THE FORCE™ 2-STAGE 5000PSI
BOTANICAL OIL EXTRACTION SYSTEM
OPERATION MANUAL

⚠️ WARNING ⚠️

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.

**WARNING**

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.

**WARNING**

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.

**WARNING**

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 gage reads zero prior to loosening the vessel hammer unions or closure bolts.

**WARNING**

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.

**WARNING**

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

**WARNING**

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.

**WARNING**

Always wear safety glasses when operating and servicing the system.
2. System Overview
2.1. **The Force™ 2-Stage System Overview**

2.1.1. **Diaphragm Compressor** – The diaphragm compressor for The Force™ 2-Stage system is a dual head compressor where both heads work in series to compress CO₂ to the desired target pressure in the extractors.

2.1.1.1. **Gauges on the Compressor**

2.1.1.1.1. **Oil Pressure Gauges** – There are two gauges that display different oil pressures on the diaphragm compressor. The first is a high-pressure loop that incorporates the oil heat exchanger and some internal bearings. This gauge should read between 40-50psi at all times when the system is running. The second is a low-pressure loop that incorporates the injection pump which supplies oil to the oil compression side of the diaphragm head. This gauge should read between 15-20psi when the system is running.
2.1.1.1.2. **Leak Detect Gauges** – There is a leak detect switch on each pump head. This
gauge monitors the cavity between the oil side and CO₂ side to ensure that there is
no crossover between the two systems. This gauge should display no pressure. See
Section 5 “Troubleshooting” if this gauge shows pressure.

2.1.1.2. **Pressure Switches**

2.1.1.2.1. **Oil Pressure Switch** – The oil pressure switch monitors the low-pressure oil loop to
make sure there is oil flowing in the system. If oil pressure is lost this switch will stop
the system and an alarm will be triggered.

2.1.1.2.2. **Leak Detect Pressure Switch** – This pressure switch works the same as the leak
detect gauge but continually monitors for the presence of pressure and will shut the
machine down if over 15psi of pressure is detected in the pump cavity.

2.1.1.3. **Over Pressure Valve (OPV) and Oil Bypass Valve** – The OPV valve on the pump is a
back-pressure regulator. The valve is set to allow the hydraulic oil pressure in the head to
reach a certain point but not go above that point. The Bypass Valve is a needle valve with
a black handle that can be opened in order to bypass the OPV. This is done during
priming of the compressor and during head maintenance (see Appendix B).

2.1.1.4. **Junction Box** – The diaphragm compressor has a single junction box for the pressure
switches that has a Harding Connector (electrical quick-connect) and thermocouples that
go to the main control enclosure.

2.1.1.5. **Regenerative Heat Exchangers** – There are two regenerative heat exchangers that are
located on the pump: one for each diaphragm head. These heat exchangers remove heat
from the compressed CO₂ to use on the separators.
2.1.2. Extraction Vessel Stand

2.1.2.1. Extraction Vessels – There are two extraction vessels on their own stand. Vessel A is located on the right-hand stand of the stand and Vessel B is located on the left. These vessels can be either 20L or 40L and are breech lock vessel closures on top and plug and screw closures on the bottom. This closer mechanism uses a nut to hold down a plug to allow the vessel to pressurize. Seals on this vessel O-rings that create a seal on the sidewall of the extraction vessel. Extraction vessels are loaded and unloaded from the top of the vessel. When loading, unloading and cleaning these vessels be sure to keep...
face surface and threads clean. Failure to keep these surfaces clean can cause the vessel not to seal properly.

2.1.2.2. **Locking Vessel Isolation Valves** – Each extractor has two locking isolation valves that should be utilized whenever the operator is working in any vessel. These valves are intended to valve off the inlet and outlet of the vessel to protect the user from any release of pressure. **WARNING:** Failure to use these valves can lead to injury.

2.1.2.3. **Temperature Control Heat Exchangers** – The temperature control heat exchangers regulate the temperature of the CO₂ just before it enters the extractor vessels and is in a cooling loop along with the extractor vessel water jackets and the extractor flow switch.

2.1.2.4. **Extractor Flow Switch** – The flow switch continually monitors for water flow in the extractor loop and will stop the system if flow is lost.

2.1.2.5. **Vent Valves** – Each extraction vessel has its own vent valve (Valve 4A and 4B). These valves will open automatically to vent the extractor so they are safe to open. These valves should be vented to the vent valve manifold (located on the Separator Stand) or outside.

2.1.2.6. **Pressure Gauges** – Three gauges: Extractor A, Extractor B and Pump outlet (located on top of temperature control heat exchanger), are located on the extractor stands and should correlate to the pressures on the HMI (Human Machine Interface) for each portion.

2.1.2.7. **Junction Boxes** – Each extraction vessel has its own junction box which will have a Harding Connector and at least one thermocouple connector that connects the main control panel.

2.1.2.8. **Extraction Cap Hoists** – These hoists are intended to lift the breech lock cap out of the extraction vessel for removal and loading of raw material. Be sure to remove hoses before trying to remove cap. **CAUTION:** Hoist arms are limited to 50 lbs. Never try and lift vessel with hoist.

2.1.2.9. **Extractor Closure Switch** – This limit switch indicates that the extraction vessel is closed and ready for pressure. The extractor will not pressurize without this switch in place.
2.1.3. **Separation Vessel/Control Stand**

2.1.3.1. **Separation Vessels** – The Separator stand holds four separators that work in banks of two. Bank 1 is located on the left-hand side of the stand and Bank 2 is located on the right. Each bank contains a main separator with an oil collection valve and a secondary separator. Users may use either set of separators at any time but only one set at a time.
Separator banks that have identical gauges, filters and manual valving. **SEPARATOR ORIFICE SIZE DICTATE SYSTEM PHASE.**

2.1.3.2. **Main Control Enclosure/HMI (Human Machine Interface)** – Unless otherwise stated at time of purchase, the separator stand will be where the main control enclosure and HMI are located. This enclosure contains the logic controller that operates the entire system. The HMI is located on the front of this enclosure and is where the user can monitor and control the system.

2.1.3.3. **Motor Starter Box** – The motor starter box is located on the back of the separator stand and houses the motor starter that controls the motor on the diaphragm compressor.

2.1.3.4. **Air Valve Manifold** – The Air valve manifold is located on the back of the separator stand directly behind the Main Control Enclosure. This manifold controls the air to each air actuated ball valve via red ¼″ airline.

2.1.3.5. **Standard Vent Line** – This vent collects all the standard vent lines (lines that are vented by the user or typically by the system at the end of the cycle) and should be vented outside by a vent line of the same pressure rating as the system. The discharge line should be ½″ in diameter and no longer than 50 feet.

2.1.3.6. **Safety Vent Line** – This vent line safety vent lines (lines that are vented to protect the system from over pressurization) and should be vented outside by a vent line of the same pressure rating as the system. The discharge line should be ½″ in diameter and no longer than 50 feet.

2.1.3.7. **Pressure Gauges** – There are four pressure gauges located on the separator stand, two for each set of separators. The gauge located behind the main separator (psi range of 0-2000) is the inlet pressure for the separator and should match the pressure of the extractors when the system is flowing. The second gauge is the pressure inside the separators and should match the separator pressure on the HMI.

2.1.3.8. **Separator Filters** – Each separator bank has its own separator filter. These filters should be inspected and cleaned between runs on the separator bank. See the Preventive Maintenance section on page 34.

2.1.3.9. **Locking Vessel Isolation Valves** – Each separator bank has two locking isolation valves that should be utilized whenever the operator is working in any vessel. The bottle connections have an isolation valve as well. These valves are intended to valve off the inlet and outlet of the vessel bank to protect the user from any release of pressure. **WARNING:** Failure to use these valves can lead to injury.

2.1.3.10. **Vent Valves** – Each separator bank has its own vent valve (Valve 10) that can be used to release pressure from that bank of separators. These valves should be vented to the vent valve manifold located above the air valve manifold.

2.1.3.11. **Collection Valve A and B** – Each separator bank has its own collection valve that can be used to collect oil from Separator A. Open valve before removing the bottom cap.

2.1.3.12. **Evacuation Valve A and B** – Each separator bank has its own evacuation valve that can be used to evacuate (draw a vacuum) the whole system before a run or evacuate the individual separator banks while running. See Manual Screen Section 2.2.5 on page 17 on the HMI to evacuate the entire system.

2.1.3.13. **Separator Flow Switch** – The flow switch continually monitors for water flow in the separator loop and will stop the system if flow is lost.

2.1.3.14. **E-Stop Button** – The E-Stop (Emergency Stop) Button can be depressed by the user at any time and will stop the system, turn off the pump, turns off the chillers and isolate every vessel.
2.1.4. **Bottle Connections** (Behind Separator 2B)

2.1.4.1. **Main Supply and Recovery Bottles** – Three 75 lb Gas Supply CO₂ bottles should be used as the main bottles for The Force™ 2-Stage system. These bottles are connected to the location shown above.

2.1.4.2. **CO₂ Make-Up Supply Bottle** – One 50 to 75 lb Gas Supply CO₂ bottle should be used as a makeup bottle for CO₂ lost during and at the end of each cycle. This bottle is connected to Valve 20 in the location shown above.

2.1.5. **Extractor TCU (Temperature Control Unit)** – The Extractor TCU is used to control the temperature of the CO₂ before it passes over the raw material in the extraction vessel. Refer to the Installation Manual for chiller loop setup and chiller manual for more information on the chiller.

2.1.6. **Separator TCU (Temperature Control Unit)** – The Separator TCU is used to control temperatures of your CO₂ after compression or expansion. Refer to the Installation Manual for chiller loop setup and chiller manual for more information on the chiller.

2.1.7. **Miscellaneous/Multi-Area Parts**

2.1.7.1. **Air Actuated Ball Valves** – These ball valves are operated automatically by the controller and the air valve manifold. Indicators on the front of the valve will display the position of the valve. If the yellow line on the indicator is parallel to the valve body then the valve is considered open. If the indicator is perpendicular then the valve is closed. Valve positioning can be verified from the I/O (Input/Output) Screen (Section 2.2.9. on page 19).

2.1.7.2. **Relief Valves** – Located throughout the system, these valves mechanically protect the system from over pressurizing.

2.1.7.3. **Rupture Discs** – Located throughout the system, these discs are required to ASME stamp the system and are intended to relieve pressure above the set pressure rating. These discs are a single use disc and will need to be replaced if they rupture.
2.2. Automation Overview

2.2.1. **Logo Screen** – This screen contains the software version information for your machine. The most current software version is shown in the lower left-hand corner of the screen. Contact Apeks for current version information (740) 809-1160 option 2.

2.2.2. **Home/Main Screen** – This screen is the most common area to monitor the system during a cycle. Key information such as temperatures, pressures and valve positioning can all be seen on this screen as well as the cycle state. This screen is also how operators start the system and contains the button to set the cycle parameters.
2.2.3. **Cycle Parameters Screen** – This screen is the place where the user will program how the system will be run. Operators will set target pressure and temperature, select run modes, set run times and switch over times, and select which separator bank to start with. Many cycle parameters such as times and temperatures can be adjusted during the run but run modes (Single or Double Extractor or Continuous Batch) cannot be adjusted after the run begins.

2.2.4. **Valve Control Screen** – This screen is for Apeks use only and is locked from customer use. Valve positioning can be seen on this screen. Current valve position will be highlighted.
2.2.5. **Manual Screen** – Aside from the Main Screen this screen is the most common screen the operator will interact with. The manual screen is where to go to reset any alarms, service/switch separators, change bottle and more. See Manual Screen Buttons Section 2.4 on page 27 for more information.

![Manual Controls Screen](image1)

2.2.6. **Maintenance Screen** – This screen is the timer screen for maintenance timers and total system time. Maintenance timers can be reset but pump and machine time cannot.

![Maintenance Utilities Screen](image2)
2.2.7. **Message Screen** – This screen is where the operator selects which messages to receive. This email messaging will require an initial setup which can be scheduled at [http://www.apexsupercritical.com/customer-support/service-request/](http://www.apexsupercritical.com/customer-support/service-request/). Set up will require a dedicated email address for the system. Messaging ability requires connection to the internet. Data collection data and remote viewing will also be set up with this alerting service.
2.2.8. **Code Entry Screen** – This screen is used for systems that are leased. Leased systems will require a monthly passcode.

2.2.9. **I/O (Input/Output) Screens** – This screen is used for more precise system monitoring. The operator can monitor every input and output of the Program Logic Controller (PLC) from these screens. These screens are mainly used during troubleshooting.
2.2.9.1. **PLC Digital Inputs**

![Image of PLC Digital Inputs](image1)

2.2.9.2. **PLC Digital Outputs**

![Image of PLC Digital Outputs](image2)
2.2.9.3. **PLC Analog Inputs**
2.2.9.4. **PLC Analog Outputs**
2.2.9.5. **I/O – Motor Starter Monitor**

![Motor Starter Monitor Diagram]

2.2.9.6. **I/O – Temp Control Units**

![Temp Control Units Diagram]
2.2.10. **Alarm History Screen** – This screen holds all the information about past alarms on the system. See the Troubleshooting Section 5 on page 36 for information about specific alarms.

2.2.11. **Pop Up Screens** – These screens will either appear to prompt the operator to enter additional information or will be called up by the operator to view or change parameters.

2.2.11.1. **Extractor Interval Time** – This window will appear when continuous batch mode is selected during start up on the cycle parameters screen.

2.2.11.2. **System Status** – This window will display messages and alarms to the operator. This screen can be called up from the bottom left hand corner of the main screen. If no message or alarm is active the operator will not see a button.
2.2.11.3. **Elapsed Time Setting** – This Screen can be called up from the bottom middle of the main screen and allows the operator to change/monitor time settings. In continuous batch mode the operator will need to go to this screen to verify that extractors are ready to come online.

![Elapsed Time Setting Screen](image)

2.2.11.4. **Recover CO₂ Separator Selection** – This window will pop up if the system is recovered by the user before the end of the cycle.

![Recover CO₂ Separator Selection](image)

2.2.11.5. **Open Extractor Vessel** – This window will pop up if the operator selects open extractor on the manual screen.

![Open Extractor Vessel](image)
2.2.11.6. **Master Reset Confirm** – This window will pop up when a master reset is selected to make sure it is not done accidently.

![Master Reset Confirm](image)

2.3. **Running Modes**

2.3.1. **Single Extractor** – In this run mode, the system will run only one extractor (selected by the operator) for the duration of the cycle time and will then recover the CO₂. The operator will also have the option to select two different cycle parameters and which separator bank to use for each set of parameters. An example of Forward Flow through Extractor A only can be seen below.

![Single Extractor Diagram](image)

2.3.2. **Dual Extractor** – In this run mode, the system will run both extractors for the duration of the cycle time and will then recover the CO₂. The operator can choose to have the CO₂ flow through either vessel first, e.g. A then B or B then A. The operator will also have the option to select two different cycle parameters and which separator bank to use for each set of parameters. An example of Reverse Flow through Extractor B to A can be seen below.

![Dual Extractor Diagram](image)
2.3.3. **Continuous Batch** – In this run mode, the system will bring both extractors online and offline automatically based on parameters selected by the operator. The operator will have the option to start with one vessel, or both, and will control the amount of time each extractor will be run. The operator will also have the option to select two different cycle parameters, which separator bank to use for each set of parameters, and how long between transitions between separators as well.

2.4. **Manual Screen Buttons (Note: Not all buttons are present at certain times)**

2.4.1. **Service Separator Mode/Leave Service Separator Mode** – This button acts like a system pause so that the operator can get into the active separator that is online. Once activated, the system will stop flow from the extractors and pump the separator down to 100psi. At that point it will put the pump into an idle bypass mode and the user will have the ability to vent the remaining pressure in the separator and then open the separator. To leave this mode reassemble separator and press the Leave Service Separator Mode button.

2.4.2. **Change CO2 Bottles** – This button should be used to switch bottles during a run. Once activated the bottles will be isolated from the system and the system will not try to add or recover any CO2 until this mode is left.

2.4.3. **Oil Pressure Lost Reset** – This button resets the Oil Pressure Lost alarm that will shut down the system if it ever loses oil pressure.

2.4.4. **Diaphragm Rupture Reset** – This button resets the Diaphragm Rupture alarm that will shut down the system if 5psi of pressure is detected in the isolation cavity on the diaphragm head.

2.4.5. **Evacuate** – This button allows the operator to pull a vacuum on the system before a run. If any pressure over 25psi is present in the system this button will disappear.

2.4.6. **Open Extractor Vessel** – This button is used to open the extractor vessel when pressure is in the extractor. This button will vent the extractor through Valve 4.

2.4.7. **Recover CO2** – This button will recover the system at any time when pressed.

2.4.8. **Water Flow Lost Reset** – This button resets the Extractor/Separator water flow lost alarm.

2.4.9. **Switch Separators** – This button will switch between separator banks. Switching separators will changes phases to whatever phase is associated with that separator. This button will not reset the separator switchover timer.

2.4.10. **Start/Stop Extractor Chiller** – These buttons start and stop the Extractor Chiller.

2.4.11. **Start/Stop Separator Chiller** – These buttons start and stop the Separator Chiller.

2.4.12. **Lamp Test** – This button will turn on both the red and green light on the light stack to test if they are working.

2.4.13. **Start/Stop Compressor Prime** – These buttons will start and stop the diaphragm compressor for the purpose of priming it (removing any air from the oil). See Appendix B for instructions on priming the compressor.

2.4.14. **Fill Separator Bank 2 Water** – This button will allow you to do an initial fill of the water jacket of separator bank 2. See Installation Manual for correct operation of valve. **Note**: valve only appears in manual mode.
3. System Operation

3.1. Before the Cycle

3.1.1. Loading and Closing Extractor

3.1.1.1. CAUTION: Extractor plugs and nuts can weigh up to 50 lbs and care should be given to avoid damage and injury.

3.1.1.2. NOTE: Use appropriate tools to open and close vessels.

3.1.1.3. Opening Extractor Vessel:

3.1.1.3.1. Remove extractor closure switch.

3.1.1.3.2. Remove flexible CO₂ lines connecting extractor to the stand.

3.1.1.3.3. Rotate plug 30°.

3.1.1.3.4. Use hoist to carefully lift plug.
3.1.1.4. Before loading the extractor visually inspect the metal filters on either end of the vessel for any signs of clogs or damage.

3.1.1.5. Use the supplied metal funnel to help load the extraction vessel. Vessels should be loaded in stages using gentle packing in between to increase the amount of material able to be loaded into the vessel.

3.1.1.5.1. Typically, botanicals perform best in CO₂ extractions when ground as fine as possible: down to a particle size of 200 µm or roughly the consistency of coffee grounds.

3.1.1.5.2. Any amount of material can be loaded into the Extraction Vessel – the vessel does not have to be full in order to operate correctly.

3.1.1.6. After loading is complete, ensure all sealing surfaces are clean and free of debris. This includes the top of the extraction vessel, the extractor walls where the plug sits and the face of the plug around the metal filter.

3.1.1.7. Closing the Extractor Vessel:

3.1.1.7.1. Lower the plug into the vessel trying to keep the plug as level as possible and then rotate the plug 30° until the holes for the extractor closure switch on both the nut and plug line up.

3.1.1.7.2. Verify that all flexible lines are attached to top and bottom of vessel.

3.1.1.7.3. Replace extractor vessel closure switch.

3.1.1.8. Open the Vessel Isolation valves once vessel is secure.

3.1.2. Prepping and Securing Separators

3.1.2.1. Before running a separator, be sure that the separator is clean and the proper orifice for the desired operating parameters is selected. See Recommended Operating Parameters Section 3.3 on page 31 for orifice sizing information. **SEPARATOR ORIFICE SIZE DICTATES PHASE.**

3.1.2.2. Separators are secured with a clamshell type closure. These swing closed over the outside of the separator nut and are secured by a pin in the front of the separator. **NOTE:** Each Separator has a proximity switch that will not allow the vessel to pressurize unless clam shell is closed.

3.1.2.3. Verify that all tubing connecting the separator vessels to each other of the rest of the system are connected and tight.
3.1.2.4. Close Valve 10 and the Evacuation Valve.
3.1.2.5. Open the Vessel Isolation Valves once vessel is secure.

3.1.3. **Evacuating System**
3.1.3.1. From the manual screen press “Evacuate”.
3.1.3.2. Open the evacuation valve on the separator bank that will be online first and attach the vacuum pump to the bottom of the evacuation valve with the supplied hose and gauge.
3.1.3.3. Verify that the vacuum pump has the appropriate level of clean oil and then start the vacuum pump.
3.1.3.4. Let the system come down to between -25 to -30 inHg and maintain for several minutes. If system does not come down, there is a leak into the system or the vacuum pump needs service (close the evacuation valve and watch the gauge to see which it is).
3.1.3.5. Close evacuation valve, turn off vacuum pump, remove hose and gauge.
3.1.3.6. Acknowledge that evacuation is complete on the manual screen.

3.2. **Starting the Cycle**
3.2.1. **The Cycle Parameters Screen** – To get to the Cycle Parameters Screen first go to the Main Screen from the bottom navigation button and click on Cycle Parameters above the extractor icons. Once on the cycle parameter screen follow the prompts on the screen which are also listed below:
3.2.1.1. Verify that all vessels to be run are secure.
3.2.1.2. Close valve 10 and the Evacuation valve on separator bank(s) to be run.
3.2.1.3. Open the two vessel isolation valves on the separator bank(s) to be run.
3.2.1.4. Open all bottles.
3.2.1.5. Verify that system has adequate air pressure (between 90-115psi).
3.2.1.6. Select which mode to run the system: Continuous, Single or Double.
3.2.1.7. Select extractor to be online at the start of the run/flow direction of the run.
3.2.1.8. If Continuous Batch is selected, a pop up window will show at this time asking the operator to enter an extractor vessel time interval. This is the total time each extractor will run before coming offline (e.g. if the extractor interval is six hours and vessel A is brought online first the system will run vessel A by itself for four hours and then bring vessel B online with Vessel A for two hours be for switching over to vessel B solely for two hours. **NOTE**: the first vessel will run for double the amount of time of each additional interval).
3.2.1.9. Enter Phase 1 extractor target pressure and temperature.
3.2.1.10. Enter Phase 1 desired separator temperature.  
**NOTE**: PHASES ARE DICTATED BY THE ORIFICE.
3.2.1.11. Enter total run time.
3.2.1.12. Select separator bank to be online first.
3.2.1.13. Enter Phase 2 extractor target pressure and temperature.
3.2.1.14. Enter Phase 2 desired separator temperature.
3.2.1.15. Enter separator switch-over time.
   3.2.1.15.1. If no switch-over is desired, make switch-over time longer than total run time.
   3.2.1.15.2. Phases are related to which separator is online and separate from the extractors entirely.
3.2.1.16. Save settings and continue back to the main screen.

3.2.2. **The Main Screen**
3.2.2.1. Press “Start Cycle” to begin the run.
3.2.2.2. If the “Cycle Parameters” button on the main screen is not green then the cycle parameters are not fully established and need attention. Return to the cycle parameters screen to fully set all the parameters.

3.2.2.3. At this point the system should start.

3.2.3. **System Response on Start Up** – At this point the system will operate automatically as follows:

3.2.3.1. The system will charge the extractor and separators with an initial burst of pressure and turn on the diaphragm pump to allow it to come up to speed before presenting pressure.

3.2.3.2. After a short time, the system will begin to supply CO₂ to the compressor to be compressed and charge the extractors.

3.2.3.3. This charging process will continue until the system has reached its target pressure and the system will go into run mode.

3.2.3.4. Temperatures and pressure are controlled by the system and will continue to be adjusted until the system reaches a steady state. If any adjustments need to be made during the cycle to maintain a steady state (i.e. additional CO₂ or temperature changes) the system will automatically adjust.

3.3. **Recommended Operating Parameters**

3.3.1. **Subcritical Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Pressure</td>
<td>1,200 psi</td>
</tr>
<tr>
<td>Extractor Target Temp</td>
<td>70-75°F</td>
</tr>
<tr>
<td>Separator Target Temp</td>
<td>25-30°F</td>
</tr>
<tr>
<td>Orifice Size</td>
<td>48</td>
</tr>
<tr>
<td>Extraction Time</td>
<td>40-60 min per pound</td>
</tr>
</tbody>
</table>

3.3.2. **Supercritical Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Pressure</td>
<td>4,000 psi</td>
</tr>
<tr>
<td>Extractor Target Temp</td>
<td>105-110°F</td>
</tr>
<tr>
<td>Separator Target Temp</td>
<td>25-30°F</td>
</tr>
<tr>
<td>Orifice Size</td>
<td>24</td>
</tr>
<tr>
<td>Extraction Time</td>
<td>20-40 min per pound</td>
</tr>
</tbody>
</table>

**NOTE:** Extraction times can vary by strain, be sure to test material before and after extraction, especially when running a new strain. Increase or decrease extraction time as needed.

3.4. **During the Cycle**

3.4.1. **Service Separator/Cleaning out Separator that is Offline**

3.4.1.1. If working on a separator bank that is online use the “Service Separator” button on the manual screen. If working on an offline vessel, verify valves to that separator are shut.

3.4.1.2. Verify the vessel has been pumped down to 100 psi and verify the air actuated ball valves are not open by looking at the color of the valves on the control screen: green is open and white is closed.

3.4.1.3. Open Valve 10A or B depending on the vessel being serviced to vent separator bank.

3.4.1.4. ⚠ Close the two Vessel Isolation Valves on both the inlet and outlet lines to protect from an unexpected release of pressure. ⚠

3.4.1.5. Disassemble separator and service/clean.

3.4.1.6. Remove the bottom of the separator filter housing and filter and clean.
3.4.1.7. Using supplied squeeze bottle, flush cleaning agent through the second separator (smaller separator in the bank) outlet down to the filter housing until the agent runs clear.
3.4.1.8. Use compressed air to blow any residual cleaning agent out of CO₂ line and reassemble filter.
3.4.1.9. Reassemble separators and reattach tubing/hoses.
3.4.1.10. Open the Vessel Isolation Valves.
3.4.1.11. Close Valve 10A or B.
3.4.1.12. If in service separator mode, return to the main screen to continue the run.

3.4.2. **Cleaning out Extractor in Continuous Batch Mode**
3.4.2.1. When in continuous batch mode the system will automatically take vessels offline after the extractor interval is complete. The system will pump the extractor down to 100psi and then vent the remainder of the pressure from the vessel.
3.4.2.2. When the pressure of the extractor has been vented, the extractor is safe to open by using the rubber mallet to loosen the top nut, and then swing out of the way for storage.
3.4.2.3. Close the two Vessel Isolation Valves on both the top and bottom lines to protect from an unexpected release of pressure.
3.4.2.4. Use a shop vac to remove the spent material from the vessel and then reload the extractor in the same manner as described in Section 3.1.1. “Loading and Closing the Extractor”.
3.4.2.5. Once the extractor is loaded and closed properly, go to the “Elapsed Time Setting” screen and verify that the extractor is ready to be brought back online.
   3.4.2.5.1. If you do not verify the extractor is ready the system will continue running the current extractor for another cycle.
   3.4.2.5.2. If no verification is given in that cycle the system will recover and wait to be loaded with fresh material.
3.4.2.6. Be sure to open the Vessel Isolation Valves when the vessel is ready to run.

3.4.3. **Changing Bottles**

```
WARNING
Do not move bottles without caps and secure all bottles in use to the system
```

3.4.3.1. From the manual screen select the “Change CO₂ Bottle” button.
3.4.3.2. Close the bottle and crack the brass nut by rotating it counterclockwise an eighth turn to vent the pressure in the lines.
3.4.3.3. Remove the hose from the old bottle and reattach to the new bottle. Be sure to use the CO₂ cylinder gasket.
3.4.3.4. Secure the new bottle with the bottle straps.
3.4.3.5. From the manual screen select the “Leave Bottle Change Mode” button.

3.5. **After the Cycle**

3.5.1. **System Response on Shutdown**
3.5.1.1. Once the total run time is complete, the system will automatically recover the CO₂ in the system back into the bottles. When all vessels get under 100psi the system will stop and vent the extractors.
3.5.1.2. The system will then prompt the operator to close the bottles and open Valve 10A and B. Once acknowledged, the system will open all valves and release the remaining pressure from the system.
3.5.2. **Operator Maintenance**  
3.5.2.1. When the pressure of the extractor has been vented, the extractor is safe to open by using the rubber mallet to loosen the top nut, and then swing out of the way for storage.  
3.5.2.2. Use a shop vac to remove the spent material from the vessel and then reload the extractor in the same manner as described in “Loading and Closing the Extractor” in section 3.1.1. on page 28.  
3.5.2.3. To clean the separators, open Valve 10 to vent separator bank  
3.5.2.4. Disassemble separator and clean.  
3.5.2.5. Remove the bottom of the separator filter housing and filter and clean.  
3.5.2.6. Using the supplied squeeze bottle, flush cleaning agent through the second separator (smaller separator in the bank) outlet down to the filter housing until the agent runs clear.  
3.5.2.7. Use compressed air to blow any residual cleaning agent out of CO2 line and reassemble filter.  
3.5.2.8. Change orifice if needed.  
3.5.2.9. Reassemble separators and reattach tubing/hoses.  
3.5.2.10. Refer to the next section “System Preventative Maintenance” for maintenance to be done between cycles.
4. System Preventive Maintenance

For Apeks System Manuals and Other Component Manuals visit http://www.apekssupercritical.com/apeks-supercritical-operation-manuals/

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

4.1. Extraction System Maintenance (Extractor and Separator Stands)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>After Each</td>
<td>• Remove extracted oil from collector cup and separator walls, clean walls and cup with alcohol.</td>
</tr>
<tr>
<td>Extraction</td>
<td>• Check separator 2 for oil carryover and clean if necessary.</td>
</tr>
<tr>
<td></td>
<td>• Inspect separator gaskets and grooves prior to reassembly.</td>
</tr>
<tr>
<td></td>
<td>• Clean piping between separator 1 and 2 with alcohol.</td>
</tr>
<tr>
<td></td>
<td>• Clean Separator 2 CO₂ outlet to separator filter.</td>
</tr>
<tr>
<td></td>
<td>• Remove spent material from the extraction vessel by vacuuming it out through the top flange.</td>
</tr>
<tr>
<td></td>
<td>• Verify the extractor filters are clear and free of debris.</td>
</tr>
<tr>
<td></td>
<td>• Check extraction vessel O-rings and O-rings groove sealing surfaces for damage – replace if necessary.</td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td>Every 80 Hours</td>
<td>• Run the system “empty of plant material” for one hour to clean the high-pressure side of the system and extraction vessel(s).</td>
</tr>
<tr>
<td>Yearly</td>
<td>• Check torque on all screws in electrical panels (see Appendix G).</td>
</tr>
</tbody>
</table>

Resource
Apeks online store: http://apeksonlinestore.com/

4.2. Diaphragm Compressor Maintenance

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>• Check oil level.</td>
</tr>
<tr>
<td></td>
<td>• Check oil pressure.</td>
</tr>
<tr>
<td></td>
<td>• Listen for abnormal noise or vibration.</td>
</tr>
<tr>
<td></td>
<td>• Check Leak Detection System status.</td>
</tr>
<tr>
<td>Every 500 Hours</td>
<td>• Clean/Change Separator Filter.</td>
</tr>
<tr>
<td></td>
<td>• Check belt tension (See Appendix A).</td>
</tr>
<tr>
<td></td>
<td>• Clean process check valves.</td>
</tr>
<tr>
<td>Every 1500 Hours</td>
<td>• Perform regular oil change.</td>
</tr>
<tr>
<td></td>
<td>• Check torque on all screws in electrical panels (see Appendix G).</td>
</tr>
</tbody>
</table>
### Every 4000 Hours
- 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.

### 4.3. Chiller Maintenance

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Maintenance Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>- Check fluid level.</td>
</tr>
<tr>
<td></td>
<td>- Check fluid filter bag and clean/replace as necessary.</td>
</tr>
<tr>
<td></td>
<td>- Listen for abnormal noise or vibration.</td>
</tr>
<tr>
<td></td>
<td>- Check for any leaks.</td>
</tr>
<tr>
<td></td>
<td>- Clean condenser filter (air filter) on front bottom of chiller.</td>
</tr>
<tr>
<td>Every Month</td>
<td>- Check/Clean fluid diffuser.</td>
</tr>
<tr>
<td>Every 6 months</td>
<td>- Replace cooling fluid.</td>
</tr>
</tbody>
</table>
5. Troubleshooting

5.1. System Messages

5.1.1. Leak Detect Switch Tripped, when pump stops, check leak detect valve for hydraulic oil. If no oil is present, press OK. If there is oil present, press OIL FOUND – Follow prompt. See Diaphragm Rupture Shutdown Alarm in section 5.2.11. and follow steps.

5.1.2. E-stop Reset – Resets the emergency stop when pressed. Make sure E-stop button is backed out.

5.1.3. Payment due by end of month – Lease payment is due by the first of the month or system will not run.

5.1.4. Check orifice size. Elevated separator pressure detected. – Separator pressure has maintained over 400psi for five minutes. Check to make sure the required orifice size is in the separator and that it is tight. Separator pressures between 400-420psi with the extractor at the target pressure can be ignored but pressures over 400psi with target pressure not reached check the following. Prime pump for ten minutes, check/clean check valves on diaphragm pump, and contact Apeks about other options.

5.1.5. Diaphragm pump pressure switch tripped – See Diaphragm Rupture Shutdown Alarm in Section 5.2.11.

5.1.6. Monthly code entry required – Lease code for that month needs entered. Go to code entry screen and enter code.

5.1.7. Pump outlet pressure high – See Diaphragm Compressor Outlet PSI High Alarm in Section 5.2.8. Check to verify that bottles are open if in recovery.

5.1.8. Separator pressure has risen – Separator pressure is higher than 500psi, separators will be pumped down or vented.

5.1.9. Low bottle detected at start up – Check that bottle is open and has pressure. Pressure needs to be above 500psi, change out if necessary.

5.1.10. Machine is in bottle change mode – Change bottle and acknowledge to continue.

5.1.11. Cycle complete or terminated but vessel(s) still pressurized – System is stopped but there is still pressure over 100psi in one of the vessels. Vent or recover vessels before opening.

5.1.12. Recovery complete – System recovered vessels down to 100psi and vented the extractor. Open valve 10 and acknowledge the prompt to relieve pressure from the rest of the system.

5.1.13. Check/Replace Bottle – Indicates machine is in bottle change mode.


5.1.15. Extractor Pressure not equalizing – see Extractor Not Equalizing Alarm in Section 5.2.13.

5.1.16. Recovering due to low system pressure – Follow prompts and reset message.

5.1.17. Recovery has begun – System has completed its cycle and is recovering CO2.

5.1.18. CO2 Low Bottle pressure – Change out bottle to get bottle pressure above 500psi.

5.1.19. Transition to (BA/AB) but Ext (A/B) not ready – Close open extractor and acknowledge on the elapsed time setting screen to continue.

5.1.20. Sep pressure test failed – Close open separator and acknowledge on the manual screen to continue.

5.2. System Alarms

5.2.1. Air PSI High/Low Alarm – Air psi is above or below range of acceptable pressure. Decrease air pressure or check the air compressor and increase pressure.

5.2.2. Chiller 1 Fault/Warning Alarm – Check chiller screen for alarm and consult chiller manual.

5.2.3. Chiller 2 Fault/Warning Alarm – Check chiller screen for alarm and consult chiller manual.
5.2.4. **CO₂ Storage PSI High/Low Alarm** – CO₂ storage bottles pressure is too high or low. Make sure bottles are open and switch out if needed.

5.2.5. **CO₂ Supply PSI High/Low Alarm** – CO₂ supply bottle pressure is too high or low. Make sure bottle is open and switch out if needed.

5.2.6. **Code Needed Alarm** – Monthly code needed. Go to code entry screen.

5.2.7. **Diaphragm Compressor Ambient Temperature Alarm** – The ambient temperature at the diaphragm compressor is outside acceptable range.

5.2.8. **Diaphragm Compressor Outlet PSI High Alarm** – Compressor Outlet is high. Check gauge on the temperature control heat exchanger to verify high pressure and check that the air actuated ball valves match the positioning on the main screen.

5.2.9. **Diaphragm Compressor Suction PSI High Alarm** – Suction pressure to the diaphragm compressor is too high. Check orifice size and target pressure, adjust accordingly. Check to make sure compressor has a hot outlet tube, if not, prime compressor or clean check valves.

5.2.10. **Diaphragm Compressor Suction PSI Low Alarm** – Suction pressure to the diaphragm compressor is too low. Check to see if there is a larger pressure drop across separator filter, remove and clean if necessary. Check bottle pressure, replace if necessary. Check orifice for correct size and presence of a clog, clear clog/adjust size accordingly.

5.2.11. **Diaphragm Rupture Shutdown Alarm** – Over 15psi of pressure was present in the isolation cavity of the diaphragm compressor. Vent pressure if still present and check for oil. If oil is present, call Apeks (740-809-1160 option 2) about replacing diaphragms. If no oil is present, reset alarm on the manual screen, restart system and monitor the leak detect gauge for pressure. If no pressure appears, continue to run. If pressure rises slowly for the first few minutes of the run but then stops climbing and no oil is present, vent to keep psi below 5 for the first few minutes and then monitor for a few minutes after venting to be sure leak has stopped. If pressure climbs rapidly or does not stabilize call Apeks about replacing diaphragms.

5.2.12. **E-Stop Alarm** – The emergency stop button has been pressed or power had been lost, make sure button is backed out and “Reset E-Stop” on main or manual screen.

5.2.13. **Extractor Not Equalizing Alarm** – The extractor is not equalizing with the bottles on initial fill. Check that bottles are open and have pressure. Check that the air actuated ball valves that are indicated as open on the main screen are open and if not, stop cycle and do a “Master Reset” on the manual screen.

5.2.14. **Extractor Water Flow Lost Alarm** – Water flow to the extractor chiller loop has been lost. Check that extractor chiller is on and that there are no kinks or clogged lines.

5.2.15. **Extractor Ambient Temperature Alarm** – The ambient temperature at the extractor stand is outside acceptable range.

5.2.16. **Extractor (Vessel A/B, Top/Bottom) PSI High Alarm** – Extractor pressure is above the acceptable pressure range. Check orifice for a clog, and clear if necessary. Check all pressure readings on the main screen to see if there is a large pressure drop across any vessels, if so recover and check material and extractor filters for clogs. Check that the air actuated ball valves that are indicated as open on the main screen are open, if not stop cycle and do a “Master Reset” on the manual screen.

5.2.17. **Extractor (A/B) Vessel Temperature Alarm** – Extractor temperature outside of acceptable range, adjust extractor temperature setting.

5.2.18. **Filter (1B/2B) PSI Drop Fault/Warning** – The separator filter is causing too large of a pressure drop and needs to be cleaned/replaced.

5.2.19. **Low System CO₂ Pressure Alarm** – The system does not have enough CO₂ in order to run at desired parameters. Check that bottles are open and have over 500psi of pressure. Replace bottles if necessary.
5.2.20. **Oil Pressure Lost Alarm** – Oil pressure in the diaphragm compressor has dropped below 15psi. Check the diaphragm pump for leaks and if there is enough oil. Reset oil pressure alarm on the manual screen and try to prime compressor until 15psi is reached on the oil pressure gauges on the diaphragm compressor.

5.2.21. **Pressure Test Fail Alarm** – A pressure test on one of the vessels has failed. Check the manual screen to see which vessel failed and secure all tubing or clean all sealing surfaces so that the vessel will hold pressure.

5.2.22. **Pump PSI High During Recovery Alarm** – Pump outlet is too high because bottles are closed or full.

5.2.23. **Pump Motor Auxiliary Fault Alarm** – Pump auxiliary not made. Check to see if motor starter armature is engaged, check voltage at auxiliary, and for any loose wires in motor starter box.

5.2.24. **Pump Motor Overload Alarm** – Pump overload has been tripped. Reset overload, check that overload is set correctly for amperage on the motor nameplate. Prime pump and check voltage and amps. If amps are still too high check for loose wires and belt tension.

5.2.25. **Separator Pressure Creep Alarm** – Separator pressure has crept up due to dry ice sublimation. Open Valve 10.

5.2.26. **Separator Water Flow Lost Alarm** – Water flow to the separator chiller loop has been lost. Check that separator chiller is on, that there are no kinks or clogged lines and that the quick connects are together.

5.2.27. **Separator (1B/2B) Vessel PSI High Alarm** – Separator pressure is above the acceptable pressure range. Check orifice size and target pressure, adjust accordingly. If system was off, dry ice sublimation or a leaky valve 12 could cause alarm. Vent and clean out separators, then reassemble, close all manual valves and open bottle to see if pressure increases.

5.2.28. **Separator (1B/2B) Vessel Temperature Alarm** – Separator temperature outside of acceptable range, adjust separator temperature setting.

5.2.29. **Separator Ambient Temperature Alarm** – The ambient temperature at the separator stand is outside acceptable range.

5.2.30. **Service Separator Mode Extractor PSI High Alarm** – Extractor pressure is higher than acceptable range during service separator mode, reassemble separator and continue cycle or turn extractor temperature setting down.

5.2.31. **Valve Fault Alarm** – The air valve manifold has faulted. Check the manifold for fault code and then try unplugging the yellow cord and plugging it back in. If fault continues contact Apeks (740-809-1160 option 2).

5.3. **Other Symptoms**

5.3.1. **Vessel not pressurizing**
   - 5.3.1.1. Verify that all Vessel Isolation Valves to that vessel are open.
   - 5.3.1.2. Check operation mode and valve positioning on main screen.

5.3.2. **High Extractor pressure and low separator pressure**
   - 5.3.2.1. Check parameters selected against orifice selected.
   - 5.3.2.2. Check orifice for clogs.

5.3.3. **High Separator pressure and low extractor pressure**
   - 5.3.3.1. Verify the correct parameters are selected by referencing the recommended operating parameters.
   - 5.3.3.2. Verify the orifice matches the operating parameters and check for tightness.
   - 5.3.3.3. Verify there is no drop across the separator filter.
   - 5.3.3.4. Prime the compressor (see Appendix B).
   - 5.3.3.5. Clean Check Valves (see Appendix C).
6. References

YouTube Instructional Videos
https://www.youtube.com/user/ApeksSupercritical

Apeks online store
http://apeksonlinestore.com/

Software Updates and E-mail Alerts (740) 809-1160 option 2
http://www.apekssupercritical.com/service/
7. Appendices
7.1. Appendix A. Belt Tension Testing/Adjustment.

7.1.1. Remove the belt guard.
7.1.2. Check belt(s) tension with belt tension tester.
  7.1.2.1. Belts should be tensioned to 10 lbs.
  7.1.2.2. If you need help using your tension tester tool please view the following video: https://www.youtube.com/watch?v=bYEHvfo8t6A
7.1.3. If the belt to be needs adjusted, loosen the four retaining nuts on top of the motor mounting plate.

7.1.4. Adjust the bottom nuts on the motor base up or down to tighten or loosen the belt as necessary.
7.1.5. Be sure to check motor shaft alignment (note: can be up to 1/8" difference from side to side).

7.1.6. Retighten the top nut.
7.1.7. Rotate the belt by hand around one turn (failure to do so could result in an incorrect reading).
7.1.8. Check belt tension again and repeat as necessary.
7.2. Appendix B. Diaphragm Pump Priming

7.2.1. Open BOTH of the Oil Bypass Valves (one on each head), see figure below, by turning counterclockwise until it stops.

7.2.2. Go to the “Manual Screen” on the HMI and hit the “Start Prime Compressor” button.

7.2.3. When pump is priming verify there is oil pressure on the pump gauges, if no pressure appears check oil level and pump motor rotation.

7.2.4. Continue to let the pump run five to seven minutes to remove any entrained air in compression head.

7.2.5. Begin to close over pump bypass valve slowly, one full turn every three to four seconds, alternating heads every three to four turns until both valves are fully closed. Tighten the oil bypass valve as tight as possible to fully close.

7.2.6. From the “Manual Screen” hit the “Stop Prime Compressor” button.

7.2.7. Start the system to see if pump is pumping properly.
7.3. Appendix C. Check Valve Cleaning

7.3.1. Remove the inlet and outlet tubing from the head of the compressor.
7.3.2. Remove the seven bolts on each check valve retainer.

7.3.3. Remove retainer and checks.
7.3.4. 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.
Suction Check Valve

- Poppet
- Springs

FLOW

1.693 [43.0]

1.772 [45.0]

1.182 [30.0]
7.3.5. Reassemble checks when cleaned and assemble in pump.
7.3.6. Torque the retaining bolts to 15 ft-lbs after reassembly.
7.4. Appendix D. Piping and Instrumentation Diagram
7.5. Appendix E. CO₂ Phase Diagram
7.6. 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.
  - CO₂ Monitor; [Amprobe CO₂ 100](http://www.apeksonlinestore.com/product/tension-tester/)

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/](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.
7.7. **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 Jumper = 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
### Apeks Automatic Machine Fault Troubleshooting Guide (Duplex and 2-Stage)

Never perform work on energized equipment. Always de-energize all systems to remove all forms of stored energy before performing any maintenance or repair to any system. Follow all OSHA lockout/tagout rules as well as any safety requirements specific to your local authority having jurisdiction. Only qualified personnel should attempt maintenance, repair or troubleshooting of any equipment.

<table>
<thead>
<tr>
<th>Fault Code and description</th>
<th>Description</th>
<th>Possible Causes</th>
<th>Possible Remedies</th>
</tr>
</thead>
<tbody>
<tr>
<td>F00 DC Suction PSI High</td>
<td>Pressure of CO2 entering the diaphragm compressor is higher than allowed.</td>
<td>Orifice may be too large for the parameters selected, dirty DC check valves, Dirty OPV, Loss of prime at DC, OPV out of adjustment, valve malfunction.</td>
<td>1. Check orifice size to make sure it matches the recommended size in the manual for the parameters selected. 2. Prime compressor. 3. Check air operated ball valve operation and condition. 4. Check and adjust OPV pressure setting. 5. Clean OPV. 6. Clean check valves.</td>
</tr>
<tr>
<td>F01 DC Suction PSI Low</td>
<td>Pressure of CO2 entering the diaphragm compressor is too low to operate compressor</td>
<td>Orifice too small for parameters selected, Filter clogged, inadequate CO2 supply, CO2 leak, Valve malfunction, Vapor filter (if equipped) obstructed</td>
<td>1. Check orifice size to make sure it matches the recommended size in the manual for the parameters selected. 2. Check air operated ball valve operation and condition. 3. Check/clean filter 1B and 2B. 4. Check/replace desiccant in vapor filter. 5. Check/replace CO2 supply bottles.</td>
</tr>
<tr>
<td>F02 DC Output PSI High</td>
<td>The pressure of the CO2 between the diaphragm compressor outlet and the entrance to the extraction vessel(s) is too high</td>
<td>Extractor filter clog, Valve malfunction, CO2 storage closed during recovery, particulate filter before extractor clogged</td>
<td>1. Check/clean extractor filters. 2. Check/clean particulate filter between compressor and extractors. 3. Check air operated ball valve operation and condition. 4. Check/open CO2 supply and storage bottle valves.</td>
</tr>
<tr>
<td>F03 DC Output PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F04 Extractor B Top PSI High</td>
<td>CO2 pressure detected in the vessel exceeds the maximum allowed by the programming</td>
<td>Extractor filter clog, Valve malfunction, tube between extractor and separator dirty</td>
<td>1. Check/clean extractor filters. 2. Check air operated ball valve operation and condition. 3. Check/clean tubing between extractor and separator.</td>
</tr>
<tr>
<td>F05 Extractor B Top PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F06 Extractor B Bottom PSI High</td>
<td>CO2 pressure detected in the vessel exceeds the maximum allowed by the programming</td>
<td>Extractor filter clog, Valve malfunction, tube between extractor and separator dirty</td>
<td>1. Check/clean extractor filters. 2. Check air operated ball valve operation and condition. 3. Check/clean tubing between extractor and separator.</td>
</tr>
<tr>
<td>F07 Extractor B Bottom PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Troubleshooting</td>
<td></td>
</tr>
<tr>
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<td>-------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>F08</td>
<td>Extractor A Top PSI High</td>
<td>Co2 pressure detected in the vessel exceeds the maximum allowed by the programming</td>
<td></td>
</tr>
<tr>
<td>F09</td>
<td>Extractor A Top PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
</tr>
<tr>
<td>F10</td>
<td>Extractor A Bottom PSI High</td>
<td>Co2 pressure detected in the vessel exceeds the maximum allowed by the programming</td>
<td></td>
</tr>
<tr>
<td>F11</td>
<td>Extractor A Bottom PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
</tr>
<tr>
<td>F12</td>
<td>Separator 1B PSI High</td>
<td>Co2 pressure detected in the vessel exceeds the maximum allowed by the programming</td>
<td></td>
</tr>
<tr>
<td>F13</td>
<td>Separator 1B PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
</tr>
<tr>
<td>F14</td>
<td>Separator 2B PSI High</td>
<td>Co2 pressure detected in the vessel exceeds the maximum allowed by the programming</td>
<td></td>
</tr>
<tr>
<td>F15</td>
<td>Separator 2B PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
</tr>
<tr>
<td>F16</td>
<td>Filter 1B PSI High</td>
<td>Co2 pressure detected at the filter housing exceeds the maximum allowed by the programming</td>
<td></td>
</tr>
<tr>
<td>F17</td>
<td>Filter 1B PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
</tr>
<tr>
<td>Scenario</td>
<td>Condition</td>
<td>Cause</td>
<td>Action</td>
</tr>
<tr>
<td>------------------------------</td>
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<td>-----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>F18 Filter 2B PSI High</td>
<td>Co2 pressure detected at the filter housing exceeds the maximum allowed by the programming</td>
<td>Diaphragm compressor OPV out of adjustment, diaphragm compressor check valves dirty, diaphragm compressor lost prime, system in bypass, valve malfunction</td>
<td>1. Prime Compressor. 2. Watch operation to ensure system is not staying in bypass. If it is, check for pressure test failure, bottle change mode, low DC suction pressure, service separator, or high pump outlet pressure to see why system is in bypass. 3. Check air operated ball valves for operation and condition. 4. Clean diaphragm compressor check valves. 5. Check OPV adjustment pressure and adjust if necessary.</td>
</tr>
<tr>
<td>F19 Filter 2B PSI Low</td>
<td>Not Currently used</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F20 AIR PSI High</td>
<td>Compressed air pressure higher than programming allows</td>
<td>Air compressor regulator set too high</td>
<td>1. Lower system compressed air pressure setpoint to 110-120psi</td>
</tr>
<tr>
<td>F21 AIR PSI Low</td>
<td>Compressed air pressure not sufficient to operate system</td>
<td>Air leak, air compressor not running, air valve closed, compressed air regulator set too low, water in compressed air tank, air compressor too small for application</td>
<td>1. Check to make sure air compressor is running. 2. Drain water from air compressor tank. 3. Adjust air pressure regulator to 110-120 psi. 4. Check to make sure any valves in compressed air supply are in the correct position. 5. Check/repair air leaks in system. 6. Check/replace air compressor if too small for the application (when using compressor not supplied by Apeks).</td>
</tr>
<tr>
<td>F22 CO2 Supply PSI High</td>
<td>Co2 supply pressure exceeds 2000 psi</td>
<td>Possible instrumentation failure, CO2 bottles warmed up since filling, high ambient room temp</td>
<td>1. Check manual gauges to make sure they match touchscreen display readings. 2. Keep ambient temperature within recommended range (see operation manual for details).</td>
</tr>
<tr>
<td>F23 CO2 Supply PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>F24 CO2 Storage PSI High</td>
<td>CO2 storage pressure exceeds 2000 psi</td>
<td>Possible instrumentation failure, CO2 bottles warmed up since filling, high ambient room temp, CO2 storage valves closed during recovery, valve malfunction</td>
<td>1. Check manual gauges to make sure they match touchscreen display readings. 2. Keep ambient temperature within recommended range (see operation manual for details). 3. Check air operated ball valves for operation and condition. 4. Check manual valves on bottles and M9 to ensure they are in correct position</td>
</tr>
<tr>
<td>F25 CO2 Storage PSI Low</td>
<td>Not currently used</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>F26 Pump Motor Over Load</strong></td>
<td>Motor starter overload relay tripped and the mechanical auxiliary contact from the overload relay has actuated. Should occur in tandem with F061.</td>
<td>Motor belts too tight, Overload relay set too low, loose connection in motor circuit, motor power grounded, defective motor, incorrect wiring terminations, voltage too low on at least one phase, single phase power on three phase motor, blown fuse in motor power circuit.</td>
<td></td>
</tr>
</tbody>
</table>

*De-energize the system and apply safety locks/tags per OSHA regulations and your company policy before performing any diagnostic or repair work on electrical components. Only qualified personnel should work on, troubleshoot, diagnose, or repair electrical equipment.*

1. Check overload dial setting to ensure it is set to match motor FLA on motor nameplate.
2. Check all connections in motor power circuit for tightness.
3. Inspect and repair any connections made that are not in the correct location per the supplied electrical drawings. Apex provides a full set of electrical drawings inside the main control enclosure prior to shipping. If you need a replacement set, call our service department with your machine serial number.
4. Check all motor power components to ensure nothing is grounded.
5. Check voltage supply to motor to ensure it is within 10% of rated voltage on all phases.
6. Adjust belts to proper tension per the operation manual. |

| **F27 Motor Auxiliary Fault** | Controller has told the Diaphragm Compressor motor to start but does not see feedback from the motor starter that it has mechanically engaged the starter. May occur after F26 or F61 alarm as a symptom of a motor overload trip. | Generally happens after overload trips (F26 and F61). When overload trips, the neutral wire connection to the motor starter coil is interrupted so the starter will turn off to prevent damage to system. Also potentially caused by loss of power to motor starter coil power wire, neutral wire, or bad motor starter coil. |

*De-energize the system and apply safety locks/tags per OSHA regulations and your company policy before performing any diagnostic or repair work on electrical components. Only qualified personnel should work on, troubleshoot, diagnose, or repair electrical equipment.*

1. Check voltage to motor starter coil when pump motor output comes on to ensure voltage is getting to coil.
2. Check to see if overload is tripped. If so, see F26 or F61 instructions.
3. If voltage is getting to the coil, check neutral wire connections to ensure neutral has not been interrupted.
4. If voltage and neutral are present at the coil but the starter armature does not move, the coil is probably bad. Replace contactor. |
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>F28 Filter 1B PSI Drop Warning</td>
<td>CO2 pressure after the filter at Separator 1B is lower than CO2 pressure before the filter, indicating a partial clog of the filter</td>
<td>Dirty filter, dirty filter housing, dirty tubing between separator and filter housing, icy filter</td>
<td>1. Clean Filter 1B. 2. Check/clean tubing between separator 1B and filter 1B. 3. Thaw the filter if frozen and adjust run parameters to minimize the formation of dry ice in the system.</td>
</tr>
<tr>
<td>F29 Filter 2B PSI Drop Warning</td>
<td>CO2 pressure after the filter at Separator 2B is lower than CO2 pressure before the filter, indicating a partial clog of the filter</td>
<td>Dirty filter, dirty filter housing, dirty tubing between separator and filter housing, icy filter</td>
<td>1. Clean Filter 1B. 2. Check/clean tubing between separator 2B and filter 2B. 3. Thaw the filter if frozen and adjust run parameters to minimize the formation of dry ice in the system.</td>
</tr>
<tr>
<td>F30 Filter 1B PSI Drop Fault</td>
<td>CO2 pressure after the filter at Separator 1B is significantly lower than the CO2 pressure before the filter, indicating a severe clog of the filter</td>
<td>Dirty filter, dirty filter housing, dirty tubing between separator and filter housing, icy filter</td>
<td>1. Clean Filter 1B. 2. Check/clean tubing between separator 2B and filter 2B. 3. Thaw the filter if frozen and adjust run parameters to minimize the formation of dry ice in the system.</td>
</tr>
<tr>
<td>F31 Filter 2B PSI Drop Fault</td>
<td>CO2 pressure after the filter at Separator 2B is significantly lower than the CO2 pressure before the filter, indicating a severe clog of the filter</td>
<td>Dirty filter, dirty filter housing, dirty tubing between separator and filter housing, icy filter</td>
<td>1. Clean Filter 1B. 2. Check/clean tubing between separator 2B and filter 2B. 3. Thaw the filter if frozen and adjust run parameters to minimize the formation of dry ice in the system.</td>
</tr>
<tr>
<td>F32 Valve Fault</td>
<td>A fault has been detected on the Numatics pilot valve bank located to the rear of the Main Control Enclosure</td>
<td>Lost Ethernet connection to valve bank, lost power to valve bank, open or shorted coil detected by valve controller</td>
<td>1. Check valve bank for display power. 2. Check valve display for error codes. 3. Check ethernet cable (green) for condition and connection to valve controller (located on back of Main Control Enclosure)</td>
</tr>
<tr>
<td>F33 Diaphragm Burst Shutdown</td>
<td>The pressure switch on one of the diaphragm heads has detected &gt;15psi, indicating a possible internal leak in the head</td>
<td>Normal wear, OPV adjusted too high, clogged check valve, loose head bolts, bad O-ring in compressor head</td>
<td>1. Check pressure gauge on each diaphragm head. If one or both are reading above zero, open the black vent valve to relieve pressure. If pressure drops to zero and there is no oil present, restart system one time to see if pressure continues to climb. If it does not, monitor closely and continue operation. 2. If there is oil present when venting the head pressure, stop operation immediately and remove material from machine to prevent contamination. The head will have to be removed to make repairs. 3. When making repairs to diaphragms and O-rings, be sure to clean check valves, properly prime the system, and properly adjust the OPV per Apelks instructions.</td>
</tr>
<tr>
<td><strong>F34 Pressure Test Fail</strong></td>
<td>A loss of pressure has been detected when attempting to pressurize a vessel that had not previously been online</td>
<td>Valve 10 open, evac valve open, loose tubing connection to separator, loose separator closure, missing o-ring or gasket on separator</td>
<td>1. Check valve 10 and evac valve to ensure they are closed during pressure test. 2. Check all connections on separator for tightness. 3. Check separators for o-rings/gaskets. 4. Evacuate and pull vacuum to see if system will hold vacuum pressure to help locate a possible leak.</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>F35 Oil Pressure Lost</strong></td>
<td>Oil pressure switch did not detect &gt;5psi oil pressure while the diaphragm compressor was running</td>
<td>Incorrect direction of compressor rotation relative to the arrow on the belt guard, bad injection pump, bad oil pressure regulator, low oil level, dirty oil, bad oil pressure switch, loose connection in oil pressure switch circuit</td>
<td><em>De-energize the system and apply safety locks/tags per OSHA regulations and your company policy before performing any diagnostic or repair work on electrical components. Only qualified personnel should work on, troubleshoot, diagnose, or repair electrical equipment.</em> 1. Check compressor rotation direction. Reverse two wires in motor power circuit if rotating backwards. 2. Check compressor oil level and condition. If dirty or low, replace and fill to correct level. 3. Check manual pressure gauges on compressor when running. High pressure side should read about 40psi and low pressure side should read about 20psi. If pressures on manual gauges are correct, check oil pressure switch electrical connections. If connections are good and pressure is good, pressure switch is likely cause. 4. If pressure is low, check blue oil pressure regulator to see if pressure can be adjusted up to 40 psi. If not, oil pump or injection pump are likely cause. Call Apels for support.</td>
</tr>
<tr>
<td>Condition</td>
<td>Description</td>
<td>Steps</td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>F36 Extractor Water Flow Lost</td>
<td>Water flow in the Extractor side of the system not detected</td>
<td>1. Check temperature control unit to make sure it is running. Make sure pump is on. 2. Check any quick disconnect fittings to ensure they are fully connected. 3. Check water flow switch to ensure water flow direction matches the arrow on the top of the switch. 4. Check electrical cable connection at water flow switch for tightness. 5. Check water line routing to ensure a complete path through the system matching the P&amp;ID drawing in the operation manual. 5. Work through the water line system cracking fittings loose to bleed out any air. Start at the highest point in the system and work downward.</td>
<td></td>
</tr>
<tr>
<td>F37 Separator Water Flow Lost</td>
<td>Water flow in the Separator side of the system not detected</td>
<td>1. Check temperature control unit to make sure it is running. Make sure pump is on. 2. Check any quick disconnect fittings to ensure they are fully connected. 3. Check water flow switch to ensure water flow direction matches the arrow on the top of the switch. 4. Check electrical cable connection at water flow switch for tightness. 5. Check water line routing to ensure a complete path through the system matching the P&amp;ID drawing in the operation manual. 5. Work through the water line system cracking fittings loose to bleed out any air. Start at the highest point in the system and work downward.</td>
<td></td>
</tr>
<tr>
<td>F38 Emergency Stop Pressed</td>
<td>The emergency stop input has been lost</td>
<td>Check position of Emergency stop button, Check force guided relays (409FGR1 and 411FGR1 in main control enclosure) for proper insertion. Check any screen for an &quot;E-stop reset&quot; button.</td>
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</tr>
<tr>
<td>F39 Second Extractor Pressure Over</td>
<td>Extractor pressure has exceeded the maximum allowable pressure at least twice in the last ten minutes</td>
<td>Extractor filter clog, valve malfunction, tube between extractor and separator dirty. 1. Check air operated ball valves for operation and condition. 2. Inspect and clean tubing and hoses between extractors and separators. 3. Inspect and clean extractor filters.</td>
<td></td>
</tr>
<tr>
<td>F40 Separator Pressure Creep</td>
<td>Separator pressure has risen with the system offline</td>
<td>Likely caused by large amount of dry ice in the separator sublimating after shutdown, which can increase separator pressure over time. 1. Select operating parameters that will minimize the possibility of dry ice forming in the separators during operation. 2. Vent separators at the end of the cycle before dry ice sublimates.</td>
<td></td>
</tr>
<tr>
<td>F41 Pump Outlet Elevated PSI</td>
<td>The Diaphragm compressor outlet pressure is near the high pressure fault</td>
<td>Extractor filter clog, Valve malfunction, CO₂ storage closed during recovery, particulate filter before extractor clogged. 1. Check air operated ball valves for operation and condition. 2. Ensure manual valves for CO₂ storage are open during removal of CO₂ from the system. 3. Inspect and clean extractor filters. 4. Inspect and clean particulate filter between compressor outlet and temperature control heat exchanger.</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Description</td>
<td>Action</td>
<td></td>
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<tr>
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<tr>
<td>F42 Low System CO2 Pressure</td>
<td>The system has been unable to maintain extractor pressure high enough to ensure solvency of CO2. CO2 supply bottle closed. CO2 supply and storage have inadequate amount of CO2 pressure to fill the system, valve 12 or 20 malfunction, valve 13 allowing CO2 to leak by when closed, diaphragm compressor OPV out of adjustment, diaphragm compressor check valves dirty, diaphragm compressor lost prime, system in bypass, valve 17 allowing CO2 to leak past when closed.</td>
<td>1. Ensure CO2 supply and storage manual valves are open. 2. Ensure Amount of CO2 pressure is adequate to overcome separator pressure and fill the system. 3. Check air operated ball valves for operation and condition. 4. Check valve 13 for indications of internal leakage (frost on valve or near valve, ice being pushed out of valve stem during operation). 5. Check OPV pressure setpoint during operation and adjust according to Apels’ instructions if necessary. 6. Re-prime diaphragm compressor. 7. Watch system run to make sure it is not in bypass (valve 17 open). If in bypass, check to see if system is in service separator mode, bottle change mode, has failed pressure test, has low diaphragm compressor suction pressure (&lt;100 psi) and rectify cause of bypass condition. 8. Inspect and clean diaphragm compressor check valves according to Apels’ instructions.</td>
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<tr>
<td>F43 Service Separator Ext PSI High</td>
<td>The extractor pressure has risen during service separator mode to a level that is close to the maximum pressure allowed by the controls. Extractor temperature increased while in service separator mode, valve 17 did not open to allow CO2 to circulate in bypass.</td>
<td>1. Check air operated ball valves for operation and condition. 2. Reduce extractor temperature if machine will be in service separator mode for extended periods of time. 3. Check diaphragm compressor outlet pressure to ensure gauge pressure matches on screen pressure.</td>
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</tr>
<tr>
<td>F44 Chiller 1 Fault</td>
<td>The extractor side temperature control unit has a fault. Loss of power, temperature control unit motor overload, temperature control unit temperature fault, faulty temperature control unit pump, faulty heater in temperature control unit.</td>
<td>See manual for temperature control unit</td>
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<tr>
<td>F45 Chiller 2 Fault</td>
<td>The separator side temperature control unit has a fault. Loss of power, temperature control unit motor overload, temperature control unit temperature fault, faulty temperature control unit pump, faulty heater in temperature control unit.</td>
<td>See manual for temperature control unit</td>
<td></td>
</tr>
<tr>
<td>F46 Chiller 1 Warning</td>
<td>The extractor side temperature control unit has a warning. Loss of power, temperature control unit motor overload, temperature control unit temperature fault, faulty temperature control unit pump, faulty heater in temperature control unit.</td>
<td>See manual for temperature control unit</td>
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<tr>
<td>Code</td>
<td>Description</td>
<td>Reason</td>
<td>Action</td>
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<tr>
<td>F47</td>
<td>Chiller 2 Warning: The separator side temperature control unit has a warning.</td>
<td>Loss of power, temperature control unit motor overload, temperature control unit temperature fault, faulty temperature control unit pump, faulty heater in temperature control unit</td>
<td>See manual for temperature control unit</td>
</tr>
<tr>
<td>F48</td>
<td>Code Needed: System requires monthly lease code entry for operation.</td>
<td>The first day of a new month will bring this fault if the monthly lease code for the new month has not been entered</td>
<td>Contact Apeks service department</td>
</tr>
<tr>
<td>F49</td>
<td>Extractor Not Equalizing: Extractor pressure did not reach 450psi within allowed time during startup.</td>
<td>CO2 supply bottle closed, CO2 supply and storage have inadequate amount of CO2 pressure to fill the system, valve 12, 13, or 20 malfunction</td>
<td>1. Open manuals M9, M1-M4. 2. Check air operated ball valves for operation and condition, paying particular attention to valves 12, 13, and 20 during fill cycle. Valve 20 will only open to fill when CO2 storage pressure is below 450psi.</td>
</tr>
<tr>
<td>F50</td>
<td>Pump High Recovery: The Diaphragm compressor outlet pressure exceeded the maximum value during recovery of CO2.</td>
<td>CO2 storage is full, CO2 storage valves closed, valve 13 malfunction</td>
<td>1. Ensure CO2 storage bottle valves are open during recovery. 2. Ensure valve M9 is open during recovery. Check operation and condition of air operated ball valve #13.</td>
</tr>
<tr>
<td>F51</td>
<td>DC Ambient Temperature TC Fault: The thermocouple for ambient temperature measurement at the diaphragm compressor has a fault.</td>
<td>Thermocouple cable damaged, thermocouple damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 4. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 5. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apeks</td>
</tr>
<tr>
<td>F52</td>
<td>Ext Ambient Temperature TC Fault: The thermocouple for ambient temperature measurement at the extraction stand has a fault.</td>
<td>Thermocouple cable damaged, thermocouple damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 4. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 5. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apeks</td>
</tr>
<tr>
<td>Fault Code</td>
<td>Description</td>
<td>Symptoms</td>
<td>Steps</td>
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<tr>
<td>F53 Sep Ambient Temperature TC Fault</td>
<td>The thermocouple for ambient temperature measurement at the separator stand has a fault</td>
<td>Thermocouple cable damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 5. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 6. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apexs</td>
</tr>
<tr>
<td>F54 Ext A Vessel Temperature TC Fault</td>
<td>The thermocouple for temperature measurement in Extractor vessel A has a fault</td>
<td>Thermocouple cable damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 5. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 6. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apexs</td>
</tr>
<tr>
<td>F55 Ext B Vessel Temperature TC Fault</td>
<td>The thermocouple for temperature measurement in Extractor vessel B has a fault</td>
<td>Thermocouple cable damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 5. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 6. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apexs</td>
</tr>
<tr>
<td><strong>F56 Sep 1 Vessel Temperature TC Fault</strong></td>
<td>The thermocouple for temperature measurement in Separator vessel 1A has a fault</td>
<td>Thermocouple cable damaged, thermocouple damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 4. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 5. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apels</td>
</tr>
<tr>
<td><strong>F57 Sep 2 Vessel Temperature TC Fault</strong></td>
<td>The thermocouple for temperature measurement in Separator vessel 2A has a fault</td>
<td>Thermocouple cable damaged, thermocouple damaged, thermocouple cable disconnected, PLC thermocouple input card damaged</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 4. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 5. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apels</td>
</tr>
<tr>
<td><strong>F58 Unready for Transition. Recovered system</strong></td>
<td>During Continuous batch mode, the machine was ready to bring the second vessel online but the vessel was not ready for transition for time that exceeded one full transition period beyond the scheduled transition. Machine automatically went into recovery.</td>
<td>Extractor closed proximity or limit switch not made, operator did not press button to indicate they are finished servicing the vessel that was offline before the timer expired to bring it online</td>
<td>1. When in continuous batch mode, be sure to go to the elapsed time settings screen, which can be accessed by a button in the center of the bottom of the main screen, and press the button to indicate the next vessel to come online is ready. If the operator does not press this button during a single vessel interval, the second vessel will not come online when the time interval says it should. If this happens, the machine will run for one more time interval and then go into recovery. 2. Ensure the interlock cap is on the extractor vessels after servicing.</td>
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<tr>
<td>Interstage Pressure State</td>
<td>Condition</td>
<td>Action</td>
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<tr>
<td>F59 DC Interstage Pressure High (5000 psi systems only)</td>
<td>CO2 pressure measured in the area between stage 1 and stage 2 of the diaphragm compressor exceeded the maximum allowable pressure</td>
<td>Stage 2 diaphragm compressor head OPV lost prime, Stage 2 diaphragm compressor OPV needs adjusted or cleaned, stage 2 diaphragm compressor check valves dirty or defective, interstage particulate filter clogged</td>
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<tr>
<td>F60 DC Interstage Pressure Low (5000 psi systems only)</td>
<td>CO2 pressure measured in the area between stage 1 and stage 2 of the diaphragm compressor fell below the minimum acceptable threshold during a run cycle</td>
<td>Filter between stage 1 and stage 2 clogged, stage 1 diaphragm compressor head lost OPV prime, stage 1 diaphragm compressor OPV needs adjusted or cleaned, stage 1 diaphragm compressor check valves dirty or defective</td>
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<tr>
<td>F61 DC Overload relay tripped</td>
<td>The motor starter Ethernet condition monitor detected an overload relay trip should occur in tandem with F25</td>
<td>Motor belts too tight, Overload relay set too low, loose connection in motor circuit, motor power grounded, defective motor, incorrect wiring terminations, voltage too low on at least one phase, single phase power on three phase motor, blown fuse in motor power circuit</td>
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</table>

1. Inspect and clean interstage filter on diaphragm compressor. 2. Check OPV set pressure on stage 2 and adjust according to Apex's instructions if necessary. 3. Prime compressor. 4. Inspect and clean stage 2 check valves on compressor head.

1. With no interstage pressure and system off, check/clean interstage filter. 2. Check OPV set pressure on stage 1 and adjust according to Apex's instructions if necessary. 3. Prime compressor. 4. Inspect and clean stage 1 compressor check valves. 5. Ensure adequate CO2 supply to first stage compressor suction side.

*De-energize the system and apply safety locks/tags per OSHA regulations and your company policy before performing any diagnostic or repair work on electrical components. Only qualified personnel should work on, troubleshoot, diagnose, or repair electrical equipment.* 1. Check overload dial setting to ensure it is set to match motor FLA on motor nameplate. 2. Check all connections in motor power circuit for tightness. 3. Inspect and repair any connections made that are not in the correct location per the supplied electrical drawings. Apex puts a full set of electrical drawings inside the main control enclosure prior to shipping. If you need a replacement set, call our service department with your machine serial number. 4. Check all motor power components to ensure nothing is grounded. 5. Check voltage supply to motor to ensure it is within 10% of rated voltage on all phases. 6. Adjust belts to proper tension per the operation manual.
<table>
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<tr>
<th>Error Code</th>
<th>Description</th>
<th>Recommended Action</th>
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<tbody>
<tr>
<td>F62 DC Overload thermal usage warning</td>
<td>The motor starter Ethernet condition monitor detects a thermal load on the overload relay in excess of 90% of the allowable threshold.</td>
<td>Motor belts too tight, overload relay set too low, loose connection in motor circuit, motor power grounded, defective motor, incorrect wiring terminations, voltage too low on at least one phase, single phase power on three phase motor, blown fuse in motor power circuit. <em>De-energize the system and apply safety locks/tags per OSHA regulations and your company policy before performing any diagnostic or repair work on electrical components. Only qualified personnel should work on, troubleshoot, diagnose, or repair electrical equipment.</em> 1. Check overload dial setting to ensure it is set to match motor FLA on motor nameplate. 2. Check all connections in motor power circuit for tightness. 3. Inspect and repair any connections made that are not in the correct location per the supplied electrical drawings. Apels puts a full set of electrical drawings in the main control enclosure prior to shipping. If you need a replacement set, call our service department with your machine serial number. 4. Check all motor power components to ensure nothing is grounded. 5. Check voltage supply to motor to ensure it is within 10% of rated voltage on all phases. 6. Adjust belts to proper tension per the operation manual.</td>
</tr>
<tr>
<td>F63 Vapor filter desiccant clog fault</td>
<td>The system detected a large pressure drop across the vapor filter, indicating the need to replace the desiccant material to restore proper flow.</td>
<td>Dirty filter media, clogged line between separator and vapor filter housing, faulty valve 30B or 31B. 1. Check air operated ball valves for operation and condition, paying special attention to 30B and 31B. 2. Check/clean tubing between filter 18/2B and vapor filter. 3. Replace filter media.</td>
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<tr>
<td>F64 CO2 temperature fault, DCINT before heat exch. (5000 psi systems only)</td>
<td>The system detected an abnormal temperature of the CO2 at the exit of stage 1 of the diaphragm compressor before the interstage heat exchanger.</td>
<td>Diaphragm compressor stage 1 check valves dirty or defective, separator side temperature control unit failure, plugged interstage heat exchanger. 1. Check separator temperature control unit for faults or warnings. 2. Inspect/clean stage 1 compressor check valves. 3. Check water flow rate on temperature controller.</td>
</tr>
<tr>
<td>F65 CO2 temperature fault, DCINT after heat exch. (5000 psi systems only)</td>
<td>The system detected an abnormal temperature of the CO2 at the entrance of stage 2 of the diaphragm compressor after the interstage heat exchanger.</td>
<td>Plugged interstage heat exchanger. May be accompanied by F37 Separator water flow lost, thermocouple calibration failure. 1. Check separator temperature control unit for faults or warnings. 2. Inspect/clean stage 1 and 2 compressor check valves. 3. Check water flow rate on separator temperature controller.</td>
</tr>
<tr>
<td>F66 Inadequate temperature drop DCINT heat exch. (5000 psi systems only)</td>
<td>The temperature change across the interstage heat exchanger at the diaphragm compressor is inadequate.</td>
<td>Plugged interstage heat exchanger. May be accompanied by F37 Separator water flow lost, thermocouple calibration failure. 1. Check separator temperature control unit for faults or warnings. 2. Inspect/clean stage 1 and 2 compressor check valves. 3. Check water flow rate on separator temperature controller.</td>
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<tr>
<td>Fault Description</td>
<td>Description</td>
<td>Action</td>
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<tr>
<td>F67 Separator bank 1 proximity switch fault</td>
<td>A proximity switch on separator bank 1 detected removal of an interlock pin with a pressurized vessel.</td>
<td>1. Check input on I/O screen with interlock pins in place to ensure proximity switch is reading the pin. If not, make sure pin is within 4mm of proximity switch and centered. 2. Check cable connections to proximity switches. 3. Check condition of cable to proximity switches on vessels.</td>
</tr>
<tr>
<td>F68 Separator bank 2 proximity switch fault</td>
<td>A proximity switch on separator bank 2 detected removal of an interlock pin with a pressurized vessel.</td>
<td>1. Check input on I/O screen with interlock pins in place to ensure proximity switch is reading the pin. If not, make sure pin is within 4mm of proximity switch and centered. 2. Check cable connections to proximity switches. 3. Check condition of cable to proximity switches on vessels.</td>
</tr>
<tr>
<td>F69 Shutdown due to 180 minutes of bypass</td>
<td>The system remained in bypass for 180 consecutive minutes. The system has automatically shut down.</td>
<td>1. Make sure any leaks are fixed and then run pressure test again. 2. Check/clean orifice if separator pressure is lower than expected during run cycle. 3. Check air operated ball valves for operation and condition. 4. Ensure system has an adequate supply of CO2 and all valves are open to allow the system to add CO2.</td>
</tr>
<tr>
<td>F70 Extractor TCU water temp TC fault</td>
<td>The thermocouple for water temperature measurement at the Extractor TCU outlet has a fault. TCU heater will not engage with this fault.</td>
<td>1. Check thermocouple cable connection to thermocouple. 2. Inspect condition of thermocouple cable. 3. Inspect condition of thermocouple. 4. Swap location of two thermocouples and see if fault follows the cable or the thermocouple to aid in diagnosis. 4. Replace cable if problem follows cable. Replace thermocouple if problem follows thermocouple. 5. If thermocouple and cable are both known good parts, PLC input card is likely cause. Contact Apex.</td>
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<tr>
<td>Fault Code</td>
<td>Description</td>
<td>Potential Cause</td>
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<tr>
<td>F71</td>
<td>Separator TCU water temp TC fault</td>
<td>The thermocouple for water temperature measurement at the Separator TCU outlet has a fault. TCU heater will not engage with this fault</td>
</tr>
<tr>
<td>F72</td>
<td>Separator change delayed shutdown</td>
<td>The machine attempted to change separators but both sets of separators were not ready. Shutdown occurs after a 60 minute delay</td>
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