



# **TWO/FOUR UNIT HYDROGEN ADDITIVE CUTTING SYSTEM OPERATION AND SAFETY MANUAL**

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## 1. Introduction

- 1.1. This system supplements two to four (depending on configuration) standard cutting torch setup using oxygen as the oxidizer and fuel or natural gas as the fuel, with on-demand hydrogen, with the goal to create a cleaner work environment, less emissions, and reduce bottle/supply consumption.
- 1.2. Oxygen and fuel supply (either propane or natural gas) is required to be connected to the system at the pressures indicated within this manual (section 4). A standard cutting torch must be connected to each station being used in the trailer. If using on-board generators, gasoline or propane must be supplied for operation. A water fill valve on the side/back of the trailer may periodically be connected to a pressurized water source and filled – low water alarms will indicate when necessary. Alternatively, a gravity fill port is also located for the same purpose.
- 1.3. If applicable, the HYFLO option allows for medium to heavy duty cutting with hydrogen concentrated in station #1 and #3 only, typically for use with three-line torch or jet torch setups. Selecting HYFLO on the valve between stations #1 and #2 will divert all hydrogen for both stations to #1, and #1 will revert to a standard fuel-oxygen torch with no hydrogen benefit. Similar holds true for stations #3 and #4. When LIGHT DUTY is selected for either valve, the normal hydrogen flow is supplied to both stations (#1/#2 or #3/#4).
- 1.4. The equipment is intended for use by persons qualified to operate gas cutting torches, specifically torches that use oxygen and propane / natural gas. This manual does not review basic cutting torch setup or operation/technique and should not be used as such.
- 1.5. Torching operators should be adequately trained to perform work at the torching site and be trained in all applicable site specific and government standard safety standards and procedures. All appropriate personal protective equipment (PPE) should be identified and used during cutting operations. A Job Safety Analysis (JSA) should be complete to identify all appropriate PPE required. It is the responsibility of the site management to ensure all persons are trained appropriately prior to starting work. Some standards that may be applicable to these operations include, but are not limited to:

- 1.5.1. General Industry Standard 29 CFR 1910 documents PPE, welding, cutting, and brazing requirements and operation, and toxic hazards.
- 1.5.2. Standard 29 CFR 1926 covers the listed topics in Section 1.5.1 for the construction industry.
- 1.5.3. OSHA 3348 provides guidance for safety hazard identification and control for scrap metal recycling processes.
- 1.5.4. Links to resources mentioned in Sections 1.5.1 through 1.5.3. are found below:
  - <https://www.osha.gov/welding-cutting-brazing>
  - <https://www.osha.gov/sites/default/files/publications/OSHA3348-metal-scrap-recycling.pdf>
- 1.6. This Operation and Safety Manual should be kept with the equipment and be always readily available. It is important to review and understand the operating procedures and safety precautions in their entirety before attempting to use this product.
- 1.7. IF ANY OF THE INSTRUCTIONS ARE UNCLEAR OR IF THERE IS A QUESTION, IMMEDIATELY STOP WORK, SECURE WORKING GAS, AND CONTACT SUPERVISOR AND/OR HYDROGEN CUTTING SYSTEMS.

## 2. Hazard Identification and Precautions

- 2.1. Protect yourself and others from injury. Read, understand, and follow these important safety precautions and operating instructions.
- 2.2. Do not use this equipment unless you are trained in its proper use or are under competent supervision. Follow the procedures described in this booklet each time the equipment is used.
- 2.3. Failure to follow these instructions may cause fire, explosion, asphyxiation, property damage, personal injury, injury to other, or death. This equipment must be used in accordance with all Federal, State, and local regulations as well as DOT (Department of Transportation) and CGA (Compressed Gas Association) regulations. Contact your gas supplier for more information on the proper use of compressed gases.
- 2.4. Personal Protective Equipment (PPE)
  - 2.4.1. PPE identified during the JSA should be in compliance with OSHA or any applicable safety/regulatory body. Recommended PPE for torching include, but are not limited to, the following:
    - Full face shield with shade rated for gas cutting
    - Fire resistant (FR) head covering / helmet
    - FR, insulated torching gloves
    - FR clothing (long sleeves, pants, cutting jacket or apron)
    - Steel toe, puncture resistant boots
  - 2.4.2.
- 2.5. Symbol Usage

- 2.5.1. The symbol shown Indicates a hazardous/dangerous situation which, if not avoided, could result in serious injury or death. This symbol will be accompanied by an applicable process or hazard warning, further defining the hazardous/dangerous situation.



2.5.2. Symbols that may be applicable to the operation of the hydrogen torching system are described herein. When you see the symbol, follow the related instructions to mitigate the hazard appropriately and proceed with caution if safe to do so. Symbols on equipment will be the same or similar to those shown throughout this document.

2.6. **WARNING:** Breathing gasoline generator engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects, or other reproductive harm.



2.6.1. Always start and operate the engine in a well-ventilated area.

2.6.2. If in an exposed area, vent the exhaust to the outside.

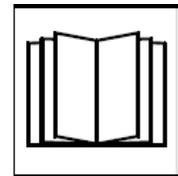
2.6.3. Do not modify or tamper with the exhaust system.

2.6.4. Do not idle the engine except as necessary.

2.6.5. For more information go to <https://www.p65warnings.ca.gov/factsheets/gasoline-engine-exhaust>

## 2.7. Read Instructions

2.7.1. The symbol shown indicates there are procedures associated with the process. Read and follow all labels and the Operation and Safety Manual carefully before installing, operating, or servicing equipment.



2.7.2. Perform operation and maintenance according to the Operation and Safety Manual, industry standards (OSHA, etc.), and national, state, and local codes.

## 2.8. Burns

2.8.1. Do not touch hot parts with exposed skin at any time. Metal, especially in large volumes, can remain hot for a significant time after torching completes and cause severe burns.



2.8.2. Allow cooling period before handling and servicing equipment. The torch head is extremely hot after torching and can cause severe burns.



2.8.3. To handle hot parts, use proper tools and/or wear heavy, insulated welding gloves and clothing to prevent burns. Ensure hot work equipment is rated for the specific application.



## 2.9. Fumes and Gases

2.9.1. Torching produces fumes and gases. Breathing these fumes and gases can be hazardous to your health.



2.9.2. Do not inhale fumes generated from torching. Some fumes are odorless, colorless, or tasteless, making them hard to identify. Understand the material and gases being used and take appropriate action to ensure fumes are not inhaled. Do not inhale cutting gases.



2.9.3. Vapors or fumes can come from coatings and residues on metal being cut. Some ingredients in coatings can have toxic effects. These ingredients include:

- metal working fluids, oils, and rust inhibitors
- zinc on galvanized steel (vaporizes to produce zinc oxide fume)
- cadmium plating
- chromates
- vapors from paints and solvents
- lead oxide primer paints
- plastic coatings

- 2.9.4. If inside an enclosed space or confined area where natural ventilation is poor, ventilate the area and/or use local forced ventilation to remove torching fumes and gases, or use an air supply respirator during torching (must have proper training and be fit tested). Some gases (natural gas, hydrogen, and acetylene) are lighter than air and will collect in high areas. Other gases (fuel and butane) are heavier than air and will collect in low areas. Heavier-than-air gases are more difficult to diffuse and are more likely to accumulate. The recommended way to determine adequate ventilation is to sample for the composition and quality of fumes and gases which personnel are exposed.
- 2.9.5. Read and understand the Safety Data Sheets (SDSs) and the manufacturer's instructions for adhesives, coatings, cleaners, consumables, coatings, cleaners, degreasers, and fluxes used in conjunction with the cutting system.
- 2.9.6. If working in a confined space, always have a trained watchperson nearby. Torching fumes and gases can displace air and lower the oxygen level, causing asphyxiation, injury, or death. Be sure the breathing air is safe. Test atmospheres in confined areas for explosive and toxic gases before using oxy-fuel equipment.
- 2.9.7. Do not torch in locations near degreasing, cleaning, or spraying operations. The heat from torching flame can react with vapors to form highly toxic and irritating gases.
- 2.9.8. Do not torch on coated metals, such as galvanized, lead, or cadmium-plated steel unless the coating is removed from the affected area, the area is well ventilated, and while wearing an air supplied respirator. The coatings and any metals containing these elements can give off toxic fumes if welded or cut.
- 2.9.9. Do not torch on sealed air conditioning or refrigeration systems unless all refrigerants have been removed from the system.
- 2.9.10. Shut off compressed gas supply when not in use to reduce gas exposure risk and risk of accumulated gases.

- 2.9.11. Gasoline generators produce carbon monoxide fumes that are invisible to sight and smell and kill in minutes. Do not use generators in an enclosed space. Do not inhale fumes from the gasoline generator.

## 2.10. Fire and Explosion

- 2.10.1. Torching on closed containers, such as tanks, drums, or pipes, can cause them to explode. Sparks can fly off from the torching operations. The flying sparks, hot workpiece, and hot equipment can cause fire and/or explosions. Check and be sure the area is safe before doing any torching.



- 2.10.2. Propane / Natural Gas fuel is extremely flammable and can explode under pressure. Exercise extreme caution when using fuel sources and check fittings and valves for leaks at the start of each day. Keep away from flame.



- 2.10.3. If applicable, a hot work permit should be completed per site and safety regulator requirements. This should be identified in the JSA.



- 2.10.4. Do not smoke or near oxygen, hydrogen, or fuel gas.

- 2.10.5. Do not use this torching equipment with gases and pressures other than those for which it is intended. Doing so may result in a leak of flammable or explosive gases



- 2.10.6. Do not perform work near hydrogen cutting trailer, gas supply (cylinders or other), or gas hoses. Ensure gas hoses are kept in a safe orientation to torching area and away from hot parts.



- 2.10.7. Follow requirements in OSHA 1910.252 (a) (2) (iv), NFPA 51B, and all applicable standards for hot work processes and have a fire extinguisher nearby and designated fire watch present.



- 2.10.8. Oxygen is not flammable by itself; however, the presence of pure oxygen will drastically increase the speed and force with which burning takes place. Oxygen must never be allowed to contact grease, oil, or other petroleum-based substances; therefore, be sure there is no oil or grease on the regulator, cylinder, valves, or equipment. Do not use petroleum-based pipe sealants. Do not use or store near excessive heat (above 125° F/51.5° C) or open flame. Do not refer to oxygen as air and do not use oxygen as a substitute for compressed air. Do not use oxygen to clean clothes or work area, for ventilation, or to operate pneumatic tools. Open oxygen cylinder valves slowly. Be sure regulator adjusting handle is in the full out (off) position before opening oxygen cylinder valve.
- 2.10.9. Inspect all equipment before use. Do not use damaged, defective, or improperly adjusted torching equipment. Make sure levers and valves work properly, threads on equipment are clean (no grease or oil) and not deformed, gauges are intact and easy to read, regulator is clean and free of oil or dirt, and fittings are properly sized for the cylinder. Make sure hoses are clean (no grease or oil) and ferrules are properly installed so the fitting does not slip inside the hose. Be sure all connections are tight.
- 2.10.10. It is recommended that a reverse-flow check valve, or a flashback arrestor be installed between the torch handle and the regulator. Check valves do not prevent the propagation of a flame upstream (flashback) but are designed to prevent the unintentional backflow of gases into the cutting attachment, torch, hoses, or regulator which could cause an explosion or fire.
- 2.10.11. A flashback arrestor can be installed on the torch handle instead of a check valve for both oxygen and fuel lines, between the torch and the hose. Using a flashback arrestor and a check valve may reduce gas flow and affect torch operation. To help prevent the reverse flow of gases, be sure the cylinders contain enough gas to complete the work.
- 2.10.12. Perform work only in an area with floor/ground that is safe to heat during torching. Do not heat concrete because it may expand and explode violently. Use heat resistant, FR shields to protect nearby walls and flooring if necessary.
- 2.10.13. Do not use if grease and/or oil is present on equipment or torching surfaces. Have equipment cleaned/repared by a qualified person. Ensure clothing is free from all grease and/or oil.

- 2.10.14. Do not open a cylinder valve quickly or the regulator may be damaged.
- 2.10.15. Do not open fuel cylinder more than approximately  $\frac{3}{4}$  turn to allow quick shutdown in the event of an emergency. Keep cylinder wrench on the cylinder for quick shut-off.
- 2.10.16. Do not slightly open or “crack” fuel cylinder valve to blow debris from the valve outlet. Remove the debris using nitrogen, air, or a clean, oil-free rag.
- 2.10.17. Always purge gas from the system before lighting torch. Purge gas in a well-ventilated area and away from flame or sparks.
- 2.10.18. Use only the gases recommended by the manufacturer of the oxy-fuel equipment being used.
- 2.10.19. Never light a torch with matches or a lighter. Always use a striker.
- 2.10.20. Do not use acetylene in this system. Regulators are not configured for Acetylene use.
- 2.10.21. Check oxy-fuel system for leaks with an approved leak detection solution or leak detector. Never test for gas leaks with a flame.
- 2.10.22. Remove all flammables within 35 ft (10.7 m) of the torching operation.
- 2.10.23. Do not torch where flying sparks can strike flammable material.
- 2.10.24. Protect yourself and others from flying sparks and hot metal.
- 2.10.25. Be alert that torching sparks and hot materials from torching can easily go through small cracks and openings to adjacent areas.
- 2.10.26. Be aware that torching on a ceiling, floor, bulkhead, or partition can cause fire on the opposite side.
- 2.10.27. Do not torch on containers that have held combustibles, or on closed containers such as tanks, drums, or pipes unless they are properly prepared according to AWS F4.1 and AWS A6.0.

- 2.10.28. Do not torch where the atmosphere may contain flammable dust, gas, or liquid vapors (such as gasoline). Keep power generators away from torching operations.
- 2.10.29. Do not use fuel gases to clean clothes or work area.
- 2.10.30. Remove any combustibles, such as a butane lighter or matches, from your person before doing any torching.
- 2.10.31. After completion of work, inspect area to ensure it is free of sparks, glowing embers, and flames.

## 2.11. Pressurized Systems.

- 2.11.1. Compressed gas cylinders contain gas under high pressure. If damaged, a cylinder can explode and if flammable, contents could ignite if near flame/heat source. 
- 2.11.2. Protect compressed gas cylinders from excessive heat, mechanical shocks, physical damage, slag, open flames, and sparks. Install cylinders in an upright position and secure to an anchored support or cylinder rack to prevent falling or tipping. Do not lay acetylene cylinders on their sides or acetone will flow out of the cylinder and damage the equipment.   

- 2.11.3. Keep cylinders away from any arc welding, cutting, or other electrical circuits.
- 2.11.4. Never drape a torching torch over a gas cylinder.
- 2.11.5. Never torch on a pressurized cylinder – explosion will result.
- 2.11.6. Use only correct compressed gas cylinders, regulators, hoses, and fittings designed for the specific application; maintain them and associated parts in good condition. Do not use any pressurized system if damaged. Do not use compressed gas cylinder unless an approved gas regulator is attached to the gas valve.

- 2.11.7. Turn face away from valve outlet when opening cylinder valve. Do not stand in front of or behind the regulator when opening the valve. Protective eye shield or full face shield is recommended when performing these operations. Comply with OSHA / safety regulator standards when operating gas cylinders / systems.
- 2.11.8. Keep protective cap in place over valve except when cylinder is in use or connected for use.
- 2.11.9. Use the right equipment, correct procedures, and sufficient number of persons to lift and move cylinders.
- 2.11.10. Store compressed gas and oxygen cylinders in separate locations.
- 2.11.11. Store empty cylinders with valves closed and caps in place.
- 2.11.12. Do not modify or repair cylinders or valves. Store leaking cylinders outdoors in a safe area, far from torching or high heat operations and processes. Identify leaking cylinders and return them to the supplier.
- 2.11.13. Dispose of used disposable cylinders according to the manufacturer's recommendations. Do not throw cylinders in fire.
- 2.11.14. Follow instructions provided by the gas supplier and on compressed gas cylinders, associated equipment, and in Compressed Gas Association (CGA) publication P-1.

## 2.12. Sparks and Flying Debris.

- 2.12.1. Torching and using pressurized systems can cause sparks and flying metal/debris.
- 2.12.2. Always wear protective eye equipment, specifically safety goggles and a face shield to prevent injury to eyes and face.



- 2.12.3. FR resistant head covering and long sleeve shirts and pants should be worn at all times while working with pressurized gas systems and torching to prevent injury from sparks and flying debris.

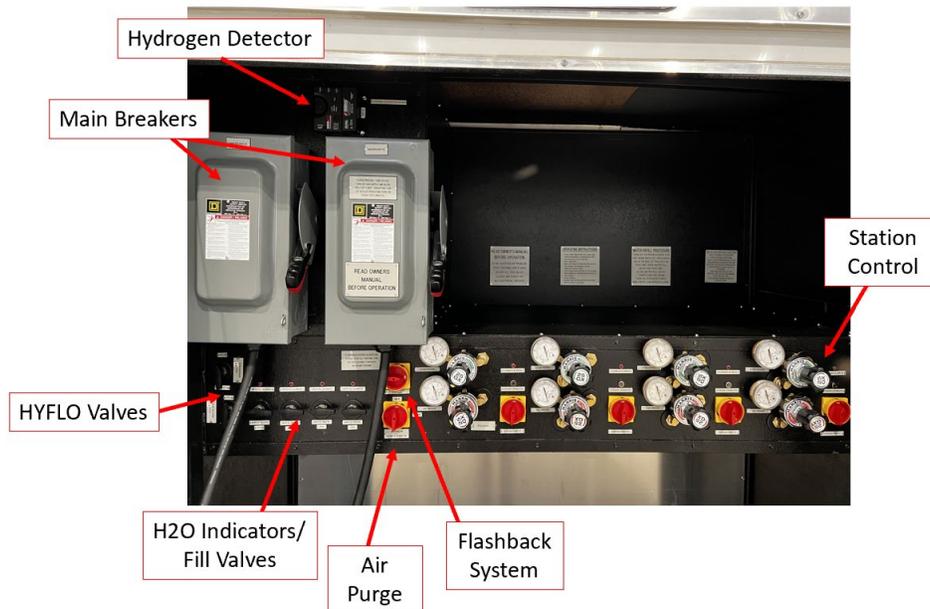
## 2.13. Electrical Hazard

- 2.13.1. Generators output up to 220 volts at 50 amps (per generator) and pose severe electrical hazard.
- 2.13.2. Check all electrical wire prior to use to ensure no exposed wire or damage exists. Do NOT use electrical cords with cuts, damage, or exposed wire.
- 2.13.3. Do not attempt to repair electrical cords or circuits. Only a qualified, authorized person is permitted to perform electrical repair and replacement. Notify supervisor that repairs/replacement are necessary.
- 2.13.4. Ensure grounding cable is in place and plugs and receptacles are free of water and debris prior to use.



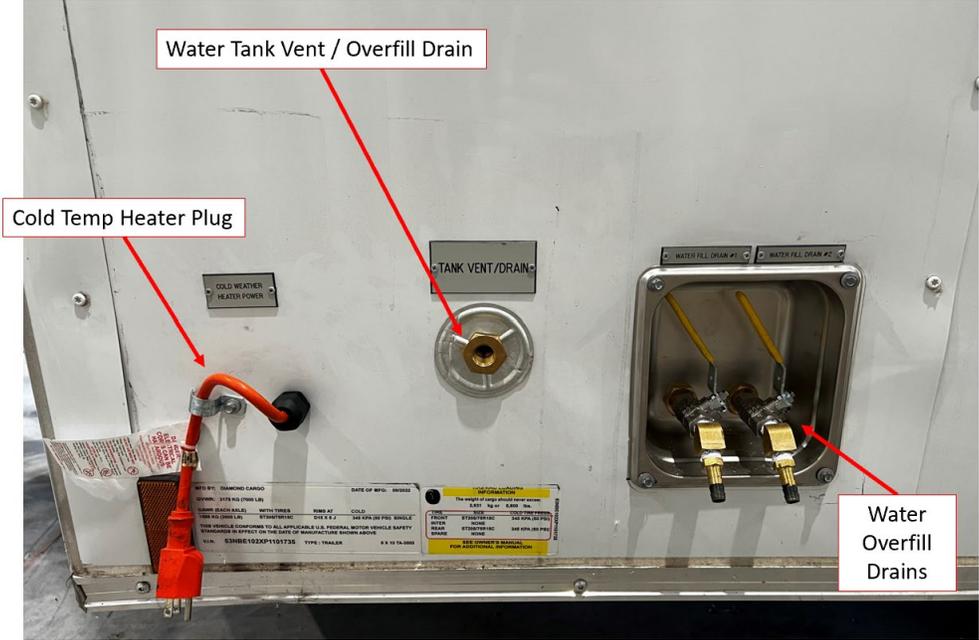
### 3. System Description and Diagram

- 3.1. The trailer system consists of a 6x10' trailer with a fold down door in the back for access for operation, a side door for maintenance access by HCS personnel only, and multiple connections, exhaust fans, drains, and vents on either side and front.
- 3.2. The maintenance door is only to be opened and entered by qualified Hydrogen Cutting Systems, LLC personnel. Camera surveillance inside the trailer and remote tracking is in use in every trailer system.
- 3.3. The side panels and back of the trailer are used by the operator to connect the gas supply and operate the system, respectively. Diagrams of the trailer layout are shown below and should be referenced for the instructions herein:

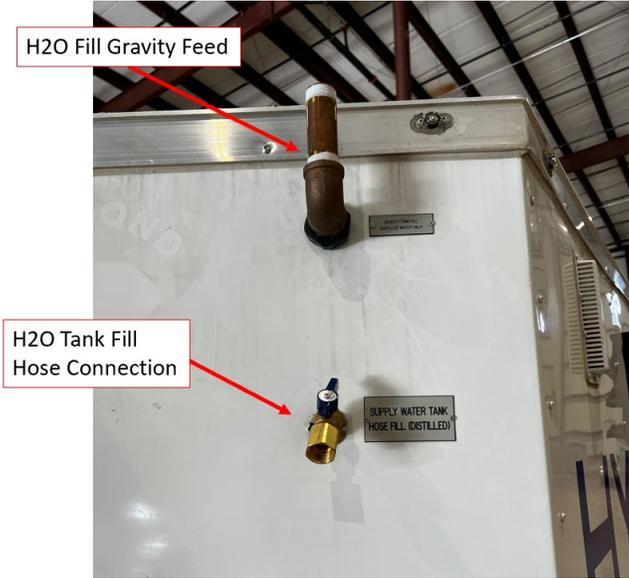


**Trailer Rear Control Panel**

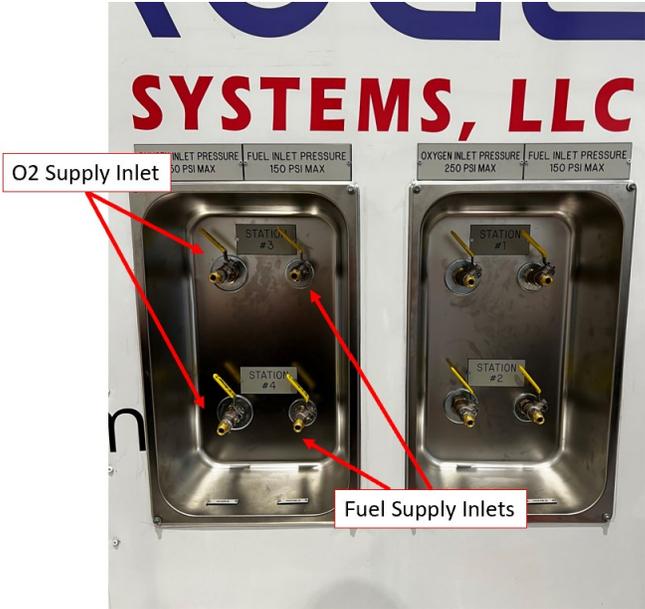




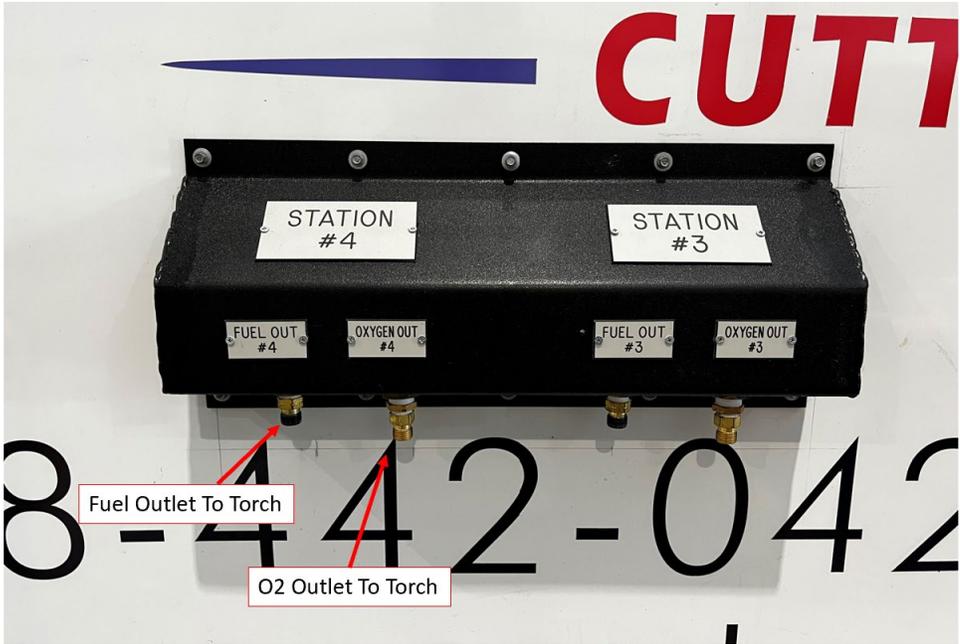
**Hydrogen System Water Drains (Trailer Side)**



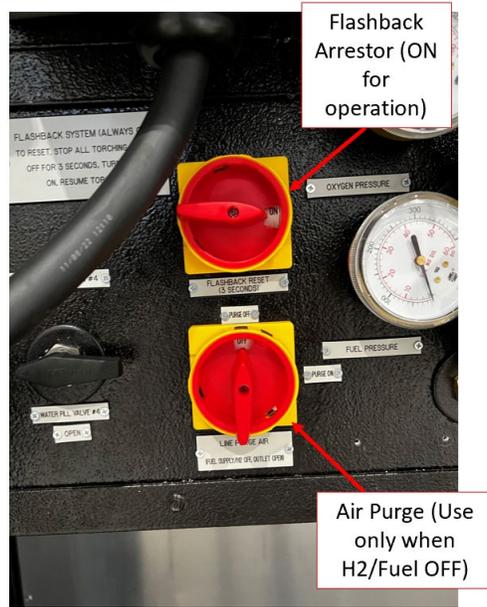
**Water Reservoir Fill Hose Connection and Gravity Feed (Trailer Side)**



Oxygen and Fuel Supply Connections (Trailer Side)



Oxygen and Fuel Outlet to Torch Hose



**Flashback and Purge Switches**



**H2 Leak Detector Main Panel (On Left Side, Operator Panel)**

## 4. Compatible Gases

- 4.1. This system is used with gaseous fuel and oxidizer only.
- 4.2. Liquified fuel/oxidizer source/supply must not be used unless a vaporizer is installed between the liquid fuel/oxidizer source and the system to create gas from liquid prior to entering the system.
- 4.3. Compatible supply fuel gases are:
  - 4.3.1. **Propane: max supply/inlet pressure, 100 psig.**
  - 4.3.2. **Propylene: max supply/inlet pressure, 100 psig.**
  - 4.3.3. **Natural Gas: max supply/inlet pressure, 100 psig.**
  - 4.3.4. **Acetylene: NOTE, the regulator configuration in this system is not for use with Acetylene. If desired, contact Hydrogen Cutting Systems for a Acetylene regulator upgrade.**
- 4.4. Compatible oxidizer gases are:
  - 4.4.1. **Oxygen: max supply/inlet pressure, 150 psig.**
- 4.5. Output pressure of the fuel regulator is 0-50 psig.
- 4.6. Output pressure of the oxygen regulator is 0-145 psig.
- 4.7. Ensure all torches and hoses used with the system are compatible with the fuel gas used. Do not mix gases.
- 4.8. Regulators on the operator panel can be used to reduce inlet/supply pressure down to suitable operating pressure for each operating station.
- 4.9. It is the responsibility of the operators to ensure max inlet/supply pressures listed in sections 4.3 and 4.4 are not exceeded during setup and operation.

## 5. Equipment Setup and Verification

- 5.1. Connect oxygen and fuel supply tanks to connectors on side of trailer using approved, pressure-rated hose designed for oxygen/fuel. Ensure any adapter or fitting conforms to pressure and gas handling requirements. Ensure supply pressures do not exceed those listed in section 4.
- 5.2. Open the rear door.
- 5.3. Roll electrical generators down ramp, position to either side of ramp. Exhaust gas egress is on the rear-side of the electrical generator and must be outside and pointed away from the bulkhead of the trailer to reduce risk CO gas build-up.
- 5.4. Connect power cords (14-50 NEMA plugs) from the gray electric disconnect boxes into 240V, 50A female receptacle plug (4 prong) on each electrical generator.
- 5.5. Connect cutting torch(es) to side output connections for the station being used on either side of the trailer (or the hose reel station(s) if option was purchased). Ensure torch valves are fully closed.
- 5.6. Turn on electrical power:
  - 5.6.1. Turn on each electrical generator:
    - Verify LOW/IDLE: ON
    - Verify MAIN SW: ON
    - Verify 50A Circuit Breaker (CB) is: OFF
    - Press and Hold ENGINE START/STOP for 3 seconds, release ENGINE START/STOP once started.
    - Switch 50A Circuit Breaker (CB) to: ON
  - 5.6.2. Turn on main power electrical disconnects for each desired electrical generator once it is on, located on the bulkhead.

5.6.3. ONCE DISCONNECTS ARE ON, VERIFY ALL EXHAUST FANS ON THE SIDE OF THE TRAILER ARE OPERATING PRIOR TO PROCEEDING. THIS IS A SAFETY FEATURE THAT MUST BE OPERATING PROPERLY BEFORE H2 USAGE CAN COMMENCE.

5.7. Turn on gases at the supply and verify pressure:

5.7.1. Slowly turn oxygen and fuel external supply tank/supply valves ON

5.7.2. Verify proper oxygen and fuel external supply tank/supply output pressures, on tank regulator gauges:

- **Fuel pressure, max inlet/supply: see section 4.3.**
- **Oxygen pressure, max inlet/supply: see section 4.4**

5.7.3. Ensure the regulators on the control panel are turned to zero flow (decrease pressure direction all the way) so that no pressure goes past the regulator.

5.7.4. Slowly open oxygen and fuel valves on side of trailer. The pressure indicators on the operator control panel should continue to read zero.

5.7.5. At the rear bulkhead, adjust the pressure for fuel and oxidizer using the gas regulators to the desired output pressure at the torch. The gauge on the regulators shows the operating pressure. Note, pressure may drop slightly once gas is flowing and should be adjusted accordingly.

## 6. Torch System Start Up and Operation

- WARNING: Different than standard oxygen/LPG torch operation
- 6.1. Verify all drain system lines are closed on the side of the trailer and all water fill switches are in the closed (horizontal) position.
  - 6.2. Ensure the flashback system switch is switched ON (horizontal position). This can be always left in this position unless a reset is needed (see section 8)
  - 6.3. Verify the torch(es) are tightly connected to the output lines for the station(s) being used and open the station oxygen and fuel valves at the connection for the specific station(s) that will be used.
  - 6.4. On the bulkhead, switch the Hydrogen power switch(es) ON for applicable stations. If applicable, select the HYFLO or Light Duty valve to the appropriate position depending on application. Verify the H2 pressure indicator(s) for the station(s) in use turn green. This may take 1-2 minutes.
    - 6.4.1. Note, if pressure indicator does not indicate green after three minutes, turn OFF the hydrogen power switch and contact Hydrogen Cutting Systems personnel for troubleshooting and possible maintenance.
    - 6.4.2. Note, if using the HYFLO feature, both stations in the HYFLO circuit will show pressure on the indicator for that respective station.
  - 6.5. Slowly open ONLY fuel valve on torch handle, and light fuel. This will result in a diffusion flame with an orange/yellow color. The flame may act differently than expected for a fuel only flame because hydrogen is flowing.
  - 6.6. Slowly open oxygen valve to introduce oxygen to flame mixture. This will cause the flame to turn blue.
    - 6.6.1. Allow flame to stabilize for 15-30 seconds as the tip heats up, adjust as necessary during this time to maintain good flame profile. Keep the flame cone visible and outside of the torch tip.

- 6.6.2. Check cutting oxygen impact to preheat flame and adjust to ensure good stability with and without cutting oxygen. Adjust as necessary to balance cutting and preheat flame.
- 6.7. Safely perform cutting. Make small adjustments to oxygen as necessary until efficient cutting is achieved.

## 7. Torch System Shutdown

### 7.1. Shutdown Situations:

- 7.1.1. Complete steps 7.2 through 7.4 when taking short breaks (0-5 minutes) from torching operation. Follow any additional site/company specific steps required for short breaks.
- 7.1.2. Complete steps 7.2 through 7.7 when taking long breaks (5+ minutes) from torching operation. Follow any additional site/company specific steps required for long breaks.
- 7.1.3. Complete steps 7.2 through 7.16 when shutting down completely from torching operation. Follow any additional site/company specific steps required for shutdown.

- **WARNING:** May differ from standard torch operation

7.2. Slowly close oxygen valve on torch handle until it is completely closed. Note: This will cause the flame to change from a pre-mixed flame (blue) to a diffusion flame (orange/yellow).

7.3. Completely close fuel valve on torch handle and verify flame is extinguished.

7.4. Turn Hydrogen power switch(es): OFF

- 7.4.1. If using HYFLO, ensure both hydrogen switches are turned off in the circuit.

### 7.5. Turn Off Electrical Power:

7.5.1. Turn OFF electrical disconnect main power switch for each electrical generator at the back of the trailer.

7.5.2. Turn OFF each electrical generator:

- Switch 50A circuit breaker (CB): OFF.
- Press and Hold ENGINE START/STOP for 3 seconds, release ENGINE START/STOP when engine shuts off.
- Switch MAIN SW: OFF

- 7.6. Slowly turn oxygen and fuel supply valves OFF at the supply inlet.
- 7.7. Bleed Trapped Gas
  - 7.7.1. In well-ventilated area far from any ignition source, preferably outdoors, slowly open oxygen valve on torch until pressure has equalized to atmosphere (flow has reduced so no detectable flow is coming out of the torch). Completely close the oxygen valve when complete.
  - 7.7.2. In well-ventilated area far from any ignition source, preferably outdoors, slowly open fuel valve on torch until pressure has equalized to atmosphere (flow has reduced so no detectable flow is coming out of the torch). Completely close the fuel valve when complete.
  - 7.7.3. Open the drain on the side of the trailer for the torch being used and wait until any gas or water has completely been expelled from the drain line and then close the drain.
- 7.8. Verify all regulator gauges on the control panel read zero pressure and hydrogen pressure indicators are no longer green.
- 7.9. Close oxygen and fuel inlet valves on side of trailer.
- 7.10. Close each individual oxygen and fuel valves at the outlet hose connection.
- 7.11. Remove torches from supply hoses and roll hoses back into reel(s) if applicable. Store torches inside trailer bulkhead or in safe location.
- 7.12. Disconnect 240V power cords (14-50 NEMA plugs), from each electrical generator
- 7.13. Roll electrical generators up ramp, back into trailer, secure with provided straps (Only required if equipment moved between setups).
- 7.14. Close and secure door.
- 7.15. Disconnect oxygen and fuel external supply hoses from side of trailer.
- 7.16. Secure external supply and hoses.

## 8. Flashback Arrestors and H2 Flashback Arrestor Reset Procedure

8.1. In the event of a flashback into the hydrogen system from the torch, there are multiple flashback arrestors in the system, including mechanical and electronic systems.

### 8.2. Electronic Flashback System - Hydrogen

8.2.1. The electronic flashback system is the first system to stop flashback of Hydrogen into the trailer and sits just within the trailer bulkhead wall.

8.2.2. If the torch experiences flashback into the hydrogen system, the electronic flashback arrestor will trip, and the flashback indicator light on the station indicator panel will illuminate. Once the system has tripped, the flow of hydrogen and fuel will be cutoff until the system is reset. No torching can resume until the system is reset.

8.2.3. To reset the electronic flashback arrestor, first shutdown torch operations per section 7.1.1. All torches and hydrogen systems must be OFF. When the system is resetting, there is no flashback protection for any torch.

8.2.4. At the control panel in the trailer, activate the flashback arrestor reset switch on the far-left side for two (2) seconds, and then switch back to ON.

8.2.5. Switch the hydrogen power ON for the applicable station and verify the flashback light is no longer illuminated and the hydrogen pressure indicator is showing green.

8.2.6. The system is now reset, and the torch can be restarted per sections 6.5 through 6.7.

### 8.3. Mechanical Flashback System – Hydrogen

8.3.1. In the unlikely event a flashback event passes the electronic system, a mechanical system is also in place for the hydrogen system. The mechanical system will trip in flashback if detected and stop the flow of hydrogen completely. The trip will be indicated if the hydrogen power is ON, no flashback light is illuminated, but the green indicator for hydrogen flow is not indicating green after the electrical flashback arrestor is reset.

- 8.3.2. The mechanical flashback system cannot be reset manually and requires service to the unit from authorized personnel. Torching with fuel and oxygen without hydrogen may resume with the hydrogen power OFF.
- 8.4. NOTE: There are no oxygen and fuel mechanical flashback arrestors built into the trailer system, only hydrogen. Oxygen and fuel flashback arrestors are typically placed at the torch connection or at the supply. Please confirm flashback arrestors are installed as necessary on the oxygen and fuel lines if required at the torching site.

## 9. Water Fill Procedure

- 9.1. If the indicator on the water panel shows a low water alarm, follow the procedure below to refill the specific hydrogen generator:
  - 9.1.1. Note: If the indicator on the water panel illuminates, there is still enough water to continue to work until the next convenient break when no torching is taking place using the hydrogen trailer system.
  - 9.1.2. During a break, shutdown torching operations by following the shutdown procedure in section 7.1.1. Note: Once the hydrogen power is OFF, the alarm will also turn off.
  - 9.1.3. Open the drain for the applicable system on the side of the trailer.
  - 9.1.4. Open the water fill valve for each station that the alarm was indicated by the low water alarm light. Observe the drain on the side of the trailer until water begins coming out of the drain.
  - 9.1.5. Close the water fill valve(s).
  - 9.1.6. Close the water drain(s).
  - 9.1.7. Turn the hydrogen switch for the filled stations ON and verify the low water alarm is no longer ON. Turn off again until torching is ready to commence.
  - 9.1.8. Restart torching per sections 6.5 through 6.7.
- 9.2. If the procedure in section 9.1 is unsuccessful and no water comes out from the drain, the reservoir tank may need replenished. This is a 45 gallon tank inside the trailer that can be accessed by either the hose connection, or the gravity fill port on the side of the trailer.
  - 9.2.1. Using the hose connection:
    - 9.2.1.1. Connect a standard hose to the trailer water reservoir fill connection. The water supply must be at standard city water supply pressure. Run water prior to connection to ensure built up water/dirt is not fed into the supply tank.

- 9.2.1.2. Turn on the water at the supply.
  - 9.2.1.3. Fill until the drain on the same side of the trailer begins to flow water. The tank is now filled and will not need refilled for some time.
  - 9.2.1.4. Close the water reservoir fill valve and the water supply valve. Disconnect the hose from the trailer.
- 9.2.2. Using gravity fill:
- 9.2.2.1. Unscrew the cap on the gravity fill port and open the valve.
  - 9.2.2.2. Add a minimum of 15 gallons of distilled water to the opening, or until the drain on the same side of the trailer begins to flow water. The tank is now filled and will not need refilled for some time.
  - 9.2.2.3. Close the valve and hand tighten the cap on the end of the port.

## 10. Cold Weather Operation

10.1. The system uses water to create hydrogen gas. There are multiple circuits and tanks within the trailer that are filled with water at any given time. If the trailer is subject to ambient temperatures at or below 32°F while not in operation for over two hours (i.e. overnight, weekend storage, etc.), the system must be supplied with outside heating source. Contact Hydrogen Cutting Systems to determine if heater installation is required.

## 11. Air Purge System

11.1. If applicable, the system has a compressor air purge that will purge the hydrogen line of moisture. This helps maintain the system and keeps water from accumulating after the electrolysis process.

11.2. Once a week, the air purge system should be used to reduce line moisture.

11.2.1. Stop all torching operation, turn off the hydrogen generators, and secure and vent all oxygen and fuel supply.

11.2.2. Vent trapped gas out of torches and leave fuel valve open at torch tip. Do this for one torch at a time.

11.2.3. Turn on compressor air for 20 minutes and allow air to vent out of the torch until all moisture has stopped coming out of the torch head. Shut the torch valves and open the next torch connected, until all lines have been bled of moisture.

11.2.4. When complete, turn off the air compressor purge, and bleed all trapped air from each system. Then ensure all torch valves are closed.

## 12. Hydrogen Alarm and Alarm Procedure

12.1. The hydrogen alarm system monitors the environment inside the cutting system trailer for leaking hydrogen gas and has both a warning light and audible alarm and strobe, depending on the percentage hydrogen gas detected.

12.1.1. At 1% hydrogen, a yellow light indicating “warning” will illuminate on the detector panel.

12.1.2. At 2% hydrogen, a red light indicating “alarm” will illuminate, a strobe will flash, an audible alarm will sound, and the automatic relay system will turn off power to the hydrogen generators.

12.2. The exhaust fans make hydrogen build-up extremely unlikely. They turn on when disconnect boxes are connected to running power generators and powered ON, which is the first step before enabling hydrogen systems.

12.3. If the alarm sounds (2% hydrogen) immediately stop cutting and shut down per section 7.1.1.

12.3.1. The alarm will automatically clear when the sensor detects the concentration of hydrogen has dropped back below 1.5%.

12.3.2. Exhaust fans are constantly providing outside air to the trailer when the system is powered and will quickly reduce percentage of hydrogen if the generators are off. Turning off power (though the relays are tripped) will ensure the generators do not turn back on and continue to leak.

12.4. Once the alarm is cleared, it is important to determine the source of the leak:

12.4.1. If only one cutting/hydrogen station was in use, do not use that station in the future. Contact Hydrogen Cutting Systems and notify which station as leaking.

- 12.4.2. If multiple stations were in use, use only one station at a time for a period of 5-10 minutes to determine if that station was causing the leak. After 5-10 minutes, if no alarm, the station in use can remain on and the next station can be used. When the alarm sounds, follow the procedure in section 12.2 to shut down the last station turned on. Do not use that station until Hydrogen Cutting Systems is contacted and performs maintenance.

## 13. Emergency Procedures

13.1. In the event of any emergency where normal shutdown operation is not possible:

13.1.1. If safe to do so, close all gas valves, oxygen and fuel, at the supply. This will stop the flow of gas into the trailer and torch(es).

13.1.2. If safe to do so, switch both electrical disconnects OFF at the trailer bulkhead. This will stop any hydrogen production inside the trailer.

13.1.3. If safe to do so, turn off electrical generators by pressing the stop switch(es). This will remove all electricity from the trailer.

13.1.4. Follow site emergency procedures as applicable.

13.2. When safe to do so, contact proper specific site person(s) and Hydrogen Cutting Systems. Contact information can be found on page 2.