PNEUMATIC & HYDRAULIC CO.

Operations Manual

Mobile Refueling System

West Air Mobile H2 Refueler

Revision 5

Date Created: 5/8/2025

Mobile Refueling System

Table Of Contents

P&ID Valve Legend

Within this manual you will see the following abbreviations representing components in this Hydrogen Mobile Refueler.

The abbreviations will be on the following pages: **6-11**, **15-16**.

ABBREVIATION	DEFINITION
MIV	Manual Isolation Valve
MVV	Manual Vent Valve
DCIV	Digital Isolation Valve
DCVV	Digital Check Valve
TIV	Tank Isolation Valve
BIV	Ball Isolation Valve
HIV	Hot Isolation Valve
CWIV	Cold Water Isolation Valve

Warranty

Seller provides the following limited warranty for all equipment of Seller's manufacture or assembly for a period of one (1) year from the date of shipment to Buyer: such equipment will materially meet the written specifications stated in the order and will be of good quality and workmanship for the equipment's ordinary use. This warranty shall not apply to equipment or components not manufactured by Seller. With respect to equipment or components sold but not manufactured by Seller, the warranty obligations of Seller shall in all respects conform and be limited to any warranty actually extended to Seller by its supplier of such equipment or components, and Seller assigns said warranty to Buyer to the fullest extent allowed by law. For any services furnished by Seller (e.g., installation, maintenance), Seller warrants such services will be performed in general conformance with industry standards. All other warranties (for sales, services or otherwise) not expressly stated herein, whether express or implied (including but not limited to the warranty of fitness for specific use or purpose and/or redhibition or latent defects) are hereby waived. Seller's warranty shall in no event apply to equipment or components which (i) shall have been repaired or altered by any person or entity other than Seller, or (ii) have been subjected to improper maintenance, operation or storage, other than normal usage or service, negligence or fault of any person or entity other than Seller, accident, or damage by any circumstances beyond Seller's control. As the sole and exclusive remedy for any breach of warranty, at Seller's sole option, Seller will either (i) repair or replace any non-conforming equipment or component(s) and/or re-perform any non-conforming services, or (ii) accept return of the non-conforming equipment or component(s) and return the purchase price or other compensation for applicable non-conforming services or goods to Buyer, in all cases without any other liability whatsoever, it being agreed that in no event will Buyer be liable for any costs or expenses for labor, transportation, removal, installation or other expenses in connection with the repair of replacement. In no event will Seller be responsible for any consequential, indirect, punitive, economic, or incidental damages which may be suffered by Buyer arising in any way out of the sale or services hereunder, regardless of whether occasioned by breach of warranty, negligence or other fault of Seller, its affiliates, suppliers, vendors, and/or subcontractors of any tier, and/or the employees of the foregoing. Notwithstanding any other provisions herein, in no event will Seller's liability for warranty exceed 120% of Seller's price or compensation for non-conforming equipment or services. Buyer releases, defends, and indemnifies Seller, its affiliates, distributors and vendors of any tier and their employees ("Seller Group") for all liabilities, claims and causes of action for any, and all damages other than Buyer's liability under the limited warranties hereof, REGARDLESS OF WHETHER CAUSED BY THE NEGLIGENCE, BREACH OF WARRANTY/DUTY, OR OTHER FAULT OF AND MEMBER OF SELLER GROUP. Buyer shall carry insurance of all types and amounts necessary to fully insure Buyer's defense, indemnity and hold harmless obligations herein to the fullest extent allowed by law, but in no event less than $10 million of Comprehensive General Liability coverage, and all such insurance shall name Seller Group as additional insured, waive subrogation rights and be primary/non-contributary as respects Seller Group (all of such insurance is collectively referred to as "Seller's Insurance"). Seller represents and guarantees that Seller has recovered all costs of Seller's Insurance in the negotiated contract price for the sale and any services hereunder. CANCELLATION. Buyer may not terminate or cancel for convenience, or direct suspension of manufacture, except with Seller's written consent signed by an officer of Seller and then only upon terms that will compensate Seller for the cost incurred as a result of any engineering, fabrication, purchasing, or any other cost relating to such termination, cancellation, or suspension, plus a reasonable amount for profit. ENTIRE AGREEMENT/MISC. These terms and conditions, and the matters set forth on the face of Seller's offer to sell, constitute the entire agreement between Seller and Buyer. No prior or subsequent understandings, agreements or representations, express or implied, are part of this contract, nor shall any subsequent modification agreement or representation become part of this contract unless expressly agreed to in writing by an authorized representative of the Seller. In the event it becomes necessary for Seller to incur any costs or expenses in the collection of moneys due Seller from Buyer, or to enforce any of its rights or privileges hereunder, Buyer upon demand shall reimburse Seller for all such costs and expenses including but not limited to, reasonable attorney's fees, expert fees and costs of suit. Any typographical or clerical errors made by Seller in any quotation, acknowledgement or publication are subject to correction. This agreement shall be governed by the laws of the State of Louisiana, without giving effect to the choice of conflicts of law provisions thereof, and the parties expressly agree to exclusive jurisdiction and venue in the court of the Parish of Lafayette, Louisiana for any dispute arising hereunder.

Safety Statement

To ensure this quality product is safely and correctly utilized, all instructions within this manual must be read and understood prior to equipment start-up. Be aware of all the safety labels on machinery. If you do not understand any of the safety instructions contact your supervisor or product supplier immediately!

Compliance with safety standards, including federal, state and local codes or regulations is the responsibility of the purchaser(s). A safety study should be made of the products' application by the purchaser(s). It is the purchaser's responsibility to provide any additional guards, safety labels or other safety equipment deemed necessary based on this safety study.

The information contained in this safety manual is correct at the time of printing. Due to the continuing development of product lines, changes in specifications are inevitable. The company reserves the right to implement such changes without prior notice.

If you suspect fire hazards, safety hazards, dangers to health or any other job safety concerns, consult your federal, state or local codes.

Inspect equipment for safety labels. Make sure the personnel are aware of and follow safety instructions. Always maintain an orderly environment in the vicinity of Mobile Refueler. Clean up spilled materials or lubricants immediately. All personnel shall be instructed regarding the necessity for continuous care and attention to safety during the operation. They must be trained to identify and immediately report all unsafe conditions or practices relating to Mobile Refueler and its operation. Know your company's machine specific Lockout / Tagout procedure. Do not perform maintenance until the electrical disconnect has been turned off! Replace all safety devices, guards and guarding prior to equipment start-up.

All electrical installations and wiring shall conform to federal, state and local codes.

Control stations should be so arranged and located that the operation of the affected equipment is visible from them. Control stations should be clearly marked or labeled to indicate the function controlled.

Remotely and automatically controlled products, and products where operator stations are not manned or are beyond voice or visual contact from drive areas, loading areas, transfer points and other potentially hazardous locations on Mobile Refueler path not guarded by location, position or guards shall be furnished with emergency stop buttons, pull cords, limit switches or similar emergency stop devices. The emergency stop devices shall be installed so that they cannot be overridden from other locations.

Only trained, qualified personnel shall be permitted to operate this machine. Training shall include instruction in operation under normal conditions and emergency situations.

It is the responsibility of the purchaser of this unit to train operating personnel in the proper manner of operation. It is furthermore understood that PHC Fluid Power assumes no responsibility for injury, disability, or death resulting from improper operation, removal, or bypassing of any electrical or mechanical safety devices incorporated in the design and manufacturing of this product.

The proper clothing for the job is always to be worn. Several types of protective equipment are available which can help you to avoid injury.

Introduction

At Pneumatic and Hydraulic Company LLC (PHC), we have been at the forefront of pneumatic, hydraulic, and fluid power technologies for over 60 years. Our extensive experience and unwavering commitment to quality enable us to provide innovative solutions and unmatched service to industries worldwide.

With a deep understanding of pneumatic and hydraulic systems, our team delivers cutting-edge, custom-engineered solutions tailored to meet the unique demands of each client. Whether you need hydraulic power units, pneumatic systems, or fluid handling solutions, we ensure that every project is executed with precision, efficiency, and reliability.

For six decades, we have built strong partnerships with our clients, offering not only high-quality products but also technical expertise and dedicated customer support. Our mission is to be your trusted partner in fluid power, driving your success with industry-leading products and comprehensive services.

System Requirements:

HYDRAULIC OIL

The performance of the hydraulic system depends on the quality of the hydraulic fluid used and should be selected according to the operating conditions. Refer to Haskel website for manufacturer oil and maintenance requirements. **Use the part number on the H-drive to confirm the proper manufacturer's designed manual is found.**

The service life of hydraulic fluid is influenced by contaminants (particulate & water) and cracking caused by high temperatures.

- Contaminants should adhere to ISO 4406 19/17/14
- New hydraulic oil does not necessarily fulfil the required cleanliness requirement and should be filtered before adding to tank.
- Mixing diverse types/grades of oils should be avoided. This may lead to undesirable chemical reactions causing sludge.
- Tank temperature should be below 150°F.

The primary consideration when determining hydraulic oil is operating viscosity. Other choices must be considered such as fluid type, (synthetic, petroleum and water based) and other additives.

- Viscosity was selected based on ambient operating temperatures.
  - Temperature: 30F to 140°F ISO 32
  - 0°F to 70°F ISO 22

  Additional heaters may be added to tank for cold weather environments

ELECTRIC SERVICE

Qualified and licensed personnel should commission electrical service according to local electrical codes. PHC Fluid Power should be consulted for electrical demands unique to each system. The following chart is provided as a reference only.

Product	Recommended Service (Amps)	Phases	Voltage
Mobile Refueler	**550**	**3 Phase**	**480**
H2 Compressor	**250**		
T40 Chiller	**150**		
T20 Chiller	**80**		
Dispenser	**40**		

Table 1. Electrical Service Table

PRODUCT DIMENSIONS & WEIGHT

Dimensions	
Length:	**53ft**
Width:	**8ft**
Height:	**12ft**

Table. 2: Dimensions

Operations Process

PHC Fluid Power equipment is carefully inspected and packed before leaving our factory. The transportation company assumes full responsibility for the safe delivery of this equipment. Visible damage or loss should be noted on the freight bill and signed by the person making delivery. A freight claim should be filed immediately with the transportation company. If damage is unnoticed or concealed until equipment is unpacked, notify the transportation company immediately and tell them you want to file a concealed damage claim. This must be done within three (3) days after delivery was made. Be sure to retain all package material and cartons.

WARNING: Installation of this equipment should be performed only by qualified personnel with consideration for local, state and federal regulations.

A qualified service technician should only perform adjustments and service work. Service & Installation is available through PHC Fluid Power.

Pre-Setup

Electrical System:

1. Install the Ground rod into ground.
2. Connect grounding rod to grounding cable.
3. Connect the Grounding cable to grounding lug mounted on trailer.
4. Visually inspect all wires to verify there is no visual damage to the external isolation coating.
5. Open the power distribution panel and ensure all the breakers are in the open/off position.
6. Hook up the 480V 60Hz 200kw power source to the main power distribution panel. Ensure the proper wire is used to handle the full load of the system. (consult local regulations to verify you meet code, PHC/THS is not liable for any issues related to supply power)
7. Do not move the breakers to the closed/on position until all pre startup check list is completed.

T40 Hydrogen Chiller:

- See manufactures manual for startup procedure, Racoon 45 US OD – MOD 1 set up (**See Pages 23- through 29 of this document**)

20-Ton equipment Chiller set up (**See Pages 30- through 40 of this document**)

- See manufactures manual for startup procedure, for Cold Shot.

H2B700 – Hydrogen Booster 700 bar model

- Ensure all valves are in the following positions by manual means, below present in Compressor Skid area:

Compressor Skid			
Valve	**Position**	**Valve**	**Position**
MIV1	CLOSED	MVV3	CLOSED
MIV2	CLOSED	MVV4	CLOSED
MIV3	OPEN	CWIV1	OPEN
MIV4	OPEN	CWIV2	OPEN
MIV5	OPEN	CWIV3	OPEN
MIV6	OPEN	CWIV4	OPEN
BIV1	CLOSED	CWIV5	OPEN
BIV2	CLOSED	CWIV6	OPEN
TIV1	CLOSED	CWIV7	OPEN
TIV2	CLOSED	CWIV8	OPEN
TIV3	CLOSED	CWIV9	OPEN
TIV4	CLOSED	CWIV10	OPEN
TIV5	CLOSED	CWIV11	OPEN
TIV6	CLOSED	CWIV12	OPEN
TIV7	CLOSED	HIV1	OPEN
TIV8	CLOSED	HIV2	OPEN
TIV9	CLOSED	HIV3	OPEN
MVV1	CLOSED	HIV4	OPEN
MVV2	CLOSED	HIV5	OPEN

Hydrogen Dispenser

- Then, power on the system to open all DCIV valves while closing the DCVV valves, ensuring proper hydrogen flow with the MIVs remaining open.

Dispenser	
Valve	**Position**
MIV-600-1	OPEN
MIV-600-2	OPEN
MIV-600-3	OPEN
MIV-600-4	OPEN
MVV-600-1	CLOSED
MVV-600-2	CLOSED
MVV-600-3	CLOSED
MVV-600-4	CLOSED
MVV-600-5	CLOSED
MVV-600-6	CLOSED
MVV-600-7	CLOSED
DCIV-600-1	CLOSED
DCIV-600-2	CLOSED
DCIV-600-3	CLOSED
DCIV-600-4	CLOSED
DCIV-600-5	CLOSED
DCIV-600-6	CLOSED
DCIV-600-7	CLOSED
DCIV-600-8	CLOSED
DCVV-600-1	CLOSED

Nitrogen Purge:

Note: this must be completed prior to and every time after introducing hydrogen for the first time and every time air has or potentially entered the system.

- Deactivate power
- Connect Nitrogen supply line to Nitrogen inlet bulkhead on the H2B700 Hydrogen Booster.
- In the main power distribution panel move the main power breaker to the closed/on position.
- In the main power distribution panel move the breaker for the Compressor to the closed/on position.
- In the main power distribution panel move the breaker for the dispenser to the closed/on position.
- Ensure all Valves are in the following positions listed below: The DCIV Valves will be operated from the HMI (Human Machine Interface) on the H2B700.

Compressor Skid			
Valve	**Position**	**Valve**	**Position**
MIV1	CLOSED	MVV3	CLOSED
MIV2	OPEN	MVV4	CLOSED
MIV3	OPEN	DCIV1	OPEN
MIV4	OPEN	DCIV2	CLOSED
MIV5	OPEN	DCIV3	OPEN
MIV6	OPEN	DCIV4	CLOSED
BIV1	OPEN	DCIV5	OPEN
BIV2	OPEN	DCIV6	OPEN
TIV1	OPEN	DCIV7	OPEN
TIV2	OPEN	DCIV8	OPEN
TIV3	OPEN		
TIV4	OPEN		
TIV5	OPEN		
TIV6	OPEN		
TIV7	OPEN		
TIV8	OPEN		
TIV9	OPEN		
MVV1	CLOSED		
MVV2	CLOSED		

Nitrogen Purge continued:

Dispenser Valving	
Valve	**Position**
MIV-600-1	**OPEN**
MIV-600-2	**OPEN**
MIV-600-3	**OPEN**
MIV-600-4	**OPEN**
MVV-600-1	**CLOSED**
MVV-600-2	**CLOSED**
MVV-600-3	**CLOSED**
MVV-600-4	**CLOSED**
MVV-600-5	**CLOSED**
MVV-600-6	**CLOSED**
MVV-600-7	**OPEN**
DCIV-600-1	**OPEN**
DCIV-600-2	**OPEN**
DCIV-600-3	**CLOSED**
DCIV-600-4	**OPEN**
DCIV-600-7	**OPEN**
DCIV-600-8	**OPEN**
DCVV-600-1	**CLOSED**

- Slowly introduce nitrogen gas into the system up to a pressure slightly above atmospheric (5-10 psi) to displace any remaining gases.
- Allow nitrogen to flow through each component of the system, including tanks, compressor, and any associated piping.
- Gradually increase pressure to the working purge of 500 psi.

Purge Using Cycles of Pressurization and Venting:

Safety Considerations:

Always perform purging in a well-ventilated area to prevent nitrogen buildup and oxygen displacement in the workspace. Maintain continuous monitoring for hydrogen leaks once introduced into the system. Follow all applicable codes, standards, and local regulations for handling and purging hydrogen systems.

- **Pressurized:** Pressurize the system with nitrogen to the designated purge pressure
- **Hold:** Allow nitrogen to remain in the system for several minutes, allowing thorough mixing and displacement of residual gases.
- **Vent:** Slowly vent nitrogen through **MVV-600-5, MVV-600-6, AND MVV-600-7** in the dispenser while monitoring for complete gas displacement. (Refer to dispenser manual for additional steps)
- Repeat the pressurize-hold-vent cycle at least three times or until the desired purity level is confirmed, with no residual oxygen or contaminants.

Monitor Purge Effectiveness:

- Use a gas analyzer at the vent to confirm low oxygen levels (typically below 1%) and absence of other impurities.
- Continue the purge cycle until readings indicate that only nitrogen is present, ensuring complete purging of all oxygen and contaminants.

Final Nitrogen Purge Verification:

- Once purging is complete, conduct a final nitrogen purge cycle and verify that the system is filled with pure nitrogen.
- Take final readings with the gas analyzer to confirm that the system is free of oxygen and hydrocarbons, ensuring it is safe for hydrogen introduction.
- Close MIV2.

Depressurize System to Slightly Above Atmospheric Pressure:

- Vent any excess nitrogen until the system is just above atmospheric pressure, preparing it for hydrogen introduction.

Introduce Hydrogen Gradually:

- Connect the Hydrogen supply trailer to the inlet connection on the Refueler.
- Open the hydrogen inlet slowly MIV1, allowing hydrogen to displace the remaining nitrogen.
- Monitor the system closely using leak detectors to ensure proper concentration and purity levels are achieved.

Final Checks:

- Check for any signs of leaks based on monitoring pressures present on the HMI of the HPU.

Ensure all Valves on the compressor are in the following positions listed below: The DCIV Valves will be operated from the HMI (Human Machine Interface) on the H2B700.

Compressor Skid			
Valve	**Position**	**Valve**	**Position**
MIV1	CLOSED	MVV3	CLOSED
MIV2	CLOSED	MVV4	CLOSED
MIV3	OPEN	CWIV1	OPEN
MIV4	OPEN	CWIV2	OPEN
MIV5	OPEN	CWIV3	OPEN
MIV6	OPEN	CWIV4	OPEN
BIV1	OPEN	CWIV5	OPEN
BIV2	OPEN	CWIV6	OPEN
TIV1	OPEN	CWIV7	OPEN
TIV2	OPEN	CWIV8	OPEN
TIV3	OPEN	CWIV9	OPEN
TIV4	OPEN	CWIV10	OPEN
TIV5	OPEN	CWIV11	OPEN
TIV6	OPEN	CWIV12	OPEN
TIV7	OPEN	HIV1	OPEN
TIV8	OPEN	HIV2	OPEN
TIV9	OPEN	HIV3	OPEN
MVV1	CLOSED	HIV4	OPEN
MVV2	CLOSED	HIV5	OPEN
DCIV1	CLOSED	DCIV5	CLOSED
DCIV2	CLOSED	DCIV6	CLOSED
DCIV3	CLOSED	DCIV7	CLOSED
DCIV4	CLOSED	DCIV8	CLOSED

Startup Compressor process for first filling:

1. Before starting the compressor, click the "**Reset Alarms Button**" and then turn green switch from "**off**" to "**on**".
2. Ensure all valves (**H2 Supply Valve, Vent Valve -1, Buffer 350 Valve-1, Buffer 350 Valve-2, Dispenser Output valve, Buffer 520 Valve-1, Buffer 520 Valve In – 2, Buffer 520 out Valve**) are closed (indicated in red)**. Refer to image 1 for valve status confirmation.**

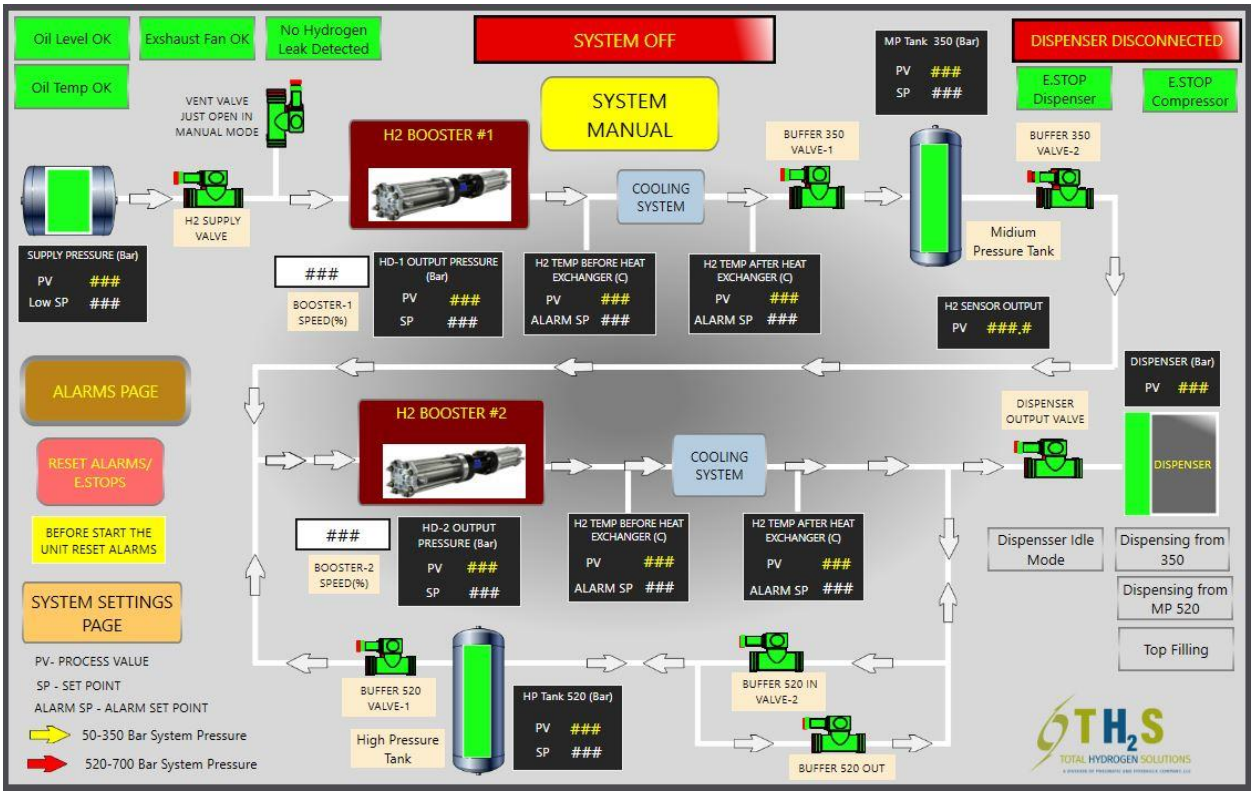


Image 1

3. On the HMI screen, navigate to the HPU section of the Mobile Refueler. Navigate to the **Settings Page** and verify all system parameters are correctly configured for your operation. This includes pressure thresholds, valve timing, and booster operation profiles. Ensuring proper settings is critical before placing the unit into **Auto Mode**.

4. Click the **System Manual/Auto** button, then it will say (**System auto**). Then, Set the **Supply Pressure Tank** to a minimum of 20 bars.

5. The system will first equalize the **supply tank** with the **buffer** and **high-pressure tanks** automatically. The **buffer** will then pressurize up to **50 bar** within the **MP Tank (350 Bar)**.
6.
7. In **Auto Mode**, this entire sequence is executed automatically opening the **H_2 Supply Valve**, activating **Booster #1**, and engaging **Buffer 300 Valve -1**. Refer to **Image 2** for a visual representation of this process.

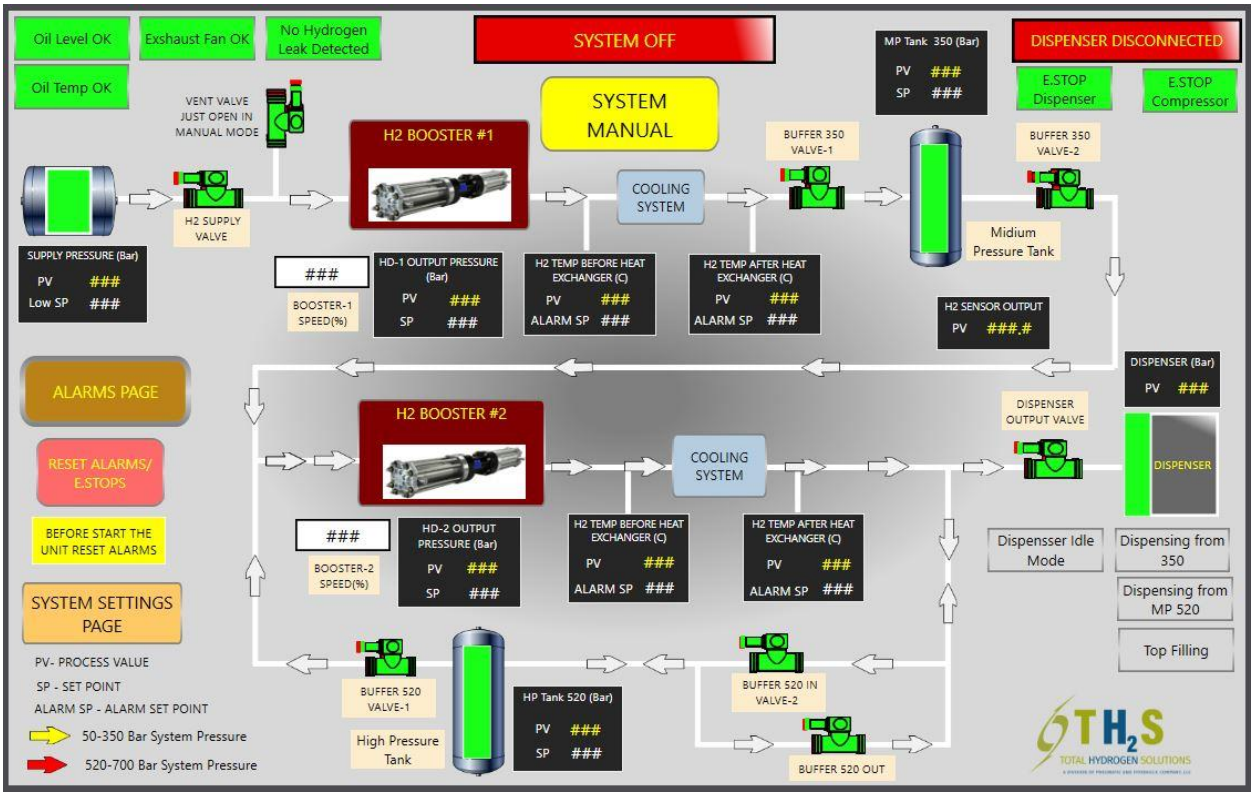


Image 2

8. Once the **MP Tank (300 Bar)** reaches its setpoint, the system will hold pressure until the **dispenser sends a request**. Upon request, the system will automatically open the appropriate valve and initiate the second-stage booster to pressurize the **high-pressure tanks**. The second-stage booster will operate until the tanks reach **520 bar**, at which point it will automatically stop.

9. Important: If the Hydrogen input pressure drops below 50 bar, the boosters will automatically stop for safety.

Upon completing **Steps 1-7**, refer to **Image 3 on page 16** for a visual representation of a successful compressor startup located on the next page.

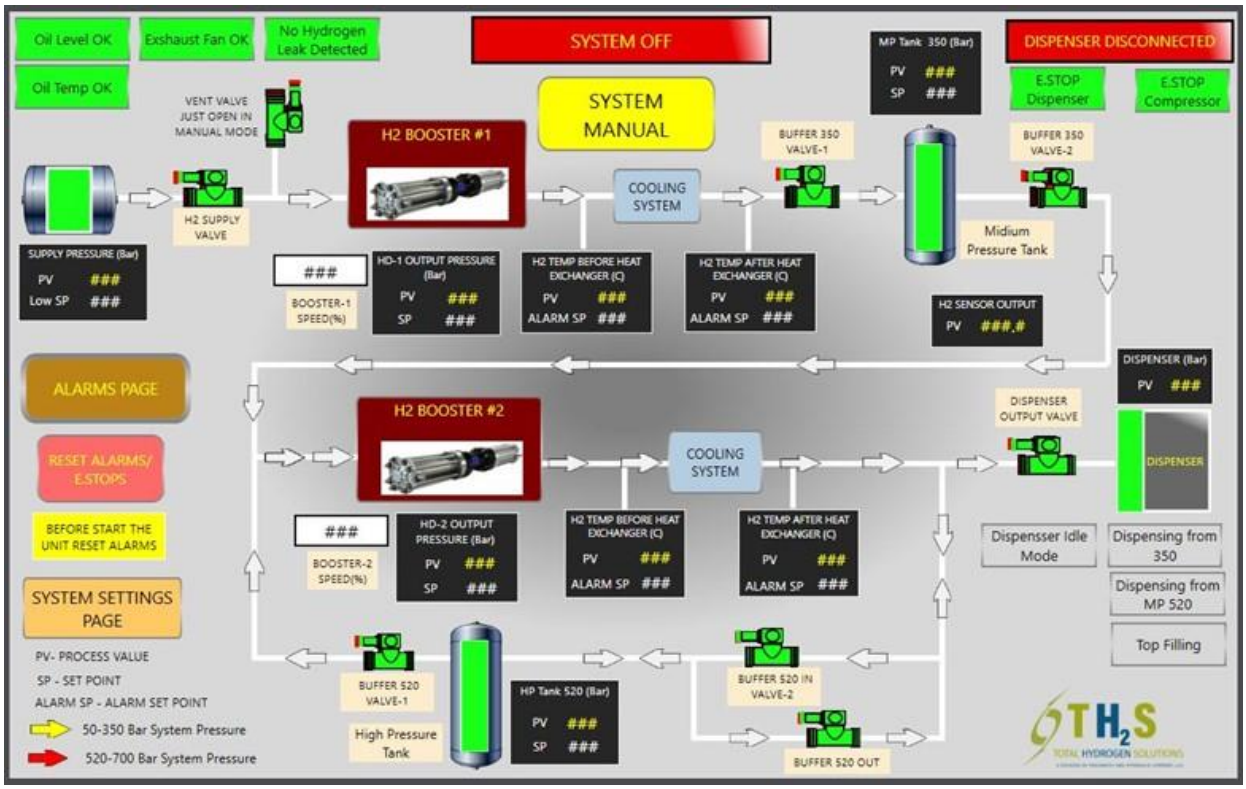

Oil Level OK
Exshaust Fan OK
No Hydrogen Leak Detected
SYSTEM OFF
MP Tank 350 (Bar)
PV ###
SP ###
DISPENSER DISCONNECTED
Oil Temp OK
E.STOP Dispenser
E.STOP Compressor
VENT VALVE JUST OPEN IN MANUAL MODE
SYSTEM MANUAL
H2 BOOSTER #1
BUFFER 350 VALVE-1
BUFFER 350 VALVE-2
COOLING SYSTEM
H2 SUPPLY VALVE
Midium Pressure Tank
SUPPLY PRESSURE (Bar)
PV ###
Low SP ###
###
BOOSTER-1 SPEED(%)
HD-1 OUTPUT PRESSURE (Bar)
PV ###
SP ###
H2 TEMP BEFORE HEAT EXCHANGER (C)
PV ###
ALARM SP ###
H2 TEMP AFTER HEAT EXCHANGER (C)
PV ###
ALARM SP ###
H2 SENSOR OUTPUT
PV ###,#
ALARMS PAGE
DISPENSER (Bar)
PV ###
H2 BOOSTER #2
DISPENSER OUTPUT VALVE
RESET ALARMS/ E-STOPS
COOLING SYSTEM
DISPENSER
BEFORE START THE UNIT RESET ALARMS
###
BOOSTER-2 SPEED(%)
HD-2 OUTPUT PRESSURE (Bar)
PV ###
SP ###
H2 TEMP BEFORE HEAT EXCHANGER (C)
PV ###
ALARM SP ###
H2 TEMP AFTER HEAT EXCHANGER (C)
PV ###
ALARM SP ###
Dispensser Idle Mode
Dispensing from 350
Dispensing from MP 520
SYSTEM SETTINGS PAGE
Top Filling
PV- PROCESS VALUE
SP - SET POINT
ALARM SP - ALARM SET POINT
50-350 Bar System Pressure
520-700 Bar System Pressure
BUFFER 520 VALVE-1
HP Tank 520 (Bar)
PV ###
SP ###
BUFFER 520 IN VALVE-2
High Pressure Tank
BUFFER 520 OUT
TH2S
TOTAL HYDROGEN SOLUTIONS

Image 3

Startup dispenser for first filling:

- Making sure Refueler is grounded.
- Verify all pre startup procedures are completed.
- Connect the hydrogen supply trailer to the inlet connection on the Refueler per procedure. Ensure all Valves on the compressor are in the following positions listed below:

The DCIV Valves will be automatically operated from the HMI (Human Machine Interface) on the H2B700 dispenser. While the MIV and MVV will be operated from inside the compressor skid section.

Compressor Skid			
Valve	**Position**	**Valve**	**Position**
MIV1	CLOSED	MVV3	CLOSED
MIV2	CLOSED	MVV4	CLOSED
MIV3	OPEN	CWIV1	OPEN
MIV4	OPEN	CWIV2	OPEN
MIV5	OPEN	CWIV3	OPEN
MIV6	OPEN	CWIV4	OPEN
BIV1	OPEN	CWIV5	OPEN
BIV2	OPEN	CWIV6	OPEN
TIV1	OPEN	CWIV7	OPEN
TIV2	OPEN	CWIV8	OPEN
TIV3	OPEN	CWIV9	OPEN
TIV4	OPEN	CWIV10	OPEN
TIV5	OPEN	CWIV11	OPEN
TIV6	OPEN	CWIV12	OPEN
TIV7	OPEN	HIV1	OPEN
TIV8	OPEN	HIV2	OPEN
TIV9	OPEN	HIV3	OPEN
MVV1	CLOSED	HIV4	OPEN
MVV2	CLOSED	HIV5	OPEN
DCIV1	CLOSED	DCIV5	CLOSED
DCIV2	CLOSED	DCIV6	CLOSED
DCIV3	CLOSED	DCIV7	CLOSED
DCIV4	CLOSED	DCIV8	CLOSED

Startup dispenser for first filling continued:

- Ensure all Valves are in the following positions listed below:

Dispenser	
Valve	**Position**
MIV-600-1	OPEN
MIV-600-2	OPEN
MIV-600-3	OPEN
MIV-600-4	OPEN
MVV-600-1	CLOSED
MVV-600-2	CLOSED
MVV-600-3	CLOSED
MVV-600-4	CLOSED
MVV-600-5	CLOSED
MVV-600-6	CLOSED
MVV-600-7	CLOSED
DCIV-600-1	CLOSED
DCIV-600-2	CLOSED
DCIV-600-3	CLOSED
DCIV-600-4	CLOSED
DCIV-600-7	CLOSED
DCIV-600-8	CLOSED
DCVV-600-1	CLOSED

Note: the MIV's should be open for flow, while the MVV's are closed to allow proper flow of H2 in the system.
Note 2: The DCIV and DCVV will be automatically opened or closed based on the HMI settings selected.

- Go to the main power distribution panel and move all breakers to the closed/on position.
- Turn on the T40 KUSTEC Chiller & 20 Ton COLDSHOT Chiller by turning on the HPU.
- On the H2B700 Control panel place the System on/off switch into the on position

HMI Dispenser Operation Process for Hydrogen Mobile Refueler:

1. **Ensure E-Stop is Released:**

   a. Verify that the **e-stop button** (red button) is **pulled out** to deactivate it.
   b. Press the **reset button** and wait for the HMI screen to show the main operating menu. This confirms that the **e-stop has been successfully released**.

2. **After E-Stop is Released:**
   a. The HMI screen will display the main menu.
   b. Connect the H70, H35, nozzles to the vehicle.
   c. Press the "Start" button on the HMI screen to initialize the system.

3. **Select Vehicle Type:**

   The HMI will display a graphical interface with vehicle type options.

   Choose the appropriate refueling option:

A	B	C
H35 (350 bar) Vehicle	H70 (700 bar) Vehicle	Tube Trailer

Note: During fueling there is an emergency stop on the dispenser, and HPU in case of emergency.

Shutdown Process

Note: Once the fueling and done and a new location is required proceed with the following to shut down the system.

1. **Gradual Pressure Reduction:**
   - Slowly reduce the system pressure by lowering the set pressure on the HPU and venting any excess pressure via the pressure relief valve, if necessary.

2. **Turn Off the HPU:**
   - Turn off the HPU motor after ensuring pressure has been safely reduced.
   - Bleed off any residual hydraulic pressure from the lines, using the MVV's in the open position.

3. **Turn Off the Chiller:**
   - Shut down the chiller system.
   - Ensure that coolant flow has ceased, and that the chiller cools down safely.

4. **Close Hydrogen Lines:**
   - Close hydrogen inlet and outlet lines.
   - Vent any remaining hydrogen safely from the system.

5. **Drain and Check Fluid Levels:**
   - If necessary, drain excess fluids such as hydraulic oil or glycol-water mixture. Semiannually after date of 1st operation.
   - Inspect and top off fluids before storage or the next use.
6. **Power Down Electrical Panels:**
   - Turn off all power sources.
   - Ensure all electrical components are powered down and locked out, if required.

7. **General Inspection:**
   - Inspect the system for any residual leaks or issues entailing (drips, hissing sounds, etc.).
   - Perform post-operation maintenance tasks such as cleaning filters, inspecting valves, and checking fluid contamination levels.

EMERGENCY SHUTDOWN PROCEDURE

1. **Push the ESD button:**
   - Engage the ESD button, it should **click or lock** into place once activated.

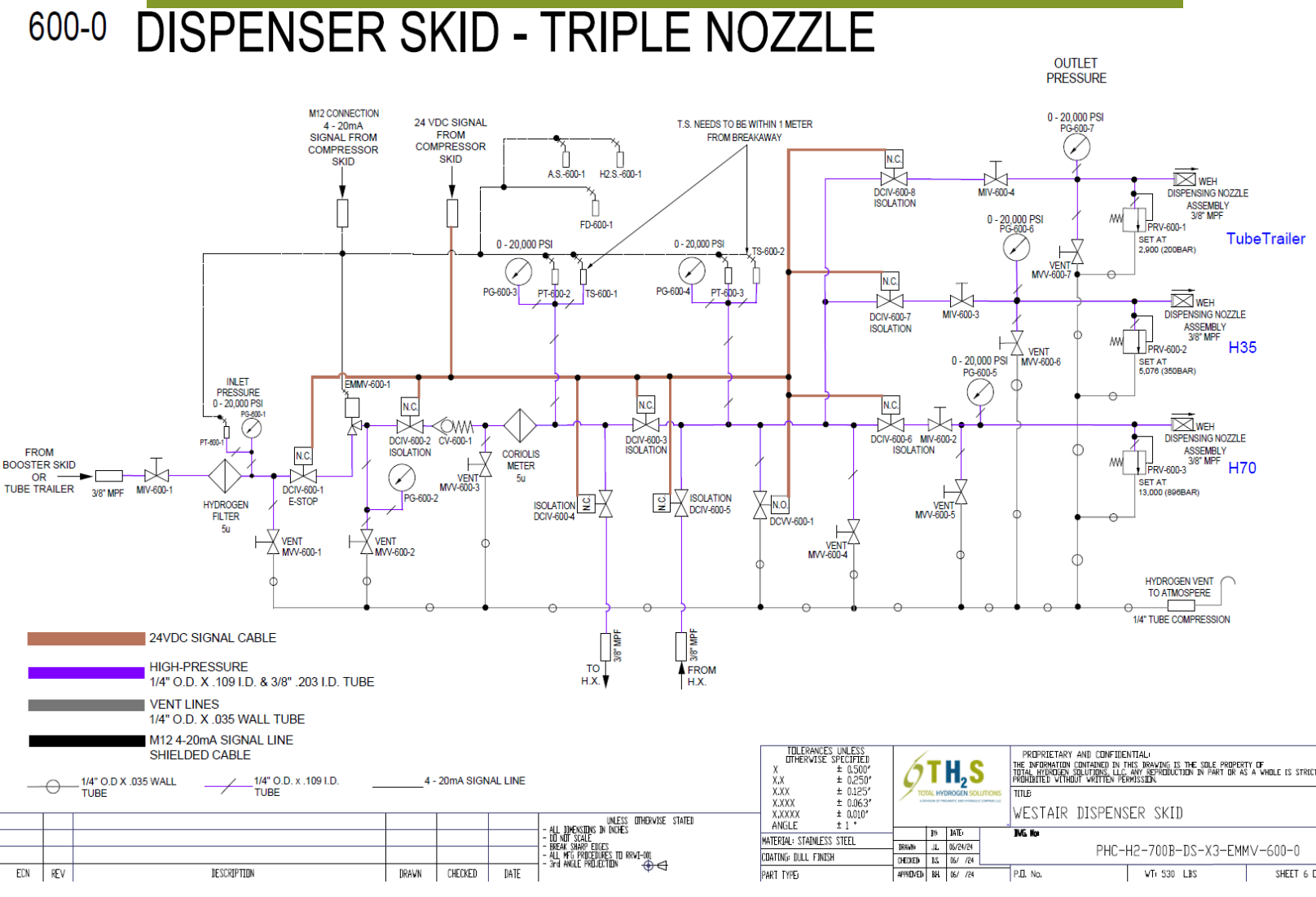
2. **Verify System Shutdown:**
   - Immediately verify that the system is shutting down.
   - This includes powering down all motors, including the HPU, compressor motor, and chiller.
   - If they are not off, go back to the ESD button and confirm it is fully engaged. Note all HMI screens should be black if off.

3. **Perform a Safety Check:**
   - Once deemed safe, conduct a quick **visual check** of the equipment and surrounding area to confirm that there are no immediate hazards, leaks, or damage.

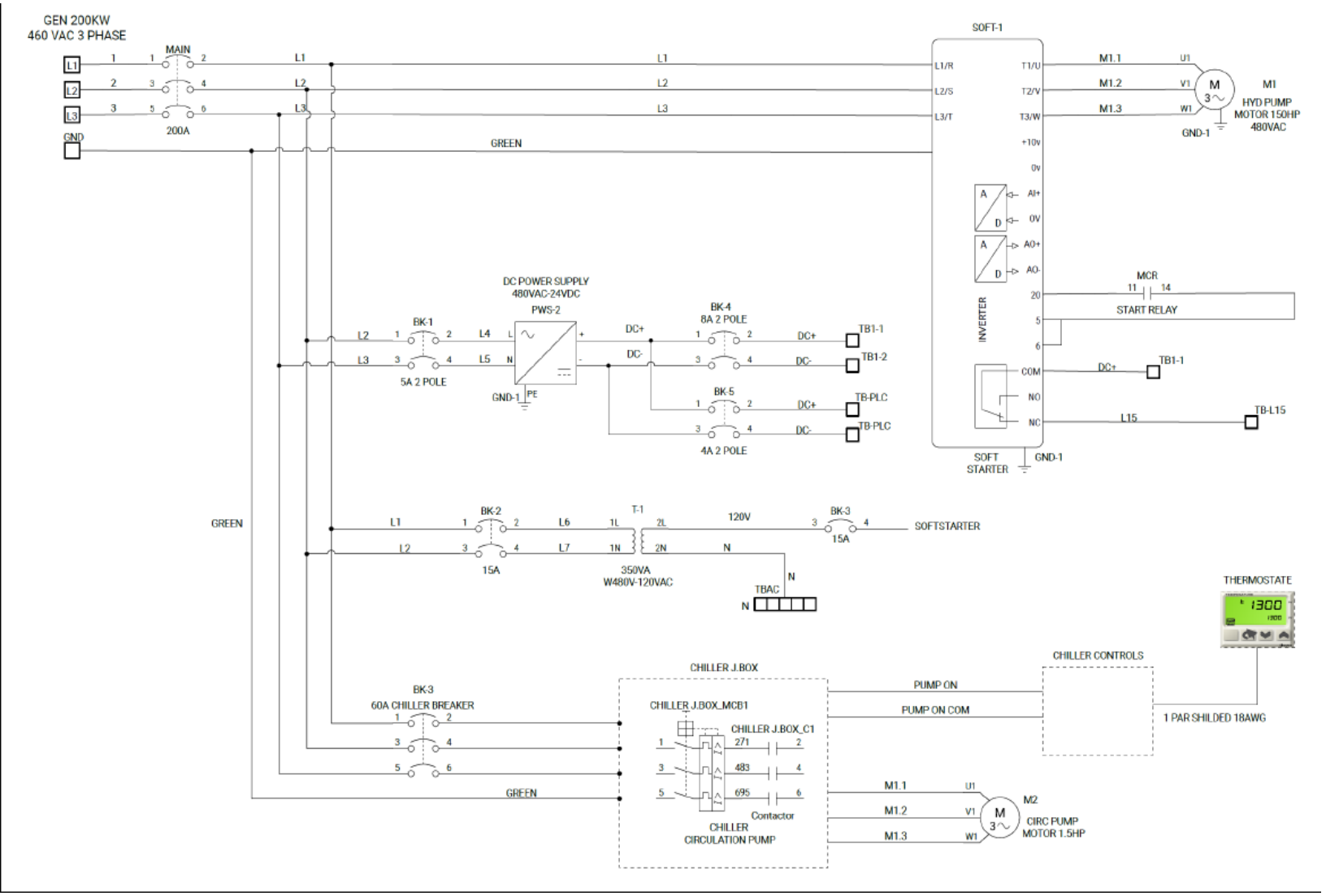
Preventive Maintenance

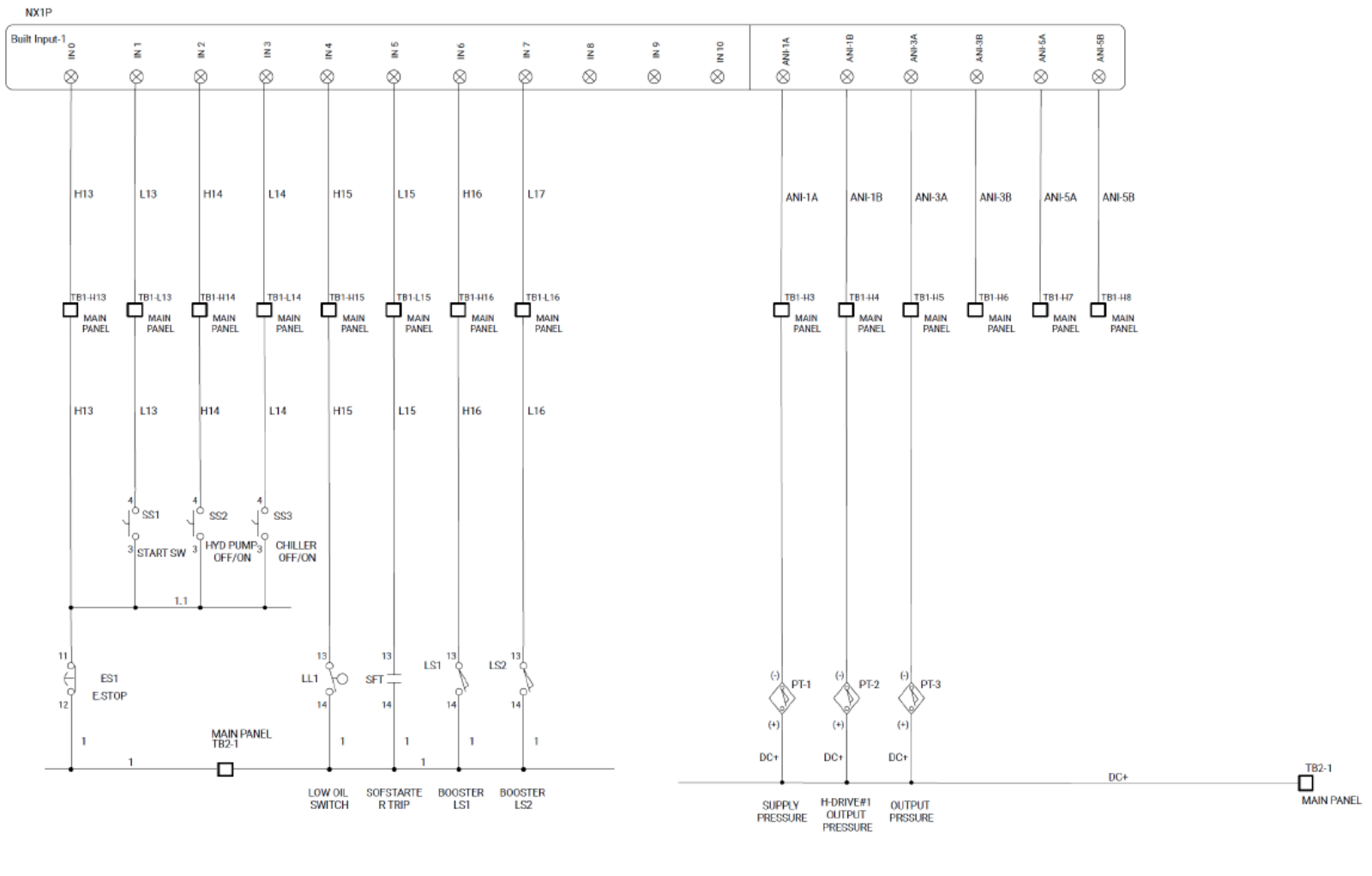
- All maintenance, including lubrication and adjustments, shall be performed only by qualified and trained personnel designated by the operating company.
- It is important that a maintenance program be established to ensure that all components are maintained in a condition which does not constitute a hazard to personnel. Do a full system check ranging from the HPU, Compressor Skid, Bottle Rack, and Dispenser and all their connections and outlets are properly mounted, or free of any obstructions once a month.
- When a unit is stopped for maintenance purposes, starting devices or powered accessories shall be locked or tagged out in accordance with a formalized procedure designed to protect all persons or groups involved with the machine against an unexpected start.
- Replace all safety devices and guards before starting equipment for normal operation.

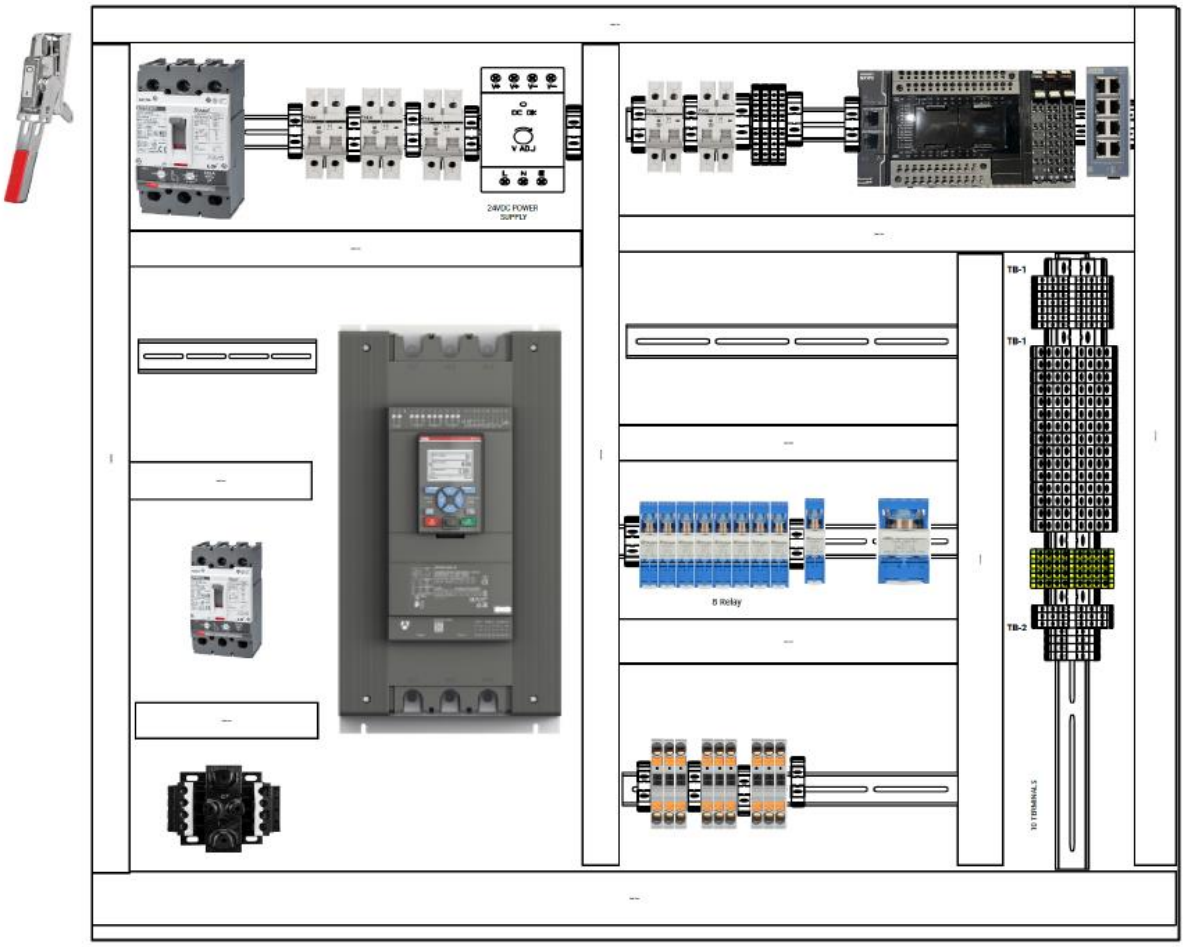
Pneumatic & Hydraulic Schematic



ELECTRICAL SCHEMATIC




NX1P
Built Input-1
IN 0
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
IN 8
IN 9
IN 10
ANI-1A
ANI-1B
ANI-3A
ANI-3B
ANI-5A
ANI-5B
H13
L13
H14
L14
H15
L15
H16
L17
TB1-H13
TB1-L13
TB1-H14
TB1-L14
TB1-H15
TB1-L15
TB1-H16
TB1-L16
MAIN PANEL
H13
L13
H14
L14
H15
L15
H16
L16
SS1
SS2
SS3
START SW
HYD PUMP OFF/ON
CHILLER OFF/ON
ES1
E.STOP
MAIN PANEL TB2-1
LL1
SFT
LS1
LS2
LOW OIL SWITCH
SOFSTARTE R TRIP
BOOSTER LS1
BOOSTER LS2
TB1-H3
TB1-H4
TB1-H5
TB1-H6
TB1-H7
TB1-H8
PT-1
PT-2
PT-3
DC+
SUPPLY PRESSURE
H-DRIVE#1 OUTPUT PRESSURE
OUTPUT PRSSURE
TB2-1
MAIN PANEL


24VDC POWER SUPPLY
V ADJ
TB-1
TB-1
TB-2
8 Relay

Appendix, A: Spare Parts List

Dispenser Recommendation Spare Parts List	
Part Numbers	**Description**
RCM-B00AF-3-20UV61V	R-SERIES 10...24VCD ACTUATOR * BUTECH 20K VALVE
WT-FTH-080-L06-5	FILTER, PARTICAL
800.819.00	1000 BAR DN6 A-3/8 (3106) + 24V COIL
800.817.00	1000 BAR DN0.5 A-1/4 (3105) + 24V COIL
HPC020ME39D2B2EZZZZMC	CORIOLIS METER, H.P. MICRO MOTION, 1/6 INCH (DN3) XM-19 S.S. 839 BAR
4700R13AB2AAZZZAZZ	FIELD MOUNT TRANSMITTER, 4700 MICRO MOTIONS
20SM6081-FRC1X-HYG	FLOW CONTROL
20UV62V-PM-H2-S	NEEDLE VALVE, 3/8" MPF, 20,000 PSI
20UV42V-PM-H2-S	NEEDLE VALVE, 1/4" MPF, 20,000 PSI
HIP-10RV-HYD	RELIEF VALVE, ADJUSTABLE,316A, HYDROGEN SERVICE, 1K - 10K SET RANGE
HIP-20RV-HYD	RELIEF VALVE, ADJUSTABLE,316A, HYDROGEN SERVICE, 10K - 20K SET RANGE
TST43B-1HX3/101	AMBIENT SENSOR, 4-20MA
6809685	DRÄGERSENSOR, HYDROGEN H2
Compressor Skid Spare Part List	
52180-1	PILOT SWITCH, N.C., 150 - 300
55792	PILOT SWITCH, N.O., 4,500 - 20,000
15700-25	RELIEF VALVE
SLPV82V-ATC5	ACTUATOR VALVE, 1/2" LPF, ANGLE, 5,500 PSI, AIR TO CLOSE
SLPV82V-ATO5	ACTUATOR VALVE, 1/2" LPF, ANGLE, 5,500 PSI, AIR TO OPEN
SLPV82V-PM	NEEDLE VALVE, 1/2" LPF, ANGLE, 5,500 PSI
SLPV42V-PM	NEEDLE VALVE, 1/4" LPF, ANGLE, 11,500 PSI
20UV62V-ATO5	ACTUATOR VALVE, 3/8" MPF, ANGLE, 20,000 PSI, AIR TO OPEN
20UV42V-ATC5	ACTUATOR VALVE, 1/4" MPF, ANGLE, 20,000 PSI
20UV42V-PM	VALVE
20LF6-40/20	LINE FILTER
41SV-20K-FP-B-1/4HPF-CALIB	GAUGE, 4" DIA., 0-20,000 PSI, P/M, BAR, 1/4" HPF, W/ CALIBRATION
40SV-1K-FP-B-1/4MPF-CALIB	GAUGE, 4" DIA., 0-1,000 PSI, P/M, BAR, 1/4" MPF, W/ CALIBRATION
20S-200-FP-B-GF	GAUGE, 2.5" DIA., 0-200 PSI, P/M, BAR, GLYCERIN FILLED
ESI-GS4200B-0014-AM-0.1	TRANSDUCER,14BAR/200PSI, 4-20mA, M12, ACCURACY NLHR 0.1%
ESI-GS4200B-0069AM-0.1	TRANSDUCER, 69BAR/1,000PSI, 4-20mA, M12, ACCURACY NLHR 0.1%
ESI-GS4200B-1379AM-0.1	TRANSDUCER, 1379BAR/20,000PSI, 4-20mA, M12, ACCURACY NLHR 0.1%
R55M-2HG	AIR REGULATOR, 1/4" FNPT
8210G002-24VDC	SOLENOID VALVE, 2-WAY, 1/2" FNPT, AIR/WATER, NC, 24VDC
P32PA94AD2VM1A	ELECTRO/PNEUMATIC AIR REGULATOR, 1/2" FNPT
P31PA92AD2VM1A	ELECTRO/PNEUMATIC AIR REGULATOR, 1/2" FNPT
CB-M12-4P-4M	ELECTRICAL CABLE FOR REGULATOR
S2FSSRRSLTT025	BALL VALVE, 1/4" FNPT, P/M
S2FSSRRSLTT050	BALL VALVE, 1/2" FNPT, P/M
KW204-BN-16-16	BALL VALVE, 1/4" MPF
K63-14-14	BALL VALVE, 3/8" LPF
Storage Skid Spare Part List	
20UV62V-PM-H2-S	NEEDLE VALVE, 3/8" MPF, 20,000 PSI
20UV42V-PM-H2-S	NEEDLE VALVE, 3/8" MPF, 20,000 PSI
20A6M4M	ADAPTER, 3/8" MPM X 1/4" MPF, 20K
20BF6	BULKHEAD, 3/8" MPF, 20,000 PSI

7.3 Operation

7.3.1 Operation and maintenance

(1) Only persons who are familiar with such work and who have been informed, in particular, of the hazardous properties of refrigerants and of the precautions necessary to prevent accidents may be used for the operation and maintenance of refrigeration systems.

(2) Unauthorized persons shall be prohibited from manipulating refrigeration systems and entering special machine and apparatus rooms by attack.

(3) Artificially ventilated installation rooms for refrigeration systems in which persons are not permanently present may only be entered after the ventilation system has been put into operation and the room has been ventilated accordingly; this must be indicated by a corresponding stop on the doors leading into these rooms.

(4) Cold rooms may not be locked until it has been established that there are no persons in those rooms. Where cold rooms are equipped with facilities enabling persons trapped in those rooms to make themselves felt to the outside, care must be taken to ensure that trapped persons can be released from the cold rooms at any time. The effectiveness of these devices shall be examined at regular intervals.

7.3.2 Operating data recording

It is possible to collect data about the system with the help of the SD card connected to the Comfort Panel. The SD card contains CSV files, with each file corresponding to one tag. The files contain information from sensors and alarm signals. The files are available in WinCC-flexible format. To obtain data, please follow the procedure below:

1. Close the HMI on the display
2. Remove the SD card from the Comfort Panel
3. Copy SD card CSV files to computer
4. Insert the SD card back into the Comfort Panel
5. Restart the HMI

7.3.3 Working on refrigeration systems

(1) In the event of infirmities or defects affecting the operational safety of refrigeration systems, such systems shall be decommissioned and may not be put back into service until the damage has been repaired. Repairs of any kind as well as the refilling of refrigerants may only be carried out by authorized, competent persons. When refrigerant escapes, sufficient ventilation of the rooms affected by this must be ensured. Refrigerants may only be discharged into containers intended for this purpose, whereby care must be taken to ensure that their permissible filling quantity is not exceeded.

(2) Only devices which prevent hazards to the operator, such as safety valves with drop levers, may be used to drain lubricants from separators.

(3) Open compressors shall not be illuminated with open light. In rooms where refrigeration systems working with Group 2 refrigerants, other than ammonia or Sulphur dioxide, or with Group 3 refrigerants are installed, handling of open fire or light shall be prohibited; in installations covered with methyl chloride, halogen testers may be used by competent persons authorised to do so to visit places where the refrigerant flows out only in small quantities, provided that leaks are otherwise difficult to detect, that there is sufficient air exchange and that there is no explosive refrigerant vapor and air mixture.

7.3.4 Protective equipment

(1) Employees exposed to major refrigerant exposure when remedying malfunctions in refrigeration systems shall be provided with appropriate respiratory protective equipment, eye protection and sturdy leather or rubber gloves for such work. Persons entrusted with work on refrigeration systems must be familiar with the effect and handling of respiratory protective equipment and with the conditions under which such equipment can be used; they must use the protective equipment. Protective equipment shall not be stored in rooms into which refrigerants can penetrate; it is kept cool, dry and easy to reach.

(2) Employees who are employed in walk-in cold rooms must be provided with appropriate protective clothing.

7.3.5 Review

(1) Refrigeration systems must be subject to a review with regard to their operational safety after major operational disruptions, major repairs and significant changes to the system, but in any case, at intervals of no more than one year. These checks shall be carried out by authorised, competent persons.

(2) Defective parts of refrigeration systems that are under overpressure may only be replaced by those parts that have been subjected to a pressure test within the framework of the provisions of §9; such a pressure test shall also be carried out after major repairs have been carried out on parts under overpressure.

7.3.6 Touch Panel (HMI) / Local PC

See documentation for PLC or *control description*.

7.3.7 Interruptions

Safety shutdown

Automatic interruption of operation due to exceedance of permissible limit values.

Disturbance

Faults that result in a safety shutdown.

7.4 Modes

7.4.1 Automatic

The refrigeration system operates in normal operation in automatic mode. No manual intervention should be required.

Annually or after major repairs, the system must be inspected by an expert. The technicians of "Kälte- und Systemtechnik GmbH" must confirm the results of the test and make them on file. This must be kept for inspection by third parties.

The electrical part of the system must comply with the rules for damp rooms.

Main components KUSTEC COOLING SYSTEM "RACOON"

4.2 Main components

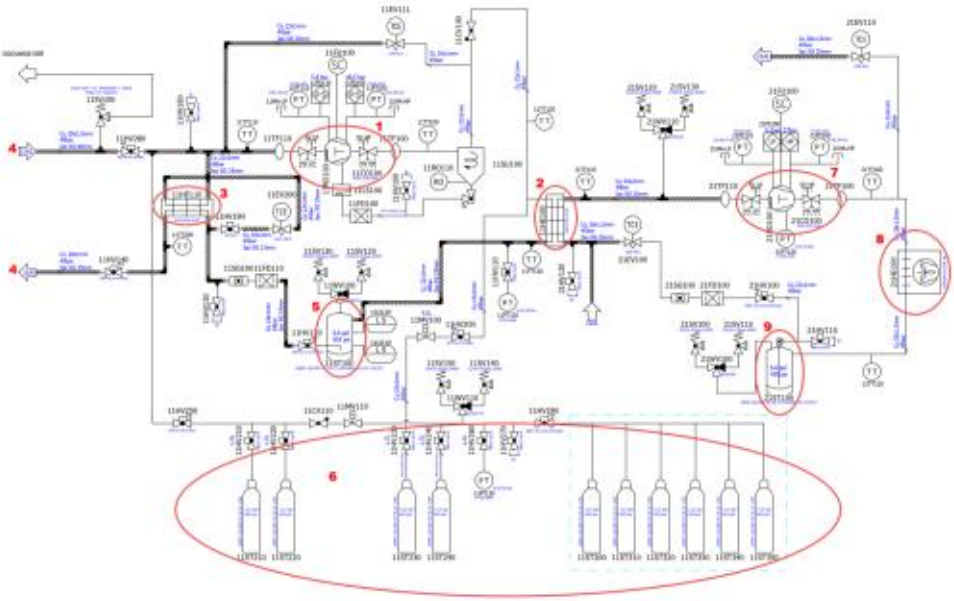


Figure 1- Main Components

1	LT compressor	6	R744 expansion vessels
2	R744 Condenser/Cascade WT	7	MT compressors
3	R744 sub-cooler	8	R449 Condenser
4	R744 Evaporator	9	R449 Collector
5	R744 Collector		

8.4 Maintenance Calendar

Activity ▼ / Interval ▶	Daily (D)	Weekly (W)	Monthly (M)	Annual (Y)	After 5 years (5Y)	as necessary (AN)
Operators						
Check medium temperature	x					
Check operating messages to HMI	x					
Checking running noise on compressors/fans		x				
Check operating temperatures, operating pressures		x				
Check refrigerant level and humidity indicator			x			
Checking the oil level and foam formation in compressors			x			
Check compressor mounting			x			
Cleaning the condenser			x			
Professionals						
Checking the refrigeration system according to the Refrigeration System Ordinance				x		
Check the status of all electrical connections in the control cabinet and on the components				x		
Chiller oil test, in case of negative result → oil change				x		
Replace safety valves					x	
Notify **in-house technicians**. If the fault cannot be remedied, contact the emergency service of Kälte- und Systemtechnik GmbH (0043/2274/44109)						x

Table 8: Maintenance calendar

8.5 Replacement of the filter dryer 11FD110

For certain operating events – e.g. after a refrigerant change – it is necessary to replace the filter dryer. The following instructions must be followed carefully.

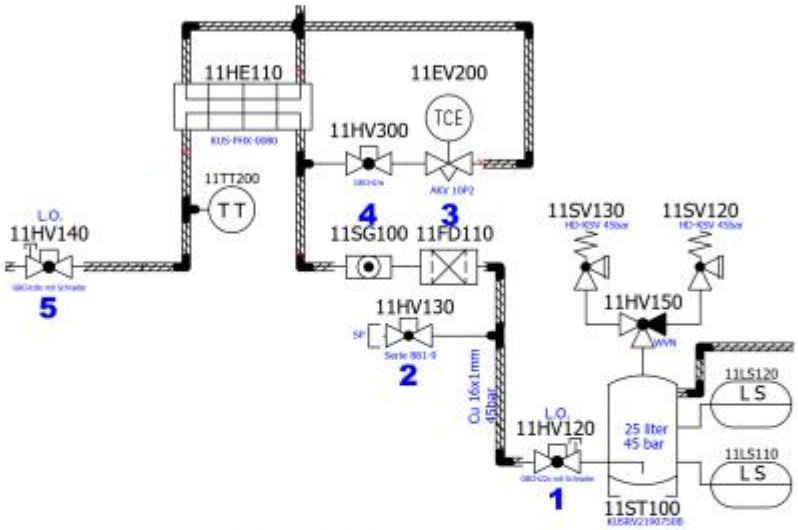


Figure 8- 11FD110 Filter Dryer Replacement

1	Valve 11HV120 on the collector	**4**	Sight glass 11SG100
2	Service port 11HV130	**5**	Manual valve 11HV140
3	Filter dryer 11FD110		

Preparatory work/requirements

Switching off the automatic operation:

- Select the manual mode on the HMI

➢ The system is now in hand mode

Required tools

- Vacuum pump
- Fork wrench WO17
- Fork wrench WO22

Performance

1. Close manual valve 11HV120 on the refrigerant collector.
2. Open valves 11EV100 and 11EV101 on the HMI (manually).
3. Start compressor 11CO100 (manually).
   - ➢ Pressure on the 11PT140 is 16barg.
4. Check on the sight glass 11SG100 whether there is still liquid CO2 in the line.
5. Close hand valve 11HV140.
6. Release CO2 in the pipe.
   - Carefully open Shut-off valve 11HV130 completely.
   - ➢ Remaining CO_2 gas has flowed out.
7. Replace filter dryer 11FD110 and optional sight glass 11SG100.
   a. Detach and remove used components.
   b. Assemble and tighten new components.
8. Remove air from the system.
   a. Connect the vacuum pump to the shut-off valve 11HV130.
   b. Completely suck out air.
   c. Close shut-off valve 11HV130.
   d. Seal the vacuum pump.
9. Open hand valve 11HV140.
10. Open manual valve 11HV120 on the refrigerant collector.

Final work

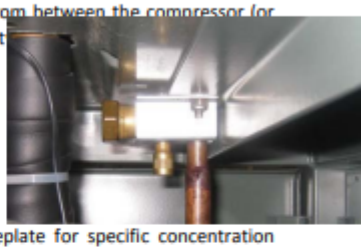
Re-activation of automatic operation:

- Select the automatic mode on the HMI
- ➢ The system is now back in automatic mode

COLDSHOT 20T PORTABLE AIR-COOLED CHILLER (model ACWC-240-E) Manual:

III. PRE-STARTUP

1. **STARTUP CHECKLIST** - Review and use. (Typically located at end of this manual.)
2. COMPRESSOR MOUNTS
   a) As shipped, the compressor(s) is held down by mounting bolts with vibration rubber grommets.
   b) Verify bolts are tight to base and that the compressor is able to move on the rubber grommets.
      (1) Single Compressor units: Verify that the shipping spacers (if installed) are removed from between the compressor bottom (or compressor plate) and the base of the unit.
      (2) Tandem Compressor units: Compressors are mounted on a common plate.
         (a) Do not loosen the compressor bolts connecting it to the plate.
         (b) Verify that the shipping spacers (if installed) are removed from between the compressor (or compressor plate) and the base of the unit. (Typically quantit



3. SERVICE VALVES
   a) Verify all service valves are open. (Typical valves on these models do not have backseats.)
4. FLUID IN SYSTEM:
   a) Fill the system with the desired solution.
   b) A 30% glycol mixture is recommended for all standard flow units. For "Low Temperature" chilled fluid and units installed outdoors may require a higher concentration to prevent freezing. See unit nameplate for specific concentration requirements or adjust based on the ambient conditions of the chiller, fluid temperature, and/or system design.
   c) For systems with a tank, fill to within a few inches from the top edge or just to the top of the sight glass.
   d) Fill system and bleed air from the highest point of piping. Vent air from pump and piping is possible by loosening or removing the strainer blowdown plug, which will vent air as the tank is filled, as long as the bypass valve is still open. Replace plug/cap after tank is full. Ensure that the pump and evaporator are filled with fluid prior to starting.
   e) Systems with an open tank are typically capable of bleeding excess air that is returned to the tank when the system is operating. Piping in and out are typically below the water line.
   f) For stationary systems (without an integral pump and tank), ensure that there is method for ensuring flow through the chiller system, such as with the use of a flow switch. See electrical system or specifications for details.

DO NOT ATTEMPT TO START CHILLER WITHOUT FLUID IN THE SYSTEM!!
This will damage the mechanical seal in the pump and void the pump warranty.
Also, potential freeze condition may exist in the evaporator.
DO NOT RESET ANY SAFETY CONTROLS UNTIL THE CAUSE HAS BEEN DETERMINED.

   g) **ROTATION**: Check for rotation prior to start-up. Do not use pump for checking rotation unless fluid is in the tank and the pump is full of fluid. Verify 3-Phase Power Electrical Rotation:
   h) All 3-phase (3Ø) motors are wired in phase. If motors are not turning in correct direction, then reverse 2 of the incoming power wires to chiller.
   i) For systems with 3Ø pumps: Pump rotation is normally clockwise as view from the back of the motor (Refer to direction decals if available). Pumps will still pump fluid if rotating reversed, so actual verification is necessary.
      (1) Quickly depress the pump contactor to verify proper rotation.
   j) For systems without 3Ø pumps: Attach refrigerant gauges to the test ports and verify that the discharge pressure rises and the suction pressure decreases. Loud noise may be indication of wrong rotation. Extended run time in reverse rotation will damage the compressor and lead to premature failure which is considered abuse and not covered by warranty.
5. CRANKCASE HEATERS:
   a) If compressor has crankcase heaters, allow the power to be applied to the heaters for at least 24 hours before starting the compressor.

IV. STARTUP

1. Verify installation is complete and all Pre-Startup steps are completed.
2. **STARTUP CHECKLIST** - Review and use. (Typically, located at end of this manual)
3. Attach refrigerant gauges to the appropriate service ports.
4. **PUMP ONLY**: Turn switch to Pump Only (or use local system pump) and operate for at least 15 minutes. Shut unit down and clean strainer to remove any debris that may have been in the system. Depending on the system cleanliness, this step may be conducted several times to help ensure all debris is removed from the system.
5. Depending on system design, if the pump is operated for extended periods without cooling, the fluid will heat up.
6. Once all the air is purged from the circuit and the system is free from debris, verify that the chilled fluid has the proper flow of 3 GPM per ton of capacity.
   a) Typical systems with a manual bypass valve which are factory set. The valve must be open enough to ensure proper flow to the evaporator or the system will shut down on low flow safety condition.
   b) Process systems with automatic and variable control flows will need to ensure that the bypass valve is throttled to accommodate all stopped process flow.
7. **TEMPERATURE CONTROLLER** (See Temperature Controller Section for details):
   a) Set the controller to the desired Set Point value. Typically, for smaller systems, press and hold the up or down scroll button for two seconds until the value starts changing. Adjust the value to the desired temperature then stop pressing any buttons. After two seconds, the new value will become operative. For larger systems, press Set after changing temperatures. (Do not adjust the set point below the temperature listed on the unit nameplate).
   b) The controller will also display "Present Value" (upper LED readout) which is an indication of the current temperature of the fluid in the chiller tank, or "Leaving Fluid Temperature" depending on the specific chiller design.
8. **COOLING CYCLE**: Unit is now ready to turn on for cooling. Move the selector switch to "Cooling Cycle" setting and the unit will begin cooling.
9. During the cooling cycle, condenser fans may turn on and off, due to changes in refrigerant pressure. This should be expected during normal operation and occurs due to ambient temperature and the amount of heat being returned in the water chiller.
10. Monitor the temperature at the process location and adjust the Set Value on the temperature controller to achieve the desired value.
11. **REFRIGERANT CHARGE:**

> **CAUTION!**: Never charge liquid into the low-pressure side of system when the system is off. Do not overcharge. During charging or removal of refrigerant, be sure there is fluid flow through the evaporator and all condenser fan(s) are operating.

   a) Refrigerant charge may need to be adjusted from the amount listed on the equipment label to achieve the proper operation of the chiller during final installation site as described below. Typically, on split systems.
   b) Charging refrigerant during system operation should only be performed into the suction line and then only is small bursts to ensure liquid does not enter compressor directly.
   c) Conditions to properly adjust the refrigerant charge of the system for optimum performance:
      (1) Chiller to be operated against a full heat load with approximately 70°F or above water temperature. Basically, the system must be at full capacity.
      (2) Fans for condenser coil must be on. (Bypass the fan cycling switch if necessary). (Flashing may occur in the refrigerant sight glass when fan turns on and off)
      (3) Refrigerant sight glass must be clear (flooded with refrigerant) while maintaining the appropriate subcooling and superheat parameters.

(4) Returning fluid temperature should not exceed 80°F on standard units or the chiller will cycle off on high head pressure and not run. Should this occur, allow water to cool down and restarting chiller once water is below 80°F.

d) SUPERHEAT: Verify or set the expansion valve (TXV) superheat to approximately 10 to 12°F immediately downstream of the TXV or approximately 12 to 14°F as measured 6 to 12 inches from the compressor on the suction line. Adjustments should be made in small increments, such as 1/4turn or less.

e) SUBCOOLING: While cooling at low load conditions, bubbles may become visible in the refrigerant sight glass. Ensure that the system is fully loaded, and then charge to establish approximately 10 to 14°F of subcooling.

f) Allow approximately five (5) minutes run time for equalization of system after any changes made (add or remove refrigerant, adjust TXV, etc).

g) Ensure all refrigerant system service ports are capped, service valves and caps tight, TXV cap is tight, etc.

V. SYSTEM COMPONENTS: (See your chiller's specification for details.)

IMPORTANT: Never open any switch or disconnect that de-energizes the crankcase heater unless unit is being serviced or is to be shut down for a prolonged period. After a prolonged shutdown on a service job, energize the crankcase heater for 24 hours before starting the compressor.

NOTE: Schrader valve cores: Most components connected to a refrigerant fitting include a Schrader valve for servicing. If leakage occurs during removal of a component, the valve may have been removed or damaged.

1. **ACCESS PANEL**
   a. Typically, accessible where the Cold Shot Chillers logo is located. Remove access screws and open.
   b. All hazardous area access panels must be in place prior to operation.
2. **COMPRESSORS**
   a. Scroll compressors are hermetically sealed with internal motor overload protection.
   b. Most Copeland compressors are equipped with an advanced scroll temperature protection (ASTP). A label located above the terminal box identifies models that contain this technology.

   c. Advanced scroll temperature protection is a form of internal discharge temperature protection that unloads the scroll compressor when the internal temperature reaches approximately 300 F. At this temperature, an internal bi-metal disk valve opens and causes the scroll elements to separate, which stops compression. Suction and discharge pressures balance while the motor continues to run. The longer the compressor runs unloaded, the longer it must cool before the bi-metal disk resets. Eventually, the motor's internal thermal electrical protection will shut down the compressor.
   d. To manually reset ASTP, the compressor should be stopped and allowed to cool. If the compressor is not stopped, the motor will run until the motor protector trips, which occurs up to 90 minutes later. Advanced scroll temperature protection will reset automatically before the motor protector resets, which may take up to 2 hours.
3. **CRANKCASE HEATER**
   a. This minimizes absorption of liquid refrigerant by oil in casing during brief or extended shutdown periods.
4. **CONTROLLER**
   a. The digital temperature controller may vary in design. For controller details, see the Controller Section of this manual.
5. **CONDENSER FANS**
   a. Fans operate along with the compressor operation along with the mode controls.
   b. Modes of fan cycling are:
      a) On (whenever the compressor is on). (Typically, 3ton and under)
      b) Cycling (with use of pressure actuated "head pressure switch". (5ton and over)
      c) Speed Controlled (if using a low ambient fan speed controller device when operating in low ambient condition).

6. **FILTER/DRIER**
   a. For system cleanliness and moisture capture. Every unit will have a filter drier factory installed.
7. **MOISTURE INDICATOR**
   a. For system charging and moisture condition. Every unit will have a sight glass (moisture indicator) factory installed.
8. **FLOW SAFETY THERMOSTAT (FST):**
   a. Generally the cause will be low or insufficient water flow caused by a clogged "Y" strainer or restricted flow in the process. Resetting this control and not determining the cause for tripping can cause the evaporator to freeze and rupture.
   b. Indoor chillers are normally equipped with a Low Flow Safety temperature sensor or thermostat that detects temperature of the refrigerant suction. This safety will automatically trip and requires manual resetting before the cooling cycle will resume. This safety can also be tripped by low ambient conditions or during shipping.
   c. Do not reset this control unless the exact cause for its tripping is determined.
9. **FREEZE SAFETY (FZT): (IF EQUIPPED)**
   a. Indoor chillers are typically equipped with a Freeze Safety temperature sensor that detects low temperature of the fluid in the system. This safety will automatically trip and is reset automatically when the water temperature returns to the higher sensor setting difference.
10. **LIQUID FLOW SWITCH (LFS): (IF EQUIPPED)**
    a. Refer to the LOW FLOW SAFETY for explanation and cautions.
    b. Outdoor units with Low Ambient Kits are normally equipped with a mechanical flow switch which monitors the fluid entering the evaporator. This switch is automatically reset when the fluid flow returns to the proper flow rate. Adjustment should not be performed unless necessary. If adjustments are made, ensure that the flow entering the evaporator is greater than 3 gallons per minute per ton of refrigeration rating of the chiller. For example, a 2 Ton chiller will need a minimum of 6 gpm.

Figure 1 Flow Switch

11. **REFRIGERANT LOW PRESSURE SAFETY (LPS)**
    a) Monitors the pressure of the refrigerant suction line and will automatically open when the pressure drops below the set point and will automatically reset when pressure is above the non-adjustable reset setting. (See specifications for details)
12. **REFRIGERANT HIGH PRESSURE SAFETY (HPS)**
    a. Monitors the pressure of the refrigerant and will automatically open when the pressure rises above the sensor fixed set point. (See specifications for details)
    b. Reset types are manual or automatic, depending on design and system.
    c. Manual Reset - requires that a button be pressed.
    d. Automatic Reset - automatically reset when pressure is below the reset setting.
13. **CAPACITY CONTROLS**
    a. System with multiple compressors permit the use of capacity control using the temperature controller system.
    b. Hot Gas Bypass (Option) - A bypass valve in the refrigerant system that permits cooling output capacity of the chiller to vary based on the load of the system.
14. **LOW AMBIENT CONDITION CONTROLS *(OPTIONS)***
    a. Low Ambient Conditions to 0°F Kit (Option)
    b. Temperature of the chiller's ambient condition is monitored and will change the operation of the chiller fans to reduce the possibility of cold temperatures affecting condenser fan/compressor operation.
    c. NOTE: Low Ambient chillers typically do not have the Low Flow Safety or a Freeze Safety. They are equipped with a pressure controlled fan control system which is used to operate the fan (or Fan #2 or #3 only on multiple fan unit chillers).
15. **WIND BAFFLES (DEPENDING ON DESIGN)**
    a. Panels mounted in or on the condenser coil section to limit/control the amount of air entering the coils. (Option)
    b. Typically used with Low Ambient kit systems with controls down to -20°F Kit.
16. **LOW CHILLED WATER TEMPERATURE (LOW LCWT)**
    a. Low Temperature refers to the temperature of the fluid leaving the chiller is lower than the temperature of the standard temperature machine's Leaving Chill Water Temperature (LCWT). Glycol or some other freeze protected fluid is required.

b. The temperature controller parameters must be setup for the lower leaving temperatures that the system will generate.
c. Also, some temperature thermostats may need to be adjusted.

17. **PUMP (DEPENDING ON DESIGN)**
    a. Systems with integral pump are typically setup to provide recirculating fluid for the chiller and some flow is routed for the process system. Refer to the unit's actual design for details.
    b. A secondary pump may be used for process specific applications, referred to as Process Pump.
18. **TANK (DEPENDING ON DESIGN)**
    a. Systems with integral tank will typically be 304 Stainless Steel with Open Top with Shoebox Type Lid, Fluid Level Sight glass, Fill Port, & Drain Plug.
19. **HEAT EXCHANGER (DEPENDING ON DESIGN)**
    a. A heat exchanger is used to transfer heat typically from the chiller fluid circuit to a separate process fluid circuit.
20. **REMOTE OPERATION/STATUS PANEL (OPTION)**
    a. Basic On/Off control switch with Cooling Mode status and Fault indicator light.
21. **REMOTE OPERATION CONTROLS (OPTION)**
    a. Various designs (contact Cold Shot Chillers for options)
22. **SWITCHOVER SYSTEM (CHILLER BYPASS) *(OPTIONS)***
    a. Manual City Switchover (MCSO) (Option)
        a) System valves which can be aligned to a backup water supply system such as the city water supply. Outlet fluid flow is normally routed to the building's drain system. Valves are connected and must be actuated simultaneously or in the proper series to operate properly. Converting back is normally performed in the reverse order.
    b. Automatic City Switchover (See ACSO literature)
        a) System has electrically operated valves similar to MCSO, however it can be setup to change automatically based on a system safety situation.
23. **TANK LEVEL *(OPTIONS)***
    a. **Float Valve**
        a) Located inside the tank, the float valve is a mechanically float-actuated valve supplied with a makeup water source of fluid for the tank.
        b) The makeup water (such as city water supply) is connected to the pipe connection on the outside of the tank.
        c) Water pressure, typically, must be less than 30psi.
        d) When the level falls below a certain level, the valve will open and fill the tank. When it reaches the top setting adjustment, the valve closes.
        e) If the valve does not maintain level:
        f) Verify water pressure supply.
        g) Verify the float adjustment.
        h) Verify the mechanical linkages are free to move.
        i) Verify there is no dirt or debris on the valve seat.
    b. **Tank Level Float Switch Solenoid Valve**
        a) Tank Level Switches
        b) Float actuated switch(s) mounted in the tank to monitor when tank is at different levels depending on design such as:
            a) Safety – to stop the operation of something such as the chiller or pump.
            b) Notification – to provide a signal for notification for manual refill or that another action must be performed.
            c) Action – to provide signal for use with other system uses such as automatic fill systems.
        c) Low Tank Level- tank is at the low level point that will/should begin filling the tank. Above pump suction.
        d) High Tank Level- level in tank is at or near top of tank and tank filling will/should stop. Tank may overflow.
    c. **Tank Level Float Controlled Solenoid Valve**
        a) A solenoid valve is an electrically operated valve to start and stop fluid flow from an outside source of fluid such as city water to refill tank, typically.

Coldshot 20T Chillier Maintenance:

VI. MAINTENANCE (BASIC GUIDE)

IMPORTANT

- **Always disconnect and lock out the electrical power source before attempting any connection, maintenance or repairs. Failure to do so can cause electrical shocks, burns and death.**
- **All work must be performed by a qualified service person based on the local codes and regulations of the area.**
- **This guide/instruction is to be used as a guide only. An understanding of the system being worked on must be understood before performing any service. Each equipment installation is unique and must be reviewed carefully.**
- **This is a list of basic maintenance items for your liquid chiller. The interval for this maintenance should be determined by the duty cycle of the chiller and the environmental conditions in which it operates. Each system may be unique, so contact the systems manager or the manufacturer for assistance.**

If any questions regarding the equipment, please contact Cold Shot Chillers for assistance.

NOTE: Not performing the following will cause early unit failure and considered abuse which is not covered by warranty.

1. **REVIEW AND COMPARE SYSTEM OPERATING PARAMETERS**
   a. Review original startup checklists and any log readings that may have been recorded to compare with existing parameters and conditions. Determine if further analysis is needed.
2. **AIR-COOLED CONDENSER (INSPECT AND CLEAN)**
   a. INSPECT: Light should be visible through the condenser coil for dirt or airborne particle build-up. Check deep into the coils with a flashlight and, if dirty, clean as needed.
   b. CLEANING: Be careful to disconnect the power first. Protect all electrical components from water and from water entering electrical conduit lines, and then cover the pump/motor, unless motor is a TEFC, to prevent water from entering the vent ports. If it needs to be cleaned, remove the covers of the chiller and use water or compressed air to blow back through the coil in the opposite direction of air flow. Avoid any damage to coil fins such as bending fins flat.
   c. EZ CLEAN FILTERS: If included on the condenser, remove the filters from the unit, and wash with water or soapy water, rinse thoroughly, and then allow filters to dry thoroughly before reinstallation. Reattach when completely dry.
3. **WATER-COOLED CONDENSERS (INSPECT AND CLEAN)**
   a. INSPECT: Clean the inline strainer on a regular basis. Depending on quality of water, the strainer may need to be cleaned more often. Verify the conditions of the condenser coil for dirt or airborne particle build-up. Check deep into the coils with a flashlight and, if dirty, clean as needed.
4. **UNIT SURFACE CLEANLINESS (INSPECT AND CLEAN)**
   a. Inspect all exposed surfaces for indications of corrosion.
   b. Metal, air, and/or water do not always mix well. When the proper concentration are in the same area, then corrosion results. Corrosion is the changing of a metal's properties from one material to another. Nearly all metals are susceptible to corrosion. One noticeable corrosion when iron and oxygen mix resulting in Iron-Oxide or Rust. Most commonly, the corrosion can be removed with wire brush and/or abrasive clothes, and then the surface can be recoated to reduce future corrosion. For severe environments, use a durable epoxy paint that can create an oxygen barrier.
   c. Fasteners which are corroded should be replaced with stainless steel fasteners.
5. **WATER QUALITY / TEST GLYCOL MIXTURE (VERIFY)**
   a. System water should be clean and free of contaminants. If the chiller has a reservoir, check for debris or contaminants which could reduce the efficiency of your chiller. If the chiller has a flow-through heat exchanger, check for normal inlet and outlet fluid pressure. A large pressure differential could indicate plugged up heat exchanger passages.
6. **STRAINERS, FLUID (INSPECT/CLEAN)**
   a. Fluid filters should be clear enough to allow for proper flow and pressure in the system. An increased fluid pressure on the system may indicate a dirty filter.
   b. To clean, turn the system off, isolate the process piping, if possible (if the chiller is not isolated from the process and the strainer is opened, then any fluid above the strainer will drain out immediately.) After isolating the

process, use a wrench to hold the strainer stationary while another wrench is placed on the strainer screen cap. The wrench on the strainer body must prevent the body from turning in the piping. Remove the cap and the strainer screen. Clean the screen and reinsert, taking care not to damage by crushing. Tighten the screen cap.

c. Setup a schedule based on the systems cleanliness and trends of use.

7. **FLUID SYSTEM CONNECTIONS (INSPECT FOR LEAKS OR LOOSE)**
   a. Visually check for fluid leaks throughout system. Physically check for loose pipe fittings or hoses. Ensure that no plumbing parts are wearing, cracking, or chaffing.
8. **PUMPS**
   a. Check the pumps for leakage. Visual indication of leakage from the pump end at the pump connection to the motor is usually an indication of a seal or O-ring failure. Only action is to replace the seal with a new seal. Seals are a consumable item.
   b. O-Rings may harden with age and may need to be replaced when they leak.
   c. Close-coupled centrifugal pumps have no bearings. Bearings in the motors are permanently grease lubricated and cannot be re-greased, unless indicated on motor.
9. **MOTOR LOADS (COMPRESSOR, PUMPS, FANS, ETC...) CHECK AMPS/OPERATION**
   a. Use an amp-meter to check for proper current draws on all motors and heaters. Refer to the chiller's electrical schematics or the motor nameplate for proper amp draws. Log readings.
10. **ELECTRICAL CONNECTIONS (CHECK ALL WIRING FOR LOOSE, CHAFFING, OR DAMAGE)**
    a. Disconnect power to the chiller. Check the electrical box and all junction boxes for any loose or damaged wiring. Replace any wiring that could cause problems with shorting or unintentional grounds.
    b. Check the condition of the contactor points for the compressor and pump. Replace them if the edges become jagged or splattered to avoid premature compressor and/or pump failure. Contactor points are consumable and their life is dependent on the amount of use and power characteristics at the unit.
11. **REFRIGERATION SYSTEM FOR LEAKS (INSPECT AND TEST)**
    a. If the system is operating and there is no indication of leaks, avoid accessing the system unless necessary.
    b. Have a certified refrigeration technician check the refrigeration system for proper operation.
    c. Leak check the unit, monitor operating pressures, and adjust as needed. Refer to manual for proper charging instructions.
12. **CASTER WHEELS AND SWIVELS**
    a. Wheels may require frequent lubrication based on the amount of use. Use good quality bearing grease and pump it into the grease fittings on the axle and swivel.
    b. If casters have locks, ensure that they are locked prior to connecting to fluid and electrical systems.
13. **COMPARE TEMPERATURE READOUT WITH ACTUAL TEMPERATURE**
    a. Use an independent thermometer (or multiple for averaging) and compare to the actual digital temperature display. If the temperature varies more than a few degrees, check condition of thermocouple/sensor. Variation more than a few degrees is usually not common.
    b. If the temperature controller is located in a different location than the thermocouple/sensor, then it may be necessary to adjust the offset in the controller parameters. Contact Cold Shot Chillers for assistance.
14. **WINTERIZATION**
    a. During cold operation months, the chiller piping exposed to freezing temperatures should be protected or damage will result. If the system is not needed during winter months, a possible option is to drain the system of all fluid and tag the system for non-use until needed again.
    b. All fluid must be removed from all components and piping to prevent possible damage.
    c. Follow the startup instructions in the manual for refilling and startup.

Trouble shooting 20T Coldshot Chiller:

VII. TROUBLESHOOTING (BASIC GUIDE)

- The Troubleshooting Guide below is to be used as a guide only. All work should be performed by a trained technician and only with proper understanding of the system. Contact manufacturer for further assistance.
- Prior to resetting any safety devices, ensure that the issue is resolved or use care in operating the system until the cause is determined.

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
COMPRESSOR DOES NOT RUN	
1. Power line open.	1. Reset circuit breaker/disconnect.
2. Contactor stuck open.	2. Replace contactor.
3. Loose terminal connection.	3. Check connections. Tighten.
4. Improperly wired controls.	4. Check and rewire.
5. Seized compressor.	5. Check motor winding for open or short. Replace compressor, if necessary. Determine cause.
6. Low line voltage.	6. Check line voltage — determine location of voltage drop and remedy deficiency.
7. Compressor motor defective.	7. Check motor winding for open or short. Replace compressor, if necessary.
8. Flow Safety Tripped	8. Determine cause of low flow issue and resolve. - Check reason for no flow. If flow is present, verify amount (~3 gpm/ton). - Verify flow is sufficient to the evaporator during all process circuit operations. - Adjust fluid bypass valve to increase flow. - Do not reset unless issue has been resolved. - Troubleshoot the switch. DO NOT BYPASS! **IMPORTANT! This condition can occur when the fluid in the evaporator nears freezing.**
9. Flow Switch Tripped (switch open)	9. Determine cause of low flow issue and resolve. (See Flow Safety Tripped)
10. Freeze Safety Tripped	10. Determine cause of low flow issue and resolve. (1) (See Flow Safety Tripped)- Typically, this is an automatic reset.
COMPRESSOR STOPS ON LOW-PRESSURE SWITCH	
1. Compressor suction shutoff valve partially closed.	1. Open valve.
2. Low refrigerant charge.	2. Determine cause of low refrigerant. Add refrigerant.
3. Liquid line solenoid valve(s) fails to open.	3. Check liquid line solenoid valve for proper operation. Replace if necessary.
4. Liquid line shutoff valve closed.	4. Open valve.
COMPRESSOR STOPS ON HIGH-PRESSURE SWITCH	
1. Compressor discharge valve partially closed.	1. Open valve or replace if defective.
2. Air in refrigerant system.	2. Purge and evacuate system, as appropriate.
3. Condenser fan(s) not operating.	3. Check, then repair or replace if defective: a. Motor/motor wiring. b. Head pressure switch. c. Capacitors.
4. System is overcharged.	4. Reclaim charge as needed.
5. Condenser coils dirty.	5. Clean coils, properly.
6. Ambient temperature too high for charge.	6. Reclaim charge as needed.
7. Partially plugged expansion valve or filter drier.	7. Clean or replace.
8. Condenser coils dirty.	8. Clean coils, properly.

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
UNIT OPERATES TOO LONG OR CONTINUOUSLY	
9. Low refrigerant charge.	9. Add refrigerant.
10. Control contacts fused.	10. Replace control.
11. Air in system.	11. Purge and evacuate system.
SYSTEM IS NOISY	
1. Piping vibration.	1. Support piping as required.
COMPRESSOR LOSES OIL	
1. Leak in system.	1. Repair leak.
2. Crankcase heaters not energized during shutdown.	2. Check wiring and relays. Check heater and replace if defective. (Some heaters are always on.)
3. Improper interconnecting piping design.	3. Check piping for oil return. Replace if necessary.
FROSTED SUCTION LINE	
1. Expansion valve not operating properly.	1. Adjust expansion valve.
2. Low temperature operation.	2. Verify low temperature operation is proper, verify superheat.
3. Low refrigerant.	3. Determine cause of low refrigerant. Add refrigerant.
4. Low fluid flow.	4. Verify fluid flow. Clean strainer and bypass is throttled to maintain 3gpm/ton.
HOT LIQUID LINE	
1. Dirty condenser coil.	1. Clean condenser coil.
2. Expansion valve malfunctioning.	2. Verify Charge and adjust expansion valve.
3. Shortage of refrigerant due to leak.	3. Repair leak and recharge.
4. Overcharged system.	4. Remove refrigerant, adjust charge.
FROSTED LIQUID LINE AFTER DRIER	
1. Restricted filter drier.	1. Remove restriction or replace.
COMPRESSOR WILL NOT LOAD/UNLOAD – HOT GAS VALVE OPERATION	
1. Defective Hot Gas Bypass valve.	1. Replace valve/solenoid.
2. Defective Capacity Control solenoid/valve.	2. Replace valve/solenoid.
3. Weak, broken, or wrong valve body spring.	3. Replace spring.
4. Program (PLC) not sending signal to solenoid.	4. Verify PLC signal and wiring.
PUMP WILL NOT RUN	
1. No Control Circuit Power.	1. Replace Fuse or reset control circuit breaker.
2. No Power to Contactor.	2. Replace Fuse or reset main circuit breaker/disconnect.
3. Low Line Voltage.	3. Check line voltage — determine location of voltage drop and remedy deficiency. - Excess operation with voltage outside of tolerance (for example "Brown Outs" will result in motor damage. (This is considered abuse and is not covered under Warranty).
4. Contactor stuck open.	4. Verify control voltage to contactor. - No Voltage – find cause of no voltage. - Low Voltage - determine location of voltage drop and remedy. - Replace contactor.
5. Loose terminal connection.	5. Check connections. Clamp on insulation material.
6. Improperly wired remote controls.	6. Verify wiring, and rewire as needed.

7. Motor defective.	7. Check motor winding for open or short. Replace motor/pump, if necessary.
VOLTAGE IMBALANCE	
1. Voltage Imbalance over 2% - Incoming Power - (Check Voltage at front and backside of each contactor during operation.)	1. Main Incoming Voltage – - A voltage imbalance may be an indication of loose wires/cable connections or faulty contactors. - Another issue may be the components themselves. Troubleshoot if needed. - If the supply voltage phase imbalance is still more than 2%, issue may require contacting local electric utility company.
2. Voltage Imbalance over 2% - Load Power - (Check Voltage at front and backside of each contactor during operation.)	2. Main Incoming Voltage – - A voltage imbalance may be an indication of loose wires/cable connections or faulty contactors. - Another issue may be the components themselves. Troubleshoot if needed. - If the supply
TEMPERATURE CONTROLLER ERROR	
1. Temperature indication not accurate.	1. Verify temperature sensor is in good condition and mounted properly. - Adjust the offset (Typically it is only adjusted a few degrees. If the offset must be adjusted more than 3 degrees, determine potential issues.)
2. Temperature indication or sensor error on controller.	2. FOR TEST PURPOSES ONLY! - Turn system off. Disconnect power. - Disconnect the thermocouple wires from controller. - Connect a short length of copper wire (Jumper) between the two contacts on the controller where the thermocouple was connected. - Reconnect power. Turn system on. - If the controller "actual" is close in range to the ambient temperature of the controller, then the thermocouple is bad. – Replace the thermocouple. (remove the jumper wire) - If the controller "actual" is <u>not</u> in range to the ambient temperature of the controller, then the thermocouple may be good, the controller may have internal issues. – Replace the controller or thermocouple input device.

Appendix, C: COLDSHOT Chiller Start Up Checklist

Cold Shot Chillers

"ECONOMICALLY PRICED DEPENDABILITY"

TYPICAL START-UP CHECK LIST

EQUIPMENT MODEL#		SERIAL#			
OWNER NAME		PHONE#			
ADDRESS					
CITY		STATE		ZIP	
INSTALLING CONTRACTOR		PHONE#			
ADDRESS					
CITY		STATE		ZIP	
START-UP PERFORMED BY		PHONE#			

** Designates Pre-Startup items. To be performed before Startup of system.*

1. *Manual referred to for details on installation and startup (IMPORTANT). ☐ Yes ☐ No
2. *Add additional information and notes on back of form, as needed. ☐ Yes ☐ No
3. *Is there any physical damage? ☐ Yes ☐ No
   a. Will this prevent start-up? ☐ Yes ☐ No

   Description: _____
4. *Unit is installed level as per the installation instructions. ☐ Yes ☐ No
5. *Electrical circuit protection has been sized & installed properly. ☐ Yes ☐ No
6. *Power supply agrees with the unit nameplate. ____V ____Ø ____Hz ☐ Yes ☐ No
7. *Electrical power wiring is installed properly. ☐ Yes ☐ No
8. *All terminals and plug assemblies are tight. ☐ Yes ☐ No
9. *Unit is grounded properly. ☐ Yes ☐ No
10. *Control voltage is appropriate per electrical drawing. _____V ☐ Yes ☐ No
11. *All piping is connected properly, as appropriate. ☐ Yes ☐ No
12. *All chilled water valves are open, as appropriate. ☐ Yes ☐ No
13. *Crankcase heaters energized for 24 hours before start-up. ☐ Yes ☐ No
14. *Outdoor piping wrapped with electric heater tape, if necessary. ☐ Yes ☐ No
15. *Water loop volume greater than 6gal/ton. ☐ Yes ☐ No
16. *Proper fluid loop freeze protection provided to _____°F
    a. With type _____ mixture _____% with _____%
17. Chilled water pump is operating with the correct rotation. ☐ Yes ☐ No
18. All air has been purged from the system. ☐ Yes ☐ No
19. Evaporator flow appropriate for capacity expected.(~3gpm/ton) ☐ Yes ☐ No
20. Check the pump(s) seals for any signs of leaking. ☐ Yes ☐ No
21. Measure the following under full load with clear refrigerant sight glass. ☐ Yes ☐ No

Suction Pressure:	PSI	Ambient Temp:	°F
Discharge Pressure:	PSI	Entering Fluid Temp:	°F
Suction Line Temp:	°F	Leaving Fluid Temp:	°F
Superheat:	°F	Set Value:	°F

22. Heat Exchanger models: If an extra heat exchanger is included with the chiller, ensure flow is adjusted through the exchanger to achieve desired cooling:

Flowrate: gpm	Temp In: °F	Temp Out: °F

23. Clean any strainers, as needed. ☐ Yes ☐ No
24. Operation Manual is given to customer. ☐ Yes ☐ No

CKL_StartupChecklist-2-20ton_1019.docx