (turn clockwise) CO₂ Bottle(s).
 - 2.5.2.2. Open Valve 10 to relieve separator pressure.
 - 2.5.2.3. Press acknowledge box, this will relieve the pressure in the CO₂ bottle lines and the rest of the system.
- 2.5.3. Open all manual valves.
- 2.5.4. Turn off the chiller/heater.
- 2.5.5. NOTE: any time the diaphragm pump stops the system will automatically vent CO₂ from valve 0 in order to relieve stress on the diaphragm head.
- 2.5.6. If system was stopped unexpectedly and system needs recovered proceed to the "Manual Screen" to recover CO₂ and then follow the steps above.

2.6. Removing Oil from Separator #1



WARNING



DO NOT ATTEMPT TO OPEN A VESSEL UNDER PRESSURE! Always make sure a vent path for the vessel is opened and the corresponding pressure gauge(s) reads zero prior to loosening the vessel closure bolts.

- 2.6.1. Ensure Valve 10 is open.
- 2.6.2. Ensure that the all three gauges on separator vessels (shown in Figure 10) and separator pressure on the home screen reads zero.



Figure 10. Gauges to Check when Removing Sanitary Clamps

- 2.6.3. Remove the flexible metal line and connection pipe from the top of the separators. Use two wrenches to prevent the bending tubes or NPT fittings from loosening in the separator cap (see Figure 11).



Figure 11. Illustration of using two wrenches to remove lines

- 2.6.4. Remove the yellow wire connected to the Separator #1 thermocouple.
- 2.6.5. Remove the white vent tube attached to the pressure relief.
- 2.6.6. Use the 5/8" ratchet wrench to remove the high-pressure sanitary clamps from the top of Separator #1.
- 2.6.7. Remove the cap from the top of separator.
- 2.6.8. Collect any available oil from the separator cap.
- 2.6.9. Use alcohol to clean the caps and orifice tube.
- 2.6.10. Use the supplied round squeegee or hard plastic scraper to push any residual oil from the sides of the Separator #1 down to the bottom and in the collector cup.
- 2.6.11. Disconnect the two blue water line quick connects on the collection cup. See Figure 12.
- 2.6.12. Attach the collector cup quick connects and attach the bottom separator 1 quick connect to the heat exchanger quick connect. This will ensure water flow even if collector cup connections are not re-attached in assembly.
 - 2.6.12.1. **Caution:** if removing the cup in the middle of a run with the pump on this step must be followed or the system may automatically shut down due to lack of water flow.
- 2.6.13. Use caution to support and not to drop the collector cup, remove the high pressure sanitary clamps from the bottom of the separator 1 with 5/8" ratchet wrench.
- 2.6.14. Remove the collection cup from Separator #1.
- 2.6.15. Collect the oil from inside the collection cup.
 - 2.6.15.1. **Note:** Oil will be carbonated with CO₂ and some dry ice may be present. This carbonation or dry ice will sublimate without any additional heat. It is sometimes more efficient to remove the dry ice/oil mixture and place it in collection device (like a Pyrex dish).



Figure 12. Image of collection cup after removal from separator.

- 2.6.16. Use the round squeegee and alcohol to thoroughly clean the inside of the separator and collection cup.
- 2.6.17. Separator #1 and the collection cup must be cleaned after each extraction.
- 2.6.18. Reassemble separator #1 by reversing the steps above, excluding the connection piping from Separator #1 to #2.
- 2.6.19. When reassembling, check gaskets for integrity and groove seals for cleanliness.
- 2.6.20. Prior to reassembling separator #1 cap, check orifice for clog and orientation.
- 2.6.21. Reconnect the collector cup water lines with quick connect to original configuration before turning on the chiller/heater.

2.7. Closing Separation Vessels

- 2.7.1. The separators are closed with sanitary clamps.
- 2.7.2. Clamps are considered tight when both nuts are torqued to 20-30 in-lbs. Over compression of the gasket by the application of too much torque on the wing nut will result in gasket intrusion into the fitting / tube ID. This creates an unsanitary joint and drastically reduces the service life of the gasket.

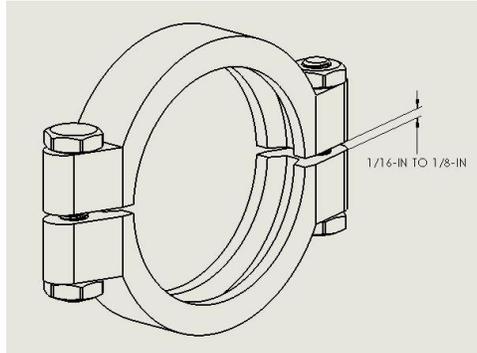


Figure 13. Appearance of tight sanitary clamp

2.8. Maintenance After Every Run

- 2.8.1. Includes harvesting oil and cleaning separator #1 as described in Section 2.6.
- 2.8.2. Separator #2:
 - 2.8.2.1. Remove Separator #2 inlet and outlets line from separator cap.
 - 2.8.2.2. Remove the top sanitary clamps and inspect Separator #2 for oil carryover.
 - 2.8.2.3. Clean Separator #2 if any oil is present.
 - 2.8.2.3.1. Remove bottom sanitary clamp.
 - 2.8.2.3.2. Use the 3" squeegee and cleaning agent to thoroughly clean the inside of the separator.
 - 2.8.2.3.3. Clean bottom cap and check gasket for integrity and groove cleanliness prior to reassembly.
 - 2.8.2.4. If there is no oil carryover then check top cap gasket for integrity and groove for cleanliness prior to reassembling clamps.
 - 2.8.2.5. Clean connection piping between Separator #1 and #2 and reassemble.
 - 2.8.2.6. Ensure separator caps are secured on top and bottom of separators, and all flexible metal hoses are connected with the exception of the Separator #2 outlet line.
- 2.8.3. Separator #2 Outlet to Pump Inlet:
 - 2.8.3.1. Ensure Valve 11 is open.
 - 2.8.3.1.1. If Valve 11 isn't open, then go to the manual screen and hit "Evacuate". This will open Valve 11. See Figure 14.
 - 2.8.3.1.2. If the evacuation button is not present this means there is entrained pressure somewhere in the system still and you may need to reassemble the vessels and finish the recovery. Check for pressure on the I/O Screen.



Figure 14. Valve 11 open

- 2.8.3.2. Disconnect the separator outlet line, if not already disconnected, from the cap of Separator #2 as shown in Figure 15.

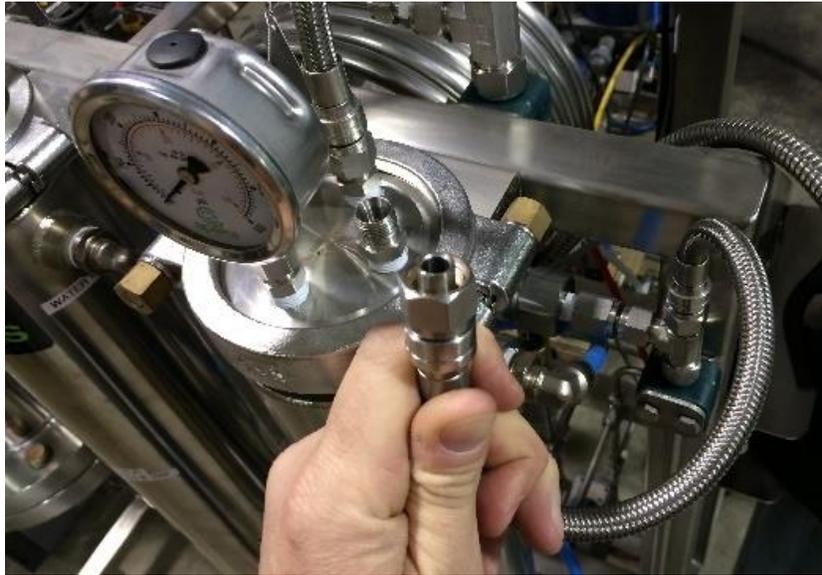


Figure 15. Image of separator outlet line after being disconnected

- 2.8.3.3. Remove the filter housing and filter on the back of the system. Inspect filter and housing for oil. Clean housing and clean/replace filter as necessary. See Figures 16 and 17.



Figure 16. Filter Housing



Figure 17. Filter Housing with bottom and filter removed

- 2.8.3.4. Pour cleaning agent into the separator outlet line using the supplied squeeze bottle (see Figure 20, page 20) until the solvent is colorless coming out the end that was connected to the pump inlet. After no color appears in solvent, use compressed air to blow out the line to ensure that **NO** residual alcohol remains in the line between the separator and the pump.
- 2.8.3.5. Reconnect the separator outlet lines and reassemble filter.
- 2.8.3.6. The separator outlet line **must** be cleaned after every extraction.

2.9. Opening Extraction Vessel



WARNING



DO NOT ATTEMPT TO OPEN A VESSEL UNDER PRESSURE!

Always make sure a vent path for the vessel is opened and the corresponding pressure gauge(s) reads zero prior to loosening the vessel closure bolts.

- 2.9.1. This operation cannot be performed during an extraction. The extraction must be stopped prior to opening the extraction vessel.
- 2.9.2. Venting of the extraction vessel happens automatically at the end of recovery.
- 2.9.3. If the system is stopped and still has pressure you can go the “Manual Screen”. See Figure 5, page 6.
 - 2.9.3.1. You can choose to hit “Recover CO₂”, which will recover the CO₂ back into the bottle, or:
 - 2.9.3.2. “Open Extractor Vessel” button, which will vent all CO₂ in the system, out of Valve 4.
 - 2.9.3.3. If the extractor is under pressure, the system will require the operator to acknowledge that they want to vent all the CO₂ in the extractor.
- 2.9.4. When the extractor vessel gauge on top of the vessel and on the home screen both read zero, it is safe to move to the next step.
- 2.9.5. Use the supplied rubber mallet to loosen the extractor hammer unions from the top or bottom flange.
 - 2.9.5.1. **Caution:** Extractor flange can weigh up to 50 lbs and care should be given to avoid damage and injury.
- 2.9.6. Pivot the top flange toward the back and let it rest on the integral hinge stops (see Figure 18). The bottom hammer union may not have a hinge, and must be lowered gently to prevent injury or damage to the remote probe and/or hammer union.
 - 2.9.6.1. Use caution not to scratch or otherwise damage the sealing surfaces on the flanges.



Figure 18. Appearance of extractor vessel in open condition

2.10. Removing Spent Material from Extraction Vessel

- 2.10.1. Once the extraction vessel is open, the spent botanical material can be removed. It is recommended all material be removed from the top of the extractor using a large shop vac.
- 2.10.2. Alternatively, the bottom vessel closure can be opened using the same instructions provided in Section 2.9. With the bottom closure open the botanical material will fall out of the vessel and can be collected in a bag or other collection device.
 - 2.10.2.1. **Warning:** you will have to remove the temperature probe before opening the bottom vessel closure. Failure to do so may result in bending and/or damaging the temperature probe.
 - 2.10.2.2. **Caution:** removing material from the bottom can cause material to get into threads on the closure nut. Threads will need to be cleaned and lubricated with anti-seize before reassembly.
 - 2.10.2.3. **Caution:** Extractor flange can weigh up to 50 lbs and care should be given to avoid damage and injury.

2.11. Loading Botanical Material

- 2.11.1. Prior to loading material visually check temperature probe and filter at the bottom as best you can from the top of extractor vessel.
 - 2.11.1.1. **Caution:** Extractor flange can weigh up to 50 lbs and care should be given to avoid damage and injury.
- 2.11.2. Material to be extracted is loaded directly into the extraction vessel. The 4 qt funnel supplied in the accessories box can be used to help minimize spillage.
 - 2.11.2.1. Typically, botanicals perform best in CO₂ extractions when ground to a particle size between 200 µin (roughly the consistency of coffee grounds).
 - 2.11.2.2. Any amount of material can be loaded into the extraction vessel – the vessel does not have to be full in order to operate correctly.
- 2.11.3. Gentle compression or packing can be used to increase the amount of material loaded in the vessel, however heavy compaction should be avoided because it can cause channeling of CO₂ during the extraction process.

2.12. Closing Extraction Vessel

- 2.12.1. Ensure all sealing surfaces are clean and free of debris.
- 2.12.2. Check the cup seal or O-ring for any visible damage or defects. Replace if necessary.
- 2.12.3. Ensure the threads of the extractor are free of debris and greased with the supplied bottle of anti-seize as shown in Figure 19.

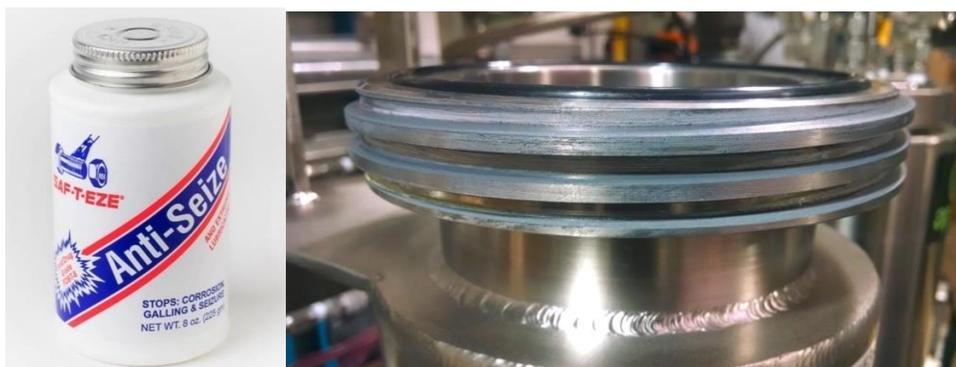


Figure 19. Supplied bottle of Anti-Seize and threads

- 2.12.4. Thread on the hammer union. Use supplied rubber mallet to fully close vessel - three to five hits past hand tight. The nut should close to approximately the same location each time. If it does not then there may be debris in the threads that needs cleaned out.
 - 2.12.4.1. If threads need cleaning remove all anti-seize lubricant from threads on both the vessel and the nut.
 - 2.12.4.2. Once all old material is removed reapply thin new layer.

2.13. Chiller Start Up

- 2.13.1. Every 80 hours verify chiller coolant level in chiller reservoir. If necessary, top off appropriate mix of distilled water and propylene glycol. Glycol percentage can be determined using a refractometer with is available on the online store.
- 2.13.2. Every 40 hours clean air filter on front of chiller.
- 2.13.3. Verify chiller cooling lines are connected to the extraction system.
- 2.13.4. Basic chiller commands:
 - 2.13.4.1. Turn on chiller: press the power button on the front of the chiller. If that does not work, check to make sure the chiller is connected to power and the breaker on the back of the chiller is on.
 - 2.13.4.2. Set the target pressure: from the main screen, when setpoint is highlighted press enter to take you to the current setpoint. To adjust setpoint press enter again till setpoint is flashing. Use arrows to turn the setpoint up or down and then save by pressing enter.
 - 2.13.4.3. Other options: other options such as changing units and monitoring values are located under the menu section. Refer to chiller manual for more detail.
- 2.13.5. Check I/O Screen to verify there is water flow. If no water flow is detected check connections.

2.14. Evacuating System (Pulling Vacuum)

- 2.14.1. After loading material, and ensuring all vessels are closed and ready for normal operation, from the Home Screen (see Figure 4, page 6), click the Manual Screen Button.
- 2.14.2. From the Manual Screen (see Figure 5, page 6), click the Evacuate Button.
 - 2.14.2.1. Evacuation button will not appear if there is any pressure in the system. Refer to the I/O Screen (see Figure 8, page 8) to find where there is pressure and relieve.
- 2.14.3. Verify that all the gauges on the system display zero pressure.
- 2.14.4. Verify that the supplied vacuum pump is filled with the appropriate oil.
 - 2.14.4.1. Refer to the vacuum pump owner's manual for more detailed information.
- 2.14.5. Connect the vacuum gauge, blue vacuum hose and vacuum pump to the evacuation valve on the bottom of Separator #2.
- 2.14.6. Open the evacuation valve.
- 2.14.7. Turn on the vacuum pump.
- 2.14.8. Allow the pump to run for approximately five minutes or until the gauge is below 25 inHg (inches mercury).
 - 2.14.8.1. If the vacuum gauge does not reach -20 inHg, there may be a leak in the system or a vessel not closed.
- 2.14.9. Close the evacuation valve.
- 2.14.10. Turn off the vacuum pump.
- 2.14.11. Disconnect the pump assembly (vacuum gauge, blue vacuum hose and pump).
- 2.14.12. Press the message button acknowledging that the evacuation is complete.
- 2.14.13. Return to the Home Screen.

- 2.14.14. **CAUTION:** Never depressurize separation vessels with the evacuation valve while vacuum pump or gauge is attached.

2.15. Conducting an Extraction

- 2.15.1. If the green start button is not present at the bottom of the home screen, then do one of two things:
- 2.15.1.1. Push the orange button on the bottom of the home screen that says maintenance is required, and this will then turn into a green start button.
 - 2.15.1.2. Push the green button on the top right corner of the screen that says “Return to Auto Mode”, and then a green start button will appear on the bottom of the home screen.
- 2.15.2. Verify that a 50 lb, 75 lb or 100 lb cylinder of CO₂ with a sufficient amount of CO₂ is connected to the system. Refer to the Pre-Training Checklist (see Appendix F, page 35) for suggested bottle quantities. Any time the bottle has less than 400psi, the pressure is considered low.
- 2.15.3. Verify that material is loaded into extraction vessel and extraction vessel is properly closed.
- 2.15.3.1. The system can be run with no material in the extraction vessel. This can be used as a way to clean the stainless-steel tubing upstream of the separation vessel.
- 2.15.4. Verify that the separator vessels are both closed and sanitary clamps are tight (section 2.7).
- 2.15.5. Press the Start button on the home screen.
- 2.15.6. After pressing start, the system will prompt the operator to follow the following steps:
- Caution:** Failure to follow prompts could result in serious injury.
- 2.15.6.1. Set extractor pressure (between 900psi and 1900psi).
 - 2.15.6.2. Set the System Run Time (between 1 hour and 48 hours).
 - 2.15.6.2.1. The recommended run time is dependent on the material being extracted and the extraction parameters but is typically between 1.5 to 3 hours per pound. Refer to the Recommended Parameters in Section 2.16 on page 19.
 - 2.15.6.3. Verify chiller is connected, turned on and set to the correct temperature.
 - 2.15.6.4. Verify the extractor is properly closed.
 - 2.15.6.5. Verify the separator is properly closed.
 - 2.15.6.6. Close Valve 10 and evacuation valve (if evacuation was not conducted these may be open, if it was then they should already be closed).
 - 2.15.6.7. Open the CO₂ bottles.
 - 2.15.6.8. If you have a single extraction vessel the system will start filling the vessels with CO₂ to the target extractor pressure.
 - 2.15.6.8.1. If you have two extraction vessels the screen will prompt you to choose which extraction vessel you will be using, either “A” (Extractor A only), “B” (Extractor B only) or “C” (both extractor A and B at the same time).
 - 2.15.6.8.2. After choosing which extraction vessel(s) you will be using, the screen will prompt you to close and/or open valves 3A and 7A or 3B and 7B depending on which extraction vessel(s) you choose to run.
 - 2.15.6.8.3. The system will start filling the vessels with CO₂ to the target extractor(s) pressure.
 - 2.15.6.9. During the filling stage the Home Screen will display a blue box labeled “Startup” to inform the operator of the systems current activities.
- 2.15.7. Once the target extractor pressure is reached, the system information box will change from “Startup” to “Running”. An additional information box will appear indicating the direction of the flow, either “Forward Flow” or “Reverse Flow”.
- 2.15.7.1. Forward flow refers to CO₂ entering the top of the vessel and exiting the bottom. Reverse flow enters the bottom and leaves the top.

- 2.15.7.2. The system switches the flow direction every run to flow clean CO₂ through the filter elements on the extraction vessel.
- 2.15.7.3. The system will continue in run mode until it reaches the target run time, then it will start recovering the CO₂. The information box will switch from “Running” to “Recovering”.
- 2.15.8. At the end of recovery, the system will automatically vent the extraction vessel but the separation vessels will have approximately 100 psi in them. The system will provide message boxes to instruct the operator through the final shut down process. The prompts are:
 - 2.15.8.1. Close the CO₂ cylinders and open Valve 10.
- 2.15.9. Once the operator acknowledges that the CO₂ cylinder are closed and Valve 10 is open, the system will open all valves, vent any trapped CO₂ and wait for the next command.

2.16. Recommended Operating Parameters

- 2.16.1. Recommended default parameters are intended as a starting point and it is up to the operator to determine best results for their operation. Please note that ambient temperature affects parameters and the system will take at least an hour to equalize out.
- 2.16.2. Subcritical runs result in lighter color oils and less waxes while supercritical runs decrease time and can increase yield.
- 2.16.3. PDC 3 Diaphragm Compressor – The Bambino®

Subcritical:

- Target Pressure: 1,200psi
- Chiller Setting: 70-75°F
- Propylene Glycol Percentage: 10%
- Orifice Size: 22
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: 20-30°F
- Extraction Time: 2-3 hours per pound

Supercritical:

- Target Pressure: 1,800psi
- Chiller setting: 105-110°F
- Propylene Glycol Percentage: 10%
- Orifice Size: 18
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: 30-40°F
- Extraction Time: 1-2 hours per pound

- 2.16.4. PDC 4 Diaphragm Compressor – The Transformer®

Subcritical:

- Target Pressure: 1,200psi
- Chiller Setting: 70-75°F
- Propylene Glycol Percentage: 10%
- Orifice Size: 37
- Resultant Separator Pressure: 350-400psi
- Resultant Separator Temperatures: 20-30°F
- Extraction Time: 2-3 hours per pound

Supercritical:

- Target Pressure: 1,800psi
- Chiller setting: 105-110°F
- Propylene Glycol Percentage: 10%
- Orifice Size: 29

Resultant Separator Pressure: 350-400psi
 Resultant Separator Temperatures: 30-40°F
 Extraction Time: 1-2 hours per pound

3. System Maintenance

This maintenance schedule is based on the maintenance timer on the Maintenance Screen (see Figure 6 on page 7).

3.1. Extraction System Maintenance

Included with each system is a small squeeze bottle (see Figure 20) to help with proper maintenance and cleaning of your systems CO₂ lines. Alcohol (200 proof) is a typical and acceptable cleaning agent. Please label the bottle accordingly.



Figure 20. Front and back of chemical squeeze bottle

Frequency	Maintenance Item
After Each Extraction	<ul style="list-style-type: none"> Remove extracted oil from collector cup and separator walls, clean walls and cup with alcohol. Check separator 2 for oil carryover and clean if necessary. Inspect separator gaskets and grooves prior to reassembly. Clean piping between separator 1 and 2 with alcohol. Clean Separator 2 CO₂ outlet to pump inlet, ensure valve 11 is open. Remove spent material from the extraction vessel by vacuuming it out through the top flange. Verify the extractor filters are clear and free of debris. Check extraction vessel O-rings and O-rings groove sealing surfaces for damage – replace if necessary. Inspect the surfaces on extraction vessel to make sure they are free from dust and debris. Failure to clean surfaces properly can cause vessel not to seal properly or damage to the cup seal.
Every 80 Hours	<ul style="list-style-type: none"> Run the system “empty of plant material” for 1 hour to clean the high pressure side of the system and extraction vessel(s).
Yearly	<ul style="list-style-type: none"> Check torque on all screws in electrical panels (see Appendix G).
Resource	<ul style="list-style-type: none"> Apeks online store http://apeksonlinestore.com/

3.2. Diaphragm Compressor Maintenance

See Diaphragm Compressor Manual for specific instructions on maintenance items. Below is general system information.

Frequency	Maintenance Item
Daily	<ul style="list-style-type: none"> • Check oil level. • Check oil pressure. • Listen for abnormal noise or vibration. • Check Leak Detection System status.
Every 500 Hours	<ul style="list-style-type: none"> • Change Diaphragm Compressor Filter located on suction side tubing. • Check belt tension (See Appendix A). • Clean process check valves.
Every 1500 Hours	<ul style="list-style-type: none"> • Perform regular oil change. • Check torque on all screws in electrical panels (see Appendix G).
Every 4000 Hours	<ul style="list-style-type: none"> • Replace diaphragms and o-rings in process head. • Clean and inspect oil inlet check valve. • Clean and inspect oil relief valve. • Inspect crankcase assembly. • Inspect compressor lower head. • Clean and inspect injection pump assembly.

3.3. Chiller Maintenance

See Chiller Manual for specific instructions on maintenance items. Below is general system information.

Frequency	Maintenance Item
Weekly	<ul style="list-style-type: none"> • Check fluid level. • Check fluid filter bag and clean/replace as necessary. • Listen for abnormal noise or vibration. • Check for any leaks. • Clean condenser filter (air filter) on front bottom of chiller.
Every Month	<ul style="list-style-type: none"> • Check/Clean fluid diffuser.
Every 6 months	<ul style="list-style-type: none"> • Replace cooling fluid.

4. Troubleshooting

4.1. Ice on Separator or Collection Cup

It is normal for the high pressure clamps and flexible metal lines on the top of the separator to form ice during operation. If ice is forming on the outside of the separator vessels this is an indication that there could be a flow restriction inside the separator cooling jacket. The system should be shut down by pressing the Recover CO₂ Button on the Manual screen. This will put the system into recovery mode so that the cooling system can be inspected.

Ensure that the chiller/heater is turned on. Ensure that all blue coolant lines and quick disconnects are properly connected. Ensure that the collection cup coolant lines are properly connected to the first separator. Ensure that the correct size orifice is being used inside Separator 1. Normal operating pressures within the separators is 350psi. If pressures are much lower than 250psi, then ice may start to form on the separators. Also ensure that the temperature of the surrounding environment is no colder than 60°F. It is possible for the chiller/heater to have difficulty maintaining system temperatures if the surrounding environment is too cold.

Do not attempt to work on the cooling system while the system is running.

4.2. Low Extractor Pressure

If the extractor pressure is unable to meet the target pressure, first verify that the CO₂ cylinder has sufficient CO₂ (bottle gauge above 400psi). If the bottles have plenty of CO₂, check to see if the orifice size is too large (if separator pressure stays above 400psi this may be an indication). Finally, check to see if the pump outlet is hot (**caution:** can be up to 160°F). If pump outlet is cool, the pump may have lost prime, follow priming instructions in Appendix B.

4.3. Extractor Overpressure/Service Separator

The valveless expansion technology uses a small orifice to regulate pressure. This orifice can become plugged when foreign material enters into the plumbing between the extraction vessel and separator vessel.

In the event that separator pressure decreases and/or extractor pressure increases causing an extractor high pressure fault, it is most likely a clogged orifice or the orifice is too small. Follow the steps below to clear an orifice clog:

- i. From the Home Screen, Press the Manual Screen Button.
- ii. From the Manual Screen, Press the Service Separator Button.
- iii. Wait for the system to provide a message pop up indicating it is safe to Open Valve 10 and clean the orifice.
- iv. Open Valve 10.
- v. Verify that both separator vessel gauges read zero.
- vi. Remove the CO₂ lines from the top of the separators. Use two wrenches to prevent from bending tubes or the NPT fittings from loosening in the separator cap. See Figure 11, page 10.
- vii. Remove the yellow wire connected to the Separator #1 thermocouple.
- viii. Remove vent tube from relief valve.
- ix. Use the 5/8" ratchet wrench to remove the high pressure sanitary clamps from the top of Separator #1.
- x. Remove the cap from the top of Separator #1.
- xi. Ensure you are using the correct size orifice and inspect for clogs.

- xii. Clean the orifice by soaking it in alcohol and blowing it out with compressed air. Verify the orifice is clear by looking through it.
- xiii. A stainless steel wire brush is available on the online store for stubborn clogs.
- xiv. Reassemble the orifice.
- xv. Replace the separator cap and tighten the clamp bolts per Section 2.7.
- xvi. Reinstall the CO₂ connections and the thermocouple wire.
- xvii. Close Valve 10.
- xviii. Press the pop up message button when orifice is reinstalled, the high pressure clamps are tight and the flexible hoses are reconnected.

4.4. Low Separator Pressure

Low separator pressure is typically caused by one of two things (an orifice clog or the wrong size orifice). If the system has lower than normal separator pressure or does not seem to equalize this may be an indication of a clogged or partially clogged orifice. To correct an orifice clog refer to the instructions in section 4.3 (Extractor Overpressure).

4.5. Wrong Orifice Size

Orifice size dictates the relationship between the separator and extractor. The main goal is to maintain the separator pressure around 350psi. While the system may run at higher or lower pressure just fine, CO₂ flow may not be optimal with lower pressures or you may be at risk for more carryover with higher pressures. The smaller the orifice size the lower the separator pressure and vice versa. Two orifice sizes are shipped with each machine and additional sizes for any specific optimization are available on the online store. See Section 4.3 (i-xviii) to change orifices.

4.6. Differing Separator Pressures

Large variations of separator pressure means there is a clog in the tubing between the two separators since they should be around the same pressure (+/- 10psi). To check for obstructions, follow the service separator instructions in Section 4.3 (i-xviii) and check tubing.

4.7. Oil Carryover to Separator #2 or Filter Housing

Oil carryover can be detected during every maintenance run when cleaning the Separator #2 outlet to pump inlet and when spot checking Separator #2. Light carryover can/will occur. The presence and severity of oil is an indication of carryover to the pump. While slight oil can be tolerated, the pump was not designed to have oil circulating through it. Oil carryover will reduce the life of the pump and can damage the pump if severe. If a large amount of carryover is detected (more than a couple grams) check the following items during the next run:

- i. Separator temperatures are above 40°F after system is equalized, usually after 1 hour after initialing. The temperature set point on the chiller has a direct relationship with separator temperature. Turn the set point on the chiller down until separator temperature is below 40°F.
- ii. Extremely cold temperatures in separators cause oil carryover as well. If the separator is encased in a block of ice the temperature is more than likely too cold. Ensure that the chiller is on and correctly functioning before beginning a run, water lines are correctly assembled between the collector cup and the separator, and the water line quick connects have disengaged the check valves.
- iii. For both cases check water line connections, chiller settings and water to propylene glycol percentages.

5. References

YouTube Instructional Videos

<https://www.youtube.com/user/ApeksSupercritical>

Apeks online store (740) 809-1160 option 2

<http://apeksonlinestore.com/>

Software Updates and E-mail Alerts (740) 809-1160 option 2

<http://www.apekssupercritical.com/service/>

6. Appendices

6.1. Appendix A - Belt Tension Testing/Adjustment

Refer to our YouTube video: <https://youtu.be/JUTNsP8vows>

6.1.1. Remove belt guard.



Figure A1. Belt Guard removed

6.1.2. Check belt(s) tension with belt tension tester. PDC-4 (The Transformer®) belts should be tensioned to 10 lbs and PDC-3 (The Bambino®) belts should be tensioned to 6-7 lbs.

- i. If you need help using your tension tester tool please watch the following video:

<https://www.youtube.com/watch?v=bYEHvfo8t6A>



Figure A2

- 6.1.3. If the belt needs adjusted loosen the 4 bolts holding the motor to the base.

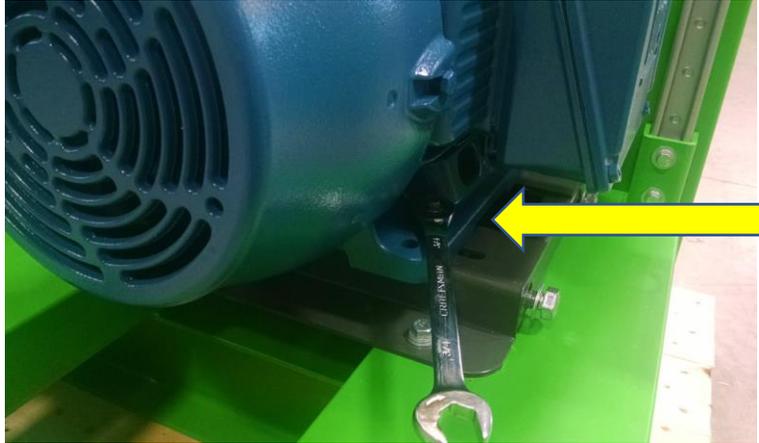


Figure A3. Bolts holding motor to base

- 6.1.4. Before moving the motor retighten the bolts to finger tight (this keeps the motor from lifting up on one side during adjusting due to the belt tension).
- 6.1.5. Adjust the set screws on the motor base in or out to tighten or loosen the bolt as necessary.

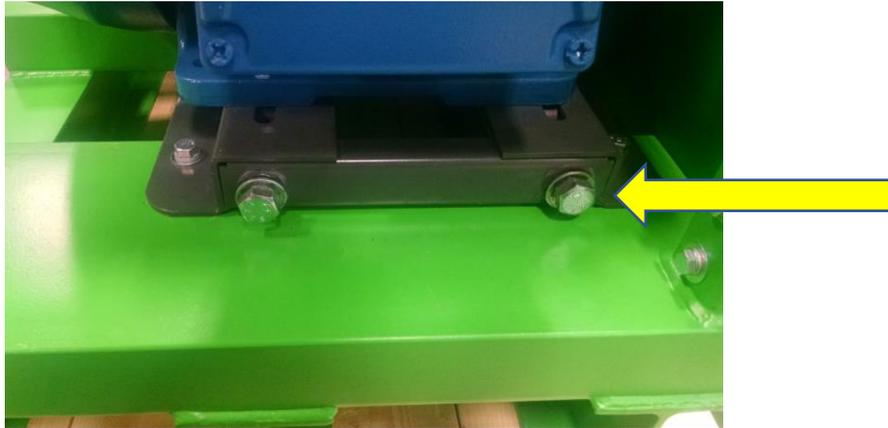


Figure A4. Bolts holding motor to base, loosened

- 6.1.5.1. Be sure to check motor shaft alignment (note: can be up to 1/8" difference from side to side).



Figure A5. Checking alignment

- 6.1.6. Retighten motor bolts.
- 6.1.7. Rotate the belt by hand around one turn (failure to do so could result in an incorrect reading).
- 6.1.8. Check belt tension again and repeat as necessary.

6.2. Appendix B - Diaphragm Pump Priming

6.2.1. Open the over pump bypass valve (see Figure B1) by turning counterclockwise until it stops.



Figure B1. Pump bypass valve at yellow arrow

- a. Go to the “Manual Screen” on the HMI and hit the “Start Prime Compressor” button.
- b. When pump is priming verify there is oil pressure on the pump gauges, if no pressure appears check oil level and pump motor rotation.
- c. Continue to let the pump run for three to four minutes to remove any entrained air in compression head.
- d. Begin to close over pump bypass valve slowly, one full turn every five to ten seconds, until fully closed.
- e. From the “Manual Screen” hit the “Stop Prime Compressor” button.
- f. Start the system to see if pump is pumping properly.

6.3. Appendix C: Check Valve Cleaning

- a) Remove the inlet and outlet tubing from the head of the compressor
- b) Remove the seven bolts on each check valve retainer

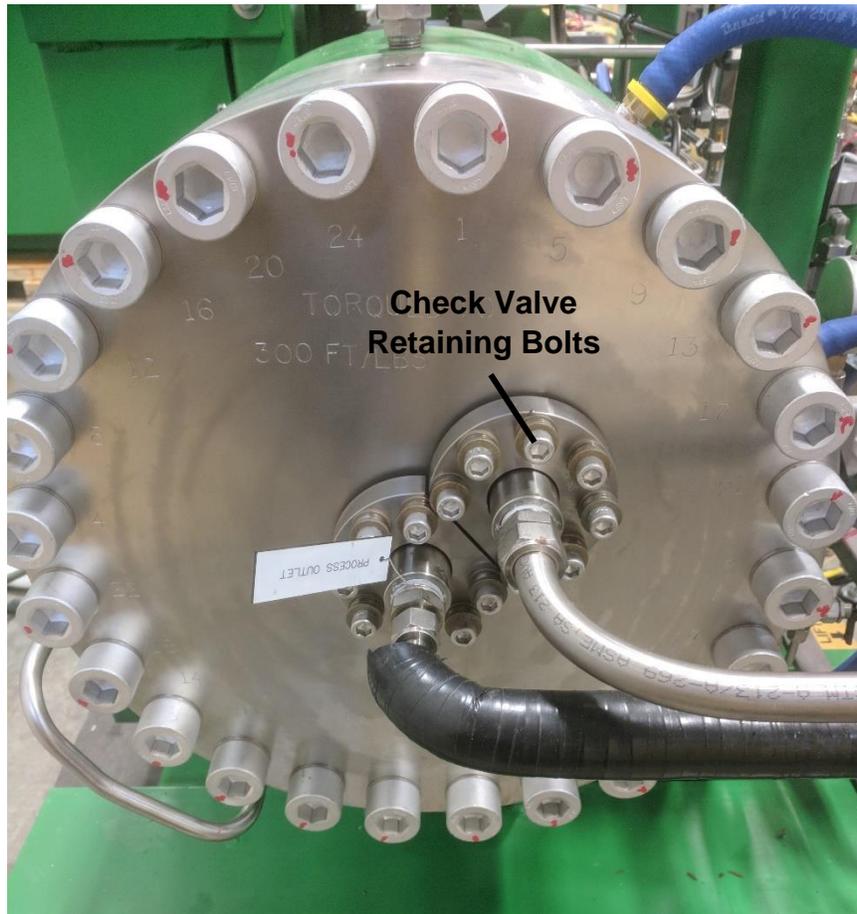


Figure C1. Check valve retainer

- c) Remove retainer and checks
- d) Disassemble check and clean thoroughly with alcohol or acetone. For heavily soiled valves use an ultrasonic cleaner on metal pieces to help remove soil. Do not clean the poppet (brown donut) in the ultrasonic cleaner. If poppet is beyond cleaning or damaged contact Apeks for a replacement.

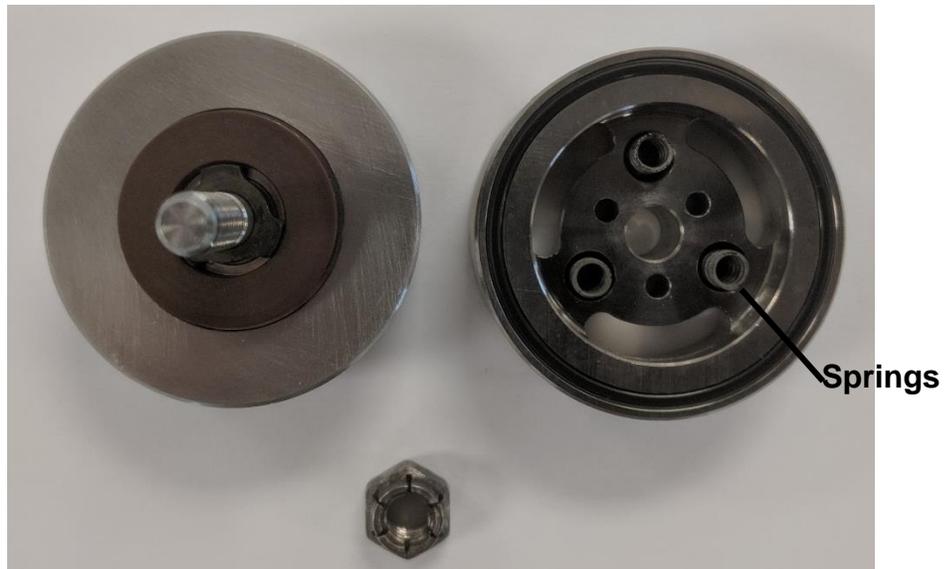
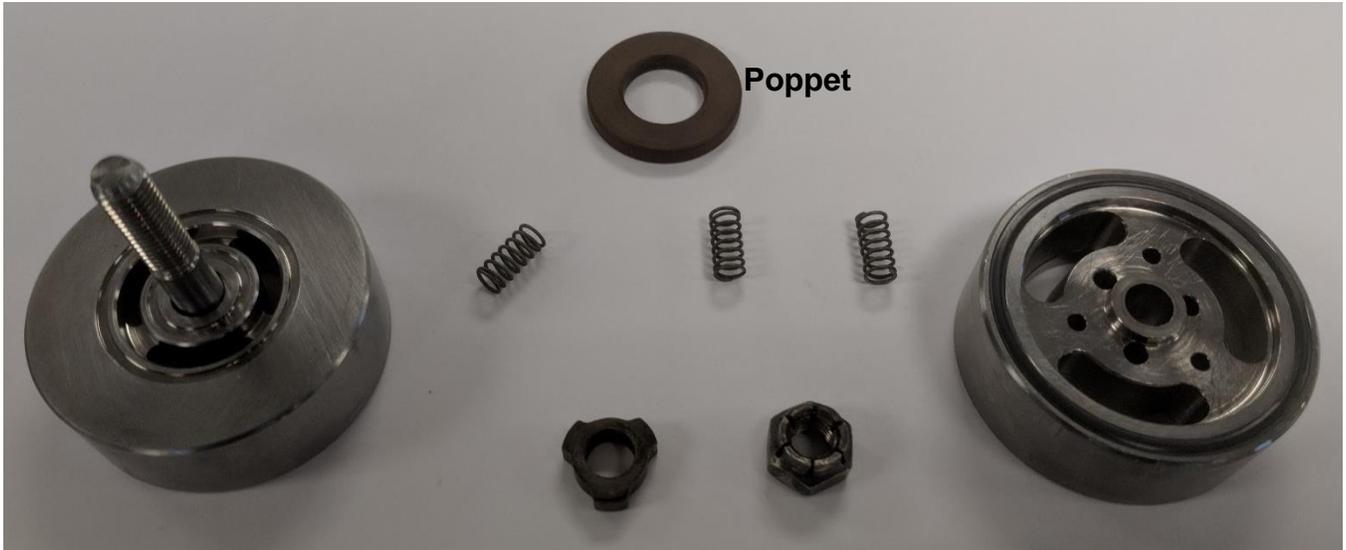


Figure C2. Components of check valve

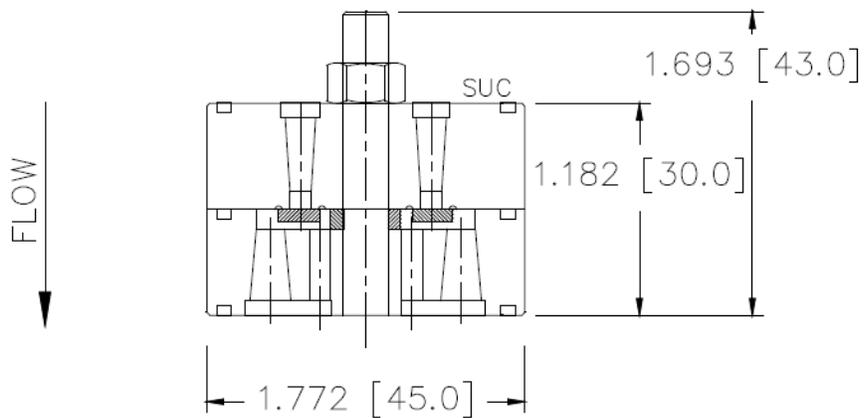


Figure C3. Suction check valve

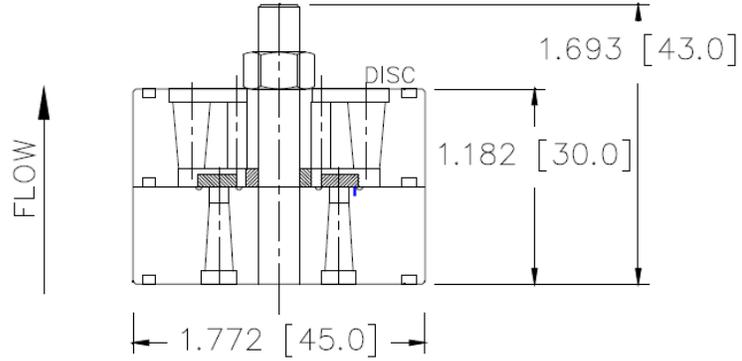


Figure C4. Discharge check valve

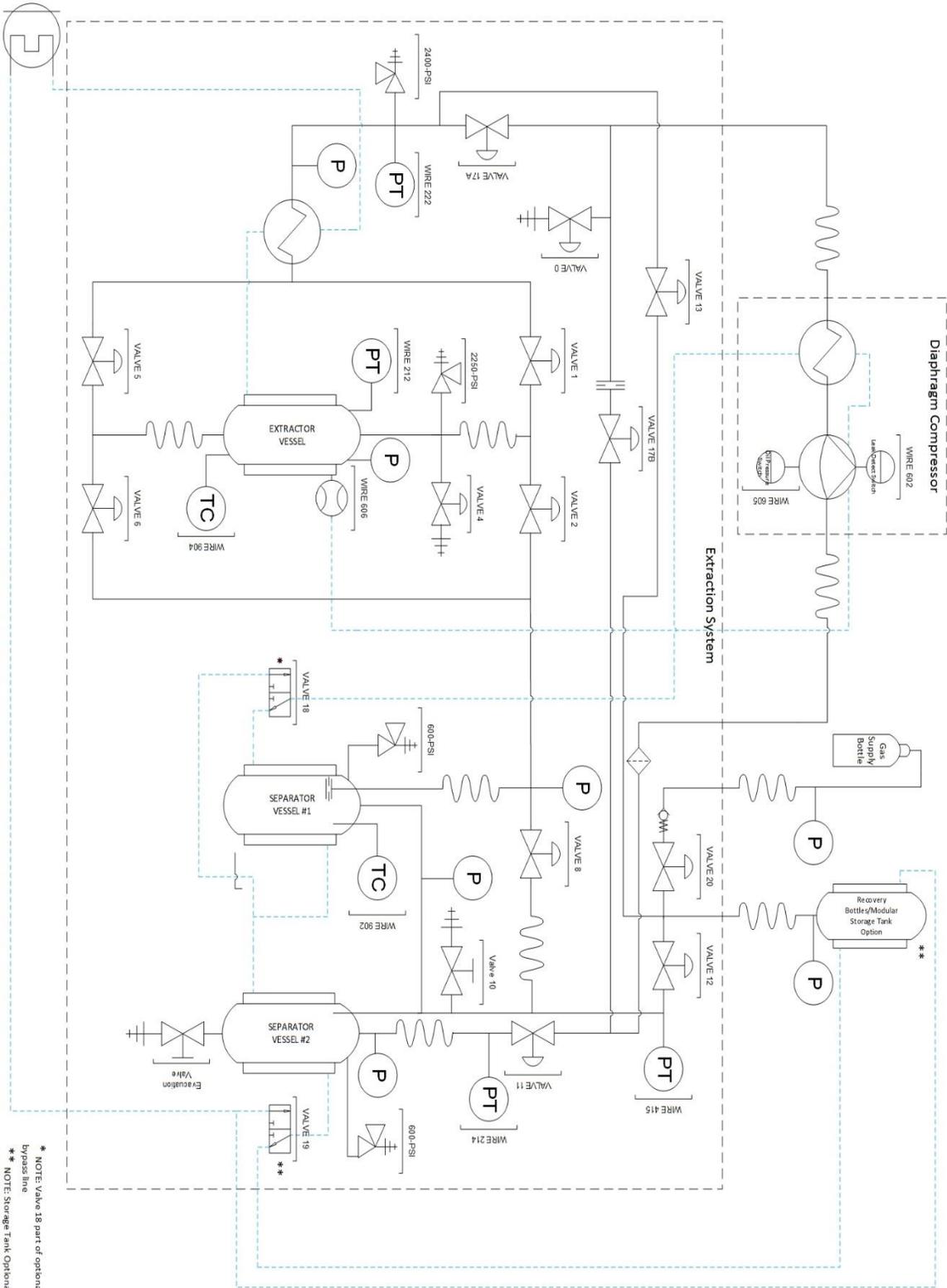
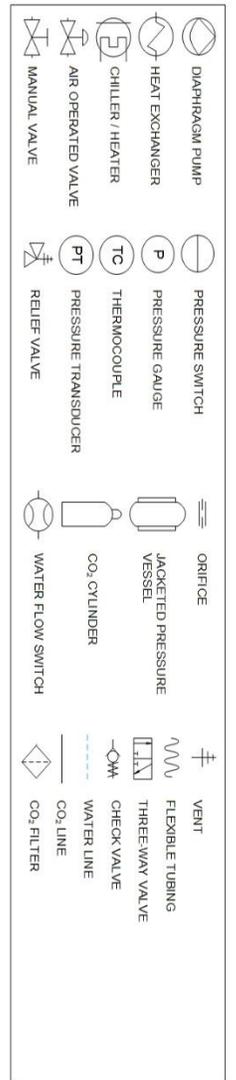
- e) Reassemble checks when cleaned and assemble in pump
- f) Torque the retaining bolts to 15 ft-lbs after reassembly.

6.4. Appendix D: Piping and Instrumentation Diagram

REVISION 05-10-17

2000-xLD System

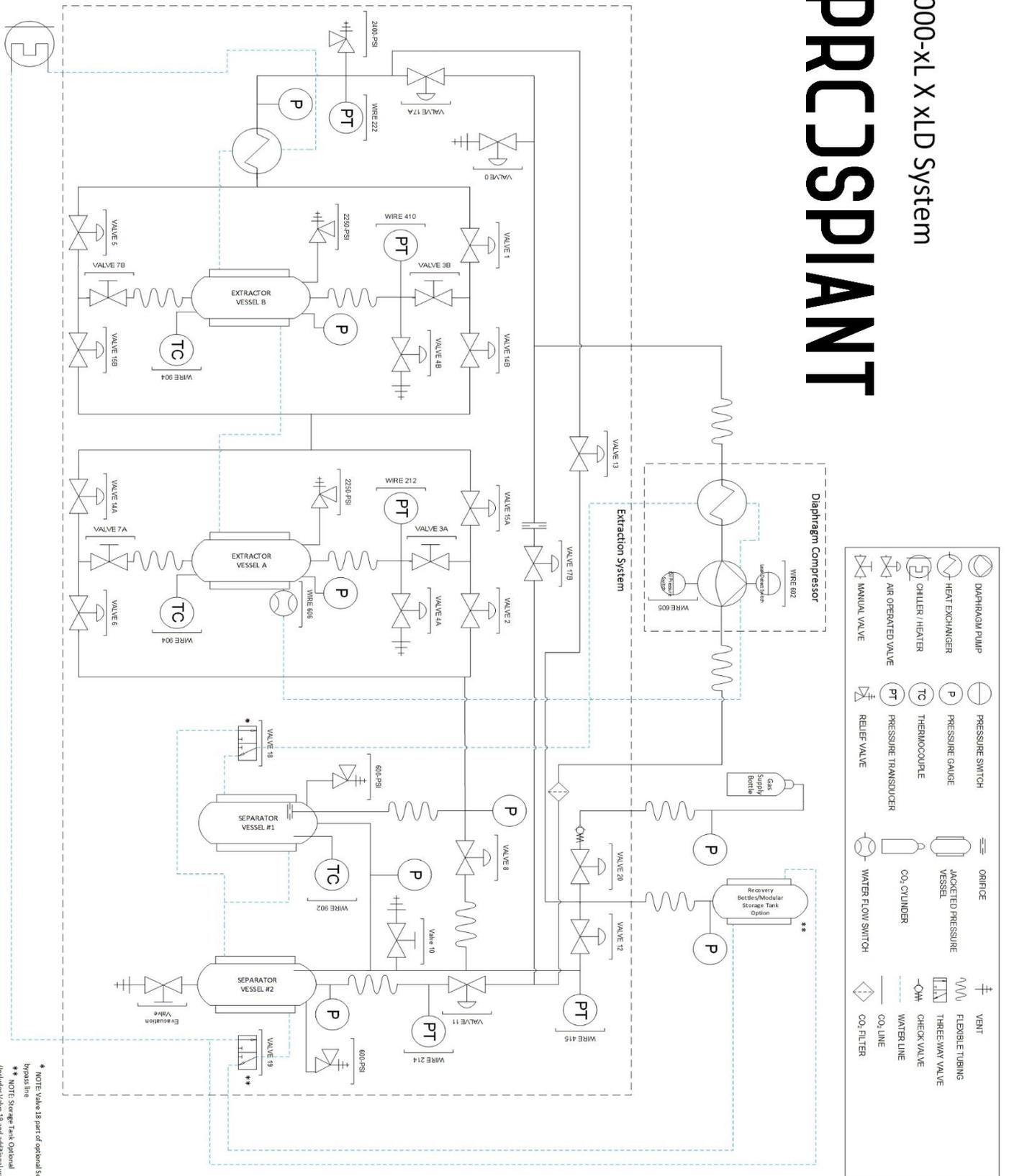
PRCCSPIANT



* NOTE: Valve 13 part of optional Separator Bypass line.
 ** NOTE: Storage Tank Optional (Includes Valve 19 and additional water lines)

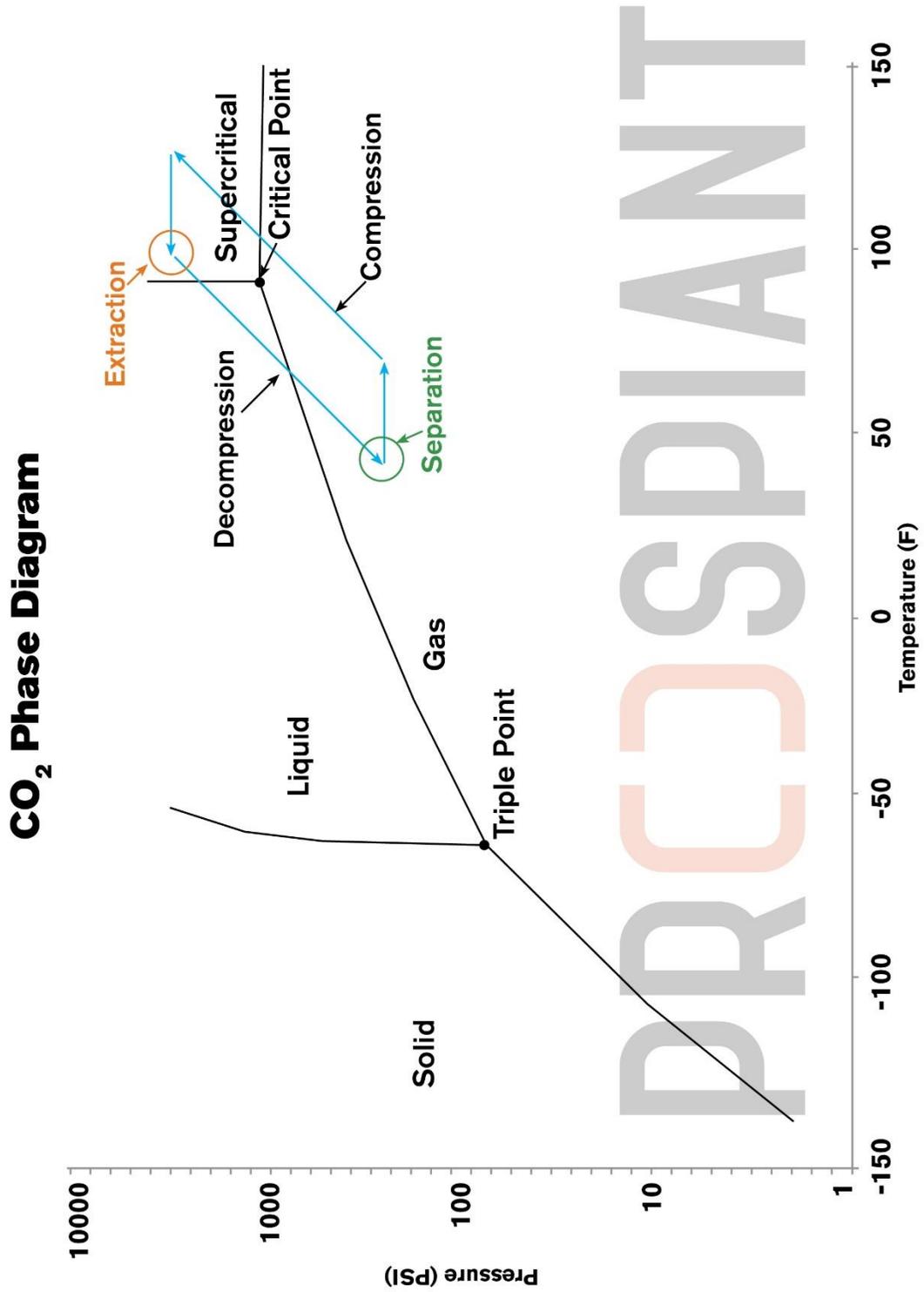
2000-XL XLD System

PRCCSPIANT



* NOTE: Valve 18 part of optional Separator bypass line
 ** NOTE: Storage Tank Optional (includes Valve 19 and additional water lines)

6.5. Appendix E: CO₂ Phase Diagram



6.6. Appendix F: Pre-Training Checklist

In preparation for training please refer to the installation manual for unpacking and set up instructions. Below is a checklist of what needs to be purchased or completed BEFORE scheduling your onsite training. Onsite training is a four hour block of instruction that is NOT designed to include unpacking and set up. Incomplete items at the time of onsite training will result in incomplete training or additional charges for rescheduling.

Our training process is as follows:

1. Customers to reference the installation manual for instructions on un-crating and system set up.
2. Customer to complete entire Pre-Training Checklist. See below.
3. A FaceTime or Skype session is required (*when available*) to ensure checklist is complete, set up is correct and cover basic operation and cleaning of the system.
4. After 1-3 are complete, onsite training can be scheduled. There is a 2-3 week lead time. Schedule your training online: <http://www.apekssupercritical.com/training/>

Pre-Training Checklist:

Below is a checklist of what needs to be purchased or completed BEFORE scheduling your onsite training:

- **Must be complete before scheduling training:** Print complete operation manual and have on site the day of training, along with the chiller manual.
- **Must be complete before scheduling training:** Apeks system and diaphragm compressor are unpacked and set up in location of operation. Refer to unpacking instructions in the installation manual.
- **Must be complete before scheduling training:** See installation manual for electrical requirements for your system. All electrical connections are to be completed before onsite training is scheduled.
- **Must be complete before scheduling training:** Purchase and have on site for training:
 - Bottles of CO₂, gas feed, check valve free, food grade or better. Minimum requirements are:
 - (3) 50 lb. bottles for 5LD and 5Lx5LD
 - (4) 50 lb. bottles for 20LD
 - (4) 75 lb. bottles for 20Lx20LD
 - Distilled water and Propylene glycol 90/10 mix: [Propylene Glycol - 1 Gallon](#)
 - Total gallons of mixture needed for system:
 - 5LD – 5 gal
 - 5Lx5LD – 6 gal
 - 20LD – 7 gal

- 20Lx20LD – 9 gal
- 190 or higher proof ethanol

- Future maintenance will require:
 - Shop vacuum with a long, slim nozzle for removing material from extractor.
 - Pencil Type Belt Tension Tester: <http://apeksonlinestore.com/product/tension-tester/>
 - CO₂ Monitor; [Amprobe CO₂ 100](#)

- Material to be extracted must be very dry and ground to the consistency of coffee grounds. Have ready the day of training.

- After completing the pre-training checklist, request scheduling of onsite training via our website: <http://www.apekssupercritical.com/training/>

- Onsite training is generally a four hour block of instruction that will cover the fundamentals of operation and maintenance of each component of the system.

6.7. Appendix G: Electrical Screw Torque Requirements

1. Fuse Holders (1492-H6) = 7.1 lb-in
2. Power Supply (1606-XLE120E) – 7 lb-in
3. Terminal Blocks (1492-J4) = 9 lb-in
4. Ground Blocks (1492-JG4) = 9 lb-in
5. Ground Block Middle Screw (1492-JG4) = 7.1 lb-in
6. JG10 Large Ground Blocks (1492-JG10) = 20.4 lb-in
7. JG10 Large Ground Block Middle Screw (1492-JG10) = 8.9 lb-in
8. Small Motor Contactor Phillip Screws (100-C55D10) = 31 lb-in
9. Small Motor Contactor (43-44) Phillip Screws = 13 lb-in
10. Overload Relay (T1/T2/T3) Phillip Screws = 22 lb-in
11. Overload Relay (95-98) Phillip Screws = 5 lb-in
12. Large Motor Contactor Allen Screws (100-C72D10) = 53 lb-in
13. Large Motor Contactor Phillips Screws (100-C72D10) = 13 lb-in
14. Overload Relay Allen Screws (193-EEGE) = 40 lb-in
15. Overload Relay Phillips Screws (192-EEGE) = 5 lb-in
16. Micro 850 Power Supply = 4.4 lb-in
17. Micro 850 Terminal Strip = 4.4 lb-in
18. 2080 TC2 = 2.21 lb-in
19. 2080 IF4 = 2.21 lb-in
20. 2080 IF2 = 2.21 lb-in
21. HMI = 5 lb-in
22. Yellow Terminal Jumpers = 7.1 lb-in
23. Estop Contact (800F-X01) = 8 lb-in
24. Relay Base Screws (700-HN153) = 7 lb-in
25. IF8 = 5.3 lb-in
26. Relay Output Module = 5.3 lb-in
27. 10A Circuit Breaker (18 AWG) = 13.3 lb-in
28. 10A Circuit Breaker (14 AWG) = 17.7 lb-in
29. 10A Circuit Breaker (8 AWG) = 39.9 lb-in
30. Ewon Flexy Power Connector = 7 lb-in
31. Ewon Cosy Power Connector = 7 lb-in
32. 125V Plug = 12 lb-in