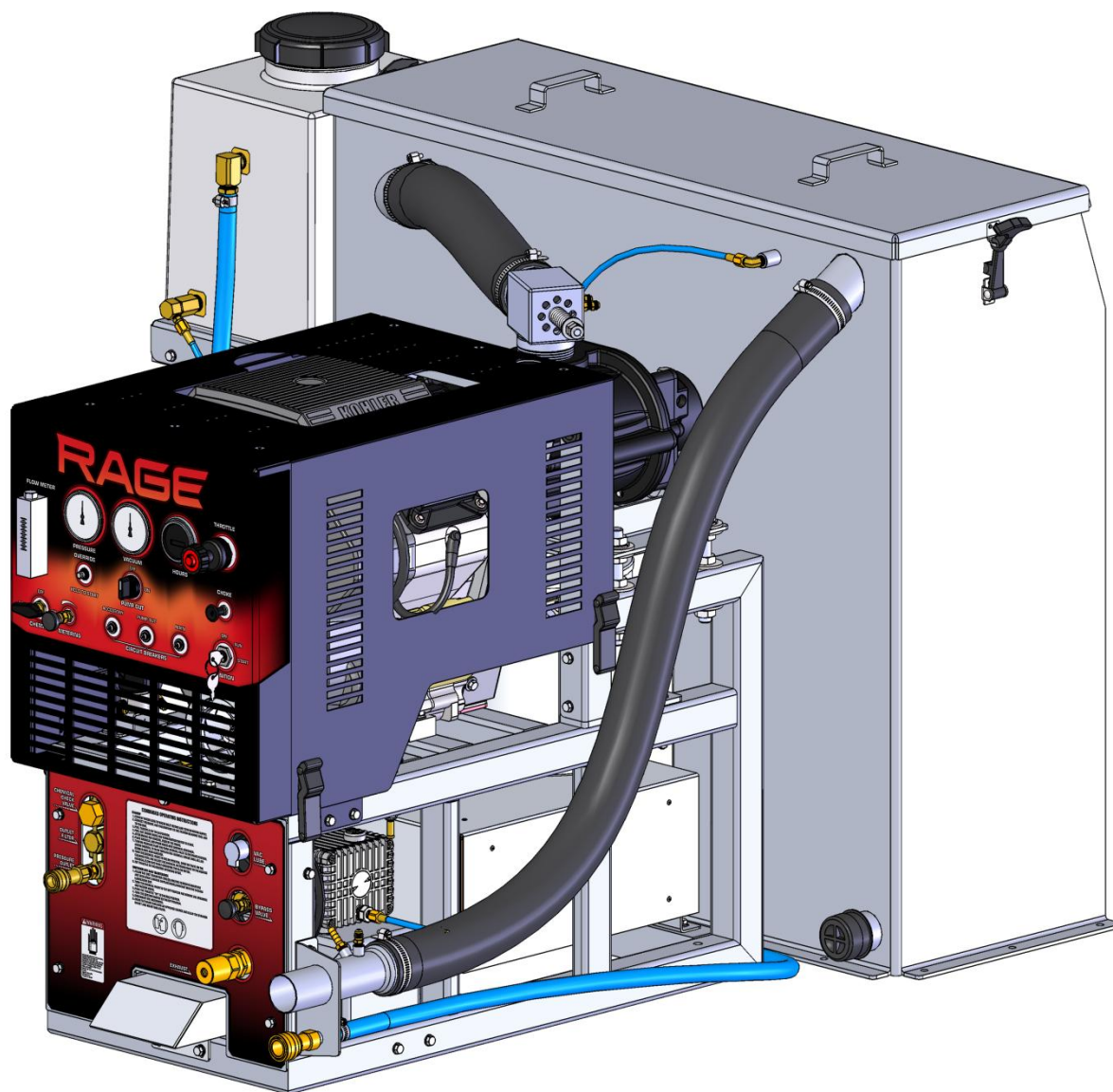


# RAGE



## Service and Operation Manual



2604 Liberator Dr., Prescott, AZ 86301 1-928-445-3030

**Congratulations** on your purchase of the **RAGE®** Truck mount cleaning unit. This instruction/parts manual is a guide for operating and servicing your **SAPPHIRE SCIENTIFIC** Truck mount unit.

Proper operation and service are necessary to ensure the outstanding performance of this unit. When properly maintained, your Truck mount will have a long and trouble-free life.

The following service methods outlined in this manual are detailed in a manner that operation and servicing may be performed properly and safely. Because service levels vary due to the skill of the mechanic, tools and parts availability, ensure that prior to attempting any repair, you are familiar with this equipment and have the proper tools. Any questions regarding the operation, service, or repair of this unit should be directed to your nearest **SAPPHIRE SCIENTIFIC** dealer.

The headings **WARNING** and **CAUTION** are utilized to warn you that steps must be taken to prevent personal injury or damage to the equipment. Please make sure that you have read and understand these instructions entirely before proceeding with the operation of this unit.

**THIS UNIT MUST BE INSTALLED BY THE DEALER THAT YOU PURCHASED IT FROM IN ACCORDANCE WITH THE SAPPHIRE SCIENTIFIC INSTALLATION PROCEDURES.**

BE SURE TO FILL OUT THE WARRANTY CARD ONLINE AT [WWW.SAPPHIRESCIENTIFIC.COM](http://WWW.SAPPHIRESCIENTIFIC.COM)

Record your units serial number here for future reference or if you should need to contact the factory in the future for any reason.

S/N:

This service and operations manual is written specifically for **SAPPHIRE SCIENTIFIC RAGE®** Truck mount Cleaning units manufactured by:

**SAPPHIRE SCIENTIFIC**  
2604 Liberator  
Prescott, AZ 86301  
USA

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Printed in USA

**RAGE®** MANUAL  
**PART# 49-057**

# SAPPHIRE SCIENTIFIC LIMITED WARRANTY

## Sapphire Scientific RAGE®

### What Does This Warranty Cover?

This warranty covers the Sapphire Scientific RAGE® and is provided to the original purchaser only.

### How Long Does This Warranty Last?

This warranty runs for:

- Two (2) years from the date of installation on parts and labor (Excluding normal maintenance items.) Factory installed original belts are covered for 1000 hours or 2 years, whichever comes first. Water box, recovery tank and frame are covered for five years. All other components including seals, o-rings and electrical components are covered for the entire two year warranty period.

### What Sapphire Scientific Will Do:

If a defect in materials or workmanship occurs within the warranty period, Sapphire Scientific at its election will repair or replace the defective part at no charge.

### What This Warranty Does Not Cover:

This warranty does not cover or apply to defects due directly or indirectly to misuse, abuse, disassembly, alteration, corrosive chemicals, improper voltage, improper fuel, fire, flood, negligence, accident, improperly or incorrectly performed maintenance or repair, or failure to perform necessary or recommended maintenance or repair (See your Owner's Manual) or if the use of this product is not in compliance with the instructions and specifications for its use. This warranty does not cover normal maintenance items such as air and oil filters, lubricants and tune up parts. Paint is not covered. Water box, recovery tank and frame are covered for five years. All other components including seals, o-rings and electrical components are covered for the entire two year warranty period. We limit all implied warranties to:

- Two (2) years from the installation date on parts and labor. It is strongly recommended that this truck mount be used with, and only with, Sapphire Scientific Chemicals and as directed by label instructions on chemical bottles.

OTHER THAN THE WARRANTIES PROVIDED HEREIN, SAPPHIRE SCIENTIFIC MAKES NO EXPRESS OR IMPLIED, ORAL OR WRITTEN WARRANTIES WITH RESPECT TO THIS PRODUCT OR WORKMANSHIP AND ALL WARRANTIES IMPLIED BY LAW INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED TO THE DURATION OF THIS WARRANTY. **Some states do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.** WE SHALL IN NO EVENT BE LIABLE FOR DEATH, INJURIES TO PERSONS OR PROPERTY OR FOR INCIDENTAL, CONTINGENT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING FROM USE OF OUR PRODUCTS. **Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.**

### How Do I Get Service?

In order to be eligible for service under this warranty you MUST do the following: (a) fill out the warranty registration card on-line within thirty (30) days of the installation of our product; (b) have your dealer write or call for a return material authorization (RMA); and (c) have the serial number and original proof of installation date available. Proof of proper maintenance may be required before warranty is granted. Contact us at:

Sapphire Scientific  
2604 Liberator, Prescott, AZ 86301  
Phone: 928-445-3030

If our dealer uncovers a defect we will repair or replace the product, at our election. Ground shipping and transportation costs will be covered by the manufacturer. Returning defective parts to the manufacturer, if required, shall be the responsibility of the purchaser. Warranty may be denied if defective parts are not returned within the allotted 30 days. If it is determined that there is no defect in the product, or that the defect resulted from causes not within the scope of our warranty, then the product will be repaired or replaced only at your request and at your expense and you must bear all shipping costs.

### How Does State Law Apply?

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

# Table of Contents

<b>SECTION ONE: GENERAL INFORMATION</b>		<b>1</b>
<b>1. SAFETY</b>		<b>2</b>
<i>Safety, Specifications, Installation, Fuel, Engine Oil, Chemical, Water Requirements</i>		
<b>2. RECEIVING YOUR TRUCKMOUNT UNIT</b>		<b>8</b>
<i>Dealer Responsibility, Acceptance of Shipment, Equipment Listing, Optional Equipment</i>		
<b>SECTION TWO: INSTALLATION</b>		<b>9</b>
<b>3. INSTALLATION</b>		<b>10</b>
<i>Lifting the Unit into the Vehicle, Positioning the Unit into the Vehicle, Fastening Down the Unit and Waste Tank, Dimensional Diagrams, Installation of Fuel Lines, Trailer Fuel Tank and Fuel Line Installation, Battery Connection, Fire Extinguisher, Console to Waste Tank Connection</i>		
<b>SECTION THREE: OPERATION</b>		<b>14</b>
<b>4. SYSTEMS</b>		<b>15</b>
<i>Water Pumping System, Heat Transfer System, Vacuum System, Chemical System</i>		
<b>5. OPERATION</b>		<b>18</b>
<i>Equipment setup, Instrumentation, Starting Your Unit, Priming the Chemical Pump, Waste Pump, Operation, Cleaning, Upholstery Cleaning, Stair Tool Cleaning, Flood Restoration, Heat Bypass Operation, Shut Down and Daily Maintenance, Freeze Protection.</i>		
<b>SECTION FOUR: MAINTENANCE and SERVICE</b>		<b>25</b>
<b>6. MAINTENANCE CHART</b>		<b>26</b>
<b>7. MAINTENANCE</b>		<b>27</b>
<b>8. GENERAL SERVICE ADJUSTMENTS</b>		<b>31</b>
<b>9. TROUBLESHOOTING</b>		<b>34</b>
<b>SECTION FIVE: PARTS and ACCESSORIES</b>		<b>39</b>
<b>10. ILLUSTRATED PARTS LISTINGS</b>		<b>40</b>
<b>11. ACCESSORIES</b>		<b>60</b>



# **SECTION 1:** **GENERAL INFORMATION**

## **1. SAFETY**

Safety.....	2
Specifications.....	5
Installation requirements.....	6
Fuel requirements.....	6
Engine oil requirements.....	6
Chemical requirements.....	7
Water requirements.....	7

## **2. RECEIVING YOUR TRUCKMOUNT UNIT**

Dealer responsibility.....	8
Acceptance of shipment.....	8
Equipment listing.....	8
Optional equipment.....	8

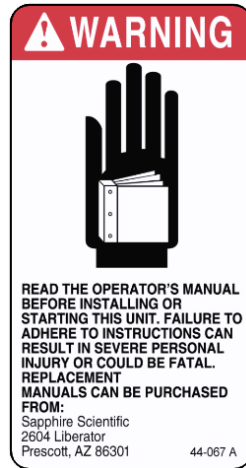
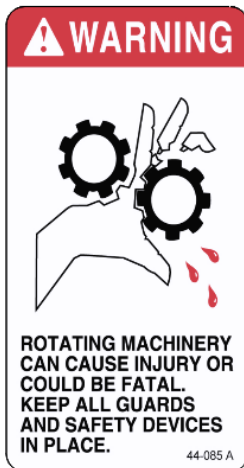
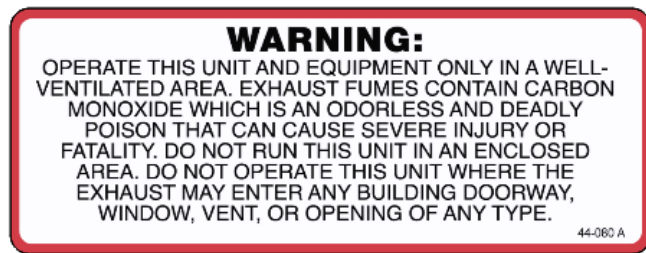
## SECTION 1

# 1. SAFETY

## **WARNING For Your Safety!**

The following **WARNING** labels are on your **RAGE**<sup>®</sup> console. These labels point out important **Warnings** and **Cautions**, which must be followed at **all** times. Failure to follow warnings could result in personal

injury or fatality to yourself and/or others or property damage. Please follow these instructions carefully! **DO NOT remove these decals.**



## SECTION 1

### **WARNING!**

#### 1. **Read the operator's manual before starting this unit.**

Failure to adhere to instructions could result in severe personal injury or could be fatal.

#### 2. **Operate this unit and equipment only in a well-ventilated area.**

Exhaust fumes contain carbon monoxide, which is an odorless and deadly poison that can cause severe injury or death. **DO NOT** run this unit in an enclosed area. **DO NOT** operate this unit where the exhaust may enter a building doorway, window, vent or other opening.

#### 3. **Gasoline is extremely flammable and its vapors can explode if ignited.**

Store gasoline only in approved containers, in well-ventilated, unoccupied buildings and away from sparks or flames. Never carry gasoline or any flammable materials in the vehicle. Fumes could accumulate inside of the vehicle and ignite, causing an explosion.

4. This unit must be operated with the vehicle doors open in order to ensure adequate ventilation to the engine.

5. **DO NOT** operate unit if gasoline is spilled. Do not turn ignition switch until the gasoline has been cleaned up. Never use gasoline for cleaning purposes.

6. **DO NOT** place hands, feet, hair, clothing or any body parts near rotating or moving parts. Rotating machinery can cause severe injury or death.

7. **NEVER** operate this unit without belt and safety guards. High speed moving parts, such as belts and pulleys, should be avoided while the unit is running. Severe injury, fatality or damage may result.

8. **NEVER** service this unit while it is running. High speed mechanical parts as well as high temperature components may result in injury or severed limbs.

9. Engine components will be extremely hot from operation. To prevent severe burns, **DO NOT** touch these areas while the unit is running or shortly after the unit is shut off.

10. **DO NOT** touch any part of the exhaust system while the system is running or for 20 minutes after the unit is shut off. Severe burns could result.

11. **Water under high pressure at high temperature can cause burns, severe personal injury, or fatality.** Shut down unit, allow it to cool down and relieve the system of all pressure before removing caps, valves, plugs, fittings, filters or hardware.

12. **NEVER** leave the vehicle engine running while the unit is in operation.

13. **Battery acid contains sulfuric acid.** To prevent acid burns, avoid contact with skin, eyes and clothing. Batteries also produce explosive hydrogen gases while charging. To prevent fire or explosion, charge batteries only in a well-ventilated area. Keep sparks, open flames, as well as other sources of ignition away from battery at all times. Remove all jewelry prior to servicing batteries. Keep batteries out of the reach of children.

**Before disconnecting** the negative (-) ground cable, ensure that all switches are in the off position. If on, a spark could occur at the ground connection terminal which could cause an explosion if hydrogen gas or gasoline vapors are present. **ALWAYS** disconnect the negative (-) terminal first.

14. **DO NOT** smoke around the machine. Gas fumes could accumulate and ignite. Battery gases are extremely flammable. This will prevent possible explosions.



## SECTION 1

15. **DO NOT** damage the vehicle in any way during the installation. When routing fuel lines **DO NOT** configure the hose in any locations where the hose or vehicle could be damaged. Avoid contact with moving parts, hot surfaces, brake lines, fuel lines, catalytic converters, exhaust pipes, mufflers or sharp objects.

16. **NEVER** cut or splice any of the vehicle fuel lines during fuel line installation. This will result in fuel leaks and potentially dangerous conditions. Use only the provided fuel hose for fuel lines. When going through the vehicle floor with fuel lines, always utilize bulkhead adaptors. This will prevent fuel leaks and ensure that hoses are not punctured by vehicle vibration abrasion.

17. **DO NOT** exceed your vehicles weight limit. The console with waste tank and accessories weighs approximately 858 pounds. Make certain that the vehicle has the correct axle rating. This will prevent unsafe or hazardous driving conditions.

18. High back seats are required for all vehicles that units are to be installed for head and neck protection. Metal partitions between the seats and equipment are strongly recommended.

19. **DO NOT** operate this unit without the water supply on and attached. The water pump and other vital components could be seriously damaged if the unit is operated dry.

20. Always keep your vehicle clean and orderly. Wands, tools and accessories must be securely stowed while driving the vehicle.

21. All high-pressure hoses must be rated at 3000 PSI and have a heat rating of 250 degrees F. Thermoplastic hoses do not meet this criteria and should never be used. Severe burns and other injuries could result if hoses do not meet these requirements.

22. Ensure that you have received proper training from the distributor that you purchased the unit from prior to operation.

23. This unit produces high pressure and high temperatures. Improper use could result in serious injury.

24. **DO NOT** modify this unit in any manner. Any modification could result in serious injury or fatality.

25. California Proposition 65 Warning: Engine exhaust from this product contains chemicals known by the State of California to cause cancer, birth defects, or other reproductive harm.

## SECTION 1

### **SPECIFICATIONS**

Engine Speed .....	3000 rpm (High Speed No Load)
1500 rpm (Idle No Load)	
Water Pump RPM .....	1450 rpm
Vacuum Pump RPM .....	3200 rpm
Water Flow Rate .....	3.0GPM (maximum)
Water Pump Pressure .....	1000 PSI (maximum)
Vacuum Relief Valve .....	13 in. Hg
Waste Tank Capacity .....	90 gal.
Console Weight .....	520 lbs.
Console Weight (w/standard waste tank & hoses) .....	858 lbs.
Operating Weight (w/full water box & standard waste tank) .....	1534 lbs.

### **TORQUE VALUES**

Engine Hub Rear .....	160 inch/lbs.	13.3 ft/lbs.
Engine Hub Front .....	160 inch/lbs.	13.3 ft/lbs.
Vacuum Pump Hub .....	160 inch/lbs.	13.3 ft/lbs.
Pressure Pump Hub .....	130 inch/lbs.	10.8 ft/lbs.

### **JET SIZING**

**SAPPHIRE SCIENTIFIC** recommends that the total floor tool tip size does not exceed #6. Using larger jet sizes on your **RAGE**<sup>®</sup> unit may reduce cleaning temperatures.

## SECTION 1

### INSTALLATION REQUIREMENTS

Prior to beginning the installation, read the ENTIRE “Installation” section of this manual. Since the **RAGE**<sup>®</sup> Truck mount unit weighs (with standard waste tank and hoses) approximately 858 lbs., please adhere to the following recommendations prior to installing the unit.

#### **CAUTION!**

**The console and waste tank with accessories must NOT exceed the vehicle’s axle weight limit.**

1. If mounting the unit in a trailer, ensure that the trailer is rated for the total weight of the **unit and trailer**. Electric or hydraulic brakes must be provided, and strict compliance with all State and Federal laws must be maintained.
2. If mounting in a trailer, the **RAGE**<sup>®</sup> console must be positioned so that it balances properly with respect to the trailer axle. Ten percent (10%) of the unit’s total overall weight (w/o accessories or water) should be on the tongue. This unit has an air cooled engine, and adequate ventilation must be provided to prevent overheating.
3. **If mounting in a trailer, the external fuel tank must meet EPA requirements for compliance.**
3. The vehicle tires must have a load rating in excess of the combined unit and vehicle weight.
4. **SAPPHIRE SCIENTIFIC** does not recommend using any type of flooring materials that absorb water. This condition will result in rust and corrosion of the vehicle floor.
5. Insulation under rubber mats should be removed prior to installation of the unit.

### FUEL REQUIREMENTS

**Use unleaded fuel ONLY.** Use only fresh, clean unleaded gasoline with a minimum octane rating of 87. **Do Not** use high octane gasoline. Gasoline with up to, not exceeding, 10% ethanol is acceptable.

**NOTE:** Using other gasoline/alcohol blends including E20 and E85 will cause damage to engine components and will void warranty.

### ENGINE OIL REQUIREMENTS

Use high-quality oil of at least API (American Petroleum Institute) service class SG, SH, SJ or higher. **Do not use additives.** High quality 30W oil is recommended. A 10-30 synthetic blend may be used after 50 hours of operation for a new or rebuilt engine to allow the piston rings to properly seat. It is never recommended to extend oil change intervals past 100 hours.

Engine oil capacity	1.7 L 1.8 U.S.qts
---------------------	----------------------

Tightening torque	Drain Plug	13.6 N·m 1.4 kgf·m 10.0 lbf·ft
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**NOTE:** Using lower service class oil or extending oil change intervals longer than recommended can cause engine damage.

**NOTE:** Synthetic oils meeting the listed classifications may be used with oil changes performed at recommended intervals. However to allow piston rings to properly seat, a new or rebuilt engine should be operated for at least 50 hours using standard petroleum based oil before switching to synthetic oil.

## SECTION 1

### **CHEMICAL REQUIREMENTS**

The **SAPPHIRE SCIENTIFIC RAGE®** Truck mount unit's unique last step chemical injection system can be used with a wide variety of water diluted chemical compounds, either acidic or alkaline, depending on the work to be performed. We recommend using only **SAPPHIRE SCIENTIFIC** and **CHEMSPEC** brand chemistry.

### **WATER REQUIREMENTS**

Because hard water deposits will damage the plumbing and heat exchange systems on this unit, **SAPPHIRE SCIENTIFIC** recommends that a high quality water softener be used in areas where the water hardness exceeds 3½ grains. If a water softener is used, it must have a flow capacity of at least five (5) GPM or greater, without any hose constrictions.

The use of a water softening system will reduce maintenance and reduce down time caused by hard water scaling. It will also enhance the performance of cleaning chemicals, which will result in greater efficiency in lower concentration.

## SECTION 1

# 2. RECEIVING YOUR TRUCKMOUNT UNIT

## DEALER RESPONSIBILITY

THE **SAPPHIRE SCIENTIFIC** DEALER THAT YOU PURCHASED THIS TRUCKMOUNT CLEANING UNIT FROM IS RESPONSIBLE FOR THE PROPER INSTALLATION OF THIS MACHINE. THE DEALER IS ALSO RESPONSIBLE FOR THE PROPER INITIAL TRAINING OF YOUR OPERATORS AND MAINTENANCE PERSONNEL.

## ACCEPTANCE OF SHIPMENT

Your **RAGE**<sup>®</sup> Truck mount cleaning unit was thoroughly tested, checked and inspected in its entirety prior to leaving our manufacturing facility. **When receiving your unit, please make the following acceptance check:**

1. The unit should not show any signs of damage. If there is damage, notify the common carrier immediately.
2. Carefully check your equipment and packing list. The standard **SAPPHIRE SCIENTIFIC RAGE**<sup>®</sup> unit should arrive with the following items as well as any optional accessories:

## EQUIPMENT LISTING

- **A. SAPPHIRE SCIENTIFIC RAGE MODEL** console.
- Operation and Service manual.
- Installation mounting plates and bolt down kit.
- Hose clamps for vacuum and fuel hoses.
- Waste tank with shutoff switch.
- Waste tank filter and stainless steel strainer basket.
- 50 ft. of ¼ in. high pressure solution hose with shutoff valve and quick connects.

- 50 ft. of ¼ in. high pressure solution hose with quick connects
- 2 50 ft. lengths of 2 in vacuum hose.
- 1 hose coupler – 2 inch.
- 50 ft. water supply hose with quick connect.

## OPTIONAL EQUIPMENT

- A. Additional 50 ft. 2 in. vacuum hose
  - Part # 18-003
- Additional vacuum hose connectors
  - Part # 21-003
- Additional high-pressure solution hoses
  - Part # 18-000
  - With shutoff valve Part # 18-001
- Demand pump system
  - Part # 68-002
- Automatic Waste Pump-Out Kit
  - Part #68-158

## FUEL HOOK-UP KITS BY VEHICLE

- Chevy 1997 to 2002 FI..... 69-003FI
- Chevy 2003 FI..... 69-018FI
- Chevy 2004+ Hook-Up Kit... 69-033
- Chevy Box Truck 2004+..... 69-081
- Dodge 1997 to 2002 FI..... 69-004FI
- Ford FI..... 69-005FI
- Ford 2004 – 2010..... 69-061
- Ford 2011+..... 69-331
- Ford Box Truck 2004+..... 68-077
- Ford Transit Connect ..... 69-261S
- Nissan NV..... 69-376

# **SECTION 2:** **INSTALLATION**

## **3 INSTALLATION**

Lifting the unit into the vehicle.....	10
Positioning the unit into the vehicle.....	10
Fastening down the unit and waste tank.....	10
Dimensional diagrams.....	11
Installation of fuel lines.....	12
Trailer fuel tank and fuel line installation.....	12
Battery Connection.....	12
Fire extinguisher.....	12
Console to waste tank connection.....	13

## SECTION 2

### 3. INSTALLATION

#### **WARNING!!!**

This unit must be bolted to the floor of the vehicle by an authorized SAPPHERE SCIENTIFIC DISTRIBUTOR.

#### LIFTING THE UNIT INTO THE VEHICLE

Because the SAPPHERE SCIENTIFIC RAGE® weighs approximately 520 lbs., a forklift is necessary to place the unit into the vehicle. Place the forks under the unit. Using two “C” clamps, secure the console to the forks. Move the unit into desired position.

#### POSITIONING THE UNIT INTO THE VEHICLE

Vehicles vary in size and openings. Owners have different preferences on where in the vehicle they want their units positioned. SAPPHERE SCIENTIFIC strongly recommends a side door installation for the RAGE®. We **DO NOT** recommend a rear door installation.

1. Ensure that enough space is provided to assure adequate engine ventilation as well as room for service and maintenance.
2. Operating weight of the complete installation (which includes water weight) with waste tank and all accessories **MUST NOT** exceed the vehicle’s axle weight limit. Please refer to **SPECIFICATIONS** in Section 1 for standard unit and waste tank operating weight.

### FASTENING DOWN THE UNIT AND WASTE TANK

#### **CAUTION!!!**

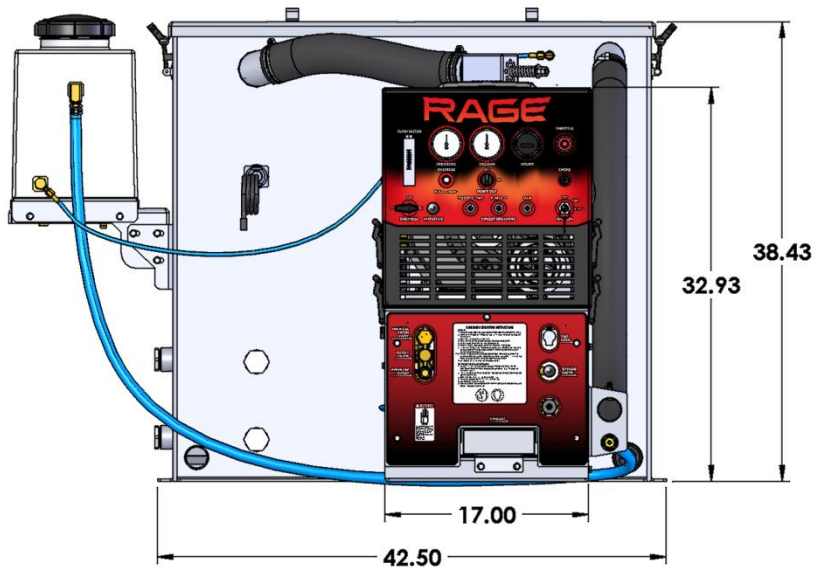
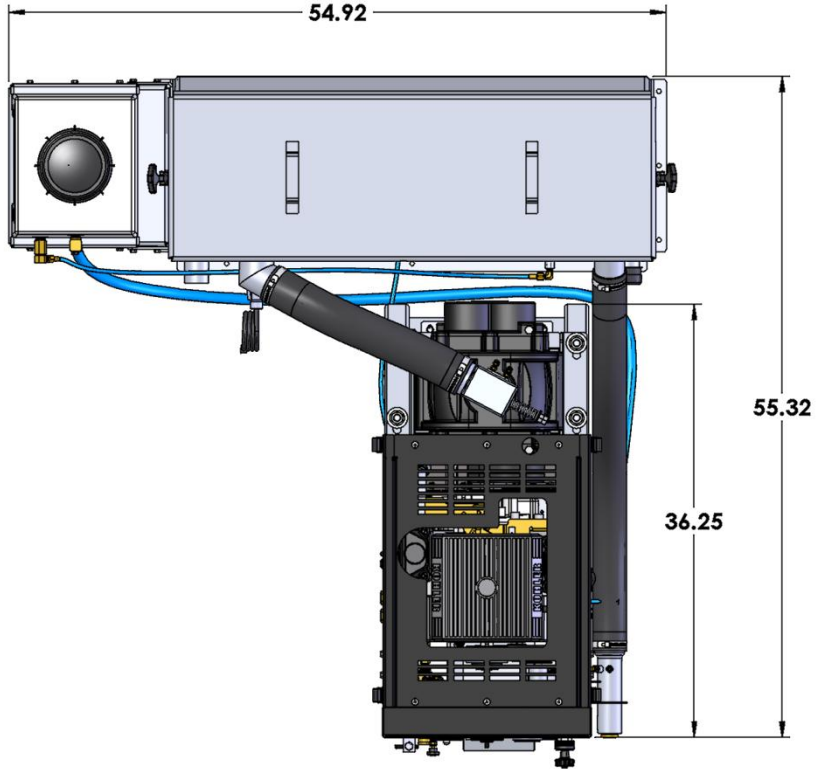
Prior to drilling any holes in the vehicle floor, ensure that while drilling, you will not damage the fuel tank, fuel lines, or any other vital components which could affect the safety or operation of the vehicle.

A. The console and waste tank mounting holes will serve as a template. Drill six (6)  $1\frac{13}{32}$  in. diameter holes for the console and four (4)  $1\frac{13}{32}$  in. diameter holes for the waste tank.

B. Using the provided mounting hardware kit:

1. Insert six (6)  $\frac{3}{8}$ -16 × 4 in. grade 5 hex head cap screws with flat washers through the RAGE® console mounting holes, and four (4)  $\frac{3}{8}$ -16 × 4 in. grade 5 hex head cap screws with flat washers through the waste tank mounting holes.
2. Install the provided mounting plates underneath the vehicle floor.
3. Screw the provided  $\frac{3}{8}$ -16 hex head lock nuts on to the mounting bolts and tighten until the console and waste tank are firmly attached to the vehicle floor.

**SECTION 2**  
**DIMENSIONAL DIAGRAM REAR MOUNT TANK**





## SECTION 2

### INSTALLATION OF FUEL LINES



**READ THESE INSTRUCTIONS IN THEIR ENTIRETY PRIOR TO PROCEEDING.**



**The Vehicle fuel lines should NOT be spliced under ANY circumstances. Severe injury or fatality could result.**

**DO NOT** damage the vehicle in any way during the installation. When routing fuel lines **DO NOT** configure the hoses in any location where the hoses or vehicle could be damaged. Avoid contact with moving parts, areas of high temperature, brake lines, fuel lines, catalytic converters, exhaust pipes, mufflers or sharp objects.

### TRAILER FUEL TANK AND FUEL LINE INSTALLATION

The following are recommendations for trailer installations:

A. Strict compliance with all federal and state laws must be maintained.

**B. Use only fuel tanks that are manufactured specifically for gasoline, that are EPA compliant with proper vented filling caps, and outlet connections that are the same size as the inlet and return connections on the unit.**

C. **DO NOT** install fuel tanks inside any type of enclosed trailer or vehicle.



**NEVER** carry gasoline or flammable materials in an enclosed trailer or vehicle.

**NEVER** store any type of flammable material in an enclosed trailer or vehicle.

D. Always mount fuel tanks where they will be protected from any vehicle collision.

E. When installing fuel lines from the fuel tank to the unit, use the proper size fuel line.

### BATTERY CONNECTION



#### **Explosive gases, Dangerous gases!**

Batteries contain sulfuric acid. To prevent acid burns, avoid contact with skin, eyes and clothing. Batteries also produce explosive hydrogen gases while charging. To prevent fire or explosion, charge batteries only in a well ventilated area. Keep sparks, open flames, as well as any other sources of ignition away from batteries at all times. Remove all jewelry prior to servicing batteries. Keep batteries out of the reach of children.

Before disconnecting the negative (-) ground cable, ensure that all switches are in the OFF position. If ON, a spark could occur at the ground connection terminal, which could cause an explosion if hydrogen gas or gasoline vapors are present. **ALWAYS** disconnect the negative (-) terminal first.

A. Attach the red positive (+) battery cable from the starter solenoid on the console to the positive (+) terminal on the battery and tighten down the nut.

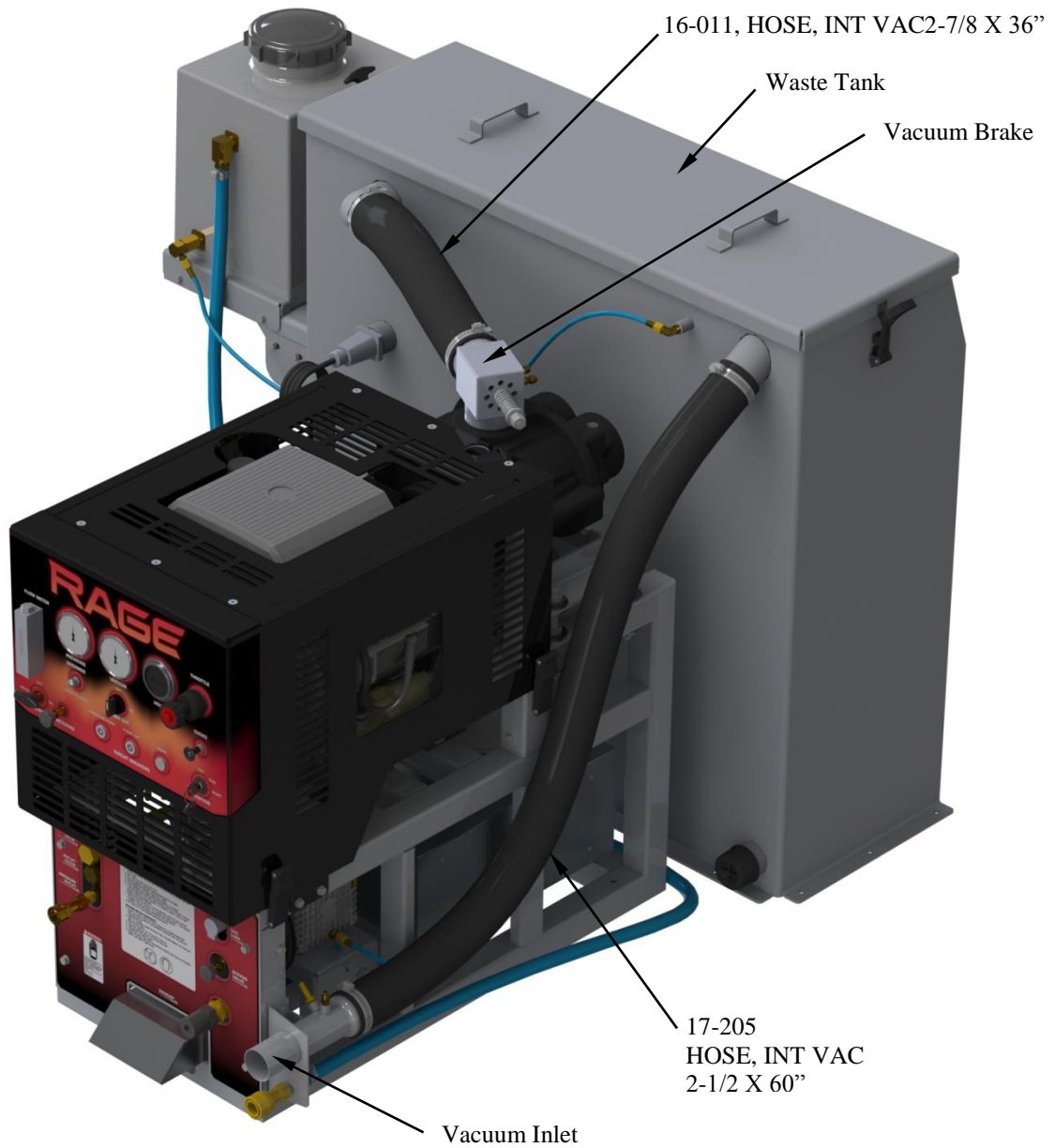
B. Attach the black negative (-) battery cable from the ground on the console to the negative (-) terminal on the battery and tighten down the nut.

### FIRE EXTINGUISHER

**SAPPHIRE SCIENTIFIC**, and many government agencies, recommend that a fire extinguisher rated for A, B, and C type fires be installed into any commercial vehicle.

## SECTION 2

### CONSOLE TO WASTE TANK CONNECTION



# **SECTION 3:** **OPERATION**

## **4. SYSTEMS**

Water/Heating system.....	15
Vacuum system.....	16
Chemical pumping system.....	17

## **5. OPERATION**

Preparation.....	18
Starting the unit.....	20
Priming the chemical pump.....	20
Automatic waste pump.....	20
Operation.....	21
Cleaning.....	21
Upholstery cleaning.....	21
Flood restoration/extraction.....	21
Heat Bypass Operation.....	22
Shut down and daily maintenance.....	22
Freeze protection.....	23

## SECTION 3

# 4. SYSTEMS

**NOTE: Read and understand this section of the manual entirely before proceeding.**

This portion of the manual divides the unit up into systems and describes how each system works. Prior to proceeding into the operations and maintenance sections of this manual it is recommended that you acquire a basic understanding of how the unit functions.

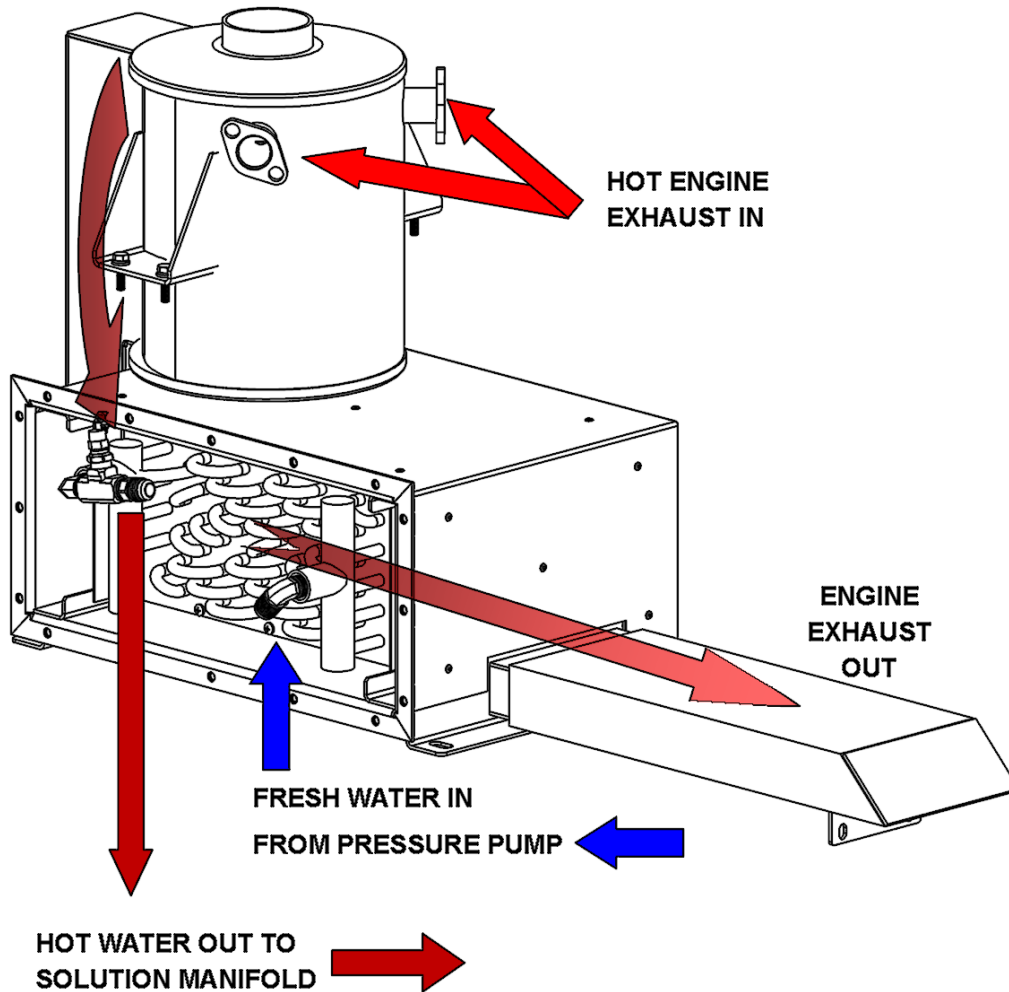
## WATER/HEATING SYSTEM

Cold water enters the water box and flows through a float valve, which shuts off the water when the water box is full.

The water then flows to the water pump where it is pressurized. From there it flows to the heat exchanger where it travels through tubing and is heated by the vacuum blower and engine exhaust.

The hot water then flows through the check valve manifold that contains a strainer and a check valve. At this point, the chemical injection takes place.

The hot solution mixture of water and chemicals then flows through the solution outlet manifold to the cleaning tool.



## SECTION 3

### VACUUM SYSTEM

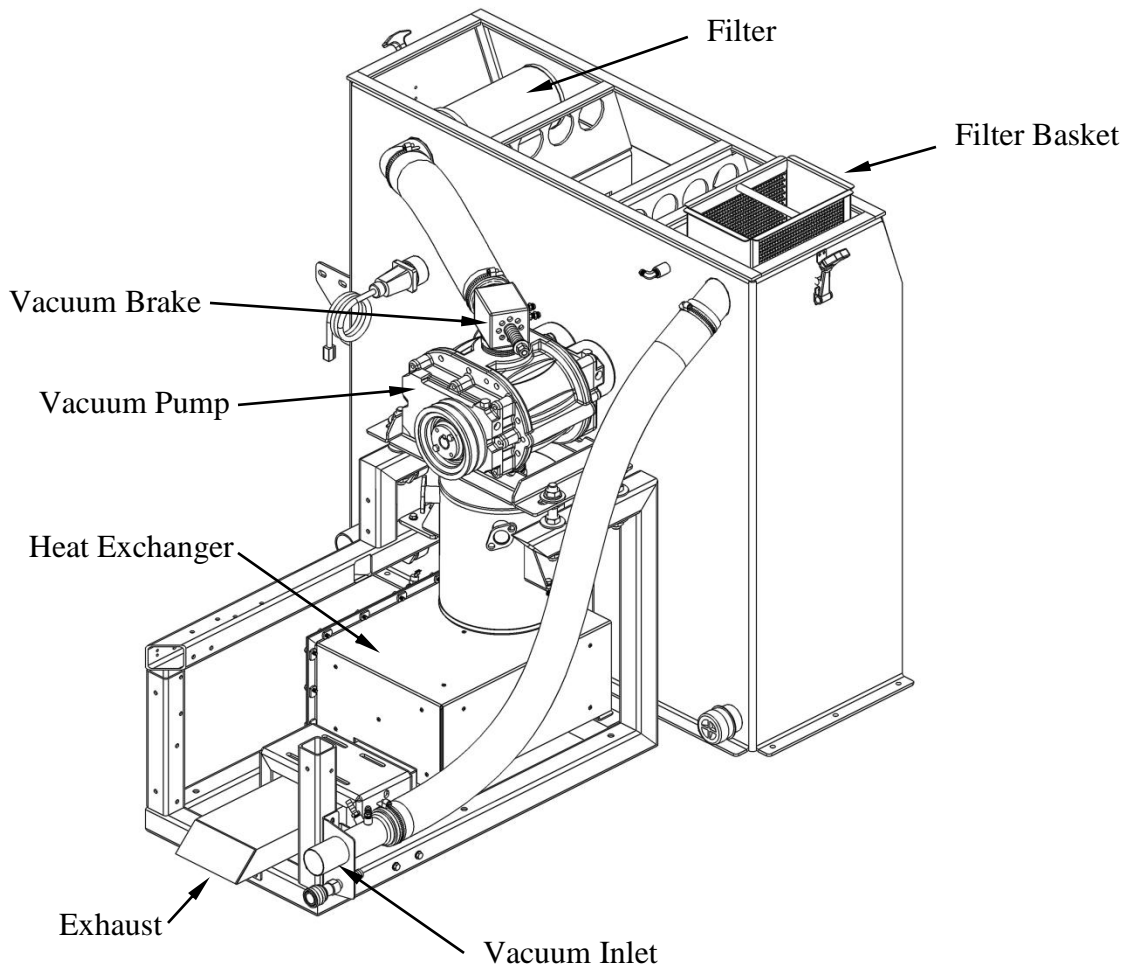
The engine turning an air pump (vacuum pump) generates vacuum. The air is channeled in one side of the vacuum pump, compressed and discharged on the opposite side, creating airflow. This airflow is used to do the work necessary for the extraction process. A vacuum nozzle applied to the carpet surface removes moisture, dirt and spent chemicals. These elements are conveyed back to a separating tank utilizing hoses and the force of air. Particles of moisture and dirt are separated in the vacuum tank using a series of changes in direction and velocity. The air is then filtered and rushes into the vacuum pump.

The vacuum pump also heats incoming air as it is compressed. The hot discharged air is forced down

stream into a silencer for noise abatement. Exiting the silencer, this hot air is directed through the heat exchanger

The vacuum pump speed is factory set to maximize vacuum and provide sustained system life. Do not alter the vacuum speed outside the recommended range shown in the Technical Specifications section.

A level shut off sensor is located near the top of the waste tank and will shut down the unit before the tank is at full capacity. This protects the vacuum pump from water damage. **Note:** Waste tank level shut off will not shut the unit off due to high levels of foam. The use of a quality defoamer is recommended.



## SECTION 3

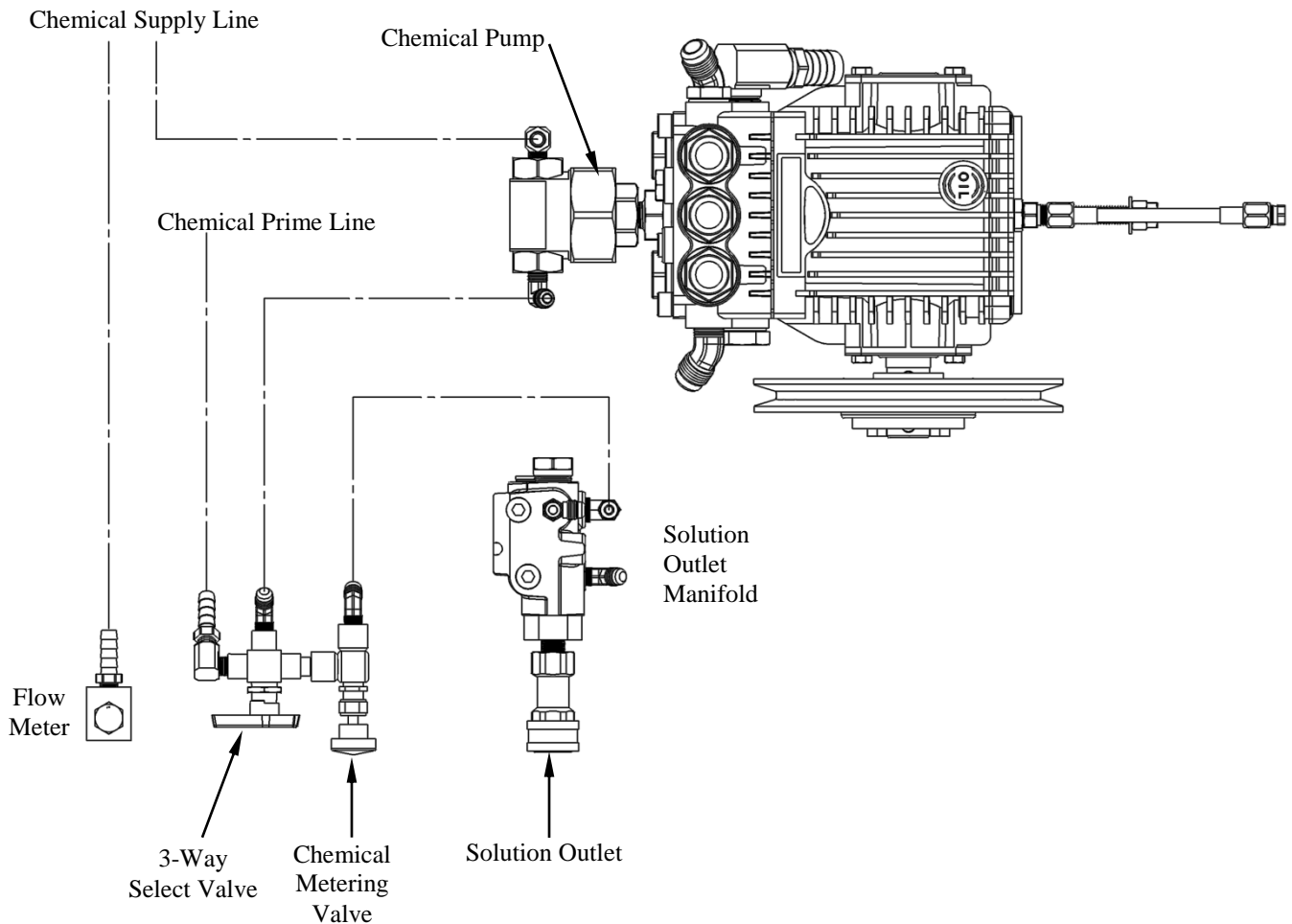
### CHEMICAL PUMPING SYSTEM

The chemicals are drawn from the chemical container through a strainer into the flow meter mounted on the control panel. The flow meter indicates the rate of chemical flow.

The chemical then flows through the stainless steel chemical pump, the chemical is then injected into a three way selector valve located on the front panel. This valve may be used to turn

the chemical flow **ON**, **OFF**, or to **PRIME** the chemical pump.

The chemicals then flow through the chemical metering valve to the solution outlet. This valve controls the rate of flow of chemical into the cleaning solution, which is indicated on the flow meter.



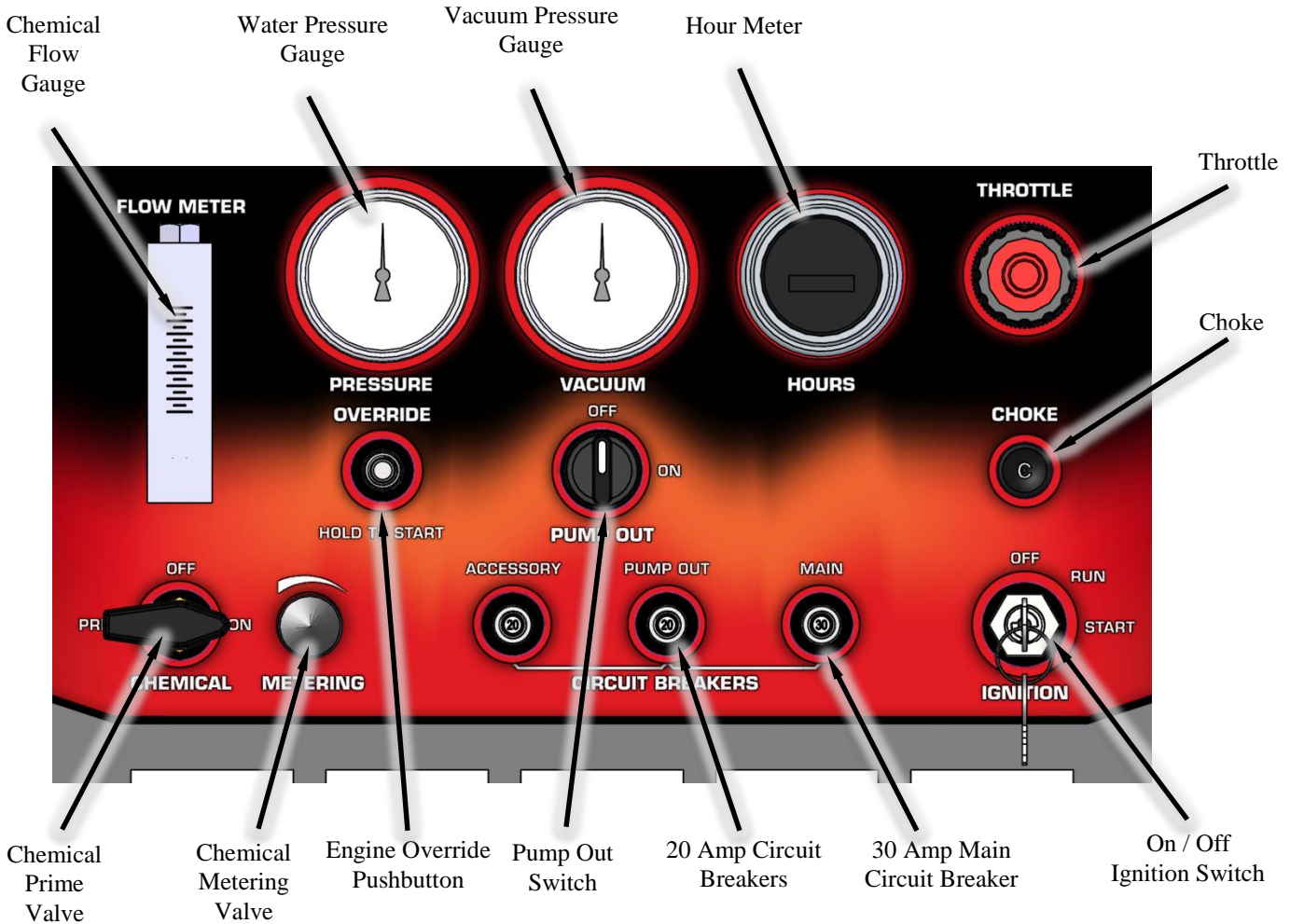
# 5. OPERATION

## PREPARATION

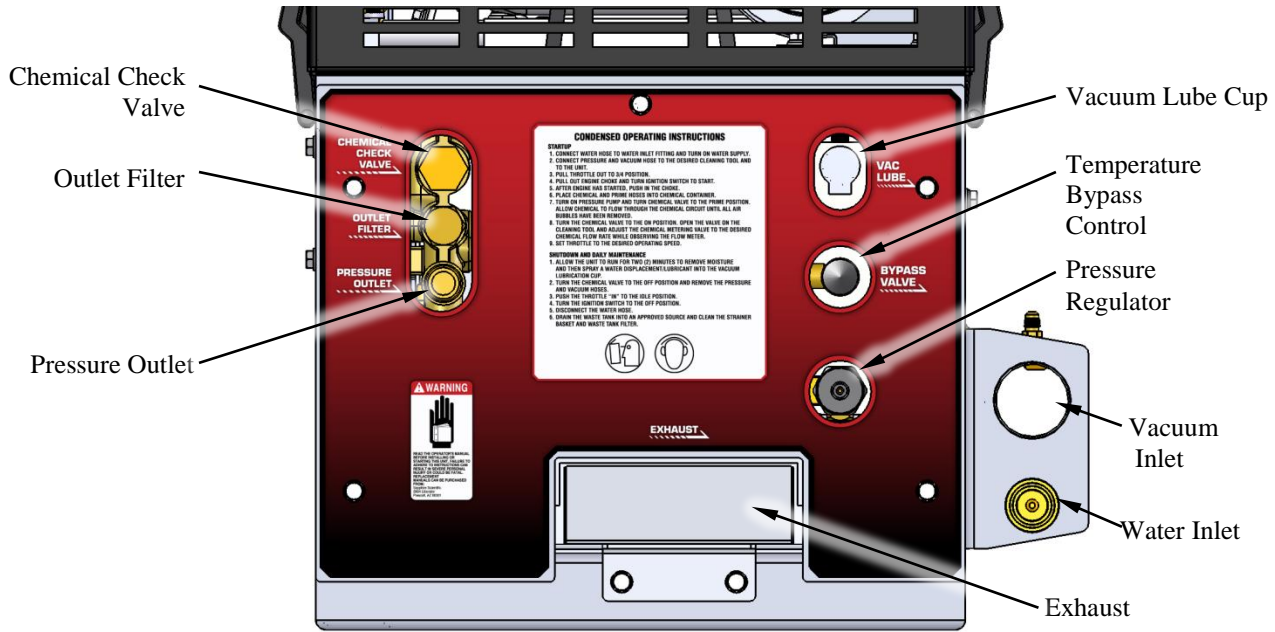
This section of the operator's manual explains how to prepare, start, operate, shut down and maintain your **SAPPHIRE SCIENTIFIC RAGE®** mobile cleaning unit. The **RAGE®** unit is easy to operate, however only trained operators should proceed.

**! WARNING!**

Operate this unit and equipment only in a well-ventilated area. Exhaust fumes contain carbon monoxide, which is an odorless and deadly poison that can cause severe injury or death. **DO NOT** run this unit in an enclosed area. **DO NOT** operate this unit where the exhaust may enter a building doorway, window, vent or any other opening.



## SECTION 3



### ENSURE THERE IS ADEQUATE FUEL

Check the fuel tank to ensure there is adequate fuel to complete the job and transport the vehicle. This unit consumes approximately 1 US gallon of fuel per hour, depending on the speed setting.

### REMOVE TOOLS FROM THE VEHICLE

Remove any tools, accessories or hoses from the vehicle that you will require.

### WATER SUPPLY CONNECTION

**NOTE:** Prior to connecting your water inlet hose to any supply faucet, flush out the faucet until the water is free of any debris. Also, flush out any debris from your water inlet hose.

1. Connect the water supply hose to the water inlet quick connector on the water box. Connect the hose to the faucet.

**NOTE:** Never use a waste pump outlet hose as a water inlet hose. Use only clean hoses for water supply.

2. Turn the water supply faucet on. Water will fill the water box.

### HIGH PRESSURE HOSE

Before starting the unit, connect the high pressure hose to the solution outlet connection at the front of the unit. Connect the cleaning tool to the opposite end of the pressure hose.





## SECTION 3

### STARTING THE UNIT



**CAUTION!**

1. Set throttle control in.
2. Pull out engine choke.
3. Press and hold the **OVERRIDE** button while turning the ignition key to start the engine.
4. Push in engine choke after engine has started.
5. Let the engine warm up at 1/2 throttle.
6. Set throttle control to maximum.

**Note: Do not operate the unit with throttle control set below 50% of maximum throttle setting.**

**NOTE:** If the unit does not build water pressure after 5 seconds, check for adequate water supply. See “Loss of Water Pump Pressure in the **Troubleshooting** section of this manual.

### VACUUM HOSE

Connect the vacuum hose(s) to the vacuum inlet connection at the front of the unit. Connect the opposite end of the vacuum hose(s) to the cleaning tool. Let the unit run for a few minutes with the vacuum inlets partially blocked off to warm up the cleaning solution.

**SAPPHIRE SCIENTIFIC** recommends that the total floor tool size does not exceed #6. Using larger jet sizes on your **RAGE**<sup>®</sup> unit may reduce cleaning temperatures.

### PRIMING THE CHEMICAL PUMP

**NOTE: SAPPHIRE SCIENTIFIC** recommends that the chemical pump be primed whenever the water pump is on. This eliminates possible pressure fluctuations and water pump pulsations related with running the chemical pump dry.

1. Insert the chemical prime tube and the chemical inlet tube into the chemical container.

**NOTE:** When inserting the chemical tube into the chemical container, ensure that it stays submerged, as the chemical pump will not function if air is allowed to enter the inlet line.

2. Turn the 3-way chemical selector valve located on the control panel to the **PRIME** position. The chemical will then flow from the chemical container through the chemical prime tube.

If the pump does not prime, then:

Seal off the vacuum port. The vacuum will quickly draw chemical from the chemical container. After the flow begins, turn the chemical selector valve to **OFF** position and turn the chemical selector valve back to the **PRIME** position and continue the procedure.

3. When the chemical flows with no air bubbles, priming has been achieved. Turn the chemical selector valve from **PRIME** to **METER**. With the cleaning tool open, check the flow meter and adjust the chemical metering valve until the desired rate of chemical flow is achieved.

### AUTOMATIC WASTE PUMP

1. If your unit is equipped with an optional automatic waste pump, connect one end of the  $\frac{5}{8}$  in. or larger garden hose to the pump-out connection and the other end to an acceptable waste disposal.

2. Turn the pump-out switch located on the front console control panel to the **ON** position. The waste pump will now operate automatically throughout the cleaning period.

**DO NOT** use an outlet hose that is smaller than  $\frac{5}{8}$  in. I.D.

**NEVER** use a waste pump hose as a water inlet hose.

## SECTION 3

### **WARNING!**

**NEVER** dispose of waste water in a storm drain, water way or on ground areas. Always dispose of waste in accordance with Local, State and Federal laws.

### **OPERATION**

**When operating the unit for cleaning or restoration, the unit should be in the maximum throttle position. This ensures full vacuum and performance from the unit.**

**NOTE: During flood extraction the throttle control must be set to maximum.**

### **CLEANING**

While cleaning, observe the following guidelines:

1. Before cleaning, ensure that the wand nozzles are functioning properly.
  - A. Hold the wand approximately one foot above the surface to be cleaned and open the wand valve. A full even spray should emit from the cleaning nozzles.
  - B. If the nozzles are not showing a full even spray pattern, adjust, clean, or replace the nozzles, if required.
2. Usually, chemical solution is applied during the push stroke of the wand during cleaning, and extraction is done on the pull stroke. For heavily soiled carpets, the wand may be used in a scrubbing action, with chemical solution applied in both push and pull strokes, provided that the final stroke is a pull stroke with no chemical injection.

### **UPHOLSTERY CLEANING**

1. Upholstery tools have a lower flow rate and smaller orifices. It may be necessary to slow the engine down and partially open the bypass valve to maintain proper cleaning.

### **FLOOD RESTORATION/EXTRACTION**

This machine can be used for limited water extraction only if connected to an adequate water source and the bypass valve is opened 1/4 turn.

### **CAUTION!**

**NEVER RUN THE PRESSURE PUMP DRY.** Doing so will quickly build up heat in the pump which may cause severe damage to internal components

An automatic waste pump-out is highly recommended when performing flood extraction to avoid shutdown from filling the waste tank.

1. Set the throttle control cable on the front control panel to maximum.
2. If an automatic waste pump-out is equipped, set the PUMP OUT switch to the ON position.
3. Proceed into the extraction process.

### **CAUTION**

To prevent excess heat build-up in the unit, do not restrict air flow to the wand head when not extracting water. If the wand must be placed down, position the head sideways or upside down.

**NOTE: A float shut-off switch is located inside of the waste tank. It will automatically shut down the unit if the tank reaches its full capacity. If this occurs, empty the waste tank before continuing.**

## SECTION 3

### HEAT BYPASS OPERATION

The heat bypass has 2 purposes.

1. To cool down the unit at the end of the job when using for carpet cleaning. When finished with the job, open the heat bypass while coiling up the hoses to allow water to circulate through the unit and prevent excess heat buildup.
2. **In flood extraction mode, open the valve 1/4 turn to keep water circulating through the pump to prevent pump overheating and premature failure.**

### SHUT DOWN AND DAILY MAINTENANCE

1. Flush out the chemical system with fresh water to remove any chemical residue.
2. Remove as much moisture from the vacuum hoses as possible. This will prevent spillage of wastewater in your vehicle when returning hoses.
3. Disconnect the vacuum hose from the front of the unit.
4. Adjust the throttle cable to the idle position.
5. Allow the unit to run at 50% throttle **for a few minutes**. This will also help to remove any excess moisture from the vacuum pump and cool the unit down.  
**NOTE:** If shutting down for the day: Plug the vacuum inlet on the front of the unit and set the throttle control cable to high. Spray WD-40 (or equivalent) into the **blower lubrication cup**, located on the left hand side of the control panel for **5 seconds**. Let machine run 2 minutes to disperse lube to blower. Unplug the vacuum inlet and remove load. Next, return the throttle control cable to idle position, and let idle for 3 to 5 minutes.
6. Turn the ignition switch to the **OFF** position.

7. Turn the water supply faucet off. Loosen the water supply hose at the water supply to bleed off any pressure. Unhook the water supply hose and return it to the vehicle.
8. Activate the valves on all cleaning tools. This will relieve any remaining pressure. Disconnect the cleaning tools and solution hoses and return them to the vehicle.
9. Drain the waste tank, disposing of wastewater in a suitable and proper location.

### **WARNING!**

**NEVER** dispose of wastewater in a storm drain, water way or on ground areas. Always dispose of waste in accordance with Local, State, and Federal laws.

10. Remove the strainer basket from the waste tank. Clean out any debris and re-install. Microban QGC cleaner is the best product for cleaning and sanitizing the waste tanks as well as other parts of the system

**NOTE:** Damage may occur to the vacuum pump. Replacement and maintenance of the filter will prevent rust and corrosion from entering the vacuum pump.

11. Inspect the vacuum inlet filter inside the waste tank **daily**. Remove and clean the filter if there is any lint or debris present.

**NOTE:** To remove the vacuum inlet filter, grip the plastic hexagon section of the filter. Gripping the filter by the screen will collapse or destroy the filter. After cleaning, grease the threads on the filter and replace the filter. Tighten the filter until hand tight and then loosen 1/4 turn. This will make the filter easier to remove when cleaning or replacement is required.

**NEVER** operate this unit with the filter removed, damaged or improperly installed.

12. At the end of the work day, rinse out the waste tank with fresh water. Microban QGC cleaner as the best product for cleaning and sanitizing the waste tanks as well as other parts of the system

13. Clean the vehicle interior, unit, tools, hoses etc., as needed. Inspect **ALL** equipment and accessories for any damage, leaks, wear, etc.

## **FREEZE PROTECTION**



### **CAUTION!**

**If the unit is exposed to freezing weather conditions, the water inside of the unit may freeze, resulting in SERIOUS DAMAGE to the unit. The following is recommended to prevent this from occurring during the cold weather season:**

1. Always park the unit in a heated building when not in use.
2. While out in operation, avoid long periods of shut down as the unit generates heat while running.
3. If a heated building is not available, winterize the unit with anti-freeze.

It is not possible to winterize units that have auxiliary water tanks. If the unit has an auxiliary water tank(s), it must be stored in a heated building.

### **WINTERIZING YOUR UNIT WITH ANTI-FREEZE:**

1. Shut off the water supply to the unit and disconnect the water inlet hose from the water box.
2. Connect all solution hoses and a tool to the console.
3. Start the unit.
4. Fill the water box with one gallon of 100% glycol based anti-freeze.

## **SECTION 3**

5. Start the unit and set the throttle control cable to the idle position. Insure the water pump is on. Open a tool valve until anti-freeze comes out of the tool. Repeat this procedure with **ALL** remaining tools and hoses.

6. After the tools and solution hoses have been filled with anti-freeze, disconnect and store them.

**Recover all anti-freeze that comes out of the tools and hoses and store in an approved container. ALWAYS re-use or re-cycle anti-freeze.**

7. Prime the chemical injection system with a 100% glycol based antifreeze. Insert the chemical inlet and prime tube into the anti-freeze container. Turn the chemical valve to **PRIME** until anti-freeze comes out of the prime hose. Turn the chemical valve to the **ON** (chemical) position. Ensure that the flow meter indicates flow while the attached tools solution valves are opened. Ensure that all anti-freeze that comes out of the chemical hose goes into an approved container.

After **25 seconds**, turn the chemical valve to the **OFF** position.

8. Allow the unit to run for at least **3 minutes**. The unit is now winterized.

### **REMOVING ANTI-FREEZE FROM THE UNIT:**

1. Connect the solution hoses to the unit, with a tool attached to the opposite end. Start the unit. Turn the water pump on. Open the tool valve and ensure that the anti-freeze goes into an approved container. Allow the anti-freeze to flow into the container until all anti-freeze has been drained.
2. Fill the water box with fresh water and repeat step 1.
3. Connect the water inlet hose to the unit and turn the water supply on. Connect all tools and solution hoses that were winterized to the solution outlet connection.

### SECTION 3

#### REMOVING ANTI-FREEZE FROM THE UNIT CONTINUED:

Open all tool valves and drain the anti-freeze into an approved container until the water runs clear and all of the anti-freeze is purged from the hoses and tools.

4. Insert the chemical prime hose into the approved container. Submerge the chemical hose into fresh water. Turn the chemical valve to the **PRIME** position until the water runs clear through the prime hose. Remove the prime hose from the container.

5. Turn the chemical valve to the **ON** (chemical) position and open attached tools solution valves. This will allow water to flow to the other side of the system.

After all of the anti-freeze has been removed, the unit is ready to operate.

The anti-freeze in your approved storage container will eventually become diluted with water. When the anti-freeze level drops below 70% of the total mixture, properly dispose of it and start over with fresh 100% anti-freeze.



**DO NOT drain used anti-freeze on the ground or into storm drains.**

**Dispose of anti-freeze only in an approved location. Observe Local, State and Federal laws when disposing of anti-freeze.**

# **SECTION 4:** **SERVICE and MAINTENANCE**

## **6. MAINTENANCE CHART**

Maintenance Chart.....	26
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## **7. MAINTENANCE**

Engine.....	27
Vacuum Pump.....	28
Water Pump.....	28
Vacuum Inlet Filter.....	29
Drive Belts, Pulleys and Hubs.....	29
Strainer Basket.....	29
Check Valve (Outlet).....	29
Chemical Pump.....	29
Chemical Metering System.....	29
Pressure Regulator.....	30
Vacuum Hoses.....	30
Battery.....	30
High Pressure Solution Hoses.....	30

## **8. GENERAL SERVICE ADJUSTMENTS**

Engine Speed.....	31
Vacuum Relief Valve.....	31
Water Pump Drive Belt.....	31
Solution Outlet Check Valve.....	31
Chemical Pump.....	32
Packing Nut Adjustment, Chemical Metering and Selector Valves.....	32
Pressure Regulator.....	33

## **9. TROUBLESHOOTING**

Engine.....	34
Blower / Vacuum Pump.....	35
Water Pump.....	36
Chemical System.....	38

SECTION 4

# 6. MAINTENANCE CHART

Engine	Daily	Check engine oil level.** Fill to proper level.
Vacuum Pump	Daily	Spray WD-40 (or Equivalent) into the lubrication cup for 5 seconds.
Water Pump	Daily	Check water pump oil level.*** Fill to proper level.
Vacuum Inlet Filter	Daily*	Inspect filter, clean and or replace if required.
Waste Tank Strainer Basket	Daily	Empty and clean stainless steel basket.
Vacuum Hoses	Daily	Rinse with fresh water.
Vacuum Pump	Daily*	Check vacuum pump oil level. Fill to proper level. Do not overfill.
Waste Pump-Out (Optional)	Daily*	Inspect and remove any debris or sediment.
Engine	Weekly	Check air cleaner for damaged, dirty, or loose parts.
Engine	Weekly	Inspect air intake and cooling areas. Clean if required.
Pump Inlet Filter	Weekly	Clean and inspect.
Battery	Weekly*	Check fluid level. Fill with distilled water only. Do not overfill.
Engine	Monthly	Inspect drive belt for wear. Replace as needed.
Water Box	Monthly	Check float valve for proper operation.
Check Valve Strainer	Monthly*	Clean and remove any debris.****
High Pressure Solution Hoses	25 Hours	Inspect for wear, damage, or impending rupture. Replace if damaged.
Belts	25 Hours	Re-tension belt*****
Water Pump	50 Hours	Change crankcase oil.***
Engine	8 Hours	Change engine oil and filter.
Belts	100 Hours	Re-tension belt*****
Engine	100 Hours	Change engine oil and filter.
Vacuum Break	100 Hours	Check and adjust vacuum relief valve to 13” Hg if needed.
Pressure Regulator	100 Hours	Lubricate o-rings. Use only o-ring lubricant part # 13-003.
Battery	100 Hours	Clean battery terminals.
Engine	200 Hours	Check spark plugs and clean if necessary.
Engine	200 Hours	Clean engine air filter.
Chemical Metering System	200 Hours	Inspect packing nut on selector and metering valve. Adjust as needed.
Engine	500 Hours	Replace in-line fuel filter.*****
Water Pump	500 Hours	Change crankcase oil.***
Pulleys and Hubs	500 Hours	Check pulley and hub set screws for proper torque.*****
Chemical Pump	500 Hours	Change diaphragm and check valves. Inspect disk.
Belts	1000 Hours	Replace belts.
Engine	1000 Hours	Replace spark plugs.
Vacuum Pump	1000Hours	Drain, flush, and replace oil.*****
Check Valve	1000 Hours	Replace Teflon seat for abnormal wear or debris.
Engine	1000 Hours	Replace air filter element.

To maximize the operating life and performance, use only recommended oils, filters and greases.

\*Or as often as required.

\*\*Change engine oil and oil filter after **first 50 hours** of operation.

\*\*\*Change water pump crankcase oil after **first 50 hours** of operation

\*\*\*\*Inspect after **first week** of operation, and remove any debris present. Inspect again after **2 to 4 weeks**.

\*\*\*\*\*Check pulley and hub set screws after **first 50 hours** of operation, and again at **100 hours** of operation.

\*\*\*\*\*Or every **6 Months**. Whichever comes first.

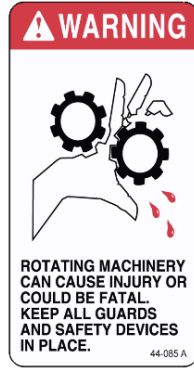
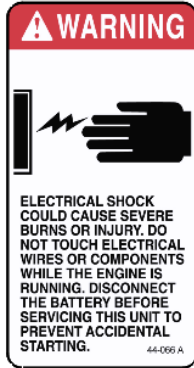
\*\*\*\*\*Or **Yearly**. Whichever comes first.

\*\*\*\*\*Re-tension all belts after **first 25 hours** then at every **100 hours** of operation.

## SECTION 4

# 7. MAINTENANCE

This section of the operator's manual contains the service and maintenance information for the **RAGE®** unit. A planned preventative maintenance program will ensure that your **SAPPHIRE SCIENTIFIC RAGE®** has optimum performance, long operating life, and a minimum amount of down time.



### **WARNING!**

**DO NOT** attempt to service this unit while it is running. High speed parts as well as high temperature components may result in severe injury, severed limbs, or fatality.

**NOTE:** Refer to the hour meter as a guide for coordinating a maintenance schedule.

## ENGINE

1. Check the engine oil level daily. Ensure that the proper oil level is maintained. **NEVER** overfill.

2. Change the oil after the first **5 to 8 hours** of operation. Thereafter, change oil and oil filter every **50 to 100 hours** of operation. **USE ONLY KOHLER OIL FILTERS. USE OF ANY OTHER TYPE OF OIL FILTER WILL VOID ENGINE WARRANTY.**

Use high-quality oil of at least API (American Petroleum Institute) service class SJ or higher. **Do not use additives.** High quality 30W oil is recommended. A 10-30 synthetic blend may be used after 50 hours of operation for a new or rebuilt engine to allow the piston rings to properly seat. It is never recommended to extend oil change intervals past 100 hours.

Engine oil capacity	1.7 L 1.8 U.S.qts
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Tightening torque	Drain Plug	13.6 N·m 1.4 kgf·m 10.0 lbf·ft
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**NOTE:** Using a lower service class oil or extending oil change intervals longer than recommended can cause engine damage.

**NOTE:** Synthetic oils meeting the listed classifications may be used with oil changes performed at recommended intervals. However to allow piston rings to properly seat, a new or rebuilt engine should be operated for at least 50 hours using standard petroleum based oil before switching to synthetic oil.

3. Check the spark plugs every **200 hours** and clean if necessary. Replace spark plugs every **1000 hours. NEVER** sandblast spark plugs. Spark plugs should be cleaned only by scraping or wire brushing.

4. Clean the engine air filter element every **200 hours. Replace the element every 1000 hours.**



## SECTION 4

Replace the in-line fuel filter **yearly**.

**NOTE:** Additional engine service information can be obtained from the provided Operation and Maintenance manual. If service or repair is required, contact an authorized Kohler Service Center. They will require the serial number of the engine.

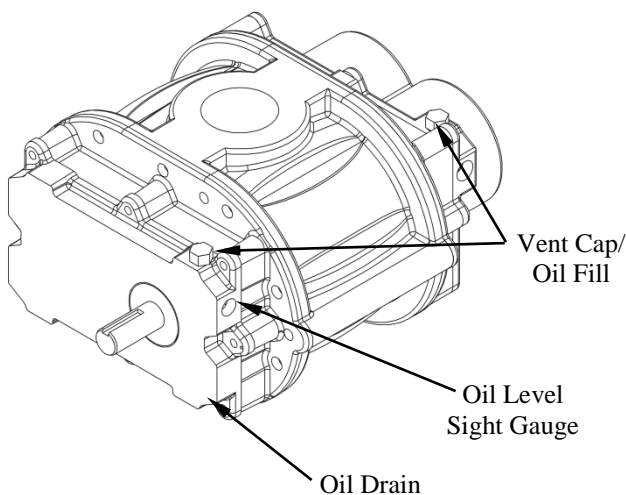
### VACUUM PUMP

**NOTE:** Refer to the provided Vacuum Pump Operation and Service Manual for specific instructions.

**Lubrication: SAPPHIRE SCIENTIFIC** recommends that you use only ISO 100 Synthetic Blower Lubricant in the vacuum pump for all operating temperatures. ISO 100 oil is formulated to provide maximum blower protection at any temperature. One filling of ISO 100 oil will last a minimum of twice as long as a premium mineral oil.

**NOTE: ISO 100 Oil** (Part # 13-039) is the only oil that **SAPPHIRE SCIENTIFIC** puts in the vacuum pump at the factory. Adding petroleum oil to synthetic oil is **NOT** recommended.

1. Check the oil level **daily** to ensure it is at the proper level. Too little oil will damage and ruin the bearings and gears. Too much oil will result in overheating.



2. A lubrication cup has been provided at the front of the console, to prevent rust from building up inside of the vacuum pump.

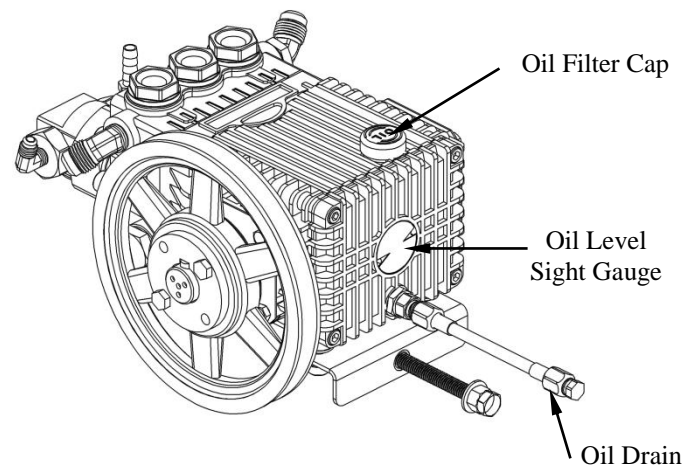
Run the unit for at least **2 minutes** to remove any moisture from the vacuum pump. Then, spray WD-40 (or Equivalent) into the lubrication cup for **5 seconds** while the unit is running and the vacuum inlet port is sealed. This procedure should be done at the end of **every working day**.

3. Drain, flush and replace the oil every **1000 hours or 1 year, whichever comes first**.

### WATER PUMP

Refer to the provided Water Pump Operation Manual for specific instructions.

1. Check the crankcase oil level **daily** to ensure the proper level. If the level has dropped, check for the source of leakage and repair.



2. After the first **50 hours** of operation, change the crankcase oil with general pump oil. Change the crankcase oil every **500 hours** thereafter.

## SECTION 4

### Vacuum Pump:

#### **Belt Replacement Procedures for The RAGE:**

- 1) Disconnect the negative battery cable
- 2) Remove hose from waste tank to vacuum pump
- 3) Remove side hoods and top panel
- 4) Remove left and right hand belt guards
- 5) Loosen the hose clamp under the blower
- 6) Slide the blower back (away from engine)
- 7) Lower the blower plate approximately ½”
- 8) Tip the back of blower up
- 9) Remove all belts. Install new belts
- 10) Reverse procedures to install new belts
- 11) After belts have been installed, check for proper tension and alignment. Do this using a belt gauge. Set deflection to 1/8”; 10-12 lbs tension
- 12) Check pulleys for alignment using a straight edge (example: ½” key stock). Make sure pulley flange touches on 2 places on each pulley (4 total places)
- 13) Ensure that the blower plate is level (equal distance from frame at four mounting points)
- 14) Estimated time, 2 hours

### VACUUM INLET FILTER

1. The vacuum inlet filter in the waste tank should be inspected and cleaned **daily**.

#### **CAUTION!**

When removing the vacuum inlet filter, grip the plastic hexagon section of the filter. Grasping filter by the screen will damage or destroy the filter. Applying grease to the threads will allow easier removal of filter when cleaning or replacement is required.

### DRIVE BELT AND PULLEYS

#### **CAUTION!**

**Ensure that when you re-torque the screws, you use a clockwise pattern and continue until the proper torque is achieved.**

TORQUE VALUES		
Component	Inch/lbs	Foot/lbs
Engine Rear Hub	160	13.3
Engine Front Hub	160	13.3
Vacuum Pump Hub	160	13.3
Pressure Pump Hub	130	10.8

### WASTE TANK STRAINER BASKET

The strainer basket located in the waste tank should be emptied and cleaned on a **daily** basis. Microban QGC cleaner is the recommended product for cleaning and sanitizing the waste tanks as well as other parts of the system.

### CHECK VALVE STRAINER (OUTLET)

Unscrew the screen and inspect the strainer after the first **week** of operation. Remove any debris present. Inspect again after **2** and **4 weeks**. Thereafter, inspect the strainer and screen at least **monthly**. If a frequent build-up of debris is noticed, inspect and clean more frequently.

### CHEMICAL PUMP

The chemical pump should be rebuilt every **500 hours**. This involves changing the diaphragm, check valves, and inspecting the disk.

### CHEMICAL METERING SYSTEM

Check and inspect the packing nut on the chemical selector and metering valves every **200 hours**. Keeping the valve packings properly adjusted will prevent leaks and add to the overall life of the valves.

## SECTION 4

### PRESSURE REGULATOR

Lubricate the o-rings in the pressure regulator every **100 hours**. Use only o-ring lubricant (Part #13-003).

### VACUUM HOSES

To ensure maximum hose life, **SAPPHIRE SCIENTIFIC** recommends that you wash out the hoses with fresh water **daily**. Microban QGC cleaner as the best product for cleaning and sanitizing the wands and hoses as well as other parts of the system

### BATTERY

#### **WARNING!**

#### **Explosive gases, Dangerous acid!**

Batteries contain sulfuric acid. To prevent acid burns, avoid contact with skin, eyes and clothing. Batteries also produce explosive hydrogen gases while charging. To prevent fire or explosion, charge batteries only in a well ventilated area. Keep sparks, open flames, as well as any other sources of ignition away from batteries at all times. Remove all jewelry prior to servicing batteries. Keep batteries out of the reach of children.

**Before disconnecting the negative (-) ground cable, ensure that all switches are in the OFF position. If ON, a spark could occur at the ground connection terminal which could cause an explosion if hydrogen gas or gasoline vapors are present. ALWAYS disconnect the negative (-) terminal first.**

1. If you do not have a maintenance free sealed battery, check the fluid level in the battery at least **once a week**. If low, fill to the recommended level **ONLY** with distilled water. **DO NOT** overfill the battery. Early failure or poor performance will result due to loss of electrolyte.
2. Keep cables, terminals and external surfaces of the battery clean and dry. A buildup of corrosive acid or grime on the external surfaces could cause the battery to self-discharge.

3. Battery terminals should be cleaned every **100 hours** to prevent corrosion buildup. Wash the cables, terminals and external surfaces with a mild baking soda and water solution. Rinse thoroughly with fresh water. **DO NOT** allow baking soda to enter the battery cells, as this will destroy the electrolyte, resulting in battery failure

### HIGH PRESSURE SOLUTION HOSES

Inspect your high-pressure solution hoses for wear after the first **100 hours**. Thereafter, inspect every **25 hours**. If the hoses show any signs of damage or impending rupture, replace the hoses.

#### **WARNING!**

**NEVER attempt to repair high-pressure solution hoses. Repairing high-pressure solution hoses may result in severe burns and serious injury.**

**All high-pressure solution hoses must be rated for 3000 PSI at 250 deg. F. Thermoplastic hoses do not meet this requirement and should not be used. Severe burns and injury may result if the hoses do not meet these requirements.**

## SECTION 4

# 8. GENERAL SERVICE ADJUSTMENTS

## **⚠ WARNING!**

**DO NOT** attempt to service this unit while it is running. High speed parts as well as high temperature components may result in severe injury, severed limbs, or fatality.

## ENGINE SPEED

1. To adjust the engine RPM, refer to the Engine Operation and Service Manual for specific instructions.

## **⚠ WARNING!**

**DO NOT** attempt to adjust without a tachometer and **NEVER** adjust the engine above 3200 RPM.

## VACUUM RELIEF VALVE

With the unit running at full RPM, block off the airflow at the vacuum inlet port and read the vacuum gauge. If adjustment is required, shut the unit down and adjust the locking nut tension on the vacuum relief valve. Re-start the unit and read the vacuum gauge. Repeat this process until the vacuum relief valve opens at 13" Hg. Always ensure the lock nut is retightened.

## WATER PUMP DRIVE BELT

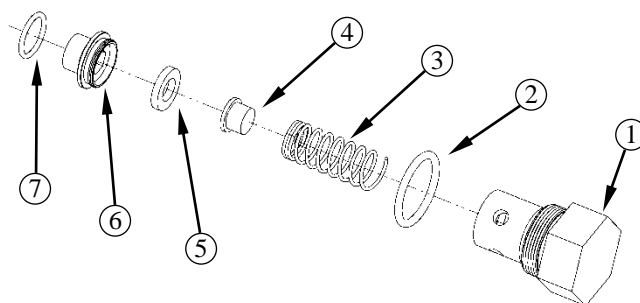
To tighten the water pump belt:

1. Loosen the four nuts, which hold the water pump base to the frame.
2. Adjust the position of the belt tensioning.
3. While checking the alignment, tighten the nuts that hold the water pump to the base.

## SOLUTION OUTLET CHECK VALVE

Inspect the check valve whenever performing service on the chemical pump or if flow problems are occurring in the chemical system.

1. Remove the check valve, ensuring that the small o-ring on the seat comes out with it
2. Next, remove the seat using a 5/16 in. Allen wrench
3. Check the seat for wear or debris. Clean and replace the seat if necessary.
4. Inspect the poppet and the spring for wear or damage. Clean and replace as necessary.
5. Re-assemble the check valve. Thread the seat by hand until snug. Then tighten with a 5/16 in Allen wrench. **DO NOT** over-tighten.



**23-063 VLV, CHECK, CHECK VLV MANIFOLD**

Item #	Part Number	Qty.	Description
1	27-009	1	CAP, CHECK VALVE ASSY. SS
2	41-007	1	ORING, 7/8 ID X 1-1/16 OD
3	15-007	1	SPRING, CHECK VALVE ASSY.
4	27-010	1	POPPET, CHECK VALVE ASSY
5	27-004	1	INSERT, SEAT-CHK VLV ASSY TM
6	27-011	1	SEAT, CHECK VALVE ASSY.
7	41-008	1	ORING, 1/2 ID 5/8 OD

**Note:** Improper seating of the check valve seat, poppet, damaged spring or o-rings will result in poor performance of the chemical system.

6. Lubricate the o-rings with o-ring lubricant. (Part # 13-003) and re-install.

## SECTION 4

### CHEMICAL PUMP

The RAGE® unit features a stainless steel chemical pump and metering system. The chemical pump requires only the replacement of the diaphragm and check valves. To replace the diaphragm, unscrew the cover from the body. When replacing the diaphragm, lube the outer edges of the diaphragm with o-ring lubricant (Part #13-003) and reassemble.

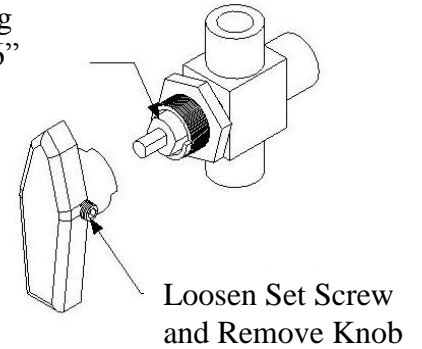
To replace the check valves, remove the check valve caps, replace the check valves and reassemble using new o-rings. **DO NOT** attempt to reuse o-rings after the check valves have been removed.

### PACKING NUT ADJUSTMENT CHEMICAL METERING/SELECTOR VALVES

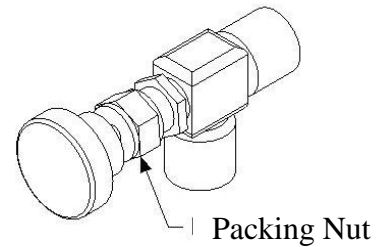
Inspect the packing nut for proper tension on the chemical metering and chemical selector valves every **200 hours**. When turning the knob, there should be some resistance. If not, slightly tighten the packing nut. **DO NOT** over-tighten. Keeping the packing properly adjusted will eliminate possible leaks and will add to the overall life of the valves.

### Chemical Prime Valve

Adjust the packing nut by turning the packing bolt clockwise at 1/16" increments.



### Chemical Metering Valve



## SECTION 4

### PRESSURE REGULATOR

The pressure regulator holds water pressure at a preset point and bypasses the excess water back to the water box.

To adjust:

1. With the unit running, close the cleaning tool valve. Check the pressure gauge. Open the tool valve. Set the pressure regulator so that the pressure gauge reads 450 PSI with the tool valve closed. With the tool valve open, there should be a normal drop in pressure. **If the drop is greater than 100 PSI, it may be necessary to lubricate the pressure regulator o-rings.**

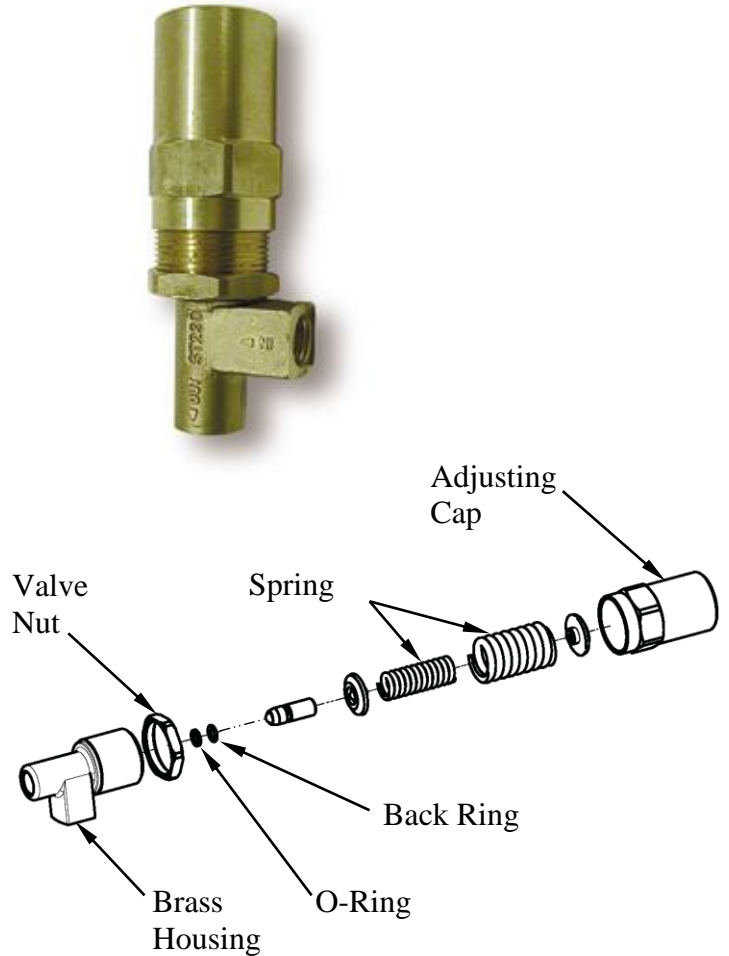
2. To adjust the pressure regulator, turn the adjusting knob (while observing the pressure gauge on the control panel) until you reach the desired pressure.

#### **WARNING!**

**DO NOT** loosen the adjusting body (cap) all the way (counterclockwise) or remove it while the unit is running.

We recommend that you lubricate the pressure regulator o-ring every **100 hours**, or whenever required. If you do not, the stem may become seized due to inadequate lubrication. If this occurs:

- a) Shutdown the unit.
- b) Relieve all pressure from the water system.
- c) Remove the cap from the pressure regulator and remove the stem with long nose pliers.
- d) Clean and lubricate stem.
- e) Reassemble pressure regulator



## SECTION 4

# 9. TROUBLESHOOTING



**WARNING!**  
**DO NOT attempt to service this unit while it is running. High-speed parts as well as high temperature components may result in severe injury, severed limbs or fatality.**

This section of the operator's manual describes how to look for and repair malfunctions, which may occur.

Accurate troubleshooting is based on a thorough and complete understanding of the **WATER, CHEMICAL, VACCUM, HEAT TRANSFER, SAFETY and WIRING** systems featured in this unit.

If there are malfunctions occurring on this unit which you do not understand, refer back to the **OPERATION** section of this manual and review **SYSTEM**

### TROUBLESHOOTING: ENGINE

PROBLEM	CAUSE	SOLUTION
<b>Engine will not start:</b> The engine does not turn over	Main circuit breaker on the control panel has been tripped.	After inspecting the unit to determine the cause of the tripped circuit breaker, press the reset button.
	Loose or corroded battery.	Clean, tighten, or replace the battery terminals.
	Dead battery.	Recharge or replace battery.
	Defective ignition switch.	Test ignition switch for power going into the switch. If there is power going in but NO power going out, replace the switch.
	Defective starter motor.	Test the starter motor. If necessary replace.
	Vacuum pump seized.	Refer to Tuthill Service and Repair Manual.
<b>Starter turns over engine, but will not start</b>	Waste tank is full.	Empty the waste tank.
	Defective fuel pump.	Replace the fuel pump.
	Loose or broken wires leading to waste tank float switch.	Repair or replace any broken electrical connections.
	Defective float switch in the waste tank.	Check switch for proper operation, replace as necessary.
	Oil pressure switch (located on engine), fuel shut-off solenoid (located on engine).	Test these components. If any are defective, replace. Consult Operation and Maintenance Manual.
	Engine is malfunctioning	Refer to Engine Operation and Maintenance Manual.
<b>Excessive heating</b>	Flow restriction caused by hard water scaling.	De-scale unit, repair or replace damaged plumbing components as necessary. Install water softener.
	Not enough water flow.	Check jet size of tool.

## SECTION 4

### TROUBLESHOOTING: ENGINE

PROBLEM	CAUSE	SOLUTION
<b>Engine stops running:</b> While doing normal cleaning, the engine stops running	Engine is out of gasoline	Add gasoline to the fuel tank.
	Waste tank is full	Empty waste tank.
	Main circuit breaker on the control panel has been tripped.	After inspecting the unit to determine the cause of the tripped circuit breaker, press the reset button.
	Defective fuel pump.	Replace fuel pump.
	Defective float switch inside the waste tank.	Check switch for proper operation. Replace as necessary.
	Oil pressure switch on engine has shut down, due to insufficient oil pressure.	Refer to the Engine Operation and Maintenance Manual. <b>DO NOT</b> restart the engine until the cause is determined and corrected.
	No ignition in the engine or engine is malfunctioning.	Refer to the Engine Operation and Maintenance Manual.
<b>Heat exchanger leaks NOTE:</b> The heat exchanger will produce water condensation discharge at times during normal operation. <b>DO NOT</b> confuse this with a leak.	Engine/vacuum exhaust heat exchanger is damaged from frozen water.	Inspect heat exchanger for leaks. Visually inspect for damage. Pressure check after removing from the unit. (Maximum test pressure 1000 PSI).
<b>Loss of temperature:</b> The heat output of the unit is LESS than normal.	Solenoid switch stuck open	Replace temperature switch
	Engine RPM is low.	Reset engine RPM.
	Defective temperature gauge.	Test gauge and sensor. Replace failed component.
<b>Automatic waste pump is malfunctioning or not operating normally.</b>	Defective waste pump float switch.	Replace float switch.
	Broken diaphragm(s).	Replace diaphragm(s).
	Weak battery.	Charge or replace battery if needed. Check charging station.
	Pump-out circuit breaker on control panel has been tripped.	After inspecting waste pump to determine the cause of the tripped circuit breaker, press the reset button.
	Inspect check valve for debris or damage.	Clean or replace if necessary.

### TROUBLESHOOTING: BLOWER / VACUUM PUMP

PROBLEM	CAUSE	SOLUTION
<b>Excessive Vacuum</b>	Improper throttle adjustment.	Adjust throttle to set desired vacuum pressure.
	Vacuum relief valve requires adjustment.	Readjust the vacuum relief valve to 13"Hg



## SECTION 4

### TROUBLESHOOTING: BLOWER / VACUUM PUMP

PROBLEM	CAUSE	SOLUTION
<b>Loss of vacuum:</b> While cleaning, the vacuum is not up to specification. Engine RPM is normal.	Vacuum gauge is giving an improper reading.	Examine the tubing between the vacuum relief valve and the vacuum gauge and remove any blockage.
	Vacuum hose(s) is damaged, causing a suction leak.	Inspect hose(s), repair or replace.
	Waste tank gaskets not sealing properly, not positioned properly	Inspect the gasket. Repair seal or replace Re-position lid(s).
	Plugged vacuum hose or vacuum plumbing between vacuum inlet and strainer basket.	Unplug vacuum hose or inlet plumbing.
	Waste tank filter or strainer basket is plugged.	Clean or replace filter. Clean strainer basket.
	Loose vacuum pump drive belts.	Tighten the drive belts
	Waste tank drain valve is damaged or left open, causing a vacuum leak.	Drain the waste tank. Close drain valve, if open. Remove the dump valve and, after inspecting, replace the defective components.
	Vacuum relief valve requires adjustment or has a vacuum leak due to damaged diaphragm.	Re-adjust the vacuum relief valve. If the vacuum does not increase, remove and inspect the relief valve diaphragm. If damaged, replace
	Vacuum pump is worn out.	Replace the vacuum pump.

### TROUBLESHOOTING: WATER PUMP

PROBLEM	CAUSE	SOLUTION
<b>Loss of solution volume at cleaning tool orifice:</b> Solution pressure gauge reads normal.	Plugged orifice and/or screen in the cleaning tool.	Unplug or replace orifice and/or screen
	Internal block between the pressure regulator manifold and the outlet manifold, or the solution screen is clogged	Inspect all lines, remove accumulated debris which is blocking proper flow. Replace any defective hoses. Remove, inspect, and clean the solution screen. De-scale unit and install a water softener, if necessary.
	Outlet check valve is plugged	Examine the check valve, remove any debris
	Cleaning tool valve is malfunctioning.	Repair or replace valve.

## SECTION 4

### TROUBLESHOOTING: WATER PUMP

PROBLEM	CAUSE	SOLUTION
<b>Loss of solution volume at cleaning tool orifice:</b> Solution pressure gauge reads normal.	Hose inner lining is constricted.	Remove restriction or replace hose.
	Air leak in chemical supply line, priming valve or metering valve.	Check for air leaks. Replace faulty parts.
	Defective quick-connect on one or more of the high pressure hoses.	Replace defective quick-connects(s) on high pressure hoses(s).
<b>Loss of solution pump pressure:</b> With the cleaning tool open, the solution pressure gauge reads below the normal operating pressure.	Water supply is turned off or the float valve is stuck.	Turn the water supply on or up. Check for kinks in the water supply hose. Examine the float or replace.
	Solution pump inlet supply line is plugged or drawing air.	Examine the water inlet filter inside the water box. Remove accumulated debris and replace if required. Check for suction leaks and loose clamps or fittings. Tighten any loose fittings or clamps. Replace any ruptured hose(s).
	Improper engine speed	Using a tachometer, check the engine speed. Full throttle engine speed is 3000 RPM. Idle engine speed is 1500 RPM. Refer to the “engine speed” section for instructions on how to re-adjust.
	Pressure regulator o-rings are dry.	Lubricate o-rings, using o-ring lubricant
	Pressure regulator has worn o-rings	Check o-rings. If necessary, replace.
	Pressure regulator is dirty, stuck open, or improperly adjusted.	Clean or repair regulator. Adjust to working pressure. Lubricate o-rings, using o-ring lubricant Part
	Low pump volume. (Measure the amount of water being returned to the water box from the pressure regulator. It should fill a gallon container about every 17.6 seconds).	Examine the check valves, plunger cups, and cylinder head on the water pump. Repair, whenever required (refer to the water pump service manual).
	Defective water pressure gauge.	Replace gauge
	Orifice (spray nozzle) in the cleaning tool is worn, defective, or wrong size.	Replace Nozzle or change nozzle size.
	Debris clogging water lines or water inlet disconnect.	Clean or replace as needed.
	Belts loose or broken	Re-tension or replace as needed.
	Loss of pump prime	Manually prime water pump.

## SECTION 4

### TROUBLESHOOTING: CHEMICAL SYSTEM

PROBLEM	CAUSE	SOLUTION
<b>Chemical flow meter indicates flow with the tool valve closed</b>	External leak in chemical piping	Tighten fittings. Re-apply thread sealant where required. If any fittings are damaged, replace.
	Outlet check valve is full of debris or damaged, not allowing it to close properly	Close the chemical valve on the instrument panel. If the flow meter does not indicate flow, remove debris or replace check valve, if necessary.
	Chemical pump diaphragm is ruptured	Close the chemical valve on the instrument panel. If the flow meter still indicates flow, replace the chemical pump diaphragm.
	Internal leak in chemical valve causing continual flow through prime tube returning to container.	Tighten valve packing nut (see “General Service Adjustments” section in this manual). Replace valve, if necessary.
<b>Loss of chemical:</b> With the cleaning tool valve open, no chemical	Chemical pump is improperly primed.	Refer to chemical pump priming instructions.
	The strainer at the inlet end of the chemical inlet line is clogged	Unclog the strainer. If damaged, replace.
	Suction leak in the inlet line leading into the chemical pump.	Inspect inlet lines and flow meter for air leaks or damage and replace, if required.
<b>Loss of chemical:</b> With the cleaning tool valve open, no chemical	Chemical pump check valve(s) is clogged	Remove any debris from the chemical check valve(s). Replace chemical check valve(s) or seals, if necessary.
	Chemical prime/on-off valve or chemical metering valve is defective.	Replace valve(s).
	Chemical pump diaphragm is ruptured.	Disassemble the chemical pump and replace the damaged diaphragm.
	Defective cylinder in the water pump.	Measure the pump volume. If the pump volume is less than normal, refer to “Loss of Pump Volume” in the Troubleshooting section in this manual.

# **SECTION 5:** **PARTS and ACCESSORIES**

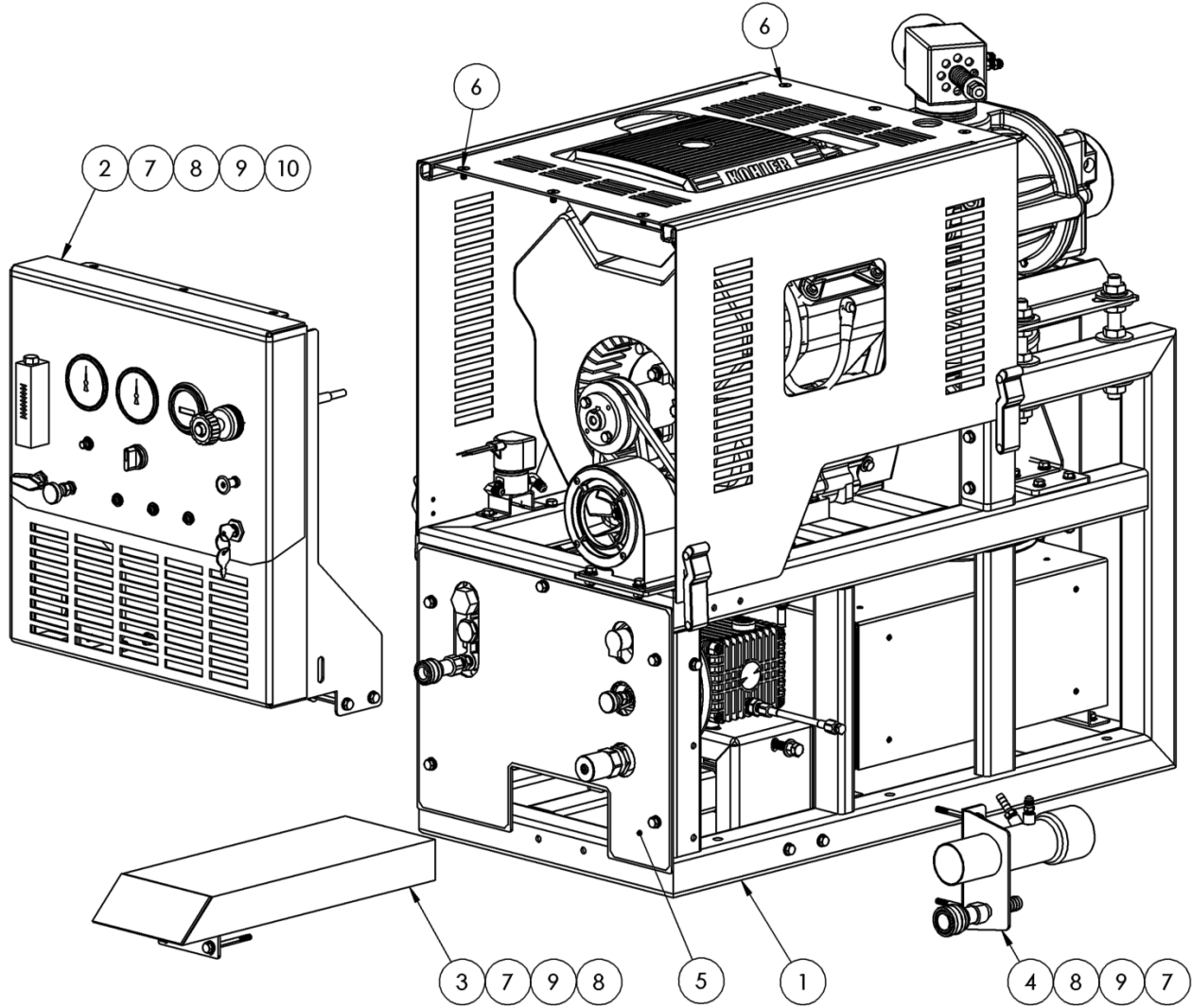
## **10. ILLUSTRATED PARTS LISTINGS**

Console Assembly .....	40
Frame and Enclosures.....	42
Control Panel Assembly – Component List Front .....	43
Control Panel Assembly – Component List Back.....	44
Engine Assembly.....	45
Vacuum Blower Assembly.....	46
Vacuum Relief.....	47
Water Pump Assembly.....	48
Heat Exchanger .....	49
Chemical Pump .....	50
Solution Manifold.....	51
Vacuum Inlet Bracket.....	52
Regulator Bracket.....	53
Belt Guard Blower.....	54
Water Box/Float Valve.....	55
Waste Tank.....	56
Electrical Diagram.....	57
Hose Identification / Flow Diagram.....	58
Decals .....	59

## **11. ACCESSORIES**

Waste Pump Out Assembly.....	60
Pressure Pump Clutch Kit. ....	61
1992 to 2002 Ford Fuel Line Install .....	62
Chevy and GMC Full Size Van Fuel Line Install .....	63
2003 Chevy and GMC Full Size Van Fuel Line Install .....	64
1997-2002 Dodge Full Size Van Fuel Line Install.....	65
Fuel Line Bulkhead Installation.....	66
Fuel Pump Assembly Installation.....	67
Fuel Supply and Return Line Installation.....	68

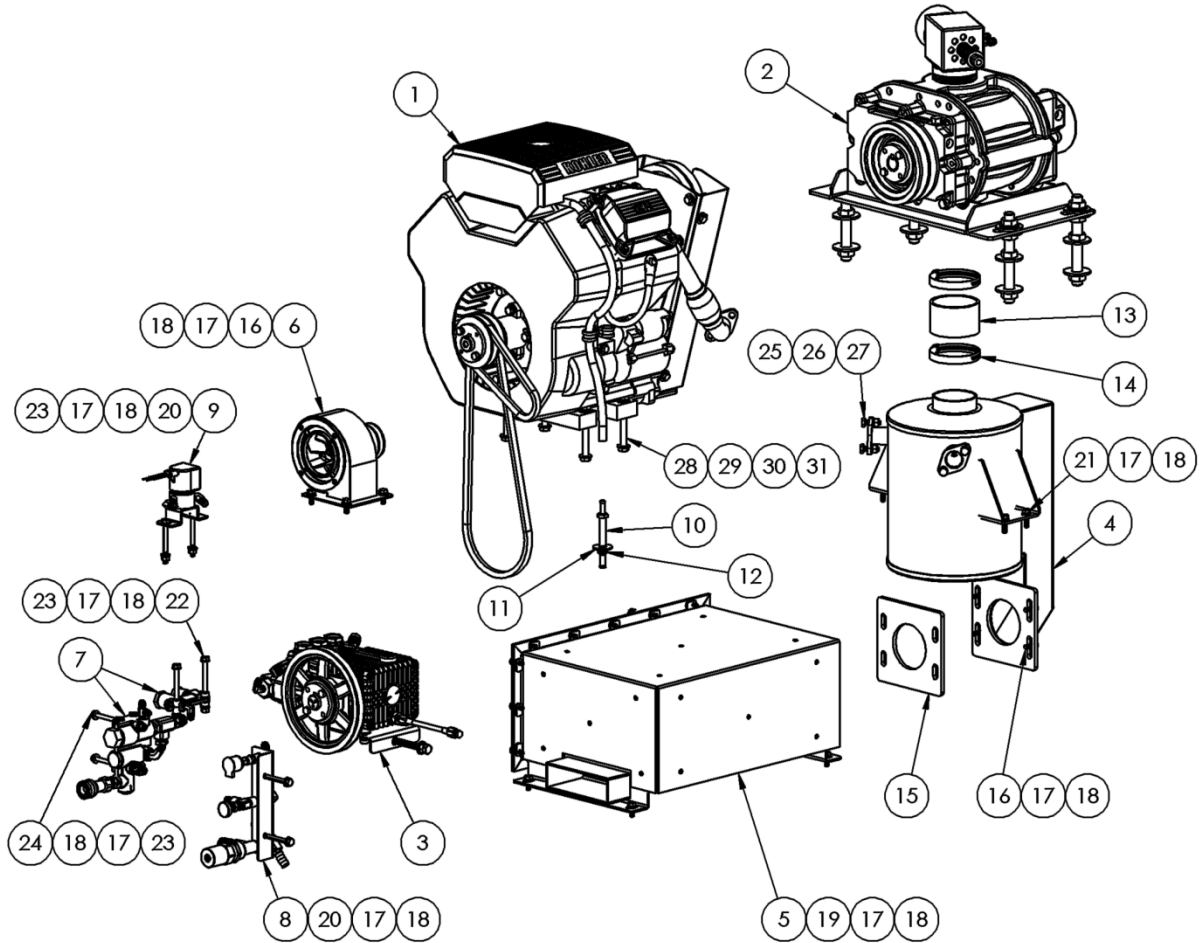
## SECTION 5



### CONSOLE ASSEMBLY, DETAIL 1

4	10	11-004	NUT, 1/4-20 ZINC
8	9	12-015	LKWSR, 1/4 ZINC
12	8	12-011	WASHER, FLAT #12 SAE
8	7	10-028	SCREW, MACH 1/4-20 X 2-3/4 HXHD
6	6	10-165	SCREW, MACH 1/4-20 X .50 FHSCS SS
1	5	44-131	DECAL, LOWER PANEL RAGE
1	4	69-450	ASSY, VACUUM INLET BRACKET
1	3	61-900	WELDMENT, EXHAUST EXTENSION
1	2	69-544	ASSY, BEZEL AND PANEL
1	1	69-498	ASSY, FRAME AND ENCLOSURES
QTY	ITEM	PART NO.	DESCRIPTION

## SECTION

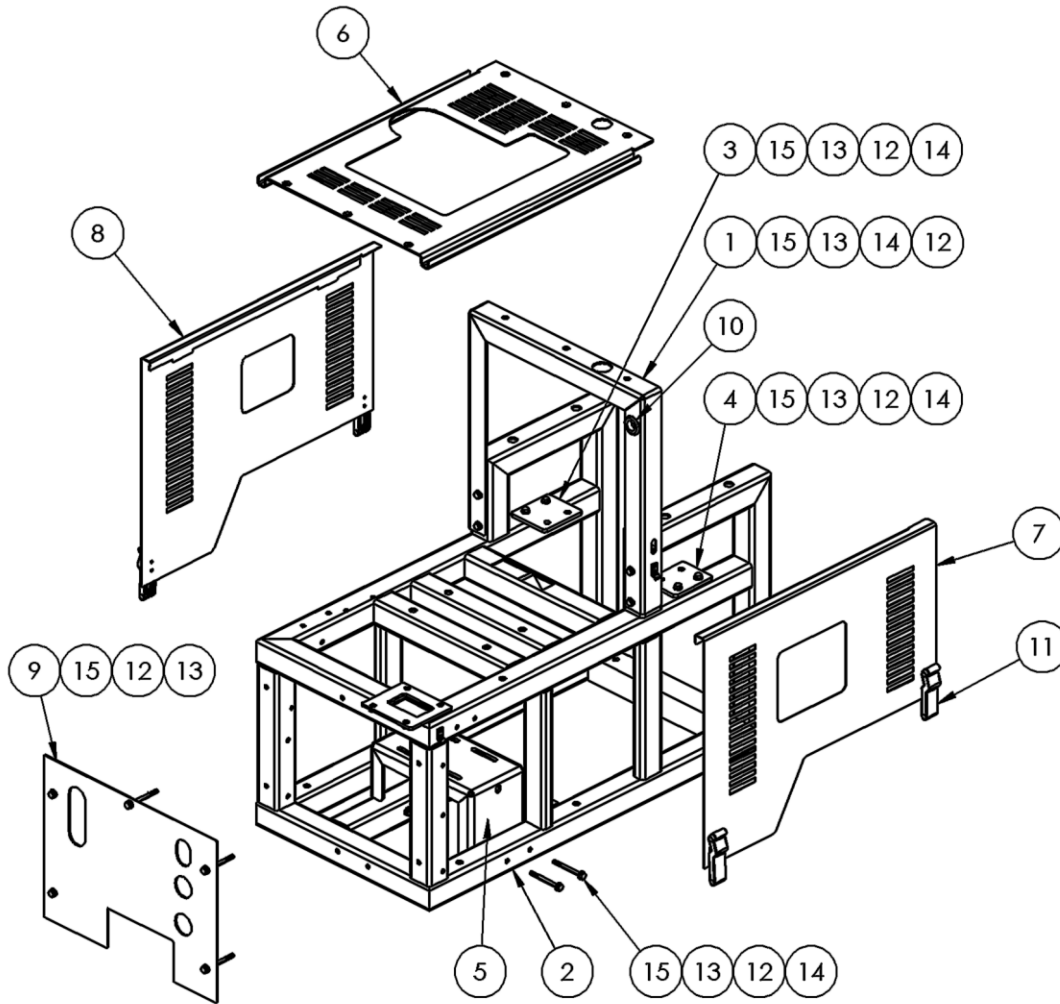


### CONSOLE ASSEMBLY, DETAIL 2

4	31	11-006	NUT, 3/8-16 ZINC
4	30	12-014	LKWSR, 3/8 ZINC
8	29	12-013	WASHER, FLAT 3/8 SAE
4	28	10-139	BOLT, 3/8-16 X 4 GRADE 5 HEX
4	27	10-106	BOLT, 5/16-18 X 1 HHCS Z5
4	26	12-016	LKWSR, 5/16 ZINC
4	25	11-005	NUT, 5/16-18 ZINC
2	24	10-160	BOLT, 1/4-20 X 4 1/2 HH ZP
6	23	11-004	NUT, 1/4-20 ZINC
2	22	10-003	BOLT, 1/4-20 X 3 1/2 HH ZP
4	21	10-026	SCREW, MACH 1/4-20 X 1 HXHD
4	20	10-028	SCREW, MACH 1/4-20 X 2-3/4 HXHD
4	19	10-025	SCREW, MACH 1/4-20 X 3/4 HXHD GRD5
30	18	12-011	WASHER, FLAT #12 SAE
24	17	12-015	LKWSR, 1/4 ZINC
8	16	10-032	SCREW, MACH 1/4-20 X 3/4 HXHD
QTY	ITEM	PART NO.	DESCRIPTION

1	15	41-135	GASKET, RAGE EXHAUST TRANSITION
2	14	14-081	CLAMP, HOSE #44 SS
1	13	16-122	HOSE, 2.88 IN ID X 3FT SILICONE 550F
1	12	11-088	NUT, 7/16-20 THIN NYLOK ZPS
1	11	12-021	WASHER, FLAT, 7/16 ZINC
1	10	66-359	FITTING, 1/4 X 5/16 FUEL LINE MANIFOLD
1	9	69-466	ASSY, FLUID CONTROL VALVE
1	8	69-449	ASSY, REGULATOR BRACKET
1	7	69-260	ASSY, MANIFOLD BLOCK
1	6	69-184	ASSY, BELT GUARD BLOWER
1	5	69-441	ASSY, HEAT EXCHANGER
1	4	61-1069	WELDMENT, SILENCER
1	3	69-447	ASSY, PRESSURE PUMP
1	2	69-500	ASSY, VACUUM PUMP
1	1	69-499	ASSY, ENGINE RAGE KOHLER
QTY	ITEM	PART NO.	DESCRIPTION

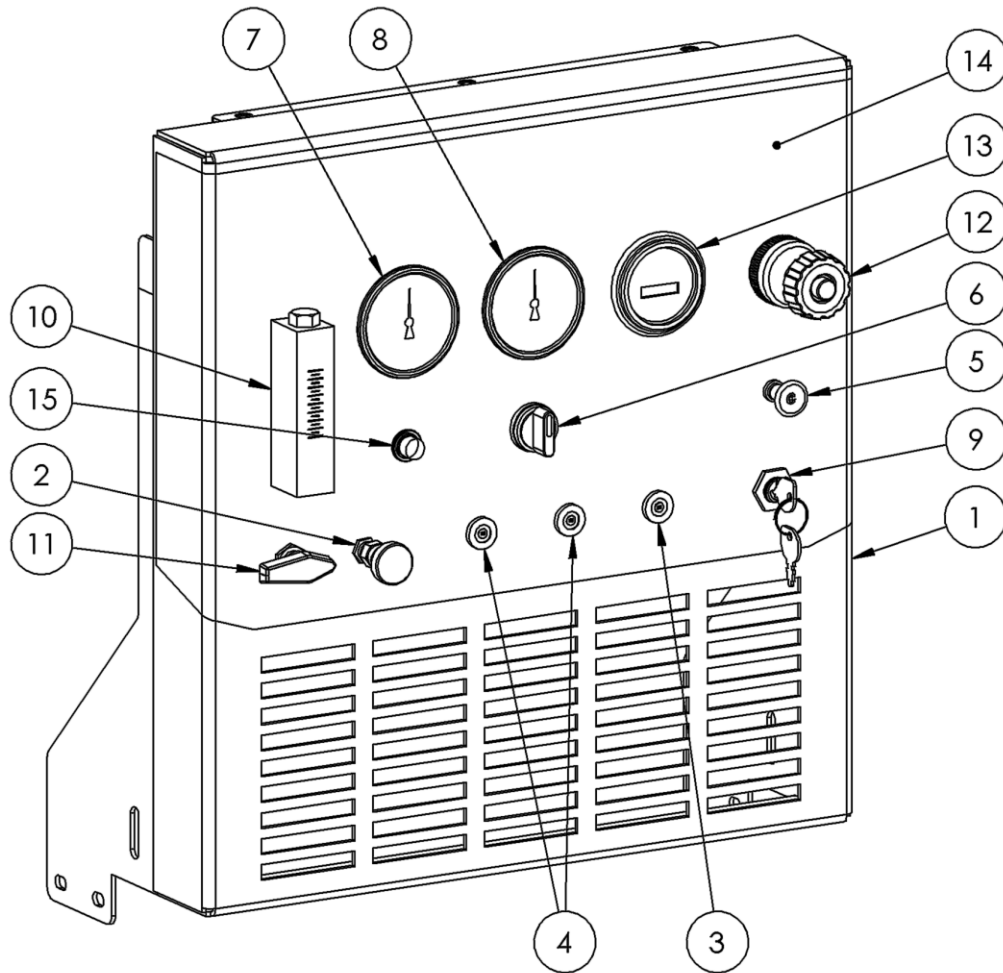
## SECTION 5



### FRAME AND ENCLOSURES

17	15	10-028	SCREW, MACH 1/4-20 X 2-3/4 HXHD
12	14	11-004	NUT, 1/4-20 ZINC
29	13	12-011	WASHER, FLAT #12 SAE
17	12	12-015	LKWSR, 1/4 ZINC
4	11	40-034	LATCH, DRAW SS CONCEALED MOUNT
1	10	41-071	GROMMET, 1-3/8" OD X 3/4" ID X 1/8" PANEL
1	9	58-614	PANEL, LOWER FRONT
1	8	58-640	PANEL, HOOD LS
1	7	58-641	PANEL, HOOD RS
1	6	58-645	PANEL, TOP HOOD
1	5	60-1552	BRACKET, PRESSURE PUMP
1	4	61-1054	WELDMENT, SILENCER SUPPORT PLATE
1	3	61-1070	WELDMENT, SILENCER SUPPORT LS
1	2	61-961	WELDMENT, FRAME
1	1	61-964	WELDMENT, REAR BRACE
QTY	ITEM	PART NO.	DESCRIPTION

## SECTION

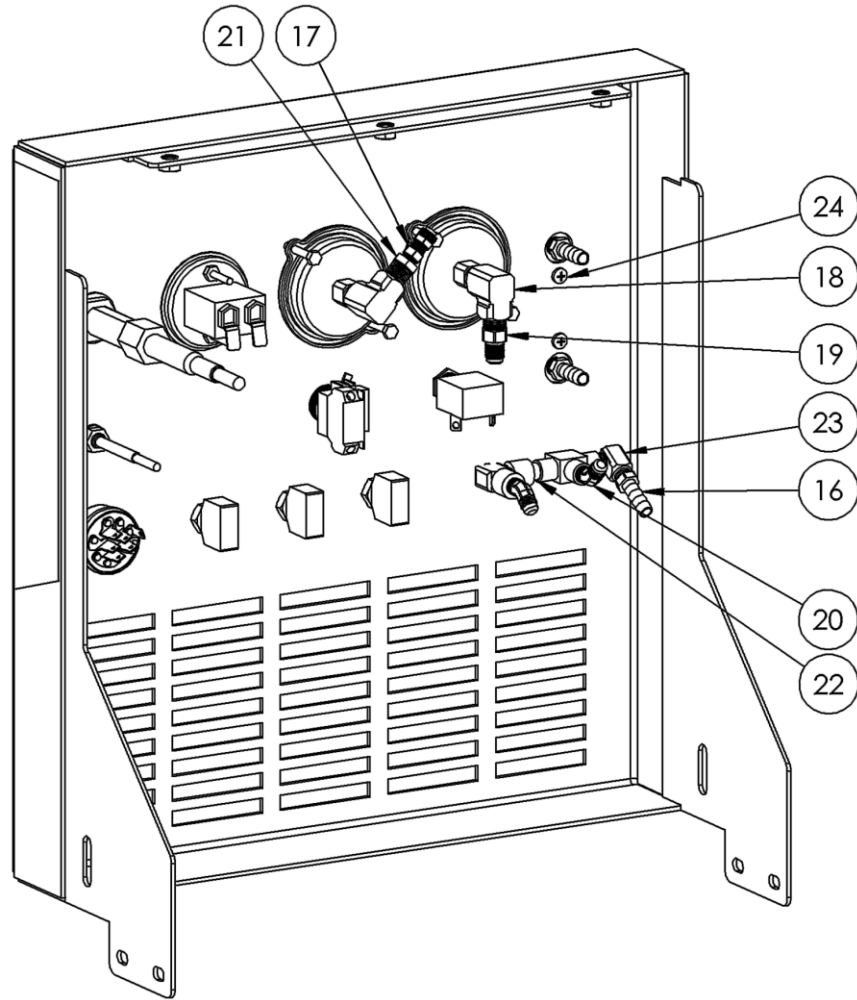


**69-544, ASSY, BEZEL AND PANEL, 1-15**

Item No.	Part Number	Qty	Description
1	61-1008	1	WELDMENT, BEZEL AND PANEL
2	23-015	1	VLV, MET 1/8 FP RT ANG BRASS
3	30-007	1	BREAKER, 30 AMP
4	30-008	2	BREAKER, 20 AMP
5	40-032	1	CABLE, CHOKE
6	29-016	1	SWITCH, ROTARY NON-ILLUMINATED
7	26-045	1	GAUGE, PRESSURE 2.5 IN 0-1500 PSI
8	26-044	1	GAUGE, VACUUM 2.5 IN 0-30 IN/HG
9	29-047	1	SWITCH, IGNITION
10	26-003	1	FLOWMETER, 1/8 FP
11	23-003	1	VALVE, 3-WAY BALL 1/8 FP BRASS
12	40-031	1	CABLE, THROTTLE
13	26-033	1	HOURMETER, HOBBS CHROME BEZEL
14	44-155	1	DECAL, PRODUCT RAGE
15	29-068	1	SWITCH, PUSHBUTTON OVERRIDE



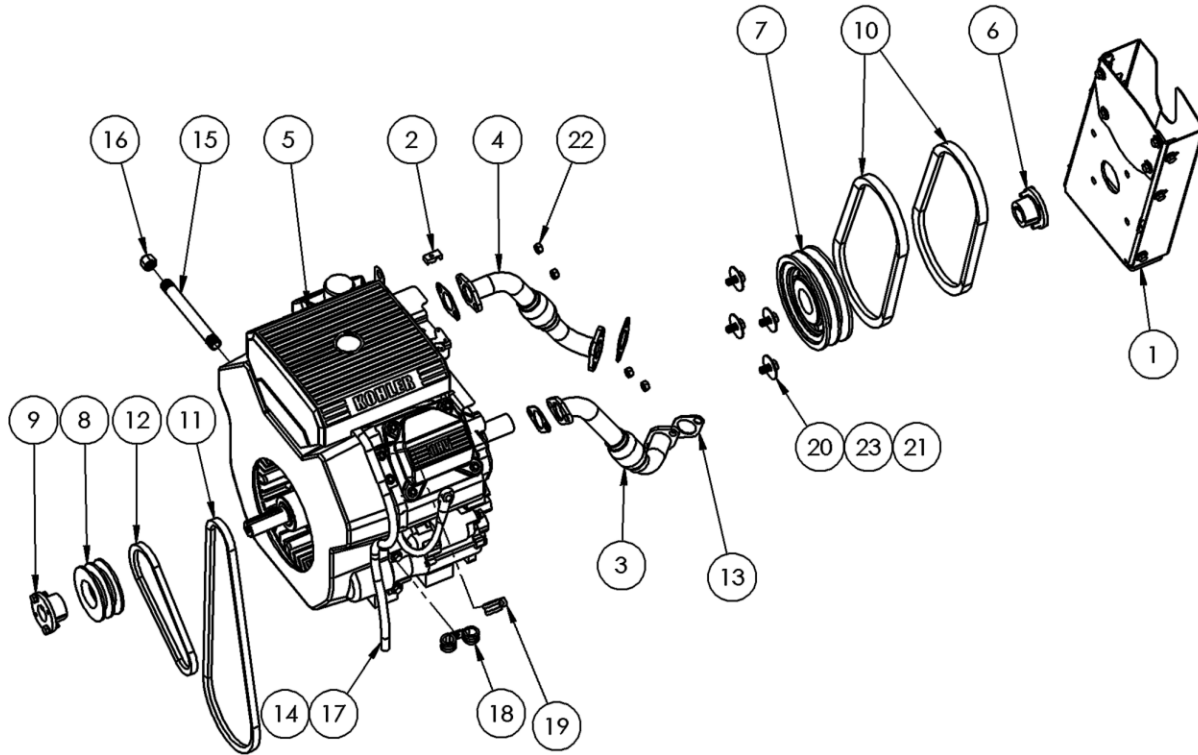
## SECTION 5



**69-445, ASSY, BEZEL AND PANEL, 16-24**

Item No.	Part Number	Qty	Description
16	21-007	3	FTTG, BRB 1/8 P X 5/16 H BR
17	21-028	1	CONN, 1/8 P X 1/4 POLY
18	21-037	2	FITTING, ELBOW, .25 IN NPT, BRASS
19	21-050	1	CONN, 1/4 NTP X -04 JIC BRASS
20	21-055	2	ELL, 1-8 P X 1/4 T 45 DEG BRASS
21	21-076	1	BUSHING, 1/4 M X 1/8 F BRASS
22	21-042	1	NIP, CLOSE, 1/8 IN BRASS
23	21-038	1	ELL, STREET 1/8 IN BRASS
24	10-150	2	SCREW, 10-32 X 1/2 PHP ZP

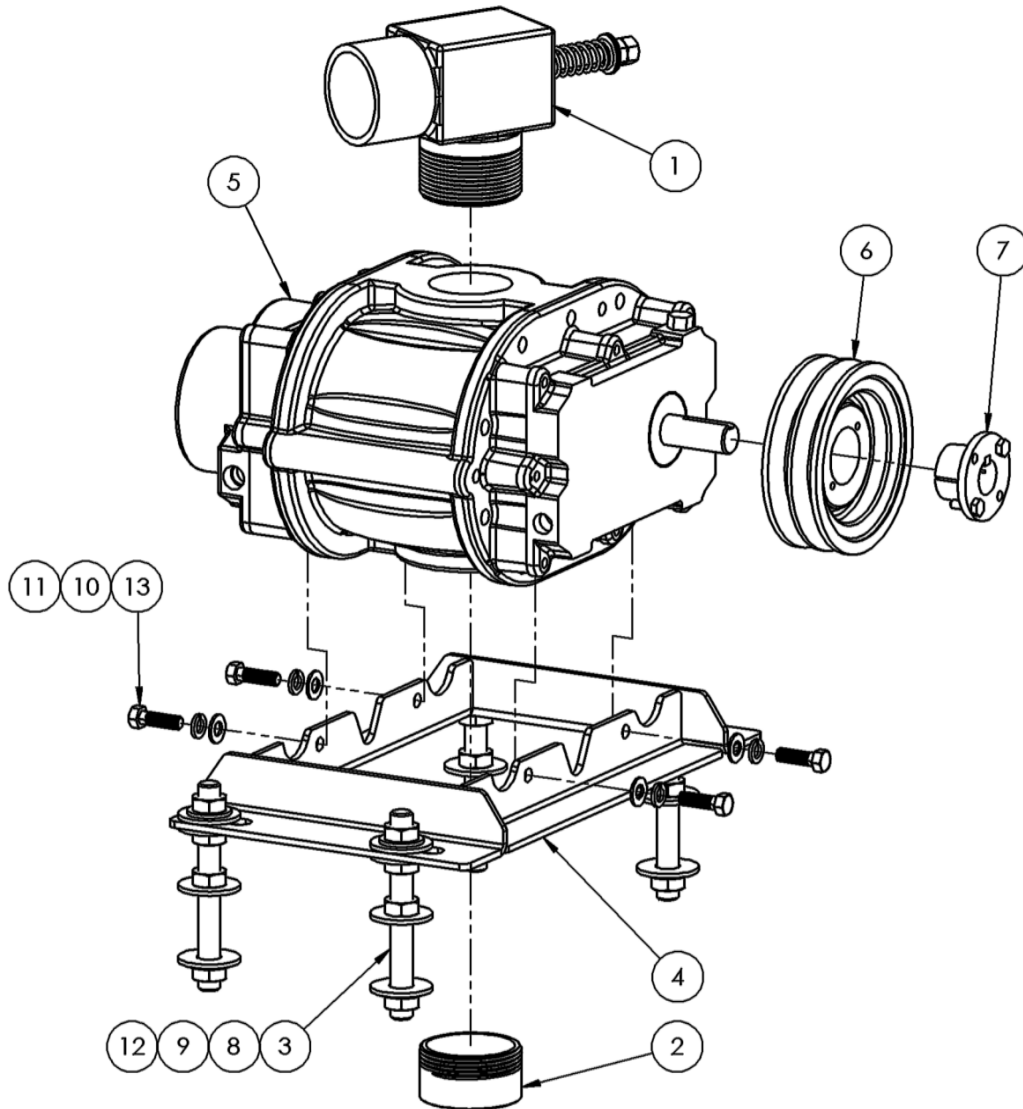
## SECTION 5



### 69-499, ASSEMBLY, ENGINE

4	23	10-070	BOLT - .375-16 X .75 HH ZP
4	22	11-005	NUT, 5/16-18 ZINC
4	21	12-014	LKWSR, 3/8 ZINC
4	20	12-049	WASHER, 3/8 X 1-1/2 FENDER ZINC
1	19	14-004	CLAMP, WIRE CUSHION 3/4 ID X 1/4 BOLT
2	18	14-005	CLAMP, WIRE CUSHION 5/8 ID X 1/4 BOLT
1.7 FT	17	16-104	HOSE, FUEL 1/4 30R9 FUEL INJECTION
1	16	21-326	CAP, 3/8 NPT BRASS
1	15	21-329	NIPPLE, 3-8 NPT X 6 SS
20 IN	14	32-027	LOOM, HI HEAT .500 DIA. BLACK
2	13	36-016	GASKET, EXHAUST
1	12	37-062	BELT, 3L190
1	11	37-063	BELT, AX40 GATES
2	10	37-094	BELT, BX29 GATES EPDM
1	9	38-021	BUSHING, BROWNING H X 1.00
1	8	38-048	PULLEY, BROWNING 2AK34H
1	7	38-049	SHEAVE, BROWNING 2BK62H
1	6	38-052	BUSHING, BROWNING H X 1.125
1	5	45-039	ENGINE, KOHLER 18HP CH620
1	4	61-1067	WELDMENT, EXHAUST TUBE LS
1	3	61-1068	WELDMENT, ENGINE EXHAUST RS
1	2	66-122	RETAINER, CABLE
1	1	69-587	ASSY, BELT GUARD
QTY	ITEM	PART NO.	DESCRIPTION

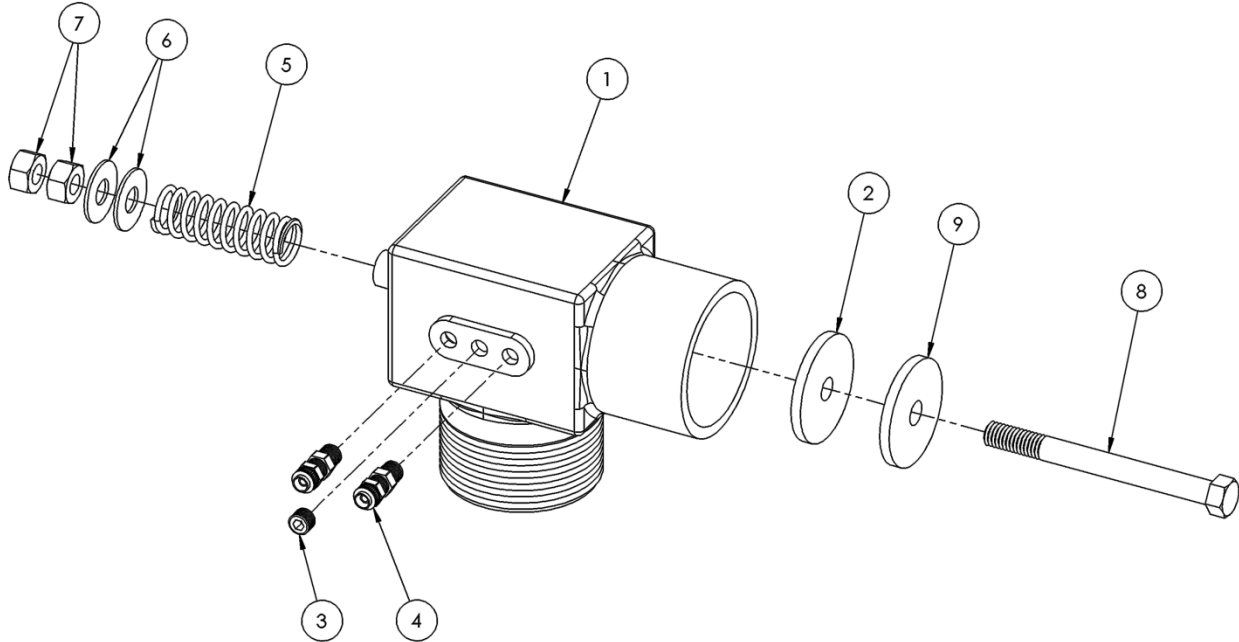
## SECTION 5



### 69-500, ASSEMBLY, VACUUM PUMP

4	13	10-004	SCREW, MACH 3/8-16 X 1-1/4 HEXHD
16	12	11-062	NUT, 5/8-18 JAM
4	11	12-013	WASHER, FLAT 3/8 SAE
4	10	12-014	LKWSR, 3/8 ZINC
8	9	12-039	WASHER, LOCK, .625
16	8	12-040	WASHER, FLAT .625 USS
1	7	38-051	BUSHING, BROWNING H X .875
1	6	38-105	SHEAVE, BROWNING 2BK57H
1	5	46-064	VACUUM PUMP, ROTARY POSITIVE BLOWER 3006
1	4	61-965	WELDMENT, VAC PUMP MTG BRKT
4	3	66-227-03	THREADED ROD, .625-18 UNF 2A X 6.0 IN
1	2	66-450	NIPPLE, BLOWER OUTLET
1	1	69-432	ASSEMBLY, VACUUM BRAKE, 3L & 4M
QTY	ITEM	PART NO.	DESCRIPTION

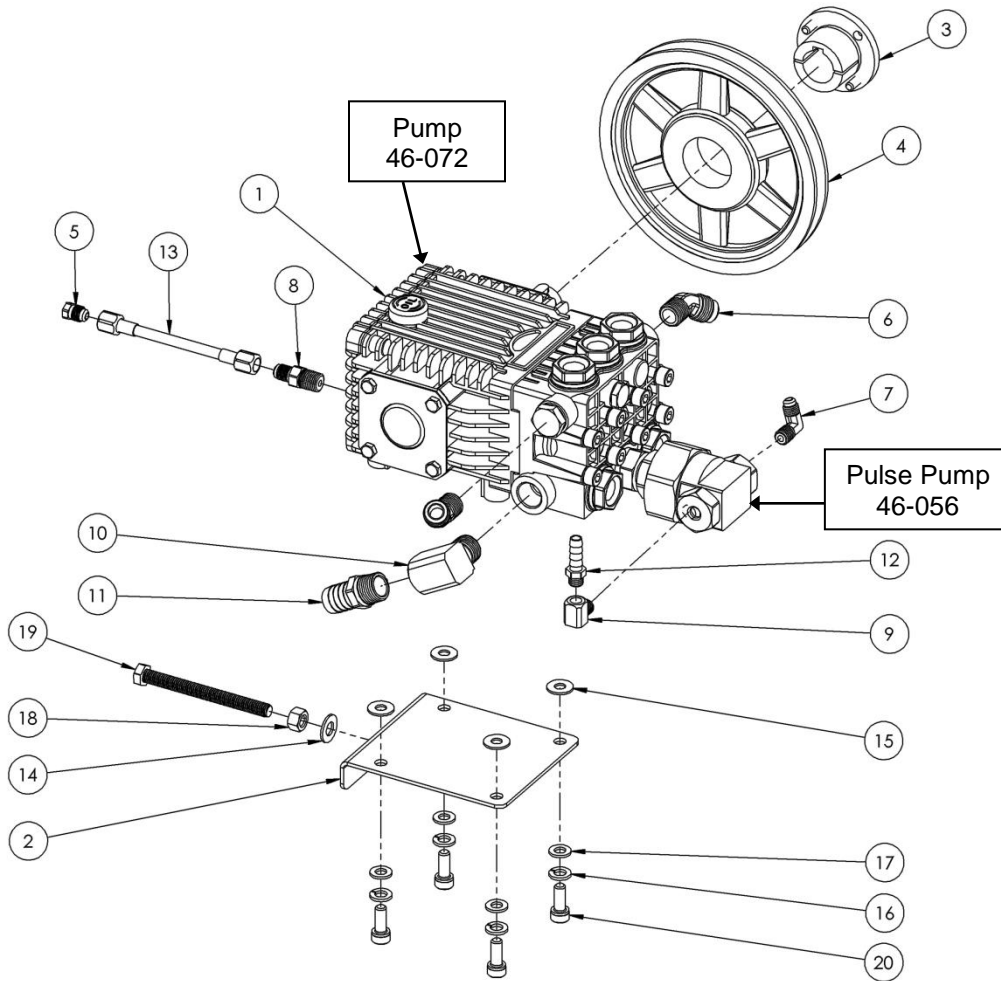
## SECTION 5



### 69-432, ASSEMBLY, VACUUM BRAKE

Item No.	Part Number	Qty	Description
1	66-000	1	VACUUM BRAKE, MACHINED
2	41-010	1	DIAPHRAGM, VACUUM RELIEF VLV 3L &4M
3	21-029	1	PLUG, 1/8 P X 1/4 POLY
4	21-028	2	CONN, 1/8 P X 1/4 POLY
5	15-002	1	SPRING, VAC RELIEF VALVE
6	12-021	2	WASHER, FLAT 7/16 ZINC
7	11-012	2	NUT, 7/16-14 ZP
8	10-001	1	SCREW, MACH 7/16-14 X 4-1/2 HEXHD
9	59-219	1	PNL, STEM VAC 3L/4M

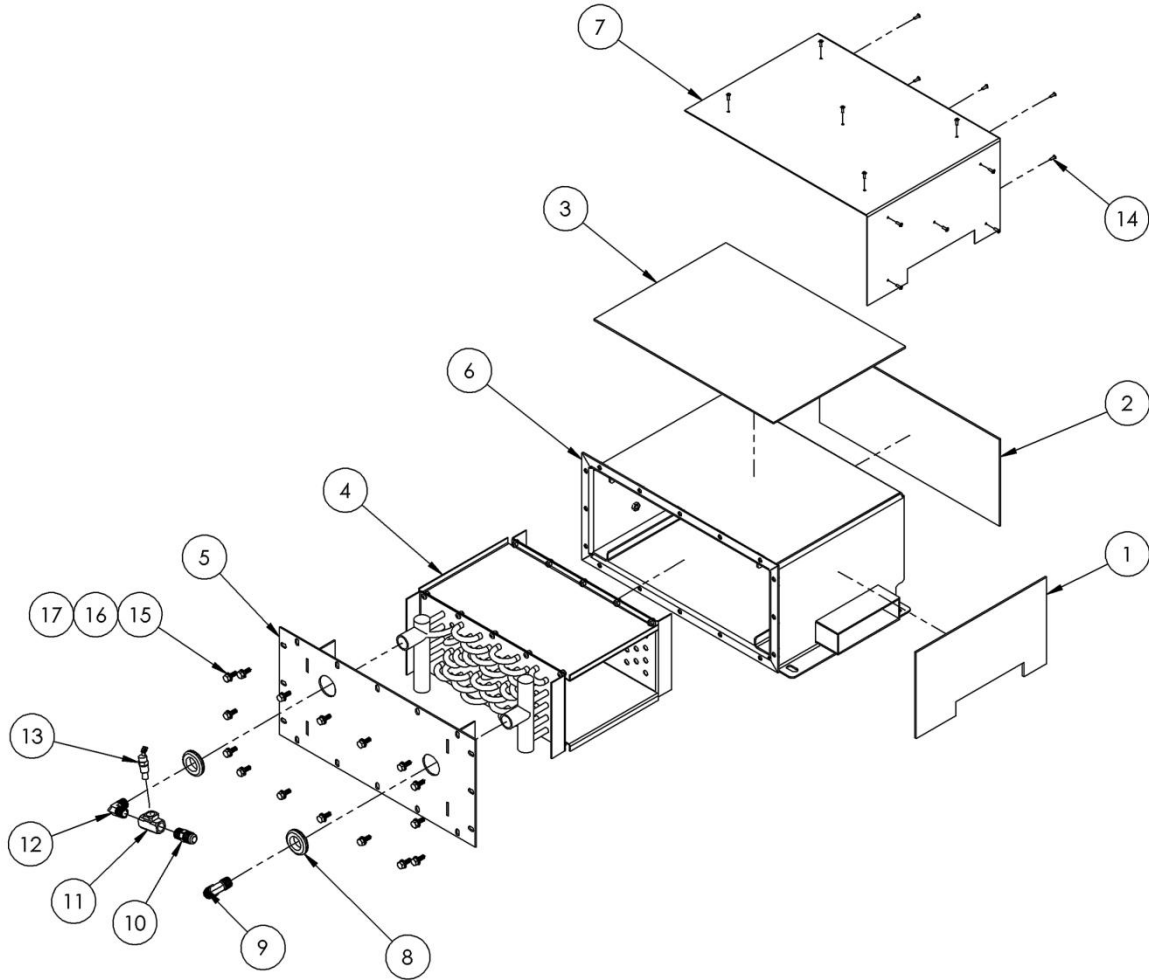
## SECTION 5



### 69-447, ASSY, WATER PUMP

Item No.	Part Number	Qty	Description
1	68-182	1	ASSY, PRESSURE PUMP
2	61-894	1	WELDMENT, PRESSURE PUMP ADJUST
3	38-065	1	HUB, H X 24MM
4	38-108	1	PULLEY, AK71H
5	21-096	1	PLUG, 1/4 JIC BRASS
6	21-059	2	ELL, 1/8P X 1/4T BRASS
7	21-054	1	ELL, 1-8P X 1-4 T BRASS
8	21-050	1	CONN, 1/4 NPT X 1/4 JIC BRASS
9	21-038	1	ELL, STREET 1/8 IN BRASS
10	21-034	1	ELL, STREET 1/2 BRASS
11	21-032	1	FTTG, BRB 1/2 P X 3/4 H BRASS.SLDPRT
12	21-007	1	FTTG, BRB 1/8 P X 5/16 H BR
13	18-215-02	1	HOSE ASSEMBLY, 3/16 ID X 5 OL
14	12-013	1	WASHER, FLAT 3/8 SAE
15	12-012	4	WASHER, FLAT 1/4 USS
16	12-005	4	LKWSR, M8 HARD
17	12-004	4	WASHER, M8 ZINC
18	11-006	1	NUT, 3/8-16 ZINC
19	10-167	1	BOLT, TAP 3/8-16 X 4
20	10-000	4	SCREW, M8-1.25 X 20 SOCHD

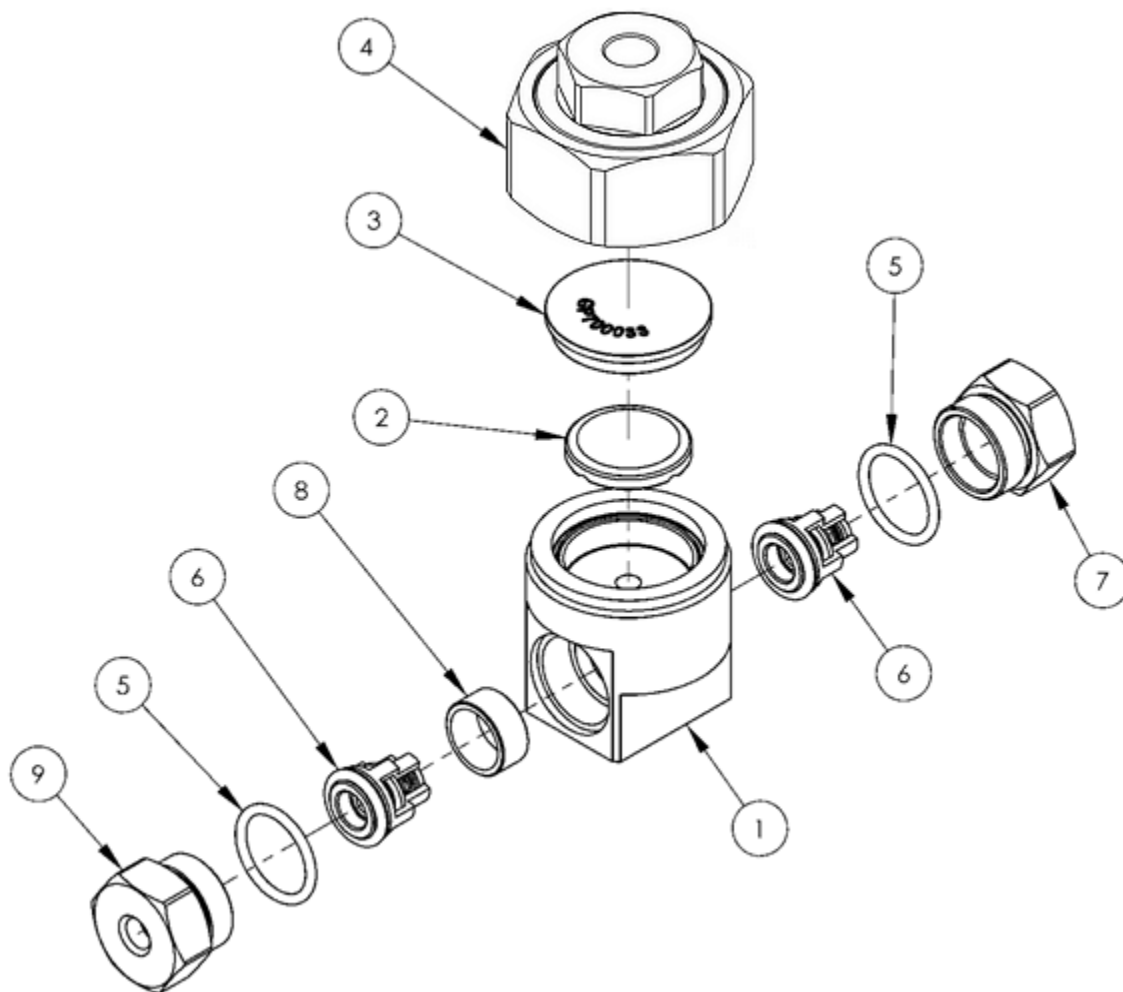
## SECTION 5



**69-441, ASSY, HEAT EXCHANGER**

Item No.	Part Number	Qty	Description
1	64-055	1	INSULATOR, HEAT EXCHANGER SIDE
2	64-054	1	INSULATOR, HEAT EXCHANGER BACK
3	64-053	1	INSULATOR, HEAT EXCHANGER TOP
4	63-033	1	ASSY, VAC HEATER CORE BLUEWAVE
5	61-901	1	WELDMENT, HEAT EXCHANGER COVER
6	61-889	1	WELDMENT, HEAT EXCHANGER HOUSING
7	58-615	1	PNL, HEAT EXCHANGER INSULATOR COVER
8	41-033	2	GROMMET, 1 ID X 1-3/4OD
9	21-061	1	ELL, 3/8 P X 1/2 T BRASS
10	21-057	1	CONN, 3/8 NPT X 1/2 JIC BRASS
11	21-041	1	TEE, 3/8 NPT BRASS
12	21-161	1	FTTG, .38M X .38M 90 DEG
13	34-044	1	SENSOR, TEMP 3/8 NPT 240 DEG
14	14-019	15	RIVET, ALUM NAMEPLATE
15	12-015	16	LKWSR, 1/4 ZINC
16	12-011	16	WASHER, FLAT #12 SAE
17	10-025	16	SCREW, MACH 1/4-20 X 3/4 HXHD GRD5

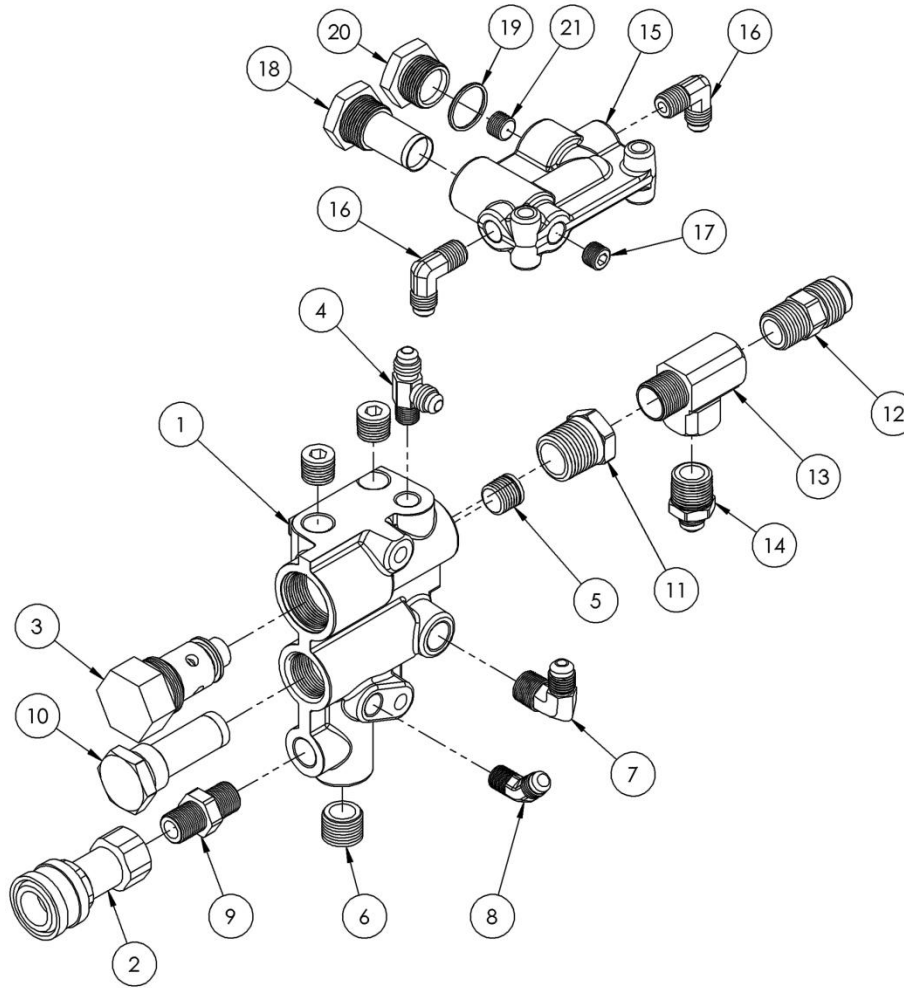
## SECTION 5



**46-056, ASSEMBLY, CHEMICAL PUMP**

Item No.	Part Number	Qty	Description
1	36-350	1	BODY, PULSE PUMP, GP PULSE PUMP
2	36-351	1	PLASTIC DISC, GP PULSE PUMP
3	36-352	1	RUBBER DIAPHRAGM, GP PULSE PUMP
4	36-353	1	TOP COVER INLET, GP PULSE PUMP
5	36-354	2	O-RING, 70 DURO, GP PULSE PUMP
6	36-356	2	ASSY, VALVE KIT, GP CHEMICAL PULSE PUMP
7	36-355	1	VALVE CAP 303SST, GP PULSE PUMP
8	36-357	1	SPACER RING, 303 SST, GP PULSE PUMP
9	36-358	1	VALVE CAP, 303 SST, GP PULSE PUMP PMP 520196

## SECTION 5

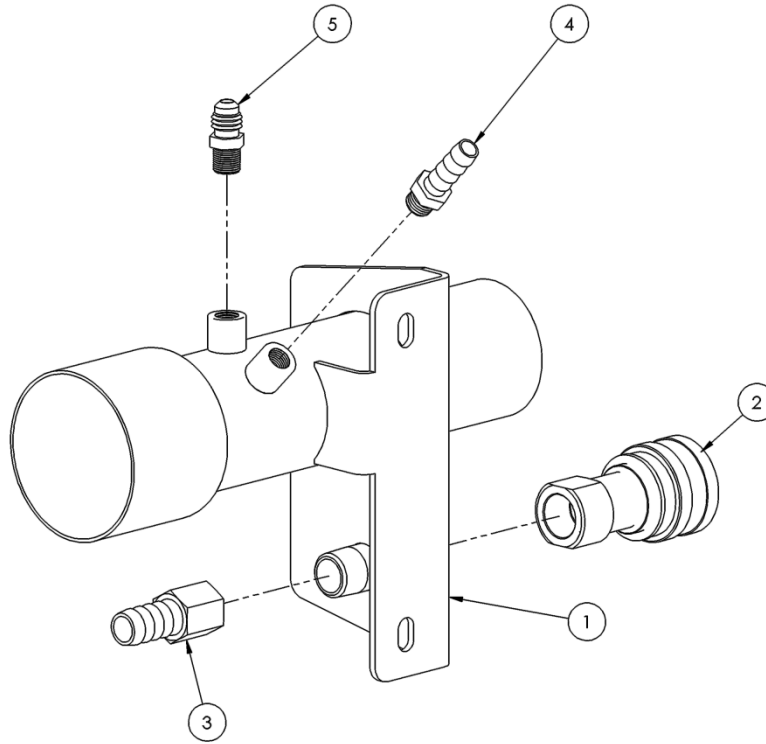


**69-260, ASSY, SOLUTION MANIFOLD**

Item No.	Part Number	Qty	Description
1	66-205	1	MANIFOLD BLOCK
2	25-001	1	QUICK DISCONNECT, .25 NPT, SOCKET, HANSEN SERIES B2-HK
3	23-063	1	CHECK VALVE MANIFOLD
4	21-336	1	TEE, 1/8 NPT X 1/4 JIC X 1/4 JIC BRASS
5	21-264	3	PLUG, 1/4 NPT BRASS
6	21-146	1	PLUG, 3/8 NPT BRASS
7	21-064	1	ELL, 1/4 P X 1/4 T BRASS
8	21-055	1	ELL, 1-8 P X 1/4 T 45 DEG BRASS
9	21-026	1	NIPPLE, 1/4 NPT HEX BRASS
10	20-018	1	SCREEN, CHECK VALVE MANIFOLD
11	21-371	1	BUSHING, 1/2 NPT X 3/8 NPT HEX BRASS
12	21-057	1	CONN, 3/8 NPT X 1/2 JIC BRASS
13	21-062	1	TEE, 3/8 FNPT X NPT X FNPT BRASS
14	21-017	1	CONN, 3/8 P X 1/4 T
15	66-011	1	MANIFOLD, BYPASS
16	21-054	2	ELL, 1/8 P X 1/4 T BRASS
17	21-029	1	PLUG, 1/8 NPT SOCKET HD BRASS
18	20-015	1	SCREEN, BYPASS MANIFOLD
19	41-003	1	O-RING, .676 ID X .816 OD
20	66-017	1	CAP, CHECK VALVE
21	66-018	1	ORIFICE, BYPASS MANIFOLD, .024 BLUE



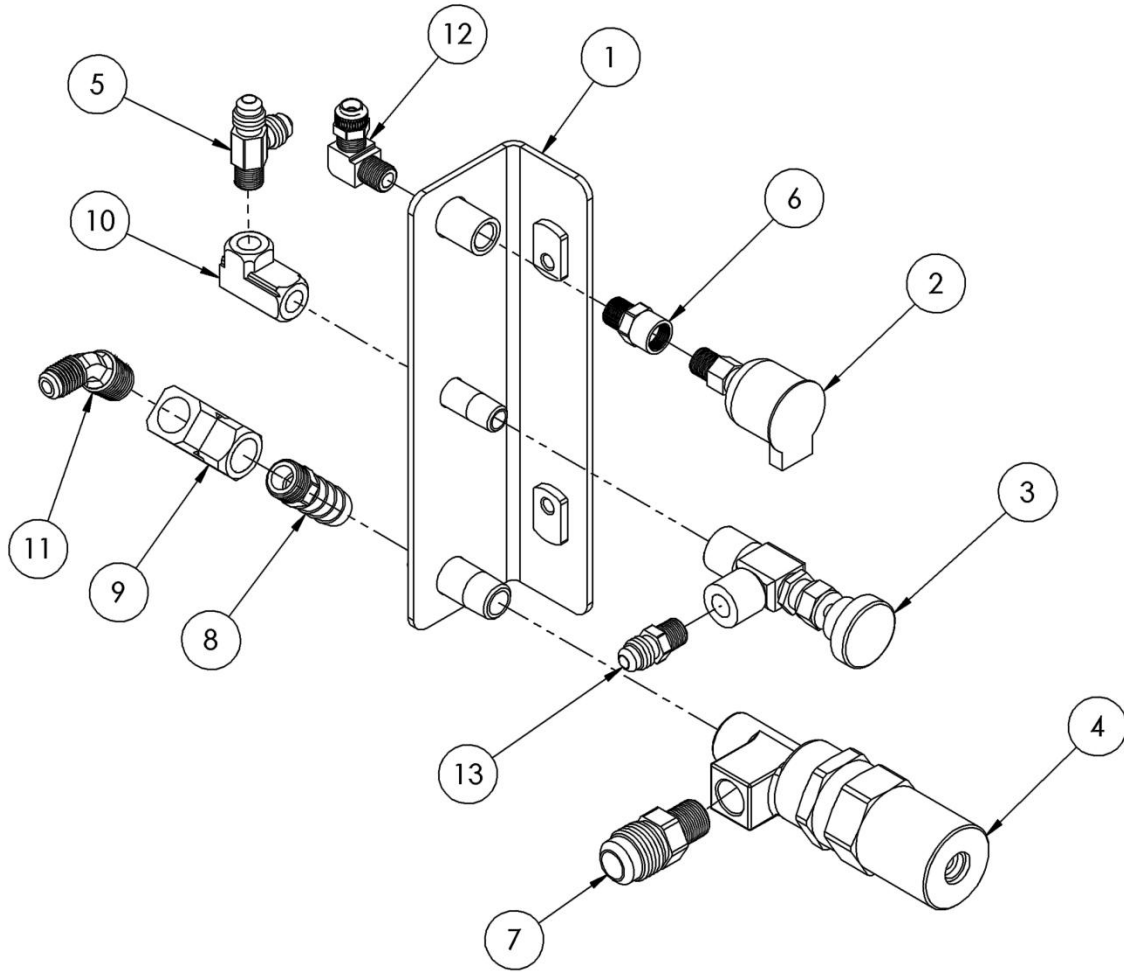
**SECTION 5**



**69-450, ASSY, VACUUM INLET BRACKET**

Item No.	Part Number	Qty	Description
1	61-902	1	WELDMENT, VACUUM INLET BRACKET
2	25-005	1	QUICK COUPLING, 3/8 F X 3/8 FNPT BRASS
3	21-434	1	FTTG, 3/8 FP X 1/2 BARB BRASS
4	21-007	1	FTTG, BRB 1/8 P X 5/16 H BR
5	21-001	1	CONN, 1/8 P X 1/4 T BR

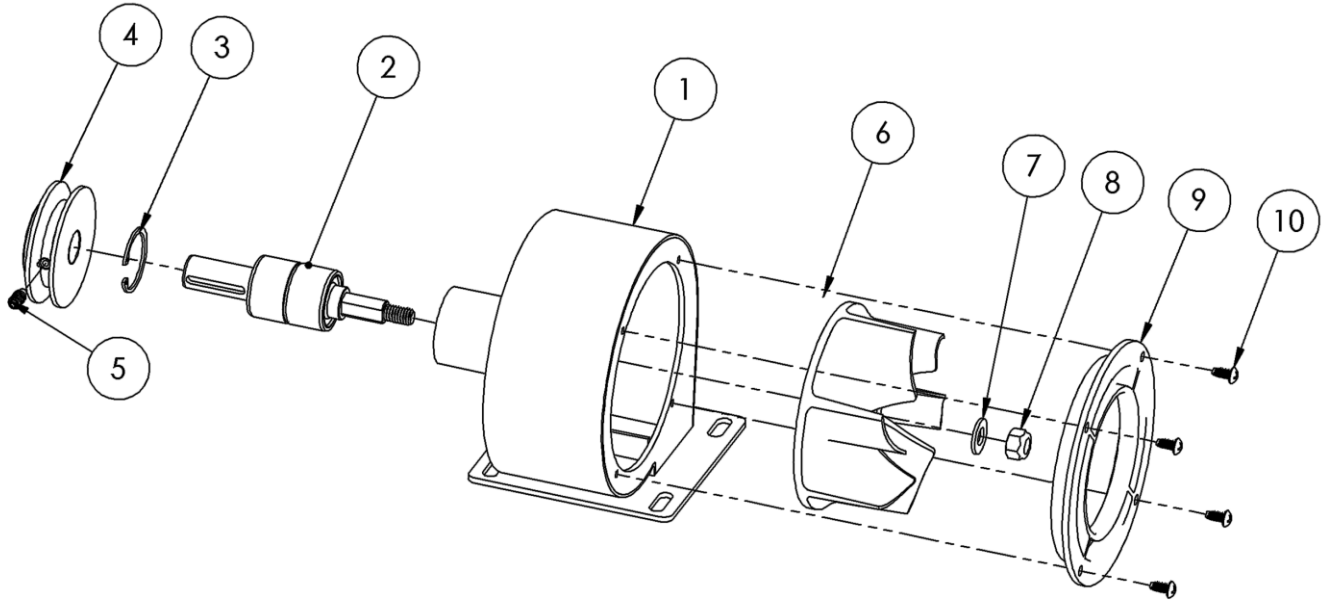
## SECTION 5



**69-449, ASSEMBLY, REGULATOR BRACKET**

Item No.	Part Number	Qty	Description
1	61-456	1	WELDMENT, BRACKET, REGULATOR MOUNTING
2	28-000	1	CUP, OILFILL, 1/8 NPT
3	23-029	1	VLV, MET 1/8 FP RT ANG WHITEY
4	23-010	1	REGULATOR, PRESSURE
5	21-336	1	TEE, 1/8 NPT X 1/4 JIC X 1/4 JIC BRASS
6	21-333	1	COUPLING, 1/8 FNPT X 1/8 MNPT BRASS
7	21-325	1	ADAPTER, 1/4 NPT X 1/2 JIC BRASS
8	21-323	1	FITTING, 1/4 NPT X 1/2 H BRB BRASS
9	21-122	1	FITTING, TEE 1/4NPT BRASS
10	21-090	1	ELL, 1/8 FNPT X 1/8 FNPT BRASS
11	21-051	1	ELL, 1/4P X 1/4T 45 DEG BRASS
12	21-011	1	ELL, 1/8 NPT X 1/4 POLY BRASS
13	21-001	1	CONN, 1/8 P X 1/4 T BR

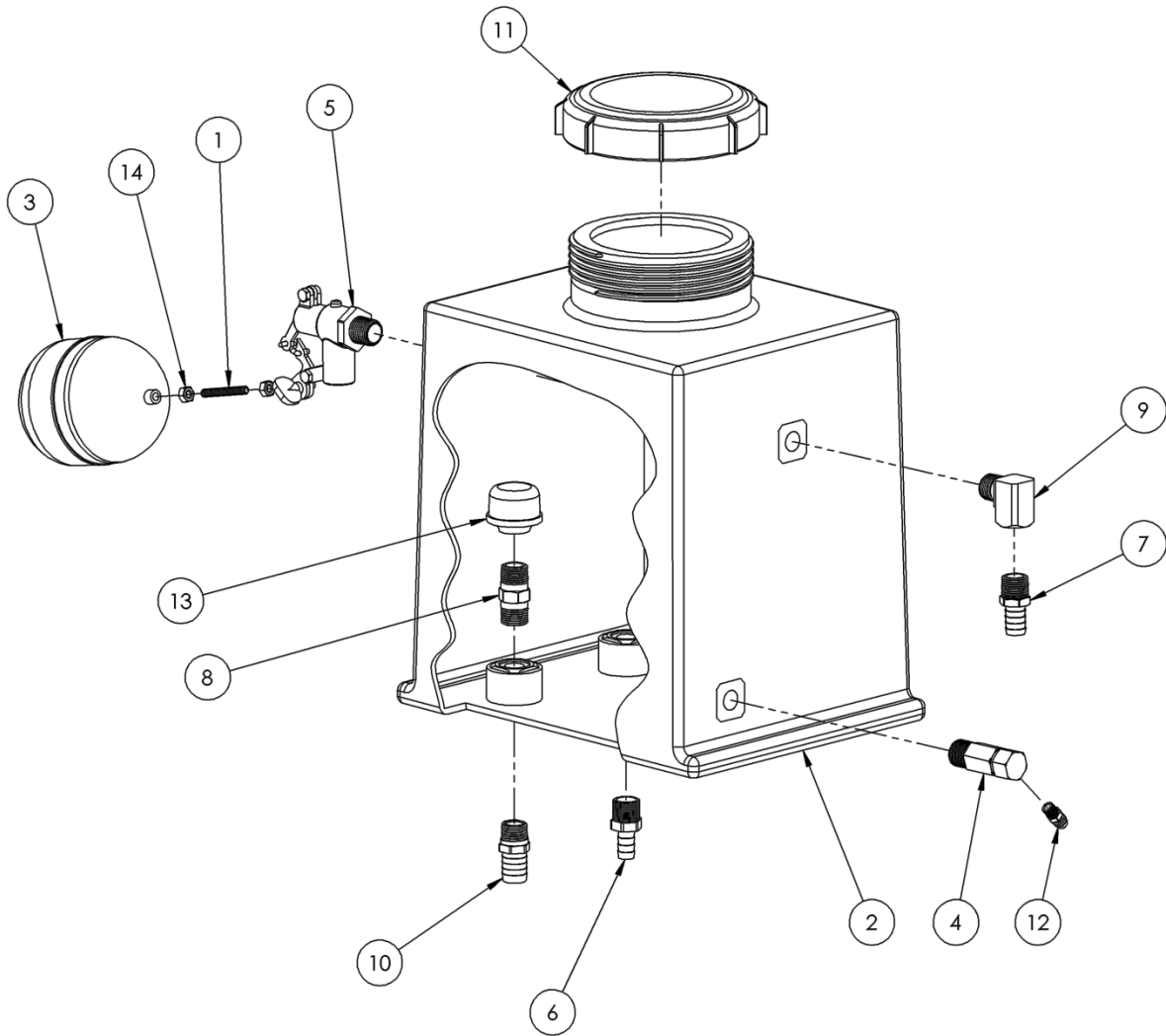
## SECTION 5



### 69-184 ASSEMBLY, BELT GUARD BLOWER

Item No.	Part Number	Qty	Description
1	61-465	1	WELDMENT, BLOWER HOUSING
2	66-263	1	BEARING & SHAFT, BLR HSG STD
3	15-027	1	SNAP RING, 1.187 INTERNAL
4	66-215	1	PULLEY, 3L BELT X 2.340 OD
5	10-219	1	SCREW, FULL DOG SET 1/4-20 X 1/2 BLK
6	51-042	1	AIR WHEEL, MOLDED
7	12-017	1	WASHER, FLAT 5/16 SAE ZINC
8	11-029	1	NUT, 5/16-18 NYLOK
9	51-043	1	COVER, AIR WHEEL
10	10-146	4	SCREW, 8-32 X .375 PHP F THREAD CUTTING ZP

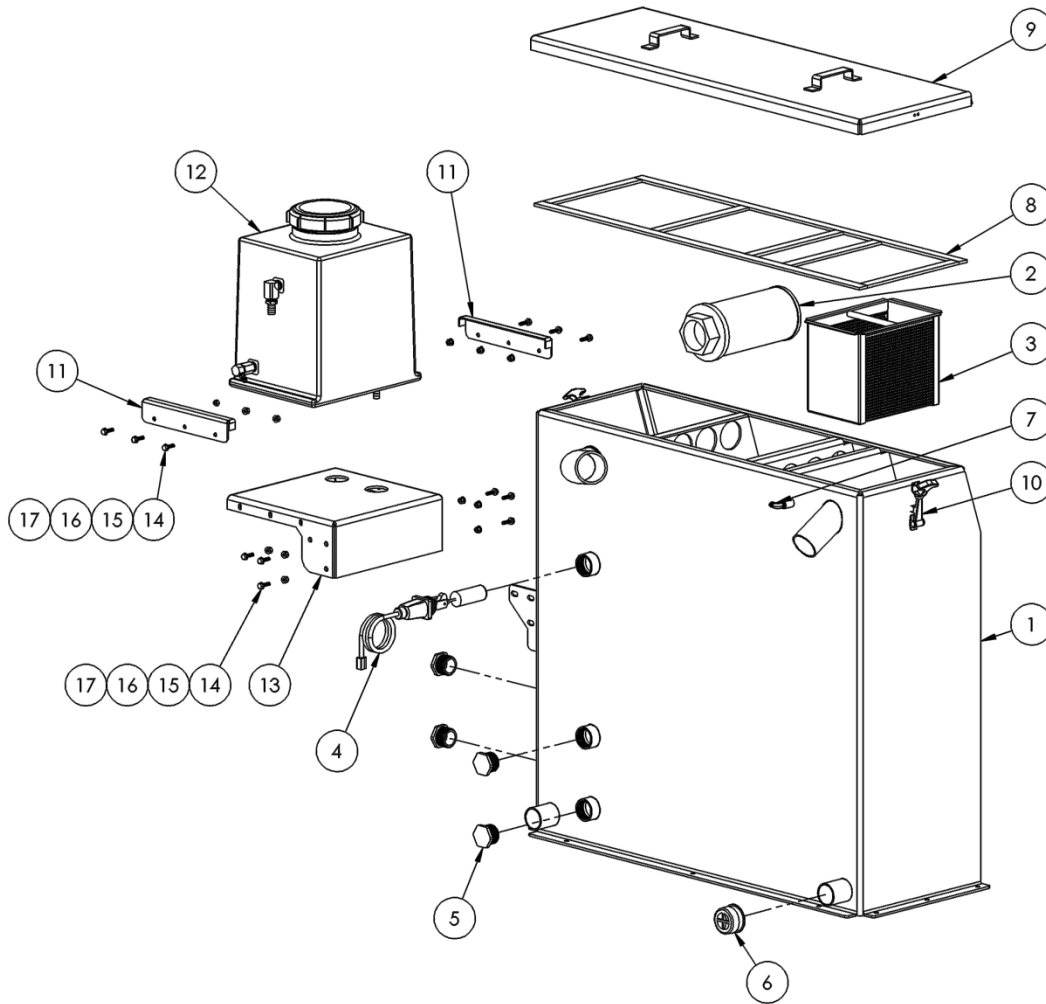
### SECTION 5



### 69-273, ASSY, WATER BOX / FLOAT VALVE

Item No.	Part Number	Qty	Description
1	64-000	1	ROD, FLOAT SS THERMAL WAVE
2	51-002	1	MOLDING, WATER BOX DISCOVERY
3	28-001	1	BALL, FLOAT
4	23-033	1	VALVE, 165 DEG THERMAL CAT 7145
5	23-025	1	VLV, FLOAT WTR BOX THERMALWAVE
6	21-154	1	FITTING, 1/2 NPT X 1/2 BARB BRASS
7	21-109	1	FTTG, 1/2 NPT X 5/8 BARB BRASS
8	21-047	1	NIP, 1/2 IN HEX BRASS
9	21-034	1	ELL, STREET 1/2 BRASS
10	21-032	1	FTTG, BRB 1/2 P X 3/4 H BRASS.SLDprt
11	21-025	1	CAP, 5 IN WATER BOX_TANK BLACK
12	21-001	1	CONN, 1/8P X 1/4T BR
13	20-014	1	STRAINER, SUC END 1/2FP 40 MESH
14	11-001	2	NUT, 1/4-20 SS

## SECTION 5

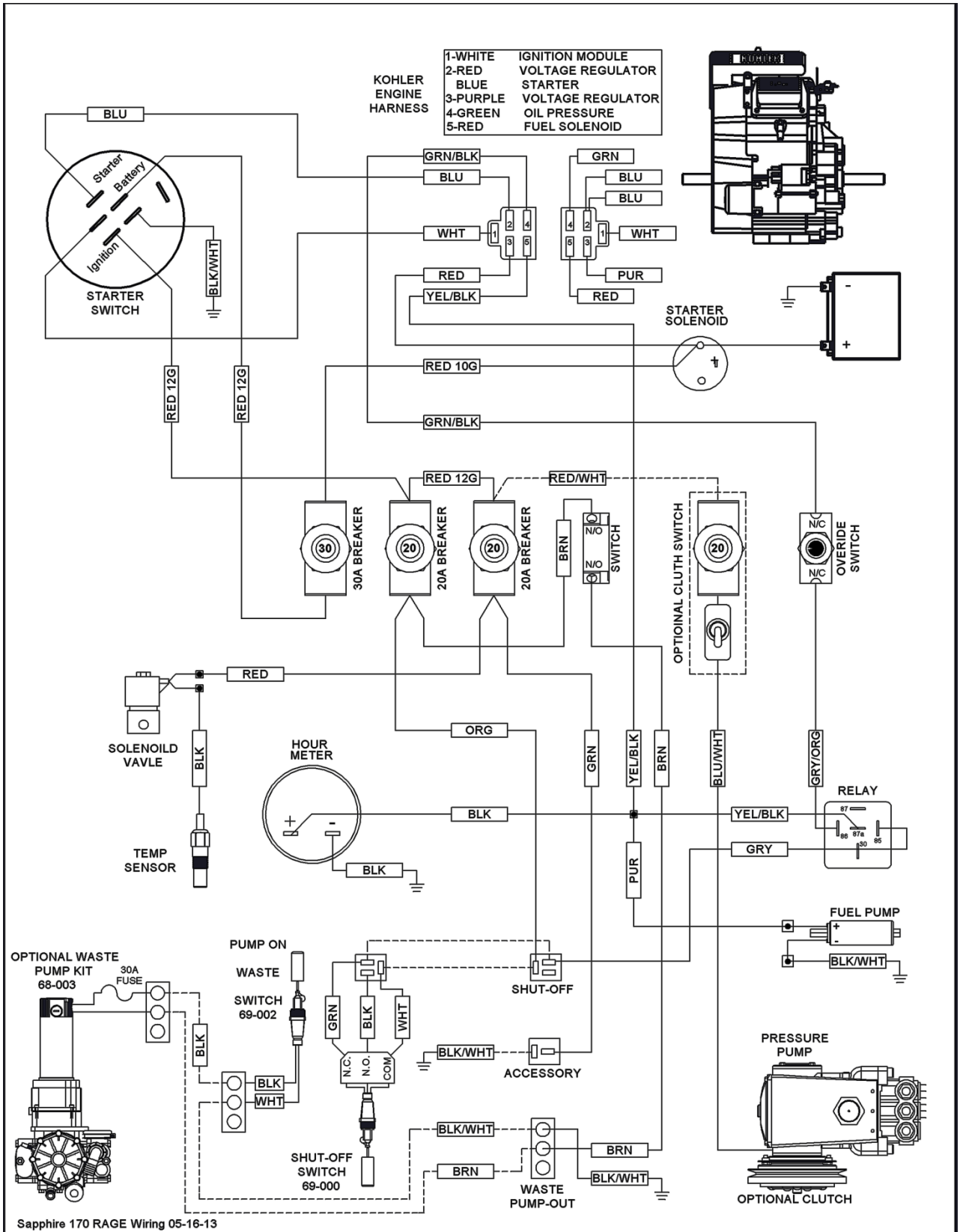


**69-276 ASSY, WASTE TANK**

Item No.	Part Number	Qty	Description
1	61-636	1	WELDMENT, WASTE TANK
2	20-009	1	2.5 NPT X 5.0 FILTER SCREEN
3	61-002	1	WELDMENT, STRAINER BASKET
4	69-000	1	FLOAT SWITCH
5	21-097	4	PLUG, 1-1/4 IN PVC
6	19-009	1	CAP, PLUG 2IN RUBBER
7	21-064	1	ELL, 1/4 P X 1/4 T BRASS
8	41-018	136.25 IN	GASKET, SPONGE 1 IN X 45 FT
9	61-587	1	WELDMENT, LID
10	40-003	2	LATCH, PRE-FILTER BOX
11	58-473	2	BRKT, MNT WTR BOX HLD DWN
12	69-273	1	ASSY, WATER BOX BLUEWAVE
13	60-979	1	MNT, WATER BOX
14	10-026	12	SCREW, MACH 1/4-20 X 1 HXHD
15	12-011	24	WASHER, FLAT #12 SAE
16	12-015	12	LKWSR, 1/4 ZINC
17	11-004	12	NUT, 1/4-20 ZINC

# SECTION 5

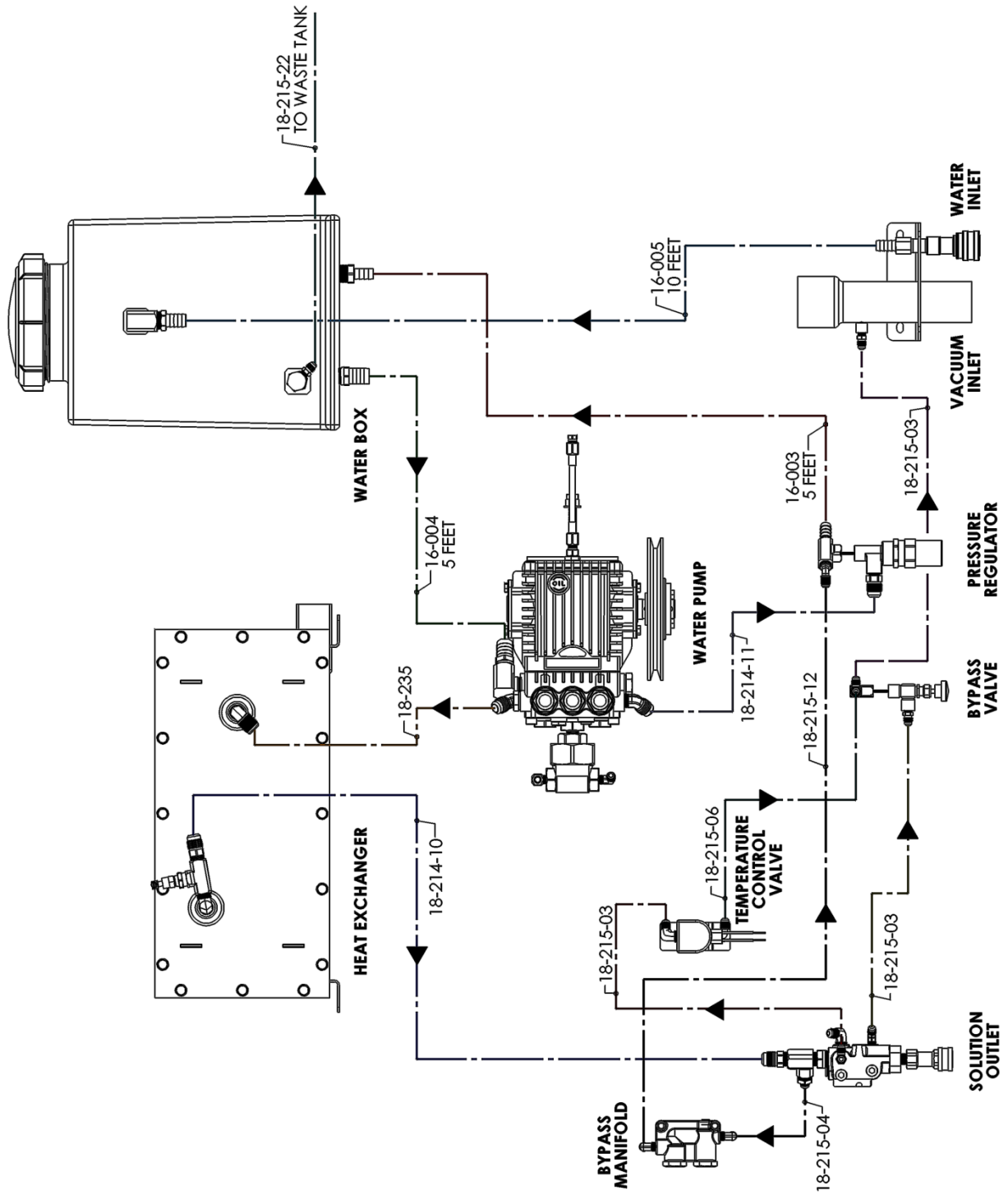
## ELECTRICAL DIAGRAM



Sapphire 170 RAGE Wiring 05-16-13

SECTION 5

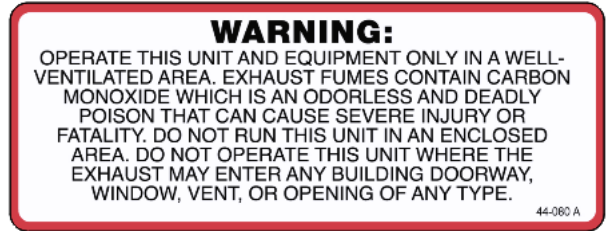
HOSE IDENTIFICATION / FLOW DIAGRAM



SECTION 5



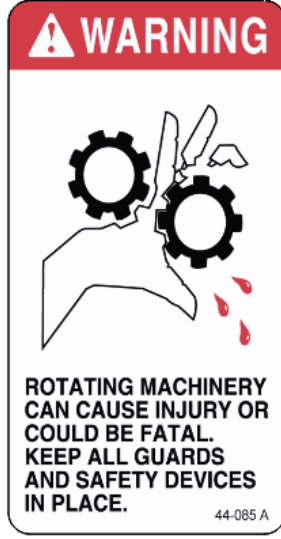
44-084 DECAL, CAUTION HOT SURFACE



44-080 DECAL, WARNING VENTILATED AREA



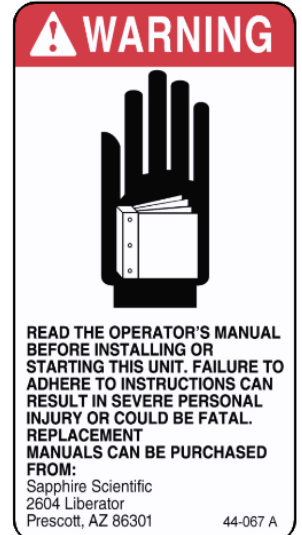
44-066 DECAL, WARNING ELECTRIC SHOCK



44-085 DECAL, WARNING ROTATING MACHINERY



44-083 DECAL, WARNING HIGH PRESSURE



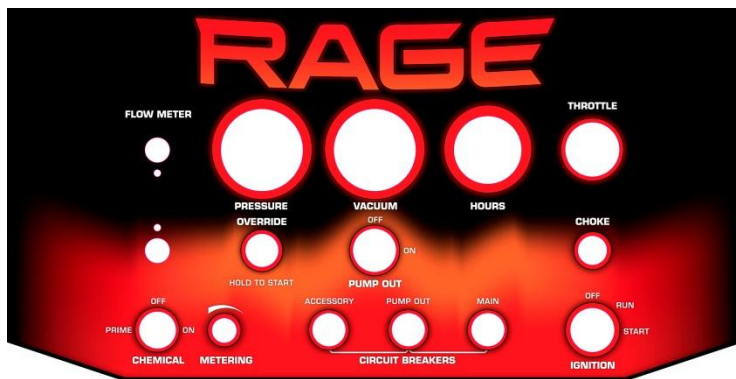
44-067 DECAL, WARNING READ MANUAL



44-081 DECAL, ENGINE COVER WARRANTY



44-079 DECAL, UNLEADED FUEL ONLY



44-155 DECAL, PRODUCT 170 RAGE

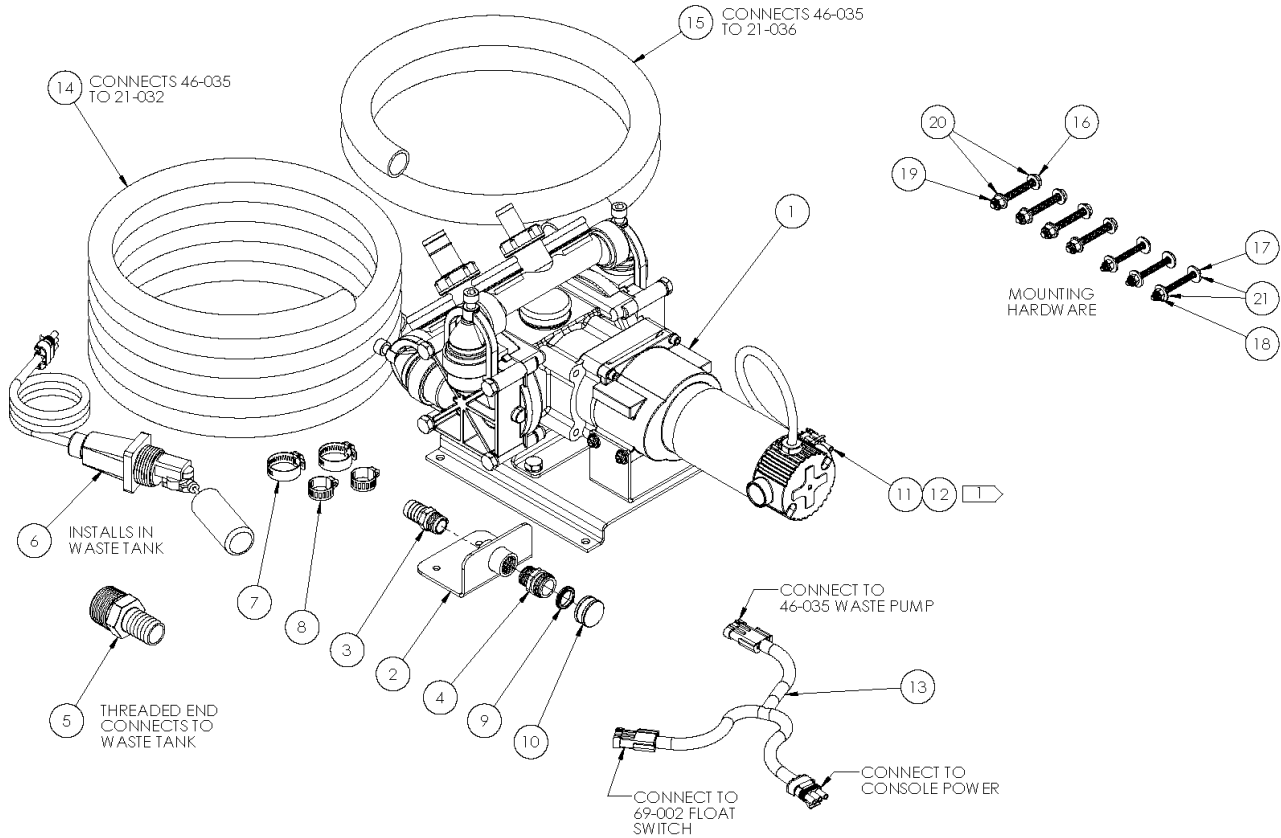


44-131 DECAL, LOWER FRONT PANEL



## SECTION 5

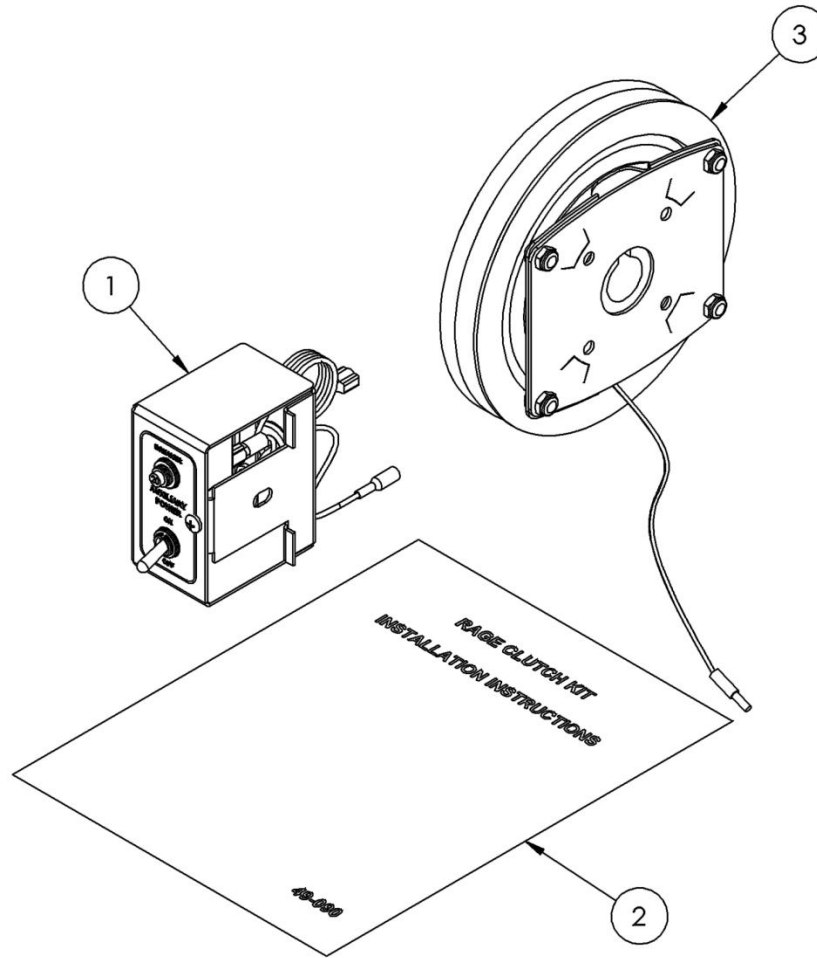
# 11. ACCESSORIES



### 68-158, ASSY, WASTE PUMP OUT

Item No.	Part Number	Qty	Description
1	46-035	1	PUMP, WASTE
2	61-656	1	WELDMENT, HOSE BRACKET
3	21-032	1	FTTG, BRB 1/2 P X 3/4 H BRASS
4	21-398	1	FTTG, GRDN HOSE 1/2 P X 3/4 H
5	21-036	1	FTTG, BARB 1-1/4 P X 1 IN BARB
6	69-002	1	ASSY, LVL SENSOR SHTOFF WASTE PUMP
7	14-006	2	CLAMP, HOSE #20 SS
8	14-000	2	CLAMP, HOSE #12 X .5 SS
9	41-038	1	WASHER, GARDEN HOSE CAP
10	21-071	1	CAP, GARDEN HOSE 3/4 BRASS
11	31-016	1	CONN, 3 PRG 1/2 TWR #38045 WAYTEK
12	31-019	3	PIN, FEMALE #31035 WAYTEK
13	47-031	1	HARNESS, WASTE PUMP OUT
14	16-004	6 FT	HOSE, WTR 3/4 IN HRZ 500 FT BULK
15	16-018	2 FT	HOSE, WTR 1 IN HRZ 100 FT BULK
16	10-178	4	BOLT, TAP 5/16-18 X 2-1/2 HXHD Z
17	10-068	3	BOLT, TAP 1/4-20 X 2-1/2
18	11-013	3	LKNUT, 1/4-20 NYLOK
19	11-029	4	NUT, 5/16-18 NYLOK
20	12-017	8	WASHER, FLAT 5/16 SAE ZINC
21	12-012	6	WASHER, FLAT 1/4 USS

## SECTION 5



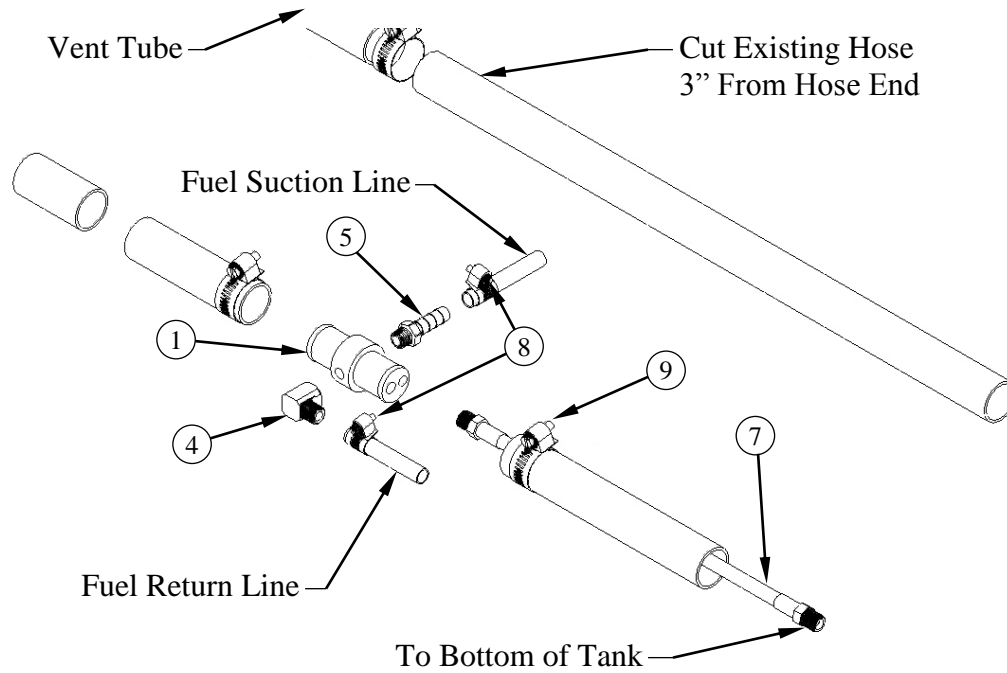
### 68-215, KIT, PRESSURE PUMP CLUTCH

Item No.	Part Number	Qty	Description
1	69-545	1	ASSY, CLUTCH SWITCH
2	49-090	1	INSTRUCTIONS, RAGE CLUTCH KIT INSTALL
3	35-029	1	CLUTCH, GENERAL 100718 12V 1G

## SECTION 5

### 1992 TO 2002 FORD FUEL LINE INSTALLATION

**FIG. B: EXTRACTION HEAD (Bottom view)**

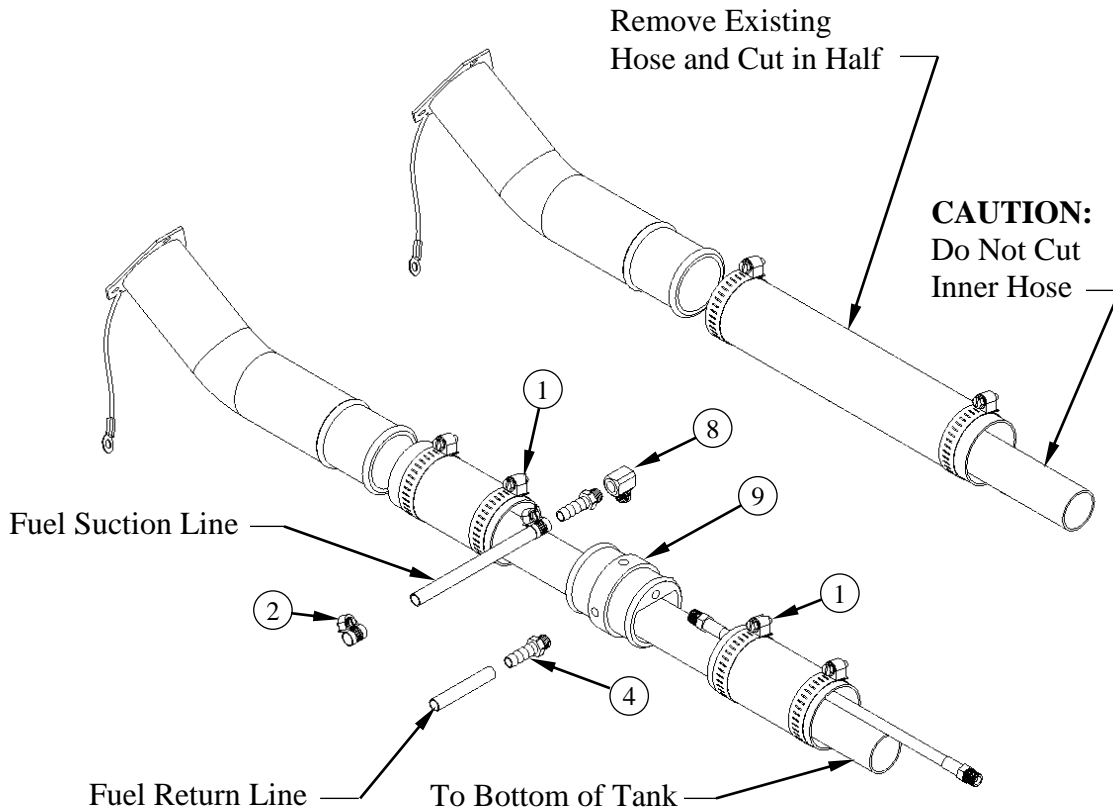


#### 69-005FI KIT, FUEL HOOKUP FORD FI

Item No.	Part Number	Qty	Description
1	66-031	1	ADAPTOR, VENT TUBE(FORD)
2	21-086	2	FTTG, BULKHEAD 1/4 IN BRASS
3	21-039	2	ELL, 1/4 IN LG STREET BRASS
4	21-038	1	ELL, STREET 1/8 IN BRASS
5	21-007	2	FTTG, BRB 1/8P X 5/16 H BR
6	21-006	4	FTTG, BRB 1/4P X 5//16H BR
7	18-028	1	HOSE, 3/16 X 25 (1/8P X 1/8P NO COVER)
8	14-011	6	CLAMP, HOSE FUEL # 6
9	14-000	2	CLAMP, HOSE #12

## SECTION 5

# CHEVY AND GMC FULL SIZE VAN FUEL LINE INSTALLATION

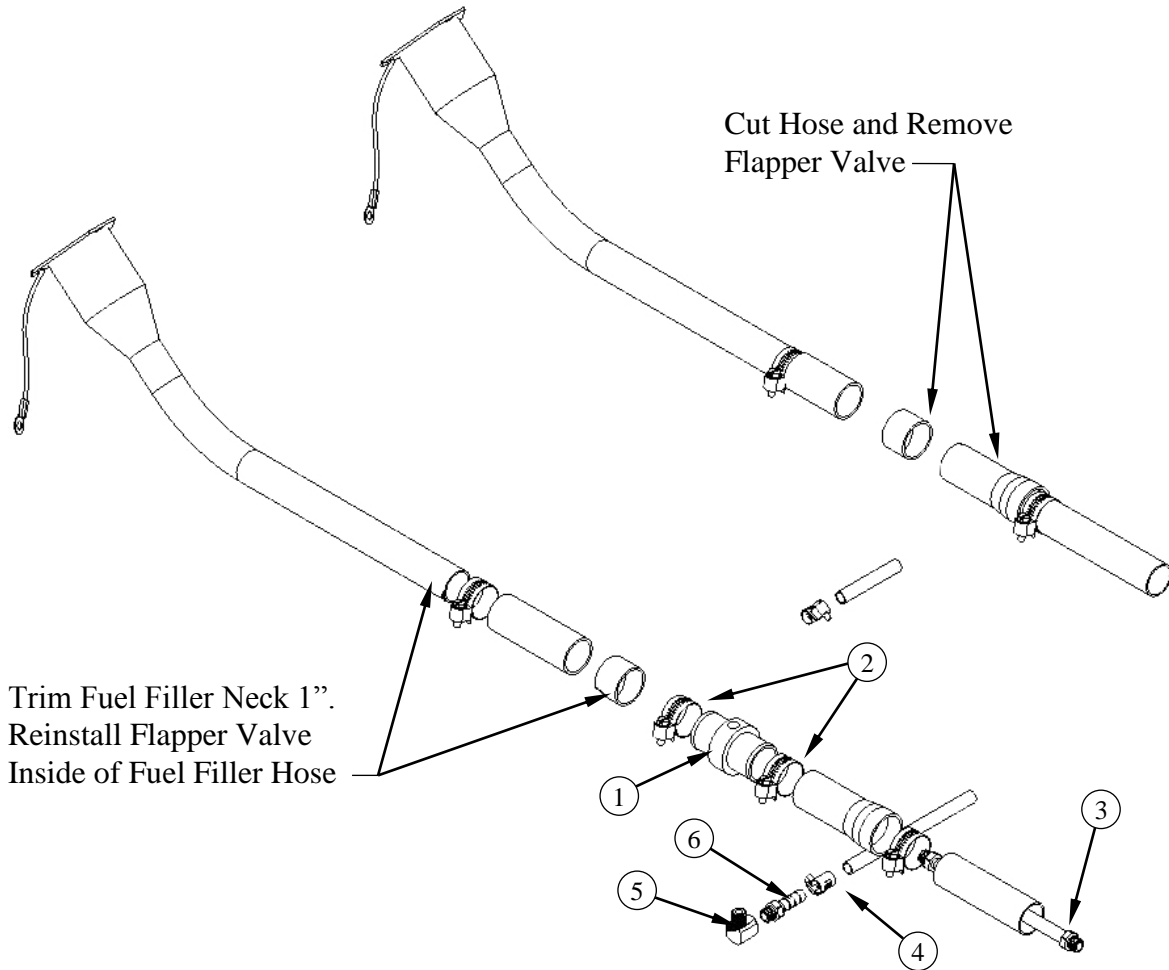


### 69-003FI KIT, FUEL HOOKUP 97 & 2002 FI

Item No.	Part Number	Qty	Description
1	14-010	2	CLAMP, HOSE # 32
2	14-011	6	CLAMP, HOSE FUEL # 6
3	21-006	4	FTTG, BRB 1/4P X 5//16H BR
4	21-007	2	FTTG, BRB 1/8P X 5/16 H BR
5	21-038	1	ELL, STREET 1/8 IN BRASS
6	21-039	2	ELL, 1/4 IN LG STREET BRASS
7	21-086	2	FTTG, BULKHEAD 1/4 IN BRASS
8	21-116	1	ELL, 1/8 FP X 1/8 FP BRONZE
9	66-030	1	ADAPTOR, FUEL NECK(CHEVY)
10	18-027	2	HOSE, 3/16 X 5 (1/8P X 1/8P NO CVR)

## SECTION 5

# 2003 CHEVY AND GMC FULL SIZE VAN FUEL LINE INSTALLATION

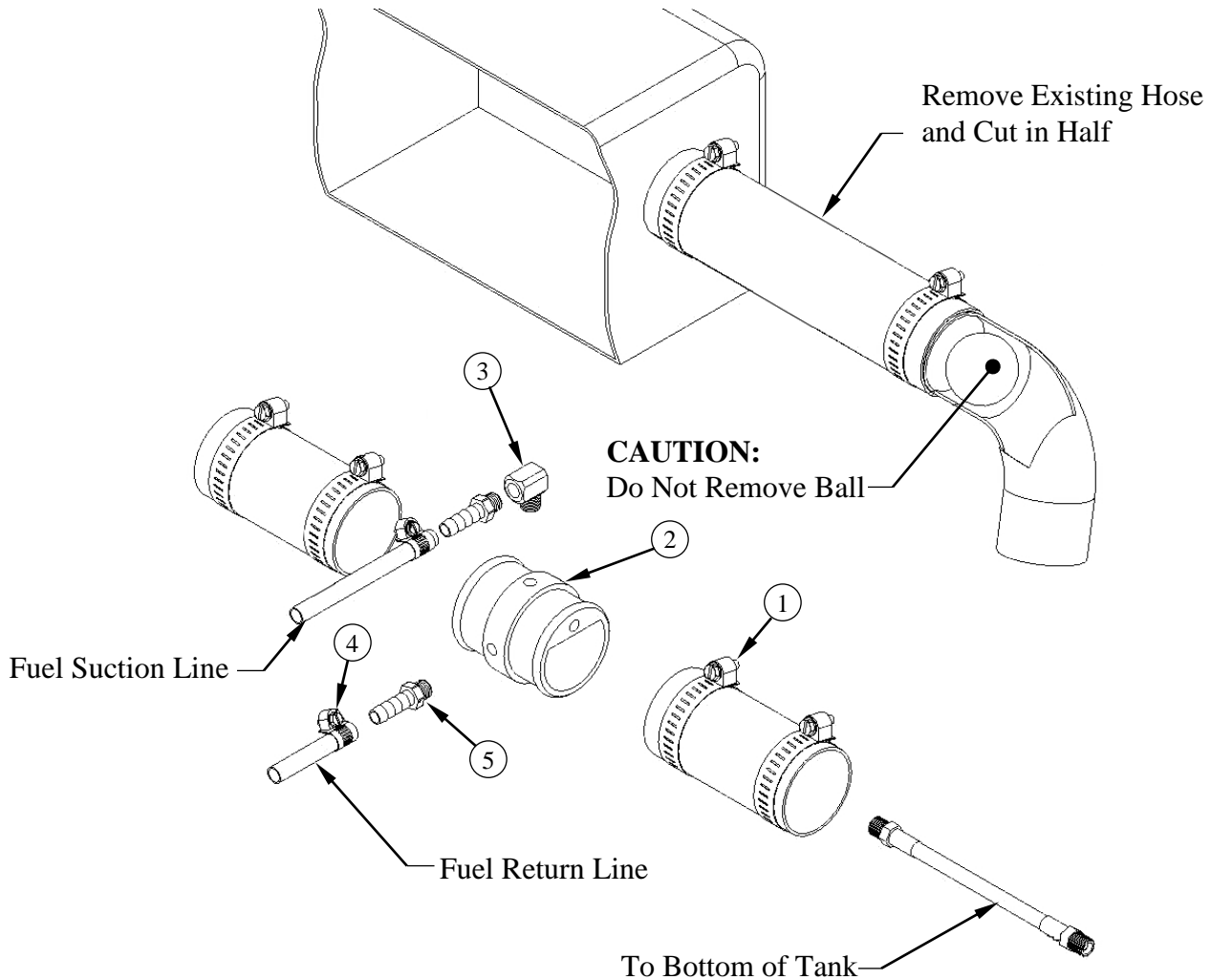


### 69-018FI KIT, FUEL HOOKUP 2003 CHEVY FI

Item No.	Part Number	Qty	Description
1	66-034	1	ADAPTOR, FUEL FLR CHVY 2003
2	14-006	2	CLAMP, HOSE # 20
3	18-028	1	HOSE, 3/16 X 25 (1/8P X 1/8P NO COVER)
4	14-011	6	CLAMP, HOSE FUEL # 6
5	21-038	1	ELL, STREET 1/8 IN BRASS
6	21-007	2	FTTG, BRB 1/8P X 5/16 H BR
7	21-039	2	ELL, 1/4 IN LG STREET BRASS
8	21-006	4	FTTG, BRB 1/4P X 5//16H BR
9	21-086	2	FTTG, BULKHEAD 1/4 IN BRASS

SECTION 5

1997-2002 DODGE FULL SIZE VAN FUEL LINE  
INSTALLATION



69-004FI KIT, FUEL HOOKUP CHEVY/DODGE

Item No.	Part Number	Qty	Description
1	14-010	2	CLAMP, HOSE # 32
2	66-030	1	ADAPTOR,FUEL NECK(CHEVY)
3	21-038	1	ELL, STREET 1/8 IN BRASS
4	14-011	6	CLAMP, HOSE FUEL # 6
5	21-007	2	FTTG, BRB 1/8P X 5/16 H BR
6	18-028	1	HOSE, 3/16 X 25 (1/8P X 1/8P NO COVER)
7	21-086	2	FTTG, BULKHEAD 1/4 IN BRASS
8	21-006	4	FTTG, BRB 1/4P X 5//16H BR
9	21-039	2	ELL,1/4 IN LG STREET BRASS

## SECTION 5 Fuel Line Bulkhead Installation (Inside Vehicle)

1. Select an appropriate location on the vehicle floor away from operator or maintenance traffic and away from contact with any accessories or tools while in use or transit. Make sure your hole is within adequate reach of the supplied hose in the finished assembly.
2. Drill a 3/4 inch hole through the vehicle floor at the location chosen for the bulkhead connector.
3. Install the bulkhead connector by inserting the fitting and tightening the nut and lock washer on the opposite side of the vehicle floor.
4. Inside the vehicle, attach the hose barb fitting and connect the fuel line from the console.
5. Drill a 1/2 inch hole nearby the bulkhead fitting for the fuel pump electrical extension harness to pass through.

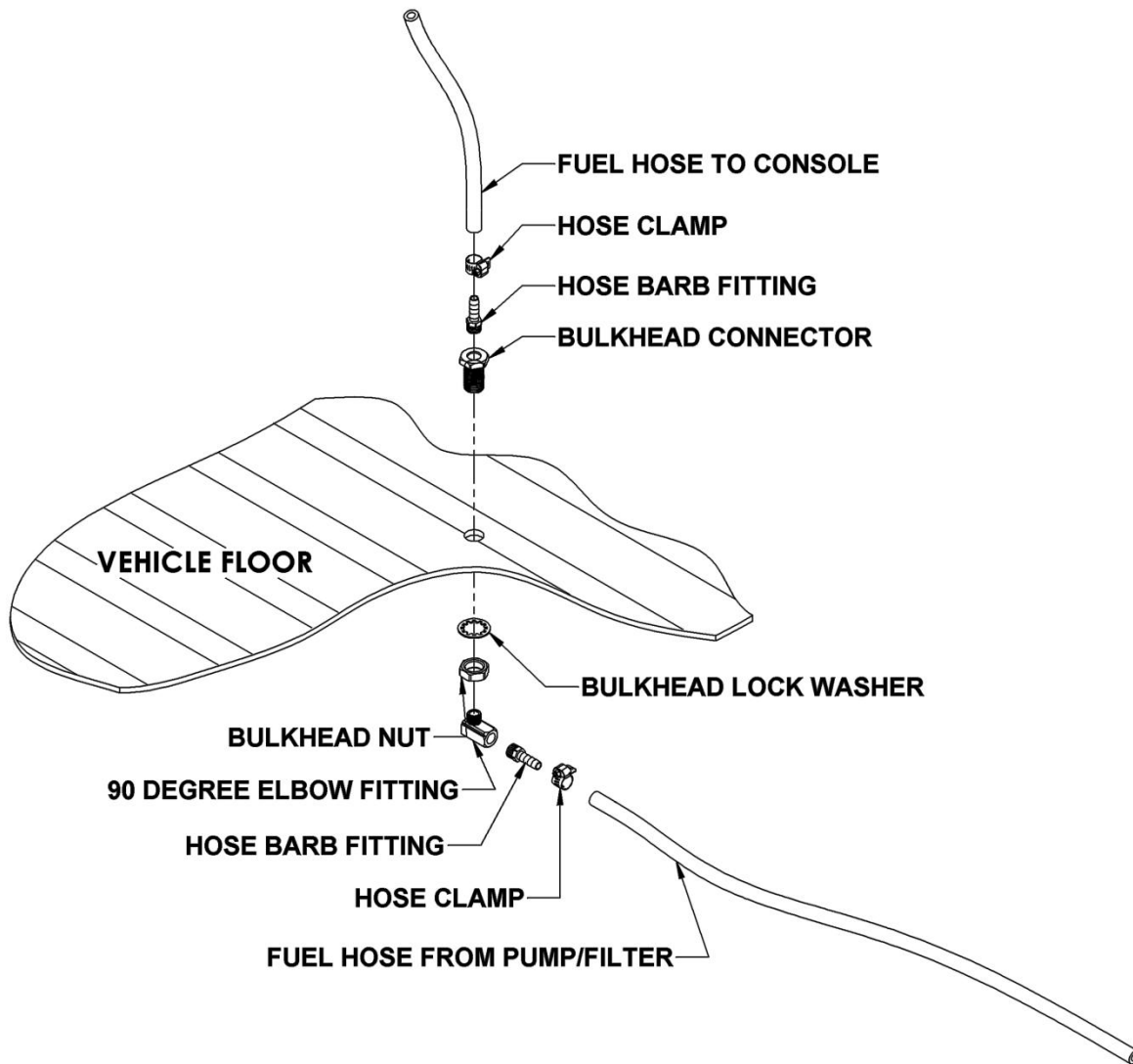


Figure 1. Fuel Line Bulkhead Assembly

## SECTION 5

### Fuel Pump Assembly Installation (Underneath the Vehicle Floor)

1. Locate an appropriate location for the fuel pump assembly housing to mount underneath the vehicle that will not cause damage to the vehicle or compromise the fuel line routing or components.
2. Remove the housing lid from the fuel pump assembly.
3. Use the supplied Tek screws to install the lid of the fuel pump housing to the vehicle.

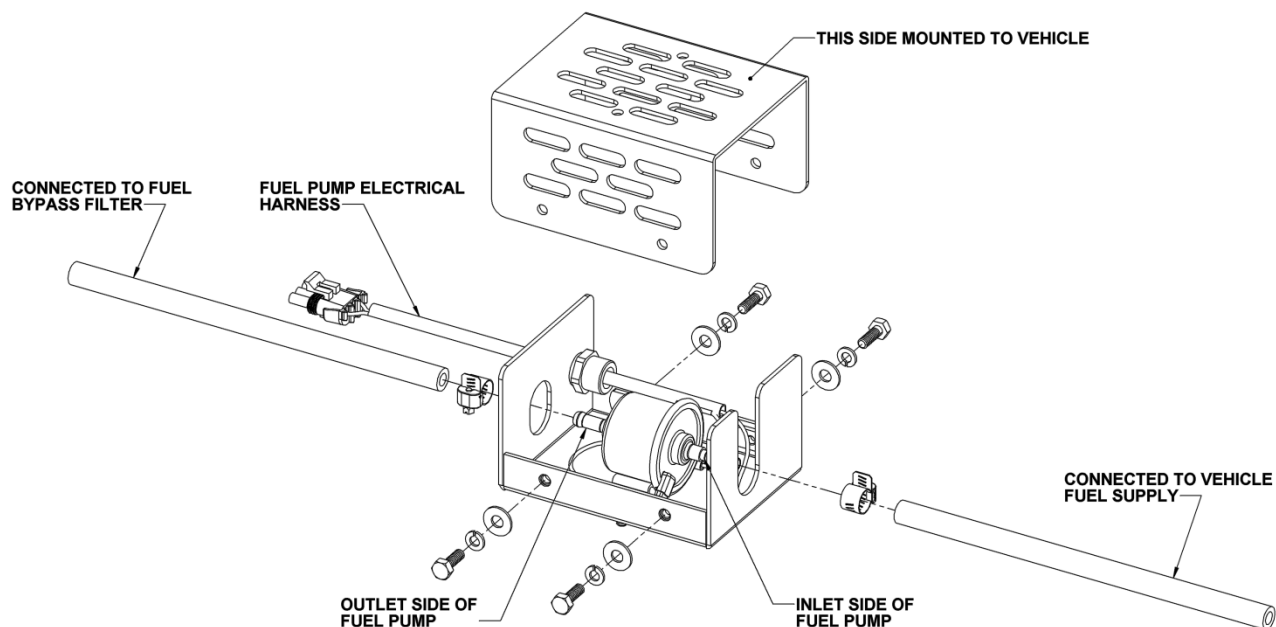


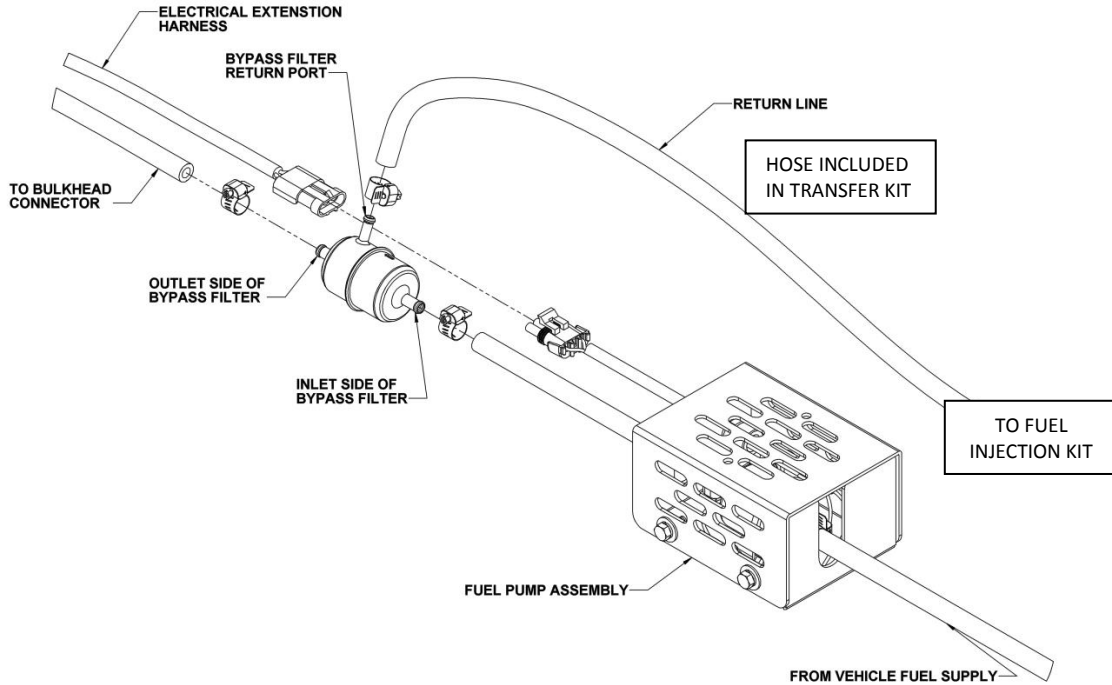
Figure 2. Fuel Pump Assembly Detail



## SECTION 5

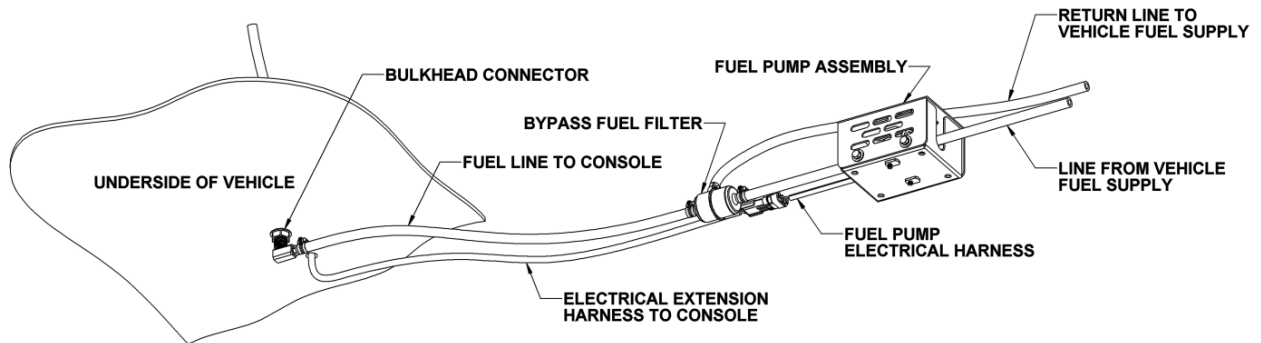
### Fuel Supply & Return Line Installation (Underneath the Vehicle Floor)

1. Refer to the transfer flow kit instructions found with the appropriate kit for your vehicle.
2. Connect the fuel line from the transfer flow kit to the inlet side of the fuel pump.
3. Connect the outlet side of the fuel pump to the inlet side of the fuel bypass filter.
4. Connect the return line from the bypass filter return port back to the vehicle fuel supply.



**Figure 3. Fuel Pump and Filter Detail**

5. Attach the 90 degree elbow and hose barb fittings to the bulkhead connector underneath the vehicle.
6. Connect a segment of hose between the outlet side of the fuel bypass filter to the hose barb fitting.
7. Ensure that all hose clamps are properly tightened.
8. Connect the electrical extension harness to the fuel pump harness, running the other end up through a hole in the floor of the vehicle, connecting to the console harness.



**Figure 4. Vehicle Underside Fuel Line Installation**