

Congratulations on your purchase of the **MODEL 454 SS[®]** 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

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 MODEL 454 SS[®]** Truck mount Cleaning units manufactured by:

SAPPHIRE SCIENTIFIC
2604 Liberator
Prescott, AZ 86301
USA

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MODEL 454 SS[®] MANUAL
PART# 49-042

SAPPHIRE SCIENTIFIC LIMITED WARRANTY

Sapphire Scientific Model 454 SS

What Does This Warranty Cover?

This warranty covers the Sapphire Scientific Model 454 SS 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 500 hours. 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.

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SECTION 1: **GENERAL INFORMATION**

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2. RECEIVING YOUR TRUCKMOUNT UNIT

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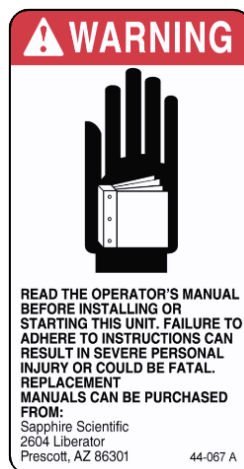
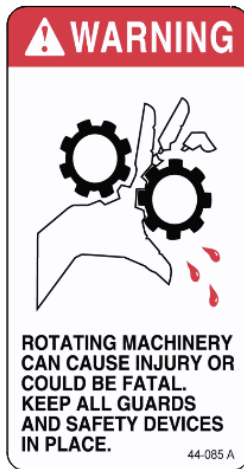
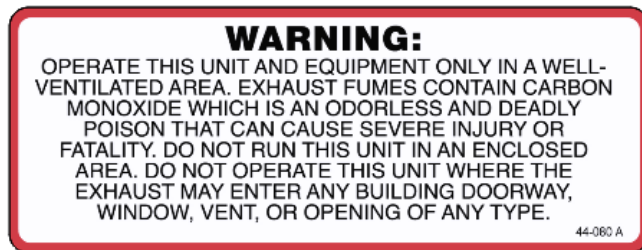
SECTION 1

1. SAFETY

WARNING For Your Safety!

The following **WARNING** labels are on your **MODEL 454 SS[®]** 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 and windows 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 to cool down, and relieve 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 1100 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. Always keep your vehicle clean and orderly. Wands, tools and accessories must be securely stowed while driving the vehicle.

20. 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 criterion and should never be used. Severe burns and other injuries could result if hoses do not meet these requirements.

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

22. This unit produces high pressure and high

temperatures. Improper use could result in serious injury.

23. **DO NOT** modify this unit in any manner. Any modification could result in serious injury or fatality. This includes the use of any open ended hoses.

**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.**

**ALL FUEL LINES MUST MEET CARB
III and EPA PHASE 3 LOW
PERMEABILITY REQUIRMENTS.**

**ALL FUEL STORAGE TANKS MUST
MEET CARB III and EPA PHASE 3
PERMEATION and VENTING
REQUIRMENTS.**

**ALL FUEL ADAPTOR KITS AND FUEL
TANKS USED IN THE STATE OF
CALIFORNIA MUST MEET CURRENT
CALIFORNIA AIR RESOURCES
BOARD (ARB) REGULATIONS.**

**CARB EXECUTIVE INFORMATION
LABEL(S) MUST BE INSTALLED IN A
VISIBLE LOCATION.**

SECTION 1

SPECIFICATIONS

Engine Speed.....	3000 rpm (High Speed No Load)
.....	1500 rpm (Idle No Load)
Water Pump RPM.....	1500 rpm
Vacuum Pump RPM.....	3000 rpm
Water Flow Rate.....	5.0 GPM (maximum)
Water Pump Pressure.....	1500 PSI (maximum)
Vacuum Relief Valve.....	14 in. Hg
Waste Tank Capacity.....	90 gal.
Waste Tank Shut-Off.....	75 gal.
Console Weight.....	880 lbs.
Console Weight (with waste tank & accessories) Approximately.....	1100 lbs.

TORQUE VALUES

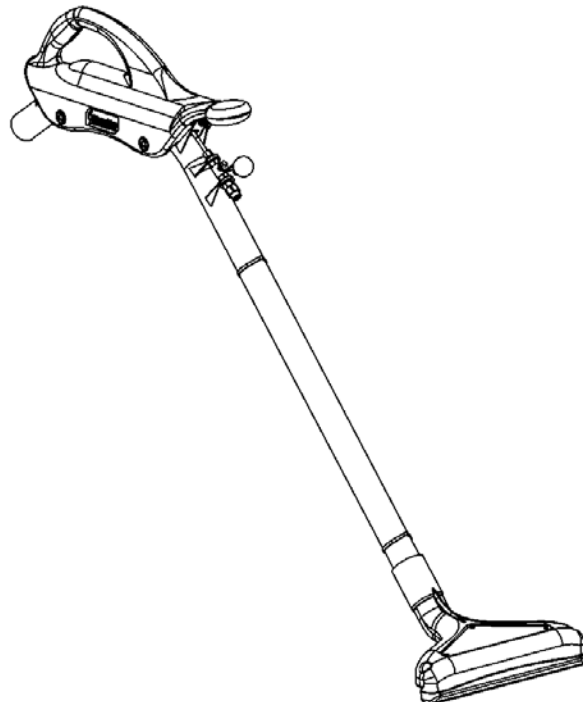
Engine Hub Rear.....	180 inch/lbs. 15 ft/lbs.
Engine Hub Front.....	180 inch/lbs. 15 ft/lbs.
Vacuum Pump Hub.....	180 inch/lbs. 15 ft/lbs.

JET SIZING

SAPPHIRE SCIENTIFIC recommends that the total floor tool tip size does not exceed #4. Using larger jet sizes on your **MODEL 454 SS[®]** unit may reduce cleaning temperatures.

Sapphire Scientific recommends using the **Stryker Cleaning and Extraction Wand:**

- * Rotomolded ergonomic handle provides balanced handling and substantially reduces operator fatigue.
- * Stainless steel extraction tube for rugged service and long life.
- * Rotomolded head resists dents and scratches and doesn't readily gouge molding or furniture.
- * Purge valve for easy cleaning.
- * Classic S-shape makes reaching under objects or furniture easy.
- * Rotomolded 14" head with full-width high pressure injector and two-way extraction glide provides maximum coverage and extraction.
- * Forged brass valve, centrally positioned for right- or left-handed operation.
- * Glide assembly is easy to replace when worn



SECTION 1

INSTALLATION REQUIREMENTS

Prior to beginning the installation, read the ENTIRE “Installation” section of this manual. Since the **MODEL 454 SS[®]** Truck mount unit weighs (with waste tank and accessories) approximately 1100 lbs., please adhere to the following recommendations prior to installing the unit.

1. The unit should **NOT** be installed in any motor vehicle rated less than 3/4 ton capacity.

CAUTION!

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

2. 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.

3. If mounting in a trailer, the **MODEL 454 SS[®]** console must be positioned so that it balances properly with respect to the trailer axle. With a minimum of ten percent (10%) of the unit’s total overall weight (w/o accessories or water) should be on the tongue. Adequate ventilation must be provided to prevent overheating. Either two sets of doors or a roof ventilation system is highly recommended.

4. The vehicle tires must have a load rating in excess of the combined unit and vehicle weight.

5. **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.

6. 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 the warranty.

ENGINE OIL REQUIREMENTS

Use high-quality oil of at least API (American Petroleum Institute) service class SF, SG, SH, SJ or higher. **Do not use additives**. Select the viscosity based on the air temperature at the time of operation as shown in the following table.

Above 37° C (99° F)	SAE40
25° C to 37° C (77° F to 99° F)	SAE30 or SAE10W-30
0° C to 25° C (32° F to 77° F)	SAE20 or SAE10W-30

Engine oil capacity	2.4 L 2.53 U.S.qts
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Tightening torque	Drain Plug	32.4 to 37.3 N·m 3.3 to 3.8 kgf·m 23.9 to 27.5 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.

SECTION 1

CHEMICAL REQUIREMENTS

The **SAPPHIRE SCIENTIFIC MODEL 454 SS[®]** 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** 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 concentrations.

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 **MODEL 454 SS[®]** 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 MODEL 454 SS[®]** unit should arrive with the following items as well as any optional accessories:

EQUIPMENT LISTING

- Waste tank filters and stainless steel strainer basket.
 - Two sections of 2 in. x 50 ft. vacuum hose
 - Two sections of 2.5 in. x 37.5 ft. vacuum hose.
 - Two 50 ft. sections of high pressure solution hose
 - Two 37.5 ft. sections of high pressure solution hose
 - Two vacuum hose connectors.
 - Two hose-reducing cuffs to 2 in.
 - 50 ft. water supply hose with quick connect.
-
- ## **OPTIONAL EQUIPMENT**
- A. Additional lengths of vacuum hose
Part # 18-003
 - B. Additional vacuum hose connectors
Part # 21-003
 - C. Additional high-pressure solution hoses
Part # 18-000
(With shutoff valve Part # 18-001)
 - D. Automatic waste pump kit
Part # 68-003
 - E. Demand pump system
Part # 68-002
 - F. KIT, FUEL HOOKUP CHEVY 97 TO 2002. FI Part # 69-003
 - G. KIT, FUEL HOOKUP CHEVY/DODGE FI
Part # 69-004
 - H. KIT, FUEL HOOKUP FORD FI
Part # 69-005
 - I. KIT, FUEL HOOKUP 2003 CHEVY FI
Part #69-018
 - J. KIT, 2004 & UP, TF FUEL INJ. CHEVY
Part # 69-033
 - K. ADAPTOR, 2004 & UP, FORD FUEL
Part # 69-061
 - L. KIT, FUEL FORD CUT AWAY 04-05
Part # 69-077
 - M. KIT, FUEL CHEVY CUT AWAY 04-05
Part # 69-081
 - N. ASSY, WASTE PUMP OUT
Part #68-158

- **SAPPHIRE SCIENTIFIC MODEL 454 SS[®]** console.
- Operation and Service manual.
- Installation mounting plates and bolt down kit.
- Hose clamps for vacuum and fuel hoses.
- Waste tank with shutoff switch.

SECTION 2: **INSTALLATION**

3 INSTALLATION

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3. INSTALLATION

WARNING!!!

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

LIFTING THE UNIT INTO THE VEHICLE

Because the SAPHIRE SCIENTIFIC MODEL 454 SS[®] console weighs approximately 880 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. SAPHIRE SCIENTIFIC strongly recommends a side door installation for the MODEL 454 SS[®]. 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. The complete unit with waste tank and accessories **MUST NOT** exceed the vehicle's axle weight limit.

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.

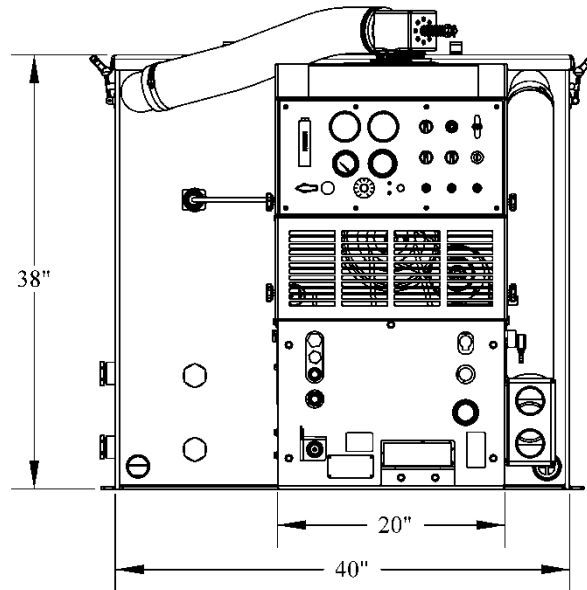
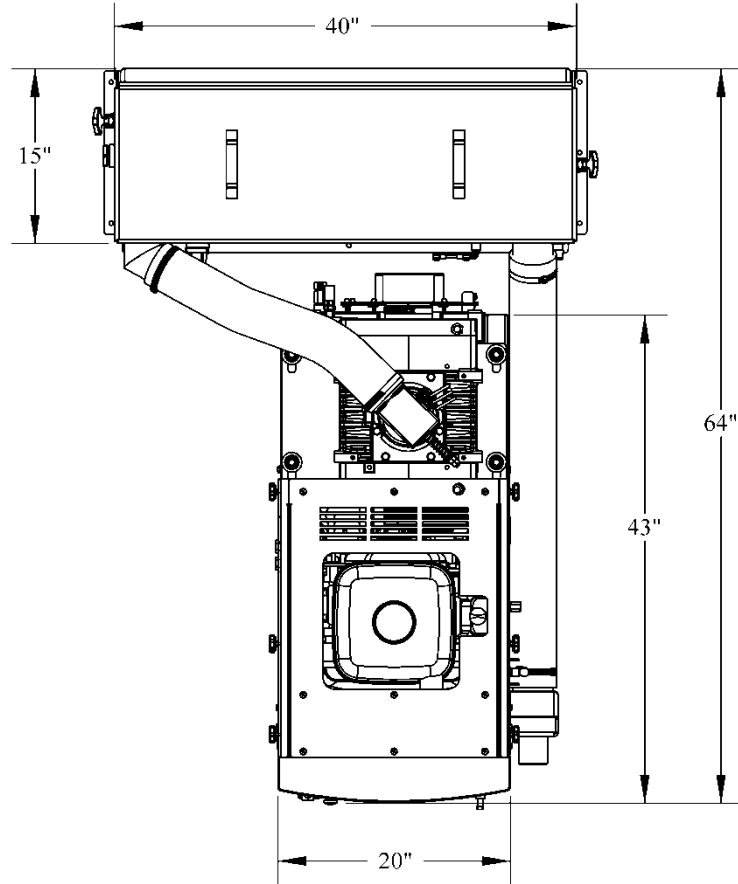
A. The console and waste tank mounting holes will serve as a template. Drill six (6) $\frac{13}{32}$ in. diameter holes for the console and four (4) $\frac{13}{32}$ in. diameter holes for the waste tank.

B. Using the provided mounting hardware kit:

1. Insert six (6), grade 5, $\frac{3}{8}$ -16 × 4 in. hex head cap screws with flat washers through the MODEL 454 SS[®] console mounting holes, and four (4), grade 5, $\frac{3}{8}$ -16 × 4 in. 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

CAUTION!!!

READ THESE INSTRUCTIONS IN THEIR ENTIRETY PRIOR TO PROCEEDING.

WARNING!

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. **All fuel lines must meet CARB TIER III and EPA PHASE 3 low permeability requirements.** Avoid contact with moving parts, areas of high temperature, brake lines, fuel lines, catalytic converters, exhaust pipes, mufflers or sharp objects. ***Fuel pump must be mounted in a vertical position as near as possible to the fuel supply, and not located near any heat sources.*** Excess heat from exhaust or other heat sources may cause the fuel pump to work improperly.

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. **Tanks must meet CARB TIER III and EPA PHASE3 permeation and venting emissions requirements.**

B. Use only fuel tanks that are manufactured specifically for gasoline, have 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.

WARNING!

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

WARNING!

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.

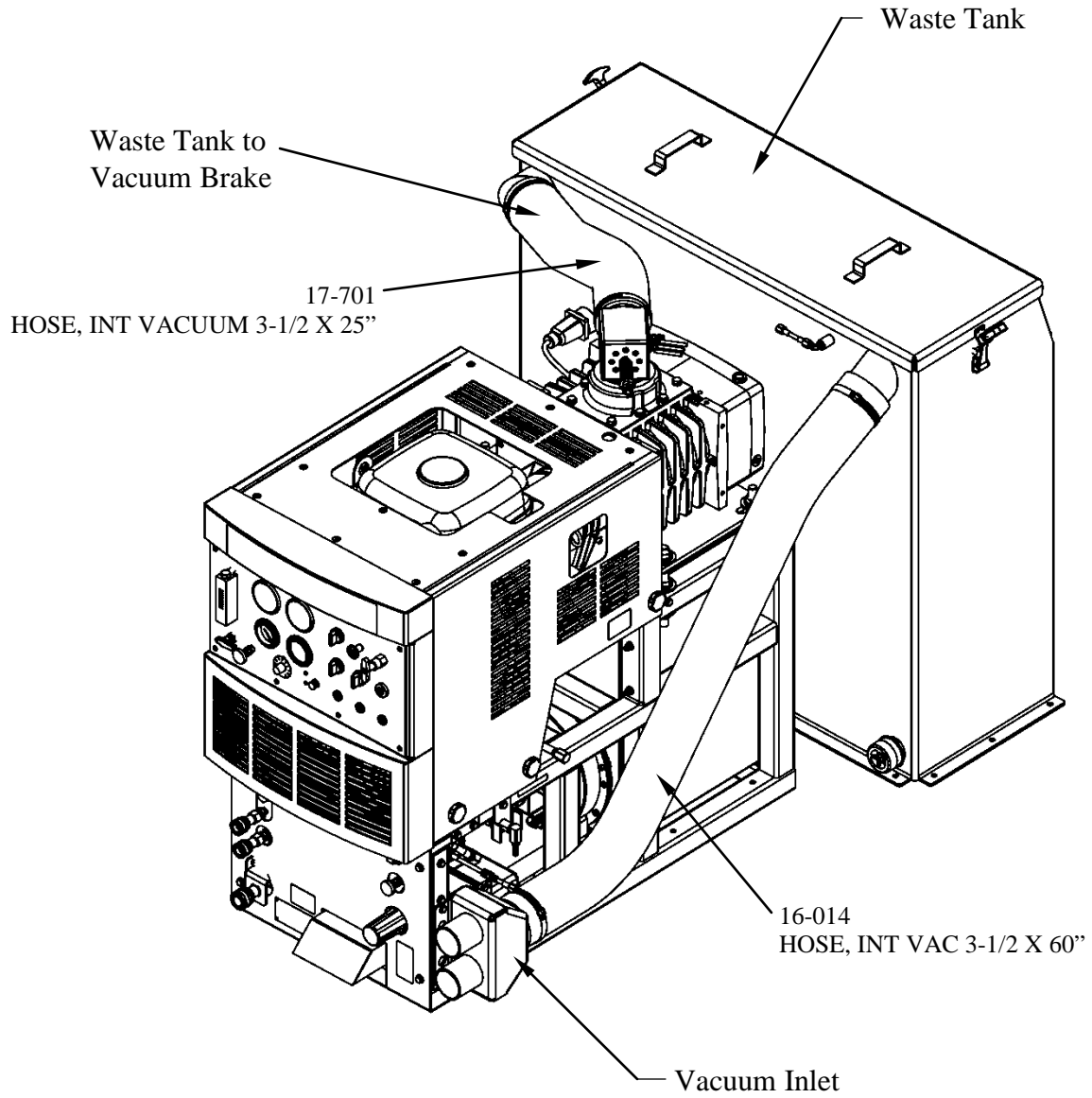
B. Attach the black negative (–) battery cable from the ground on the console to the negative (–) terminal on the battery and tighten down the nut.

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

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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

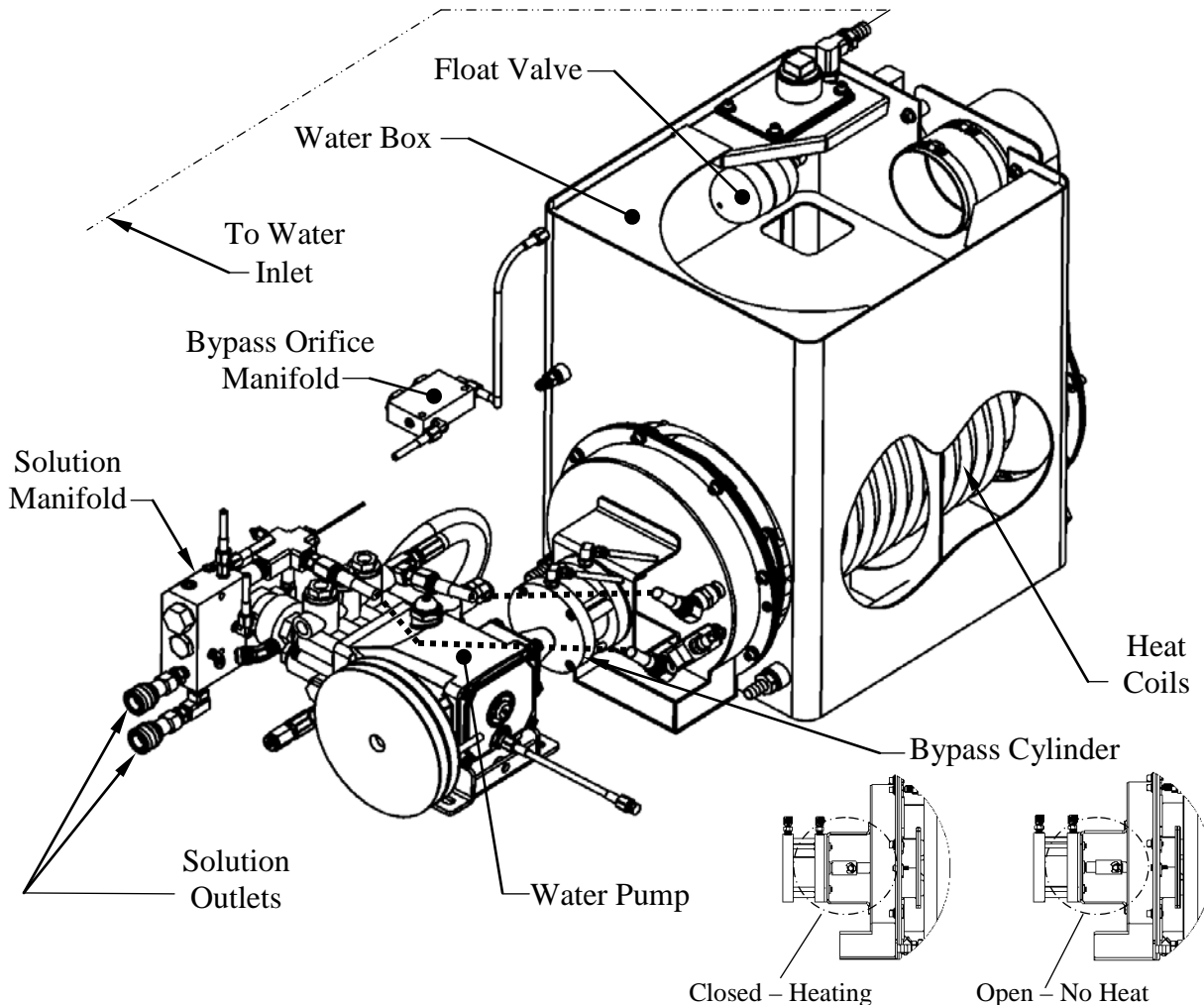
Cold water enters the console through the water inlet connection located on the lower left corner of the lower front panel. The water then flows to the water box through a float valve, which shuts off the water when the water box is full.

The water is pre-heated in the water box using radiant heat generated by the vacuum blower and the engine.

The water then flows to the water pump where it is pressurized. From there it flows to the heat exchanger where it travels through finned tubing and is further 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

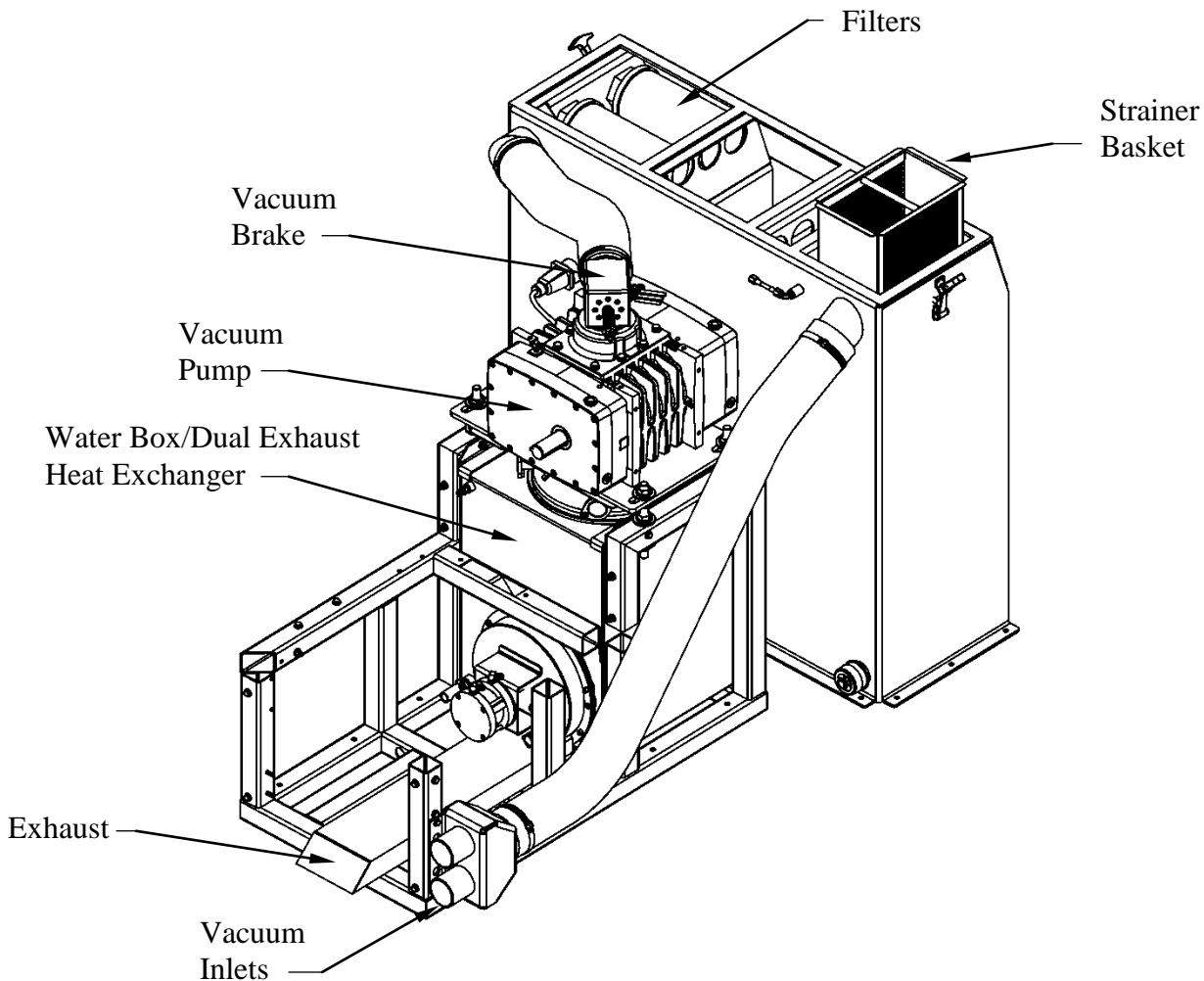
The engine turning an vacuum pump generates the vacuum. The air is channeled in one side of the vacuum pump, compressed and discharged on the opposite side, creating airflow. This airflow is used to do the work necessary for the extraction process. A vacuum nozzle applied to the carpet surface removes 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 pressure 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.



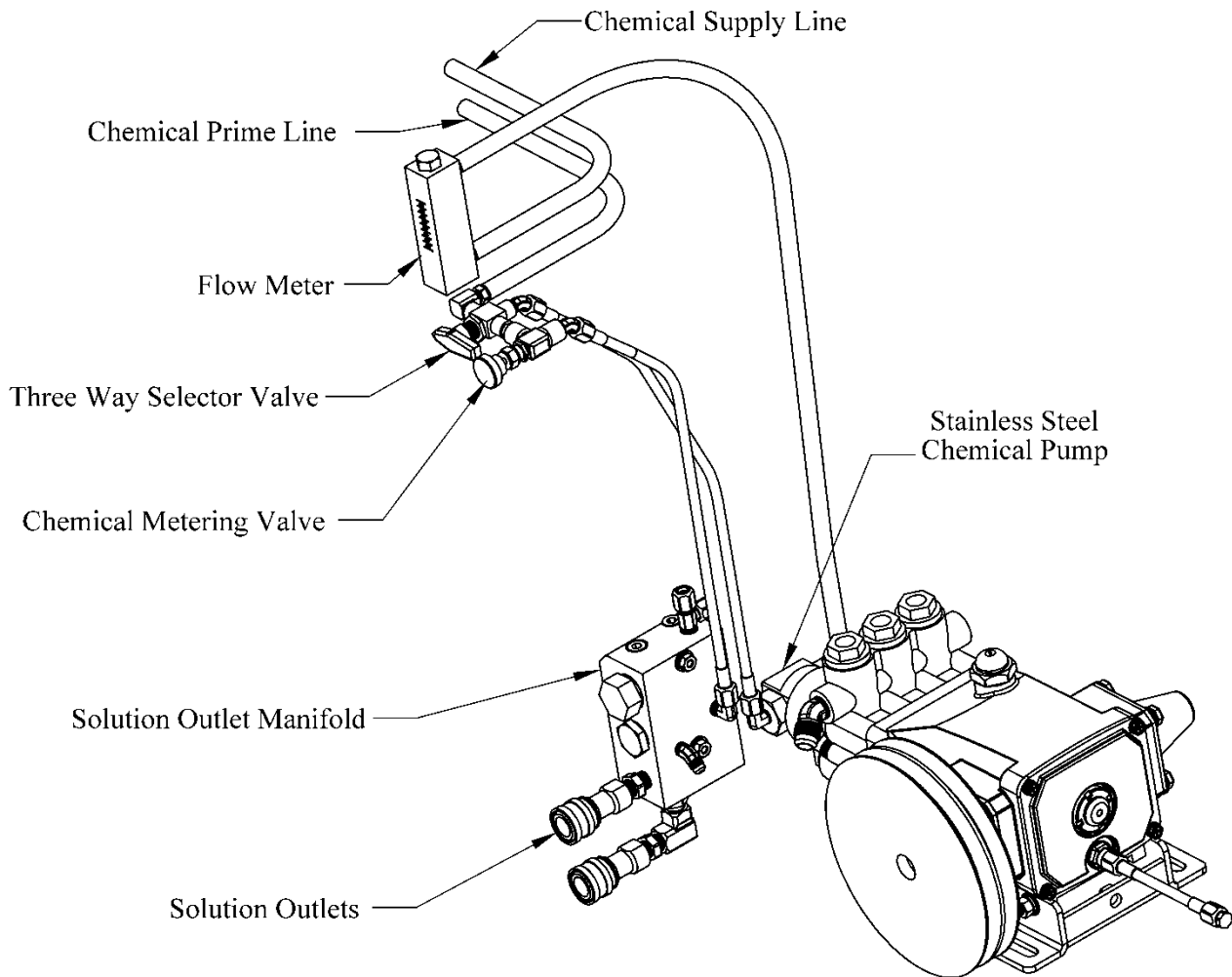
SECTION 3

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 chemicals then flow 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.



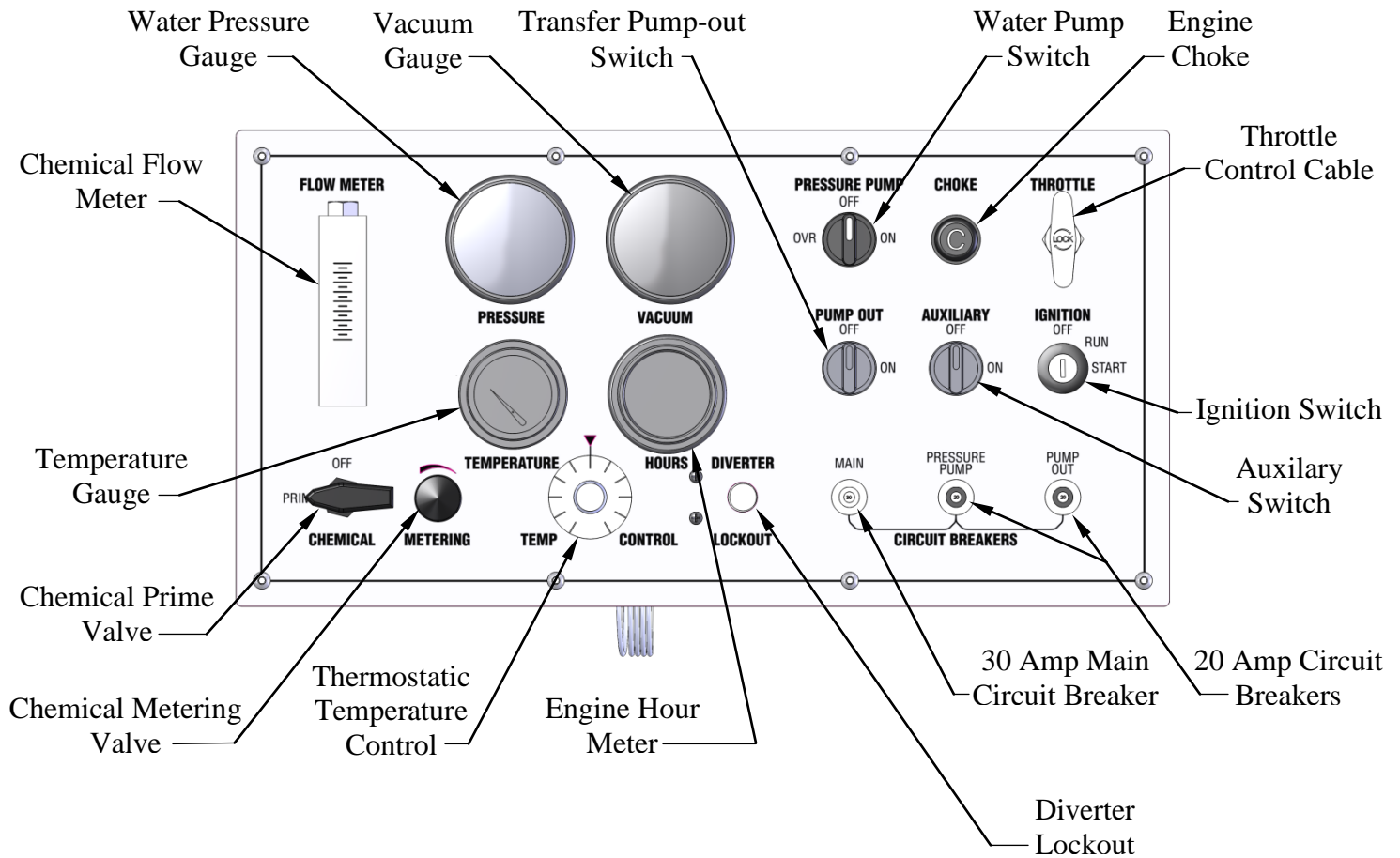
5. OPERATION



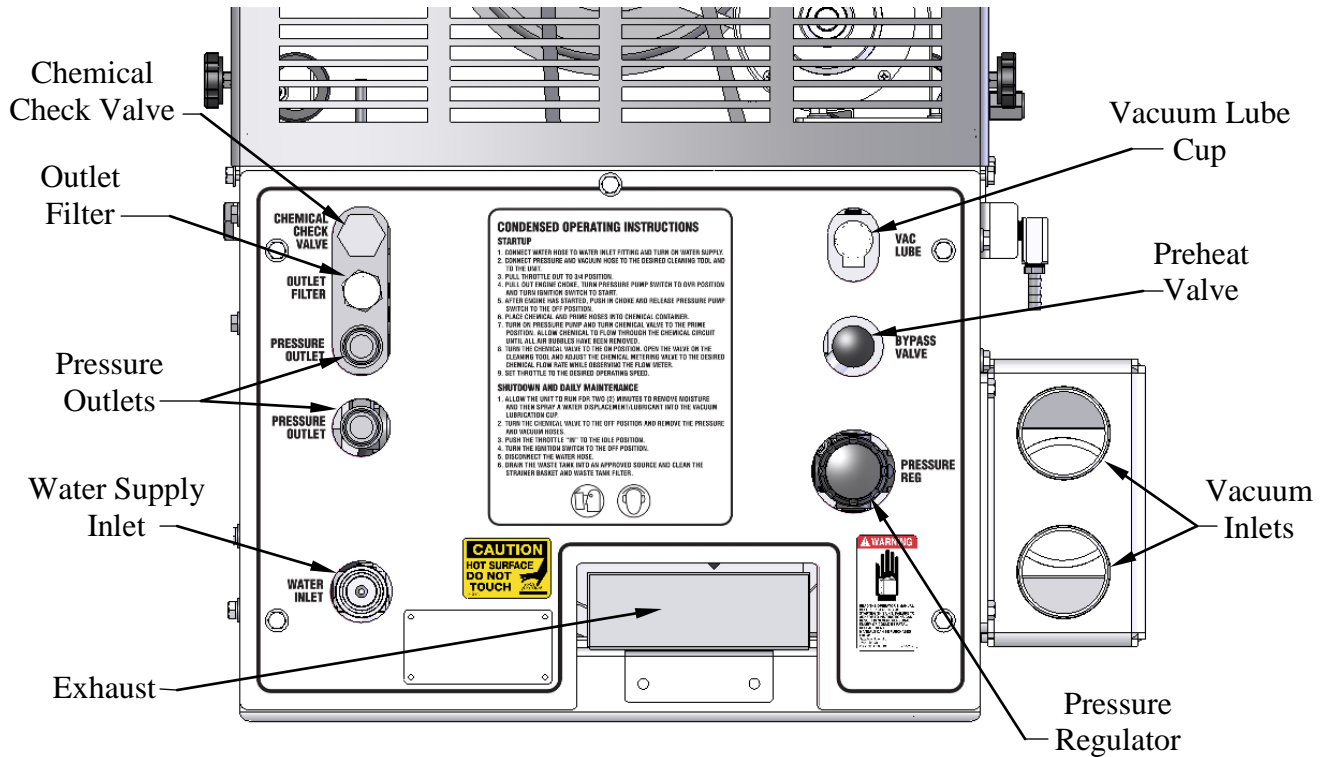
PREPARATION

This section of the operator's manual explains how to prepare, start, operate, shut down and maintain your **SAPPHIRE SCIENTIFIC MODEL 454 SS[®]** mobile cleaning unit. The **MODEL 454 SS[®]** unit is easy to operate, however only trained operators should proceed.

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 1.5 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 front of the unit. 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 pressure 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



1. Set throttle control in, pull out engine choke, turn water pump switch to override (OVR) and turn ignition key to start.
2. Push in engine choke after engine has started.
3. Set throttle control to desired speed.

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

4. Turn the water pump switch to the **ON** position.

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 #4. Using larger jet sizes on your **MODEL 454 SS[®]** 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 prime valve located on the control panel to the **PRIME** position. The chemical will then flow from the chemical container through the chemical prime tube into the vacuum system.

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 prime valve to **OFF** position and turn the chemical prime 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 prime valve from **PRIME** to **ON**. With the cleaning tool open, check the flow meter and adjust the chemical metering valve until the desired rate of chemical flow is achieved.

SECTION 3

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.



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

After you have completed the previous steps, proceed with the cleaning or restoration operation. Place the throttle control cable to a minimum of 50% of throttle control maximum for cleaning or restoration. 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. When doing flood extraction, the water pump switch should be in the **OFF** position.

NOTE: Vacuum pressure must have a minimum 7"hg for the diverter valve to work properly. Attaching 1 length of hose should create enough vacuum pressure to achieve this.

NOTE: During flood extraction it is recommended the throttle control is set to maximum.

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. Run unit on low speed. Upholstery tools have a lower flow rate and smaller orifices. Adjust the thermostatic temperature control to the desired temperature. To maintain proper cleaning temperatures, make certain that the unit has been fully heated up prior to cleaning.

STAIR TOOL CLEANING

1. Run unit on low speed. Adjust the thermostatic temperature control to the desired temperature.

SECTION 3

FLOOD RESTORATION/EXTRACTION

CAUTION!

1. Set the throttle control cable on the front control panel to a minimum of 50% of throttle control maximum. Make certain that the **water pump switch** is in the **OFF** position and depress and turn the Diverter Lockout button. Proceed into the extraction process.

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 control cable to the idle position.
5. Adjust the thermostatic temperature control to the lowest setting.
6. Allow the unit to run for at least **5 minutes** with bypass valve open. 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 inlets on the front of the unit and set the throttle control cable to high. Spray WD-40 (or equivalent) into the **vacuum lubrication cup**, located on the right 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.

7. Turn the ignition switch to the **OFF** position.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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 ¼ turn. This will make the filter easier to remove when cleaning or replacement is required.

SECTION 3

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

13. 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

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

FREEZE PROTECTION



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. Keep the unit running just prior to leaving for the next job.
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 console.

2. Connect all solution hoses and a tool to the console.

3. Start the unit with the water pump switch in the **ON** position. Open a valve on the tool.

4. Fill the water box with one gallon of 100% glycol based anti-freeze.

5. Start the unit and set the throttle control cable to the idle position. Insure the water pump is on. Open the 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 prime valve to **PRIME** until anti-freeze comes out of the prime hose. Turn the chemical prime 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:

SECTION 3

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.

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 prime 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 prime 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**

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SECTION 4

6. MAINTENANCE CHART

Engine	5 Hours	Change engine oil after first 5 hrs of operation. Then every 100 hrs.
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.
Waste Pump-Out (Optional)	Daily*	Inspect and remove any debris or sediment.
Vacuum Pump	Daily*	Check vacuum pump oil level. Fill to proper level. Do not overfill.
Engine	Monthly	Check air cleaner for damaged, dirty, or loose parts.
Pump Filter	Monthly	Clean and Inspect
Engine	Monthly	Inspect air intake and cooling areas. Clean if required.
Battery	Monthly*	Check fluid level. Fill with distilled water only. Do not overfill.
Engine	Monthly	Inspect drive belts for wear. Replace as needed.
Water Box	Monthly	Check float valve for proper operation.
Thermal Well	Monthly	Lubricate diverter shaft; anti seize
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 all belts*****
Belts	100 Hours	Re-tension all belts*****
Engine	100 Hours	Change engine oil and filter.
Vacuum Pump	100 Hours	Check Oil level
Vacuum Break	100 Hours	Check and adjust vacuum relief valve to 14" 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 (only use OEM spark plugs).
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 all belts.
Engine	1000 Hours	Replace spark plugs.
Check Valve	1000 Hours	Check Teflon seat for abnormal wear or debris. Replace as needed.
Engine	1000 Hours	Replace air filter element.
Vacuum Pump	1000 Hours	Drain, flush, and replace oil.*****

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 5 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.

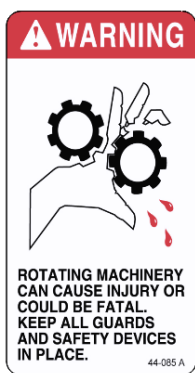
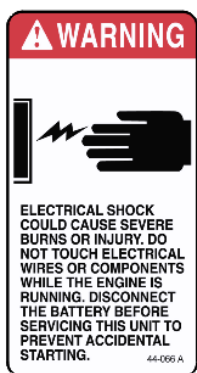
*****Or every **6 Months**. Whichever comes first.

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

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

7. MAINTENANCE

This section of the operator's manual contains the service and maintenance information for the **MODEL 454 SS[®]** unit. A planned preventative maintenance program will ensure that your **SAPPHIRE SCIENTIFIC MODEL 454 SS[®]** 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 hours** of operation. Thereafter, change oil and oil filter every **100 hours** of operation. **USE ONLY BRIGGS & STRATTON BRAND 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 SF, SG, SH, SJ or higher. **Do not use additives.** Select the viscosity based on the air temperature at the time of operation as shown in the following table.

Above 37° C (99° F)	SAE40
25° C to 37° C (77° F to 99° F)	SAE30 or SAE10W-30
0° C to 25° C (32° F to 77° F)	SAE20 or SAE10W-30

Engine oil capacity	2.4 L 2.53 U.S.qts
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Tightening torque	Drain Plug	32.4 to 37.3 N·m 3.3 to 3.8 kgf·m 23.9 to 27.5 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.

SECTION 4

3. Check the spark plugs every **200 hours**. Replace spark plugs every **1000 hours**. Use only **OEM specified spark plugs**.

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

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

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

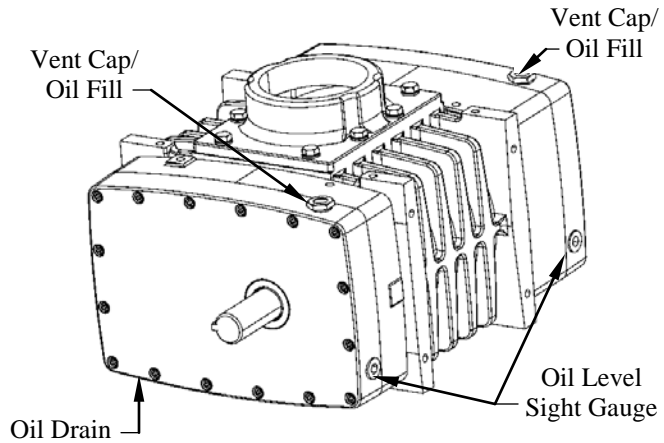
VACUUM PUMP

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

Lubrication: **SAPPHIRE SCIENTIFIC** requires that you use only AEON PD-XD Synthetic Blower Lubricant in both sides of the vacuum pump for all operating temperatures. AEON PD-XD is formulated specifically for positive displacement blower service to provide maximum blower protection at any temperature.

NOTE: AEON PD-XD (Part # 13-004) 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 **weekly** on both sides to ensure they are 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 yearly, whichever comes first**.

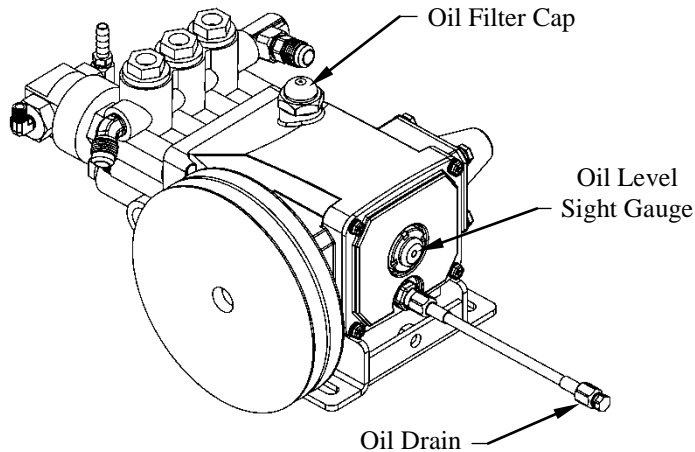
NOTE: Two drains are on your vacuum pump. Ensure that both sides of the vacuum pump are filled to their proper level when servicing.

SECTION 4

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 CAT Pump Crankcase Oil, (Part # 13-000). Change the crankcase oil every **500 hours** thereafter.

Vacuum Pump:

Belt Replacement Procedures for Model 454:
ONLY use **EPDM** belts:

- 1) Disconnect the negative battery cable
- 2) Remove hose from waste tank to vacuum pump
- 3) Remove hoods
- 4) Remove top panel (6 screws)
- 5) Remove left and right hand belt guards
- 6) Loosen all 4 blower mounting nuts
- 7) Remove clamp between blower & silencer

- 8) Slide the blower back (away from engine)
- 9) Lower front 2 nuts located under the front of blower mounting plate approximately 1/2"
- 10) Tip the back of blower up
- 11) Remove all belts. Install new belts
- 12) Reverse procedures to install new belts
- 13) After belts have been installed, check for proper tension and alignment. Do this using a belt gauge. Set deflection to 1/4"; 10-12 lbs tension
- 14) Check pulleys for alignment using a straight edge (example: 1/2" key stock). Make sure pulley flange touches on 2 places on each pulley (4 total places)
- 15) Estimated time, 20 minutes

VACUUM INLET FILTER

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



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 a grease to the threads will allow easier removal of filter when cleaning or replacement is required.

DRIVE BELTS, PULLEYS and HUBS

Check pulley set screws and hub screws after the first **25 hours** of operation and again at **100 hours**. Re-torque these screws with a torque wrench. Follow the torque values on the following table.

SECTION 4

Check pulley set screws and hub screws every **500 hours** thereafter.

Insure belts are properly tensioned after checking the torque values. Use Gates EPDM belts.



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 Hub #38-019	180	15
Vacuum Pump Hub #38-032	180	15
Engine Hub #38-021	180	15

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. **DO NOT** attempt to reuse o-rings after the check valves have been removed. Replace all o-rings when servicing check valves.

CHEMICAL METERING SYSTEM

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

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.

SECTION 4

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.



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.

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 Briggs & Stratton Engine Operation and Service Manual for specific instructions.

WARNING!

DO NOT attempt to adjust without a tachometer and **NEVER** adjust the engine above 3000 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 14" Hg. Always ensure 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 adjusting bolt until the proper belt tension is achieved (1/2" deflection in the center of the belts, half way between the pulleys).

Do not over tighten. Damage to pump may occur.

3. While checking the alignment, tighten the nuts that hold the water pump to the base.

CAUTION

Over tightening of belts may cause damage to pump casing, causing it to fail.

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 Teflon 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.

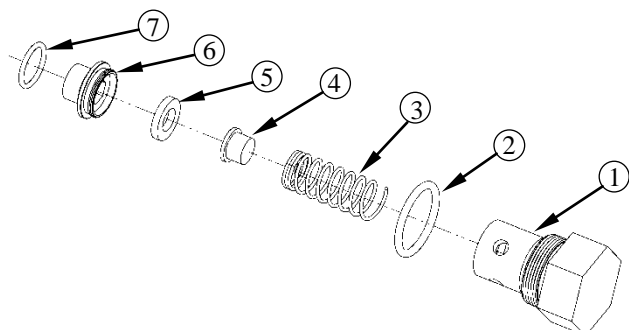
NOTE: New o-rings must be installed **anytime** the check valve is removed.

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.

SECTION 4

(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.



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.

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

CHEMICAL PUMP

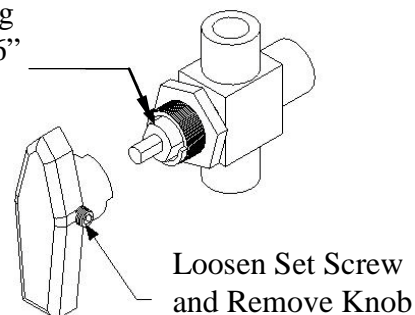
The **MODEL 454 SS[®]** unit features a stainless steel chemical pump and metering system. The chemical pump requires only the replacement of the diaphragm and check valves (see page 56). To replace the diaphragm, unscrew the cover from the body. When replacing the diaphragm, lube the outer edges of the diaphragm with o-ring lubricant

PACKING NUT ADJUSTMENT CHEMICAL METERING/ SELECTOR VALVES

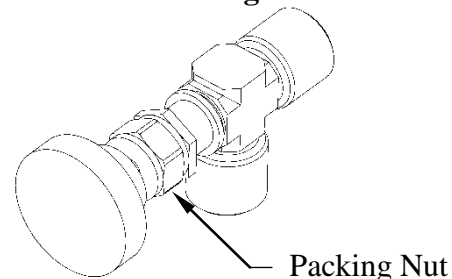
Inspect the packing nut for proper tension on the chemical metering and chemical selector valves every **200 hours**. When turning the knob, there should be some resistance. If not, slightly tighten the packing nut. **DO NOT** over-tighten. Keeping the packing properly adjusted will eliminate possible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

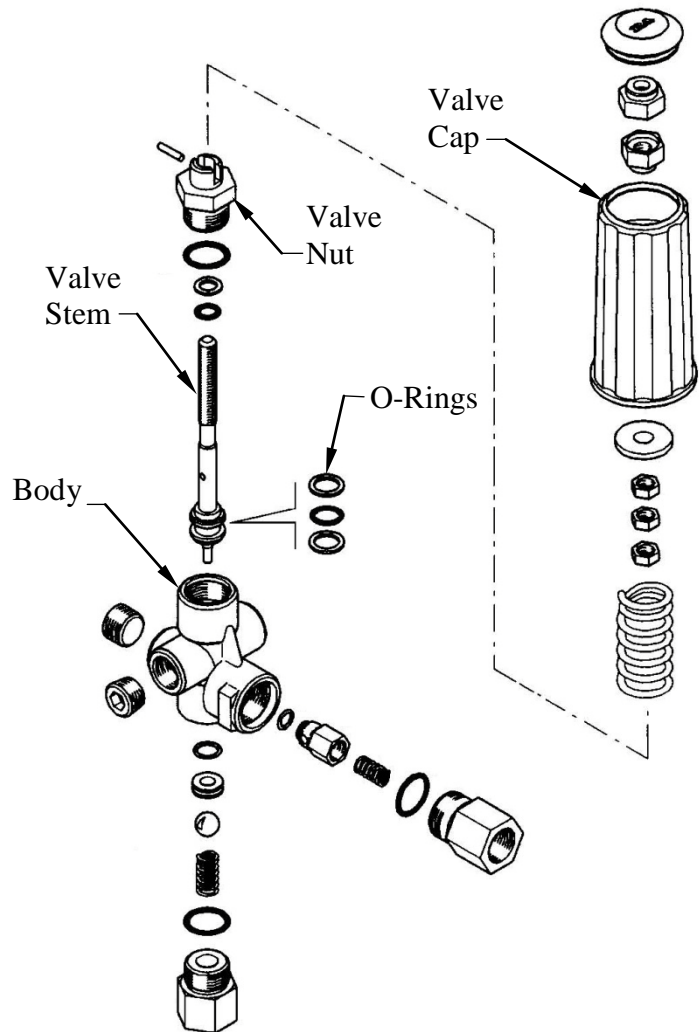
DO NOT loosen the adjusting body (cap) all the way (counterclockwise) or remove it while the unit is running.

We recommend that you lubricate the pressure regulator o-ring every **50 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



Loosen nut & remove entire valve stem from valve body to service seals.



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**

TROUBLE SHOOTING: ENGINE

PROBLEM	CAUSE	SOLUTION
Heat exchanger leaks NOTE: The heat exchanger will produce water condensation discharge at times during normal operation. DO NOT 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 1200 PSI).
Loss of temperature The heat output of the unit is LESS than normal.	No vacuum hose connected.	Connect vacuum hose to vacuum inlet.
	Temperature relief valve on water box is stuck open.	Clean temperature relief valve and test. Replace, if necessary.
	Engine RPM is low.	Reset engine RPM.
	Defective temperature gauge.	Test gauge and sensor. Replace failed component.
	Temperature balance orifice missing	Replace orifice
Automatic waste pump is malfunctioning or not operating normally.	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.

SECTION 4

TROUBLE SHOOTING: ENGINE

PROBLEM	CAUSE	SOLUTION
Engine will not start 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 Gardner Denver Service and Repair Manual.
Starter turns over engine, but will not start	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 the Briggs & Stratton Engine Operation and Maintenance Manual.
Starter turns over engine, but will not start	Engine is malfunctioning	Refer to Briggs & Stratton Engine Operation and Maintenance Manual.
Engine stops running 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 Briggs & Stratton Engine Operation and Maintenance Manual. DO NOT restart the engine until the cause is determined and corrected.
	No ignition in the engine or engine is malfunctioning.	Refer to the Briggs & Stratton Engine Operation and Maintenance Manual.
Excessive heating	Flow restriction caused by hard water scaling.	Descale unit, repair or replace damaged plumbing components as necessary. Install water softener.
	Not enough water flow.	Check jet size of tool.

SECTION 4

TROUBLE SHOOTING: BLOWER / VACUUM PUMP

PROBLEM	CAUSE	SOLUTION
Excessive Vacuum	Improper throttle adjustment.	Adjust throttle to set desired vacuum pressure.
	Vacuum relief valve requires adjustment.	Readjust the vacuum relief valve.
Loss of vacuum. 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 exhaust heat exchanger plugged.	Remove and clean.
Vacuum pump is worn out.	Replace the vacuum pump.	

TROUBLE SHOOTING: WATER PUMP

PROBLEM	CAUSE	SOLUTION
Loss of solution volume at cleaning tool orifice. 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.

SECTION 4

**TROUBLE SHOOTING:
WATER PUMP**

PROBLEM	CAUSE	SOLUTION
Loss of solution volume at cleaning tool orifice. Solution pressure gauge reads normal.	Outlet check valve is plugged	Examine the check valve, remove any debris
	Defective quick-connect on one or more of the high pressure hoses.	Replace defective quick-connects(s) on high pressure hoses(s).
	Cleaning tool valve is malfunctioning.	Repair or replace valve.
	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.
Loss of solution pump pressure. 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.
	Temperature Balance Orifice missing	Replace Orifice

SECTION 4

TROUBLE SHOOTING: CHEMICAL SYSTEM

PROBLEM	CAUSE	SOLUTION
Loss of chemical. 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.
	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.
Solution pump does not engage	Solution pump circuit breaker has been tripped	Check the solution pump circuit breaker on the control panel. Press the circuit breaker reset button.
	Defective electrical connection in the console wiring or defective switch.	Examine switch, electrical connections, and wiring. Repair any defective connections. If there is power going to the switch but not going out, replace the defective switch.
	Solution pump has not been activated	Turn solution pump switch to on.
	Defective solution pump clutch. NOTE: The clutch may be manually engaged by inserting two ¼-20 x ½ bolts. Line up the holes on the clutch and insert the bolts. To disengage the pump, remove the bolts.	If there is power in the switch, but not power at the clutch, replace the defective wire. If there is power at the clutch, replace the defective switch.
	Loose or broken solution pump belts.	Tighten or replace belts.
Chemical flow meter indicates flow with the tool valve closed	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.

SECTION 4

TROUBLE SHOOTING: CHEMICAL SYSTEM

PROBLEM	CAUSE	SOLUTION
Chemical flow meter indicates flow with the tool valve closed	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.

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PARTS and ACCESSORIES

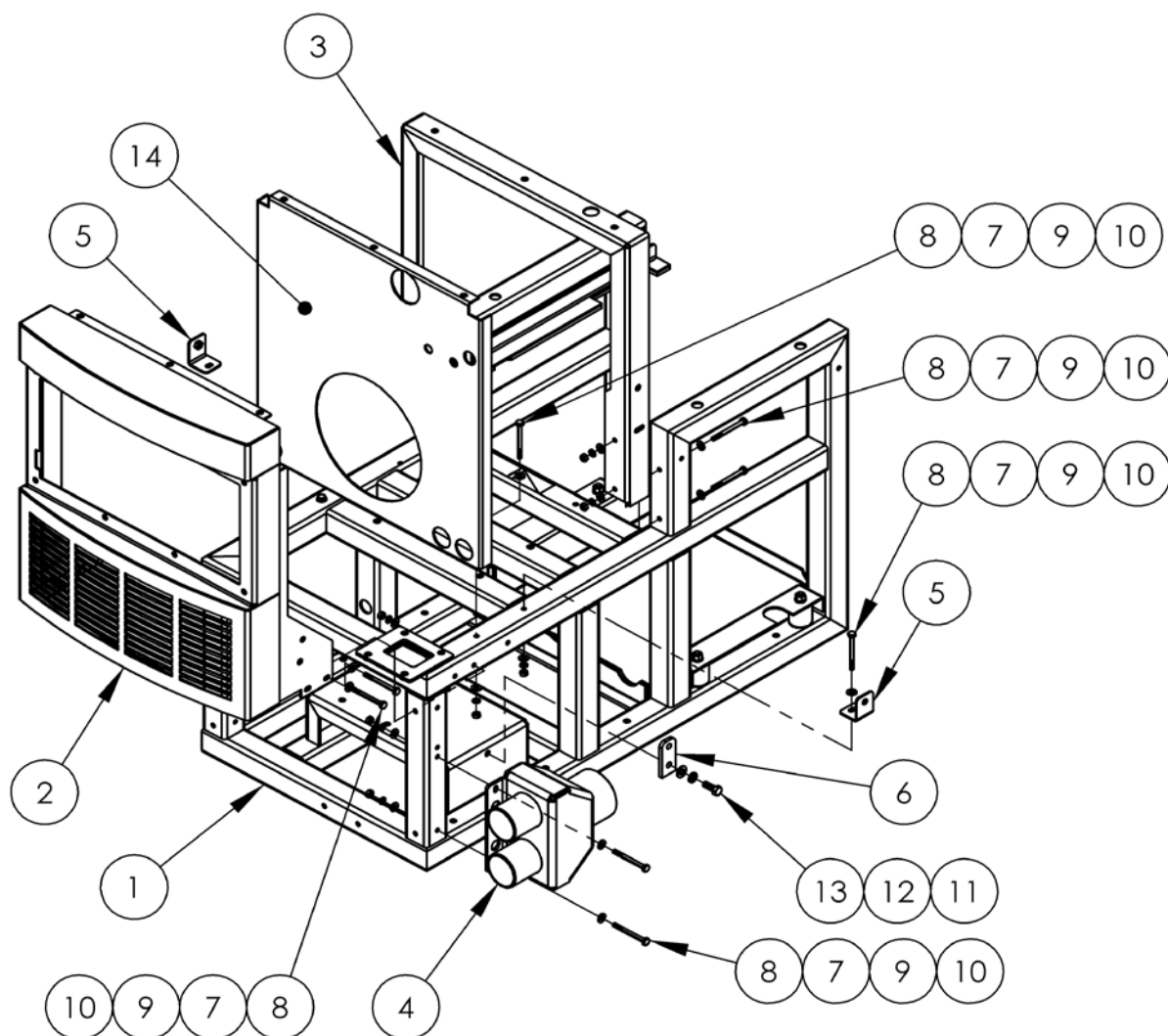
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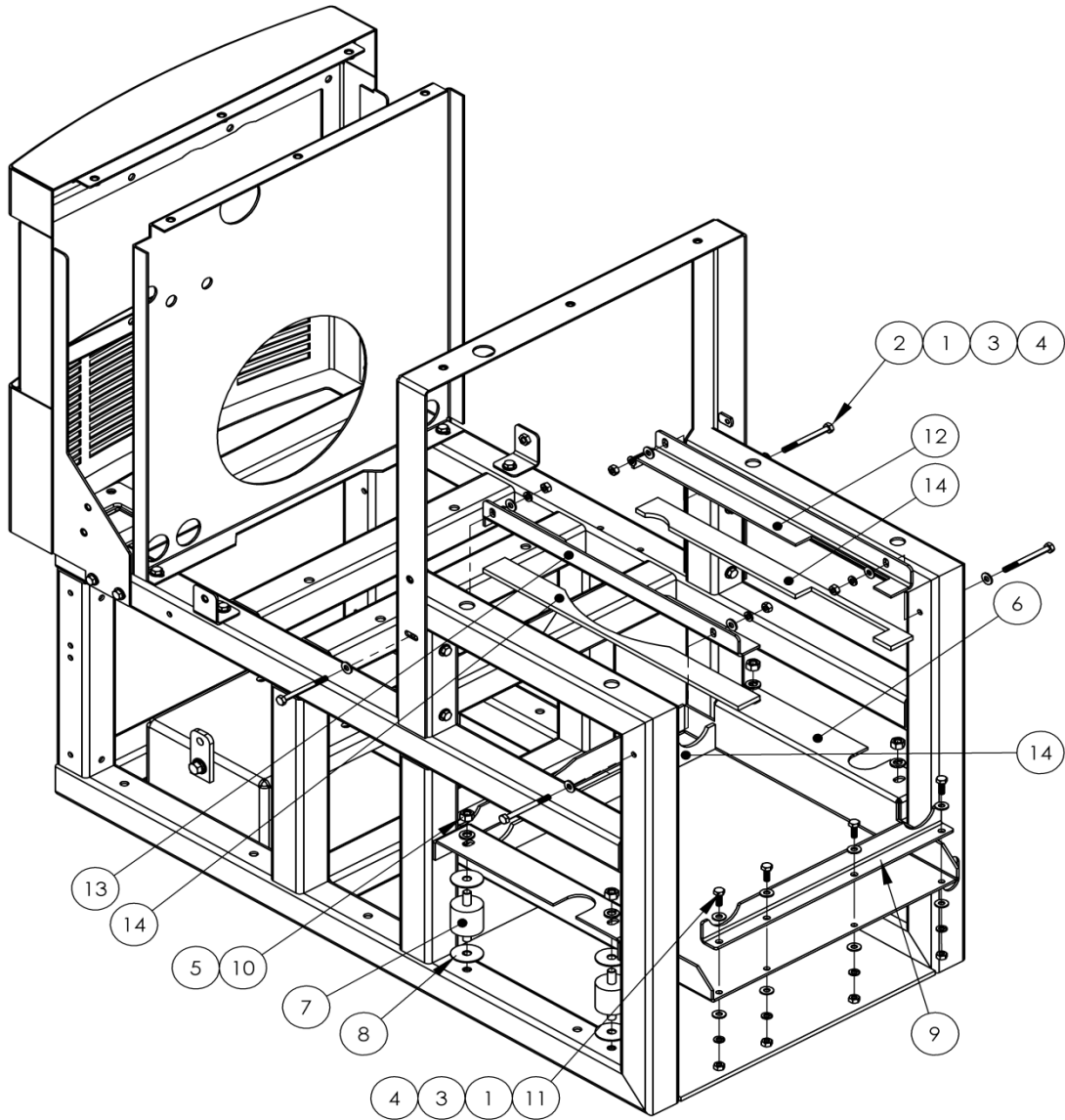
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ASSY, FRAME, FRONT 454SS

Item No.	Part Number	Qty	Description
1	61-503	1	WELDMENT, FRAME BIG BLOCK BRIGGS
2	61-486	1	WELDMENT, CONTROL PANEL, 20 INC
3	60-468	1	REAR SUPPORT BRACE
4	61-592	1	WELDMENT, DUAL 2.5 TO 3.5 IN VAC BRACKET
5	58-398	2	ANGLE, HOOD MOUNTING
6	58-363	1	3 AND 5CP ADJUSTMENT TAB
7	12-012	37	WASHER, FLAT 1/4 USS
8	10-028	18	SCREW, MACH 1/4-20 X 2-3/4 HXHD
9	12-015	19	LKWSR, 1/4 ZINC
10	11-004	18	NUT, 1/4-20 ZINC
11	12-013	1	WASHER, FLAT 3/8 SAE
12	12-014	1	LKWSR, 3/8 ZINC
13	10-029	1	SCREW, MACH 3/8-16 X 1 HXHD
14	60-467	1	PANEL, AIR DAM 454 SS

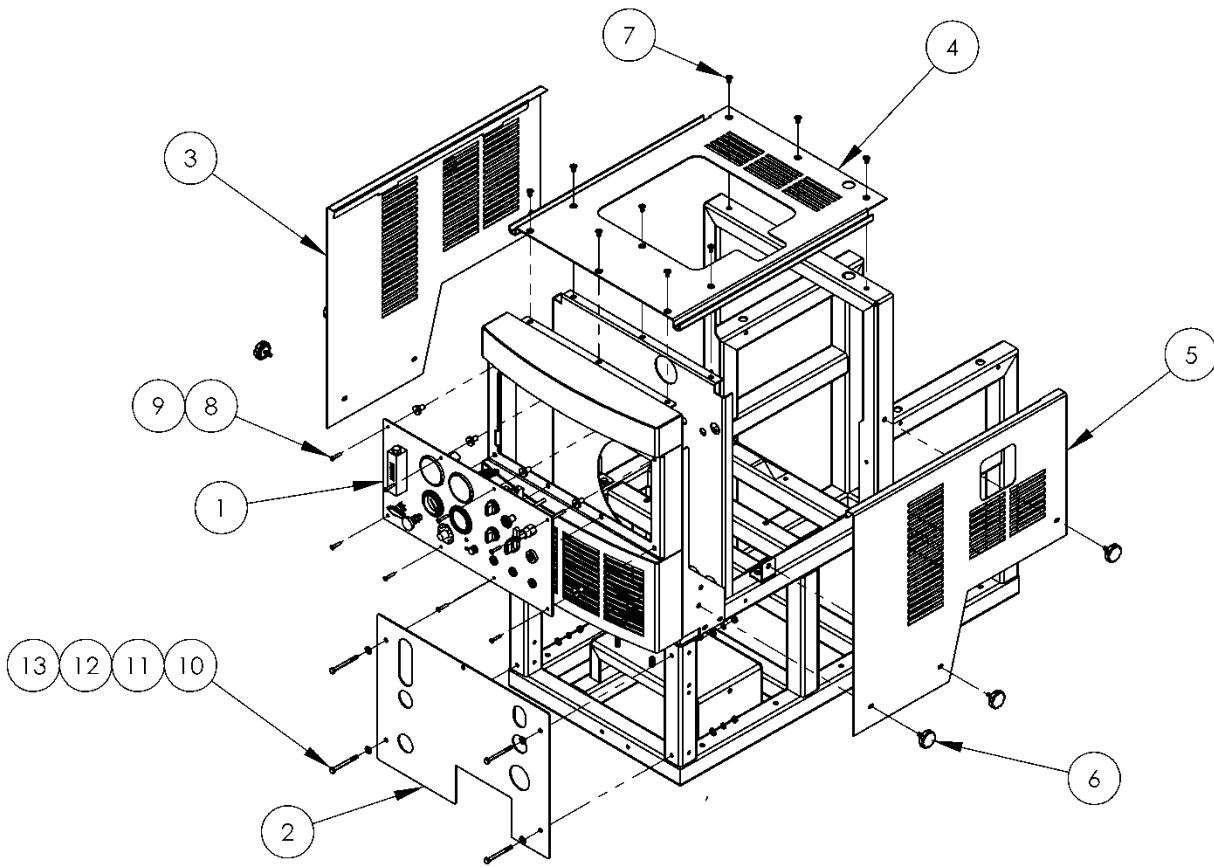
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ASSY, FRAME, BACK 454SS

Item No.	Part Number	Qty	Description
1	12-012	16	WASHER, FLAT 1/4 USS
2	10-028	4	SCREW, MACH 1/4-20 X 2-3/4 HXHD
3	12-015	8	LKWSR, 1/4 ZINC
4	11-004	8	NUT, 1/4-20 ZINC
5	12-014	4	LKWSR, 3/8 ZINC
6	60-885	1	PANEL, WATER BOX CRADLE
7	41-095	4	ISOLATOR, 1.5 OD X 1.5 TALL 50 DURO
8	12-049	8	WASHER, 3/8 X 1.5 FENDER ZINC
9	58-588	1	BRACKET, ANGLE CLAMP
10	11-006	4	NUT, 3/8-16 ZINC
11	10-025	4	SCREW, MACH 1/4-20 X 3/4 HXHD GRD5
12	58-591	1	BRACKET, WATER BOX MOUNTING LS
13	58-592	1	BRACKET, WATER BOX MOUNTING RS
14	41-091	3	PAD, 1/4 SILICONE SPONGE 1.5W X 16.5L

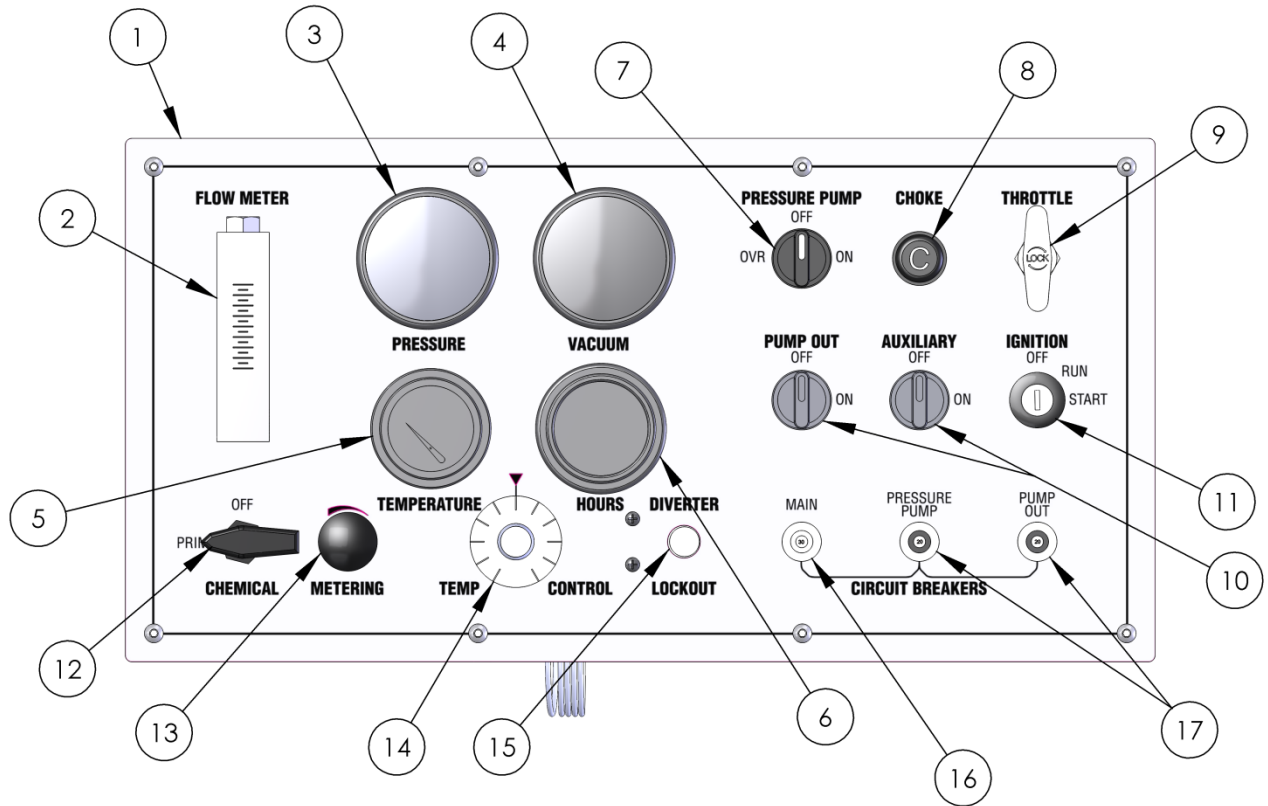
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FRONT SHEET METAL

Item No.	Part Number	Qty	Description
1	69-196	1	ASSY, INSTRUMENT PANEL
2	66-230	1	PANEL, LOWER FRONT 454 & 570 SS
3	58-393	1	PANEL, LEFT SIDE 454 SS
4	58-392	1	PANEL, TOP MODEL 454 SS
5	58-394	1	PANEL, RIGHT SIDE 454 SS
6	11-007	6	NUT, THUMB 1/4-20 FKWR. HEAD KNOB
7	10-165	9	SCREW, MACH 1/4-20 X 3/4 FLTHD SS
8	11-002	8	NUT, WELL G 10-32 .375
9	10-016	8	SCREW, MACHINE 10-32 X 1 SOCHD SS
10	10-028	4	SCREW, MACH 1/4-20 X 2-3/4 HXHD
11	12-011	4	WASHER, FLAT #12 SAE
12	12-015	4	LKWSR, 1/4 ZINC
13	11-004	4	NUT, 1/4-20 ZINC

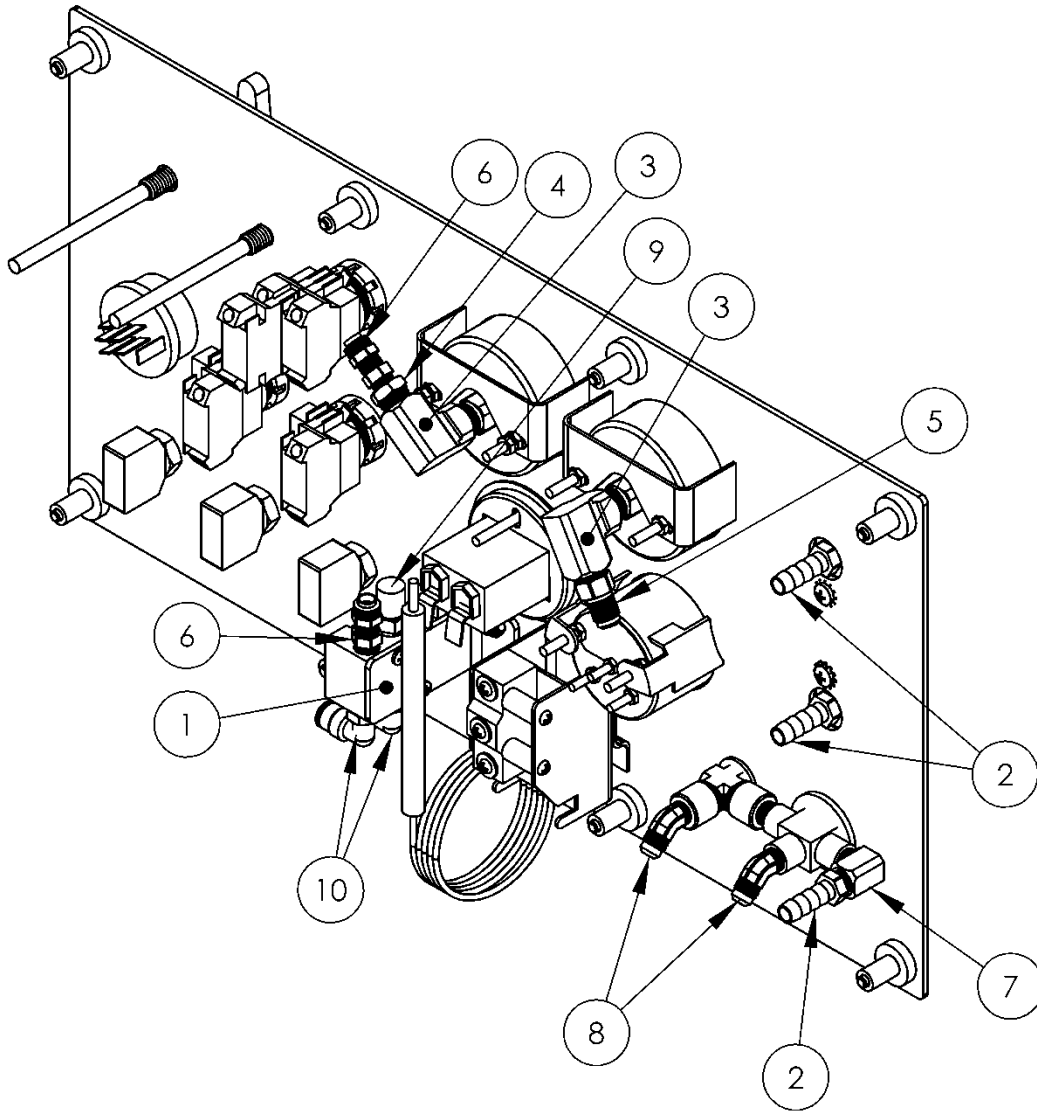
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69-196 ASSY, INSTRUMENT PANEL

Item No.	Part Number	Qty	Description
1	66-229	1	PANEL INSTRUMENT 454 SS
2	26-003	1	FLOWMETER, 1/8P
3	26-005	1	GAUGE, WTR. PRESS1500PSIDUAL
4	26-004	1	GUAGE, VAC 30in.HG DUALSCALE
5	26-034	1	GAUGE, WTR TEMP CHROME 320 DEG F
6	26-033	1	HOURMETER, HOBBS CHROME BEZEL
7	29-049	1	SWITCH, ROTARY, 3 POS, SR FROM LEFT, 1 NO, 2 NC
8	40-001	1	CABLE, CHOKE
9	40-000	1	CABLE, THROTTLE
10	29-016	2	SWITCH, ROTARY NON ILLUMINATED
11	29-047	1	KEY SET, BRIGGS & STRATTON 496603
12	23-027	1	VLV, 3-WAY BALL 1/8 FP SS
13	23-028	1	VLV, CHEM SS
14	34-007	1	CONTROL, TEMP 275 DEGREE
15	23-066	1	MACVALVE, 45A-AA1-DDBJ-4KA
16	30-007	1	BREAKER, 30 AMP
17	30-008	2	BREAKER, 20 AMP

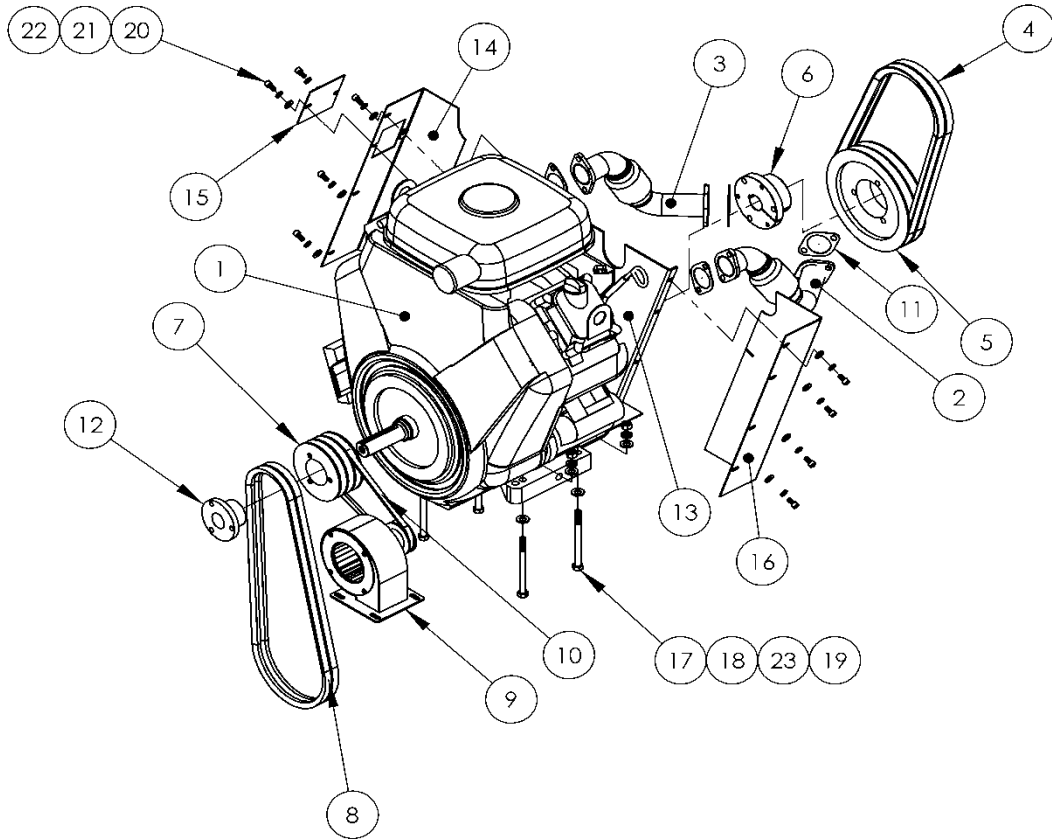
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69-196 ASSY, INSTRUMENT PANEL

Item No.	Part Number	Qty	Description
1	58-364	1	BRACKET, DIVERTER LOCKOUT VALVE
2	21-007	3	FTTG,BRB 1/8 PX 5/16 H BR
3	21-037	2	ELL, 1/4 IN. BRASS
4	21-076	1	BUSHING, 1/4 M X 1/8 F BRASS
5	21-050	1	CONN, 1/4 NPT X -04 JIC BRASS
6	21-028	2	CONN, 1/8 P X 1/4 POLY
7	21-038	1	ELL, STREET 1/8 IN. BRASS
8	21-055	2	ELL, 1/8 P X 1/4 T 45DEG BRASS
9	20-030	1	1/8" AIR MUFFLER
10	21-331	2	CONNECTOR, 1/8 M NPT X 1/4 HOSE 90DEG SWIVEL
11	21-042	1	NIP, CLOSE 1/8 IN. BRASS (NOT SHOWN)

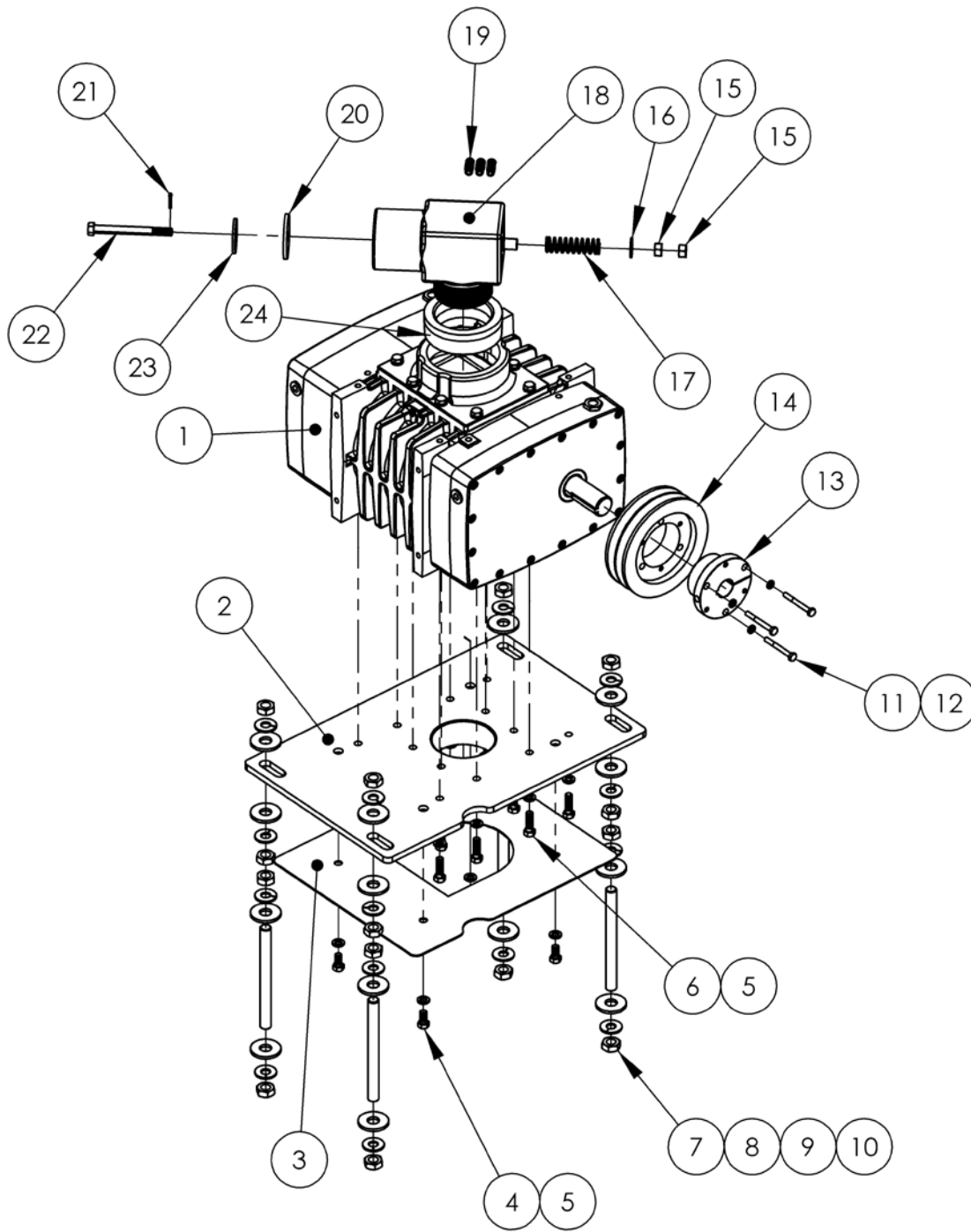
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ASSEMBLY, ENGINE, 406TMT

Item No.	Part Number	Qty	Description
1	45-021	1	ENGINE, BRIGGS 35 HP AIR COOLED
2	61-535	1	EXHAUST PIPE RS
3	61-534	1	EXHAUST PIPE LS
4	37-066	2	BELT, 5VX412
5	38-028	1	PULLEY, 5V710SK 2G C, CPR, BW, HAZ
6	38-019	1	HUB, SK-1 1/8
7	38-061	1	PULLEY, 3TA40P1
8	37-068	2	BELT, AX41 GATES EPDM
9	69-184	1	ASSEMBLY, BLOWER, BELT GUARD
10	37-019	1	BELT, 3L230 GATES EDPM
11	36-349	4	GASKET, EXHAUST BRIGGS & STRATTON 35HP
12	38-062	1	HUB, PI X 1-1/8
13	61-509	1	WELDMENT, 454 SS BELT GUARD
14	58-401	1	PANEL, BELT GUARD, LS, 454 SS
15	58-403	1	PLATE, BELT GUARD INSPECTION COVER
16	58-402	1	PANEL, BELT GUARD, RS, 454 SS
17	10-145	4	SCREW, MACH, 5/16-18 X 4 HXHD
18	12-017	14	WASHER, FLAT 5/16 SAE
19	11-029	4	NUT, 5/16-18 NYLOCK
20	10-007	9	SCREW, MACH 1/4-20 X 1/2 SOCHD SS
21	12-003	9	LKWSR, 1/4 IN SS
22	12-002	9	WASHER, FLAT 1/4 SS ANC
23	12-014	4	LKWSR, 3/8 ZINC

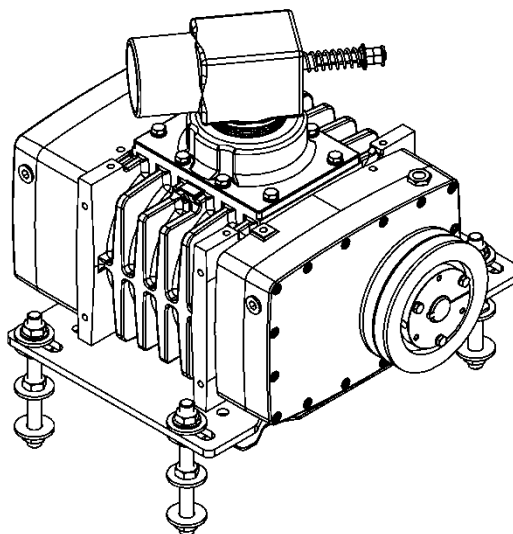
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69-212 ASSEMBLY, HF408 VACUUM BLOWER

SEE FOLLOWING PAGE FOR PARTS LIST

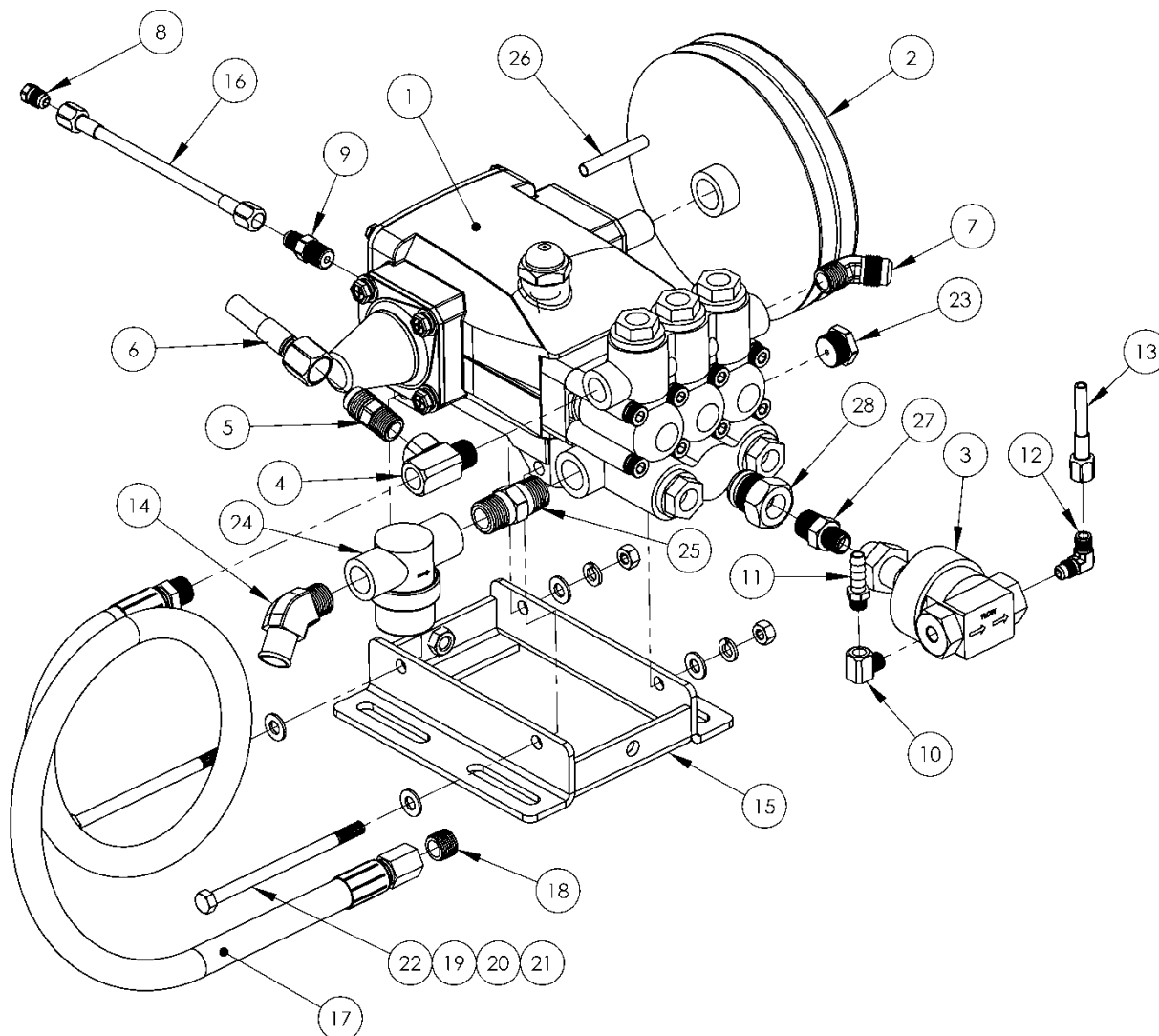
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69-212 ASSEMBLY, HF408 VACUUM BLOWER

Item No.	Part Number	Qty	Description
1	46-058	1	VACUUM PUMP, HELI FLOW HF408 HORZ RH CW
2	61-564	1	WELDMNT, VACUUM PUMP MTG PLATE 408
3	58-447	1	PANEL, HEAT SHIELD
4	12-014	16	LKWSR, 3/8 ZINC
5	10-070	4	BOLT - .375-16 X .75 HH ZP
6	10-004	12	SCREW, MACH 3/8-16 X 1-1/4 HEXHD
7	66-227-04	4	THREADED ROD, .625-18 X 7.0 IN
8	12-040	16	WASHER, FLAT .625 USS
9	12-039	16	WASHER, LOCK, .625
10	11-062	16	NUT, 5/8-18 JAM
11	10-027	3	SCREW, MACH, 1-4-20 X 2 1-4 HXHD ZP
12	12-015	3	LKWSR, 1/4 ZINC
13	38-032	1	HUB, SK 1.25
14	38-027	1	PULLEY, 5V630SK
15	11-012	2	NUT, 7/16-14 ZP
16	12-021	1	WASHER, FLAT 7/16 ZINC
17	15-002	1	SPRING, VAC RELIEF VALVE
18	66-001	1	VACUUM BRAKE, MACHINED 4L
19	21-028	3	CONN, 1/8 P X 1/4 POLY
20	41-009	1	DIAPHRAGM, VAC RELIEF VLV 4L, 5M
21	14-032	1	PIN, COTTER 7/64 X 3/4 SS
22	10-001	1	SCREW, MACH 7/16-14 X 4-1/2 HEXHD
23	59-219	1	PNL, STEM VAC 3L/4M
24	66-249	1	ADAPTER, 4 IN NPT TO 3 IN NPT

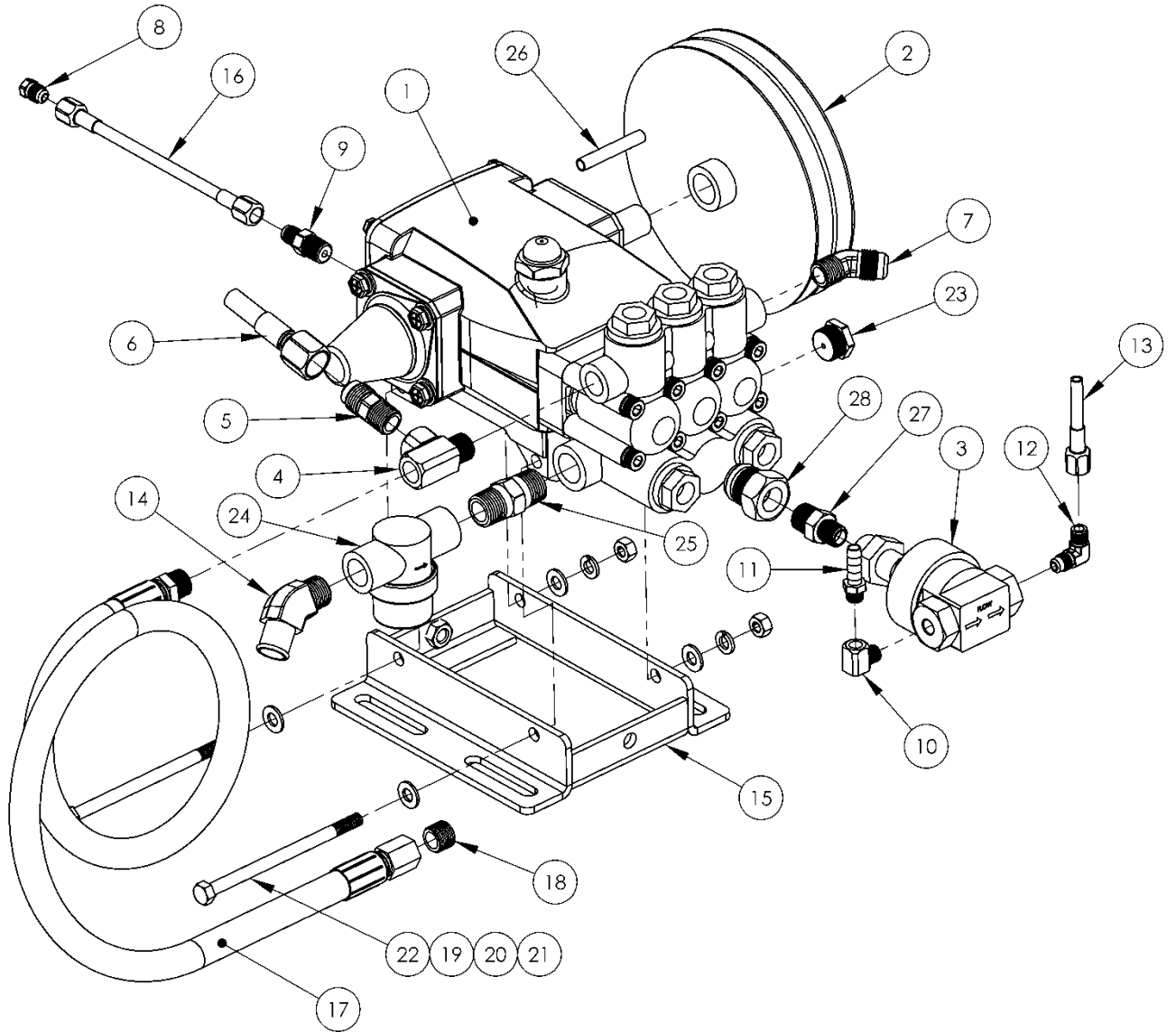
SECTION 5



69-215 ASSEMBLY, PUMP WATER, 70-454

Item No.	Part Number	Qty	Description
1	46-057	1	PUMP, WATER, CATP 5CP5120
2	35-005	1	CLUTCH, ELECT CAT 5CP 2 GROOVE
3	46-056	1	PUMP, CHEMICAL, MFG BY GENERAL PUMP
4	21-062	1	TEE, 3/8 FNPT X NPT X FNPT BRASS
5	21-057	1	CONN, 3/8 NPT X 1/2 JIC BRASS
6	18-214-03	1	HOSE ASSEMBLY, 7/16 ID X 08 FJIC X 08 FJIC X 15.0 L W / SS
7	21-059	1	ELL, 3/8 NPT X 1/2 JIC 45 DEG BRASS
8	21-096	1	PLUG, 1/4 JIC BRASS
9	21-050	1	CONN, 1/4 NTP X -04 JIC BRASS
10	21-038	1	ELL, STREET 1/8 IN BRASS
11	21-007	1	FTTG, BRB 1/8 P X 5/16 H BR
12	21-066	1	ELL, 1-8 NPT X 1-4 JIC BRASS
13	18-215-18	1	HOSE ASSEMBLY, 3/16 ID X 04 FJIC X 04 FJIC X 21.0 L W / SS
14	21-324	1	ELL, 1/2 NPT X 5/8 BARB 45 DEG BRASS
15	61-491	1	WELDMENT, MTG BRCKT CAT PUMP
16	18-215-19	1	HOSE ASSEMBLY, 3/16 ID X 04 FJIC X 04 FJIC X 7.0 L W / SS

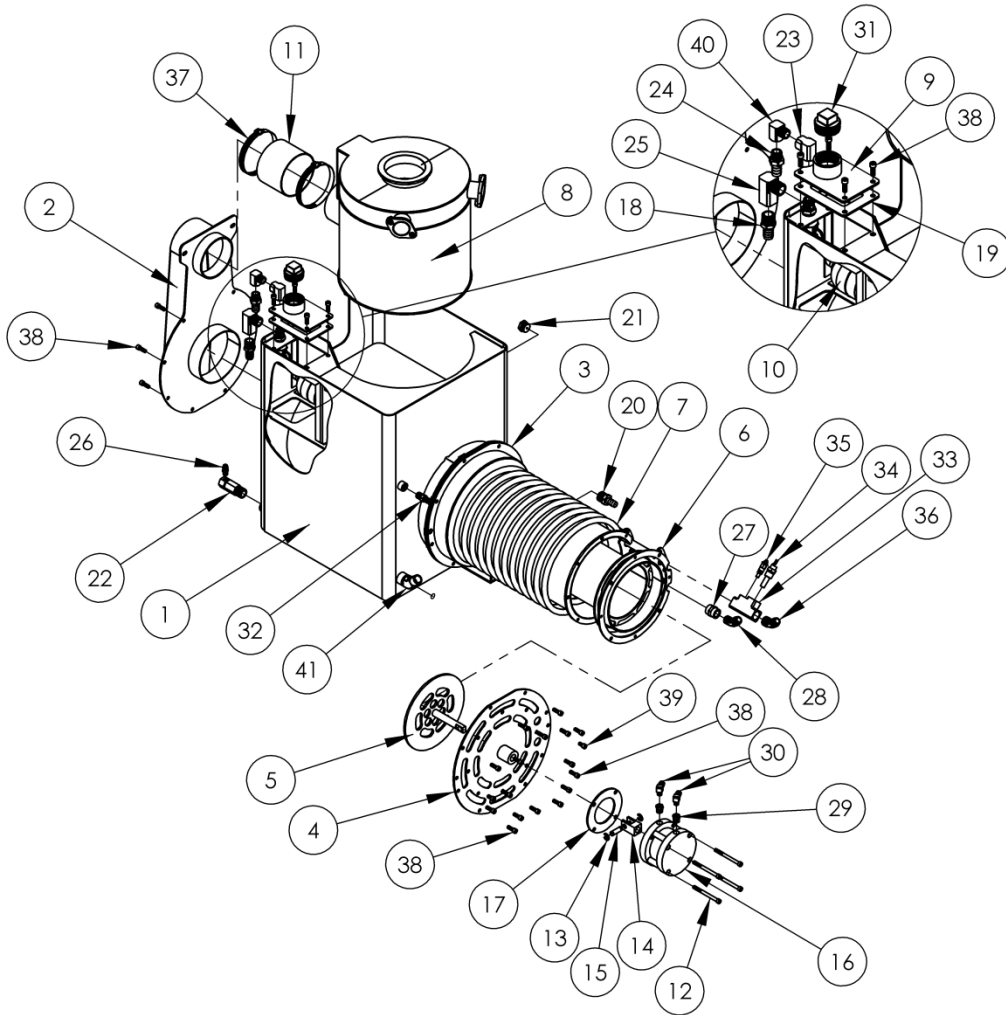
SECTION 5



69-215 ASSEMBLY, PUMP WATER, 70-454....CONT.

Item No.	Part Number	Qty	Description
17	18-199	1	HOSE, PULSE 3/8 S 36 IN
18	21-146	1	PLUG, 3/8 NPT BRASS
19	12-017	4	WASHER, FLAT 5/16 SAE ZINC
20	12-016	2	LKWSR, 5/16 ZINC
21	11-005	2	NUT, 5/16-18 ZINC
22	10-124	2	BOLT, 5/16-18 X 5.00 HH ZP
23	21-065	1	PLUG, 1/2 NPT SOLID BRASS HEXHD
24	20-033	1	FILTER, MICRO INLINE CAT 1/2 FNPT X 1/2 FNPT
25	21-047	1	NIP, 1/2 IN HEX BRASS
26	32-025	1	LOOM, HI HEAT .250 DIA. BLACK
27	21-231	1	NIPPLE, 1/4 X 3/8 SS NPT
28	66-064	1	ADAPTER, PUMP SS HP

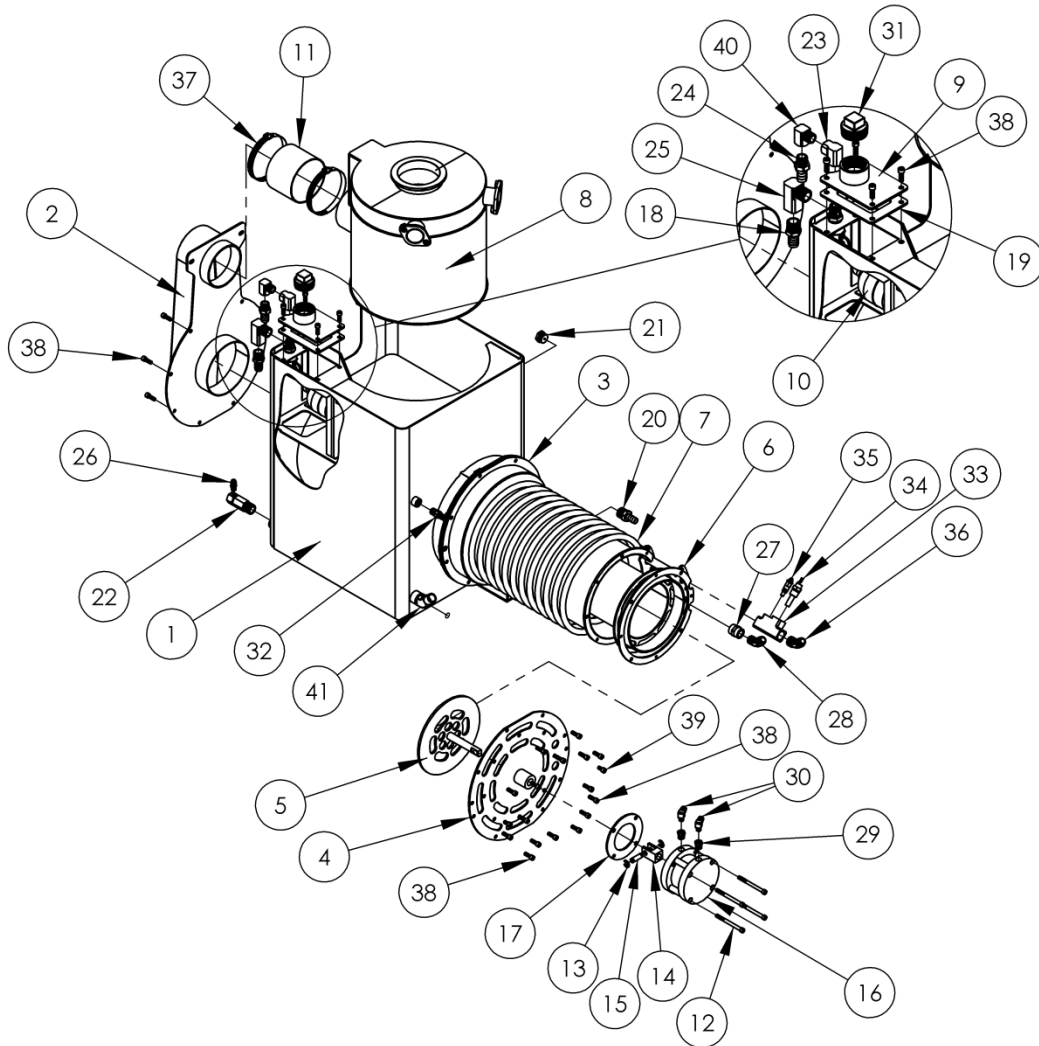
SECTION 5



69-200 ASSY, THERMAL WELL

Item No.	Part Number	Qty	Description
1	61-612	1	WELDMENT, WATER BOX
2	61-504	1	WELDMENT, END PLATE ADAPTER
3	61-528	1	WELDMENT, DIVERTER COVER, 454 SS
4	61-529	1	WELDMENT, DIVERTER HOUSING PLATE
5	61-530	1	WELDMENT, DIVERTER PLATE
6	61-531	1	WELDMENT, DIVERTER CHAMBER
7	61-532	1	WELDMENT, FINNED TUBE COIL
8	61-537	1	WELDEMENT, SILENCER 454 SS
9	61-459	1	WELDMENT, INSPECTION COVER
10	69-230	1	ASSY, FLOAT VALVE (HIGH FLOW)
11	16-085	1	4.00 ID HOSE
12	10-143	4	BOLT, 1/4-20 X 3 SHCS
13	15-028	2	SNAP RING, .375 EXT E (FAST 1168079)
14	66-211	1	.875 SQ CLEVIS WITH 5E-11 THREAD
15	66-221	1	RND STOCK, 3/8" DIA RULON X 12"

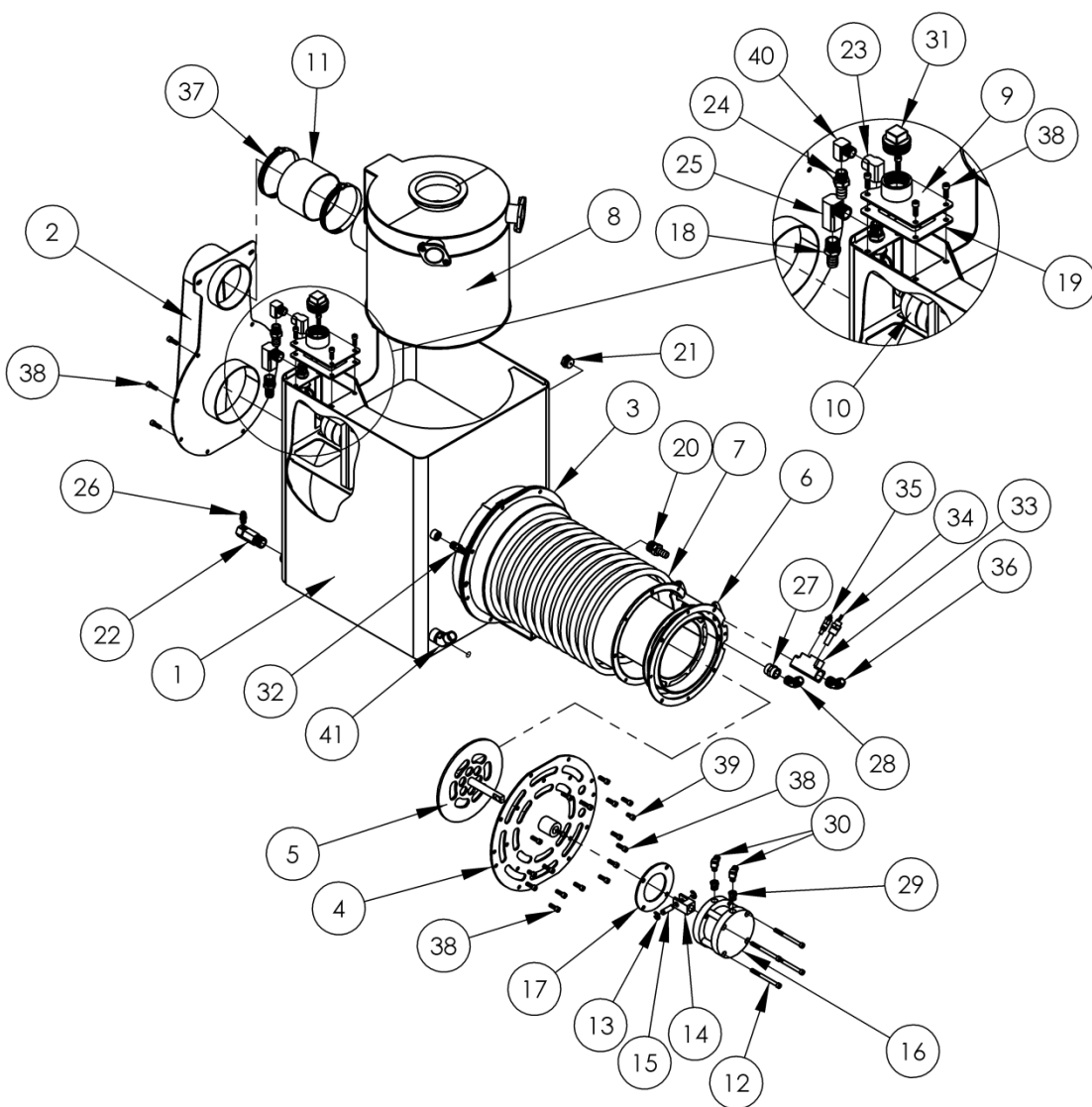
SECTION 5



69-200 ASSY, THERMAL WELL

Item No.	Part Number	Qty	Description
16	23-067	1	CYLINDER, AIR, BIMBA FO-701.5-CMTV
17	41-069	1	GASKET, DIVERTER CYLINDER
18	21-109	1	FTTG, 1/2 NPT X 5/8 BARB BRASS
19	41-076	1	GASKET, INSPECTION COVER
20	21-154	1	FITTING, 1-2 NPT X 1-2 BARB BRASS
21	21-065	1	PLUG, 1/2 NPT SOLID BRASS HEXHD
22	23-033	1	VALVE, 165 DEG THERMAL CAT 7145
23	21-152	1	ELL, 3/8 FNPT X 3/8 FNPT BRASS
24	21-261	1	FITTING, 5/8 HOSE BARB X 3/8 NPT BRASS
25	21-034	1	ELL, STREET 1-2 NPT BRASS
26	21-001	1	CONN, 1/8 P X 1/4 T BR
27	21-073	1	COUPLING, 3/8 NPT BRASS
28	21-059	1	ELL, 3/8 NPT X 1/2 JIC 45 DEG BRASS
29	21-076	2	BUSHING, 1/4 M X 1/8 F BRASS
30	21-011	2	ELL, 1/8 NPT X 1/4 POLY BRASS

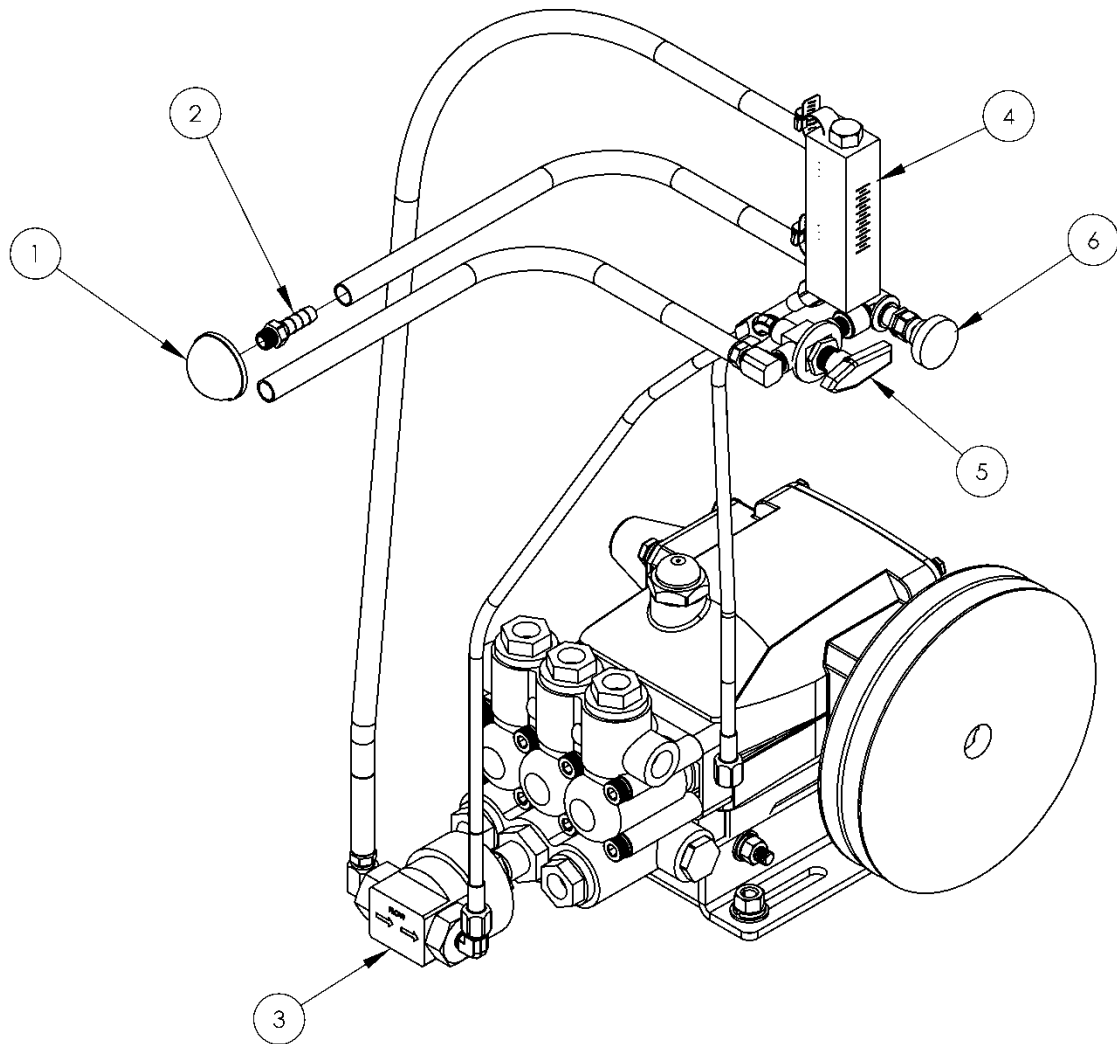
SECTION 5



69-200 ASSY, THERMAL WELL

Item No.	Part Number	Qty	Description
31	21-382	1	PLUG, 1-1/4 NPT SQ HEAD BRASS
32	21-050	1	CONN, 1/4 NTP X -04 JIC BRASS
33	66-246	1	MANIFOLD, TEMPERATURE SENSORS
34	34-008	1	SENSOR, TEMP 285DEG NASON
35	34-000	1	SENER, TEMP, 140-320 DEGREE
36	21-363	1	ELL, 1/2 NPT X 1/2 JIC 45 DEG BRASS
37	14-050	2	CLAMP, HOSE 4 1/2 TO 2 1/2 HD SS
38	10-021	28	SCREW, MACH 1-4-20 X 3-4 SOCHD SS
39	10-007	2	SCREW, MACH 1-4-20 X 1-2 SOCHD SS
40	21-040	1	FITTING, STR ELL, .375 IN NPT, BRASS
41	21-324	1	ELL, 1/2 NPT X 5/8 BARB 45 DEG BRASS

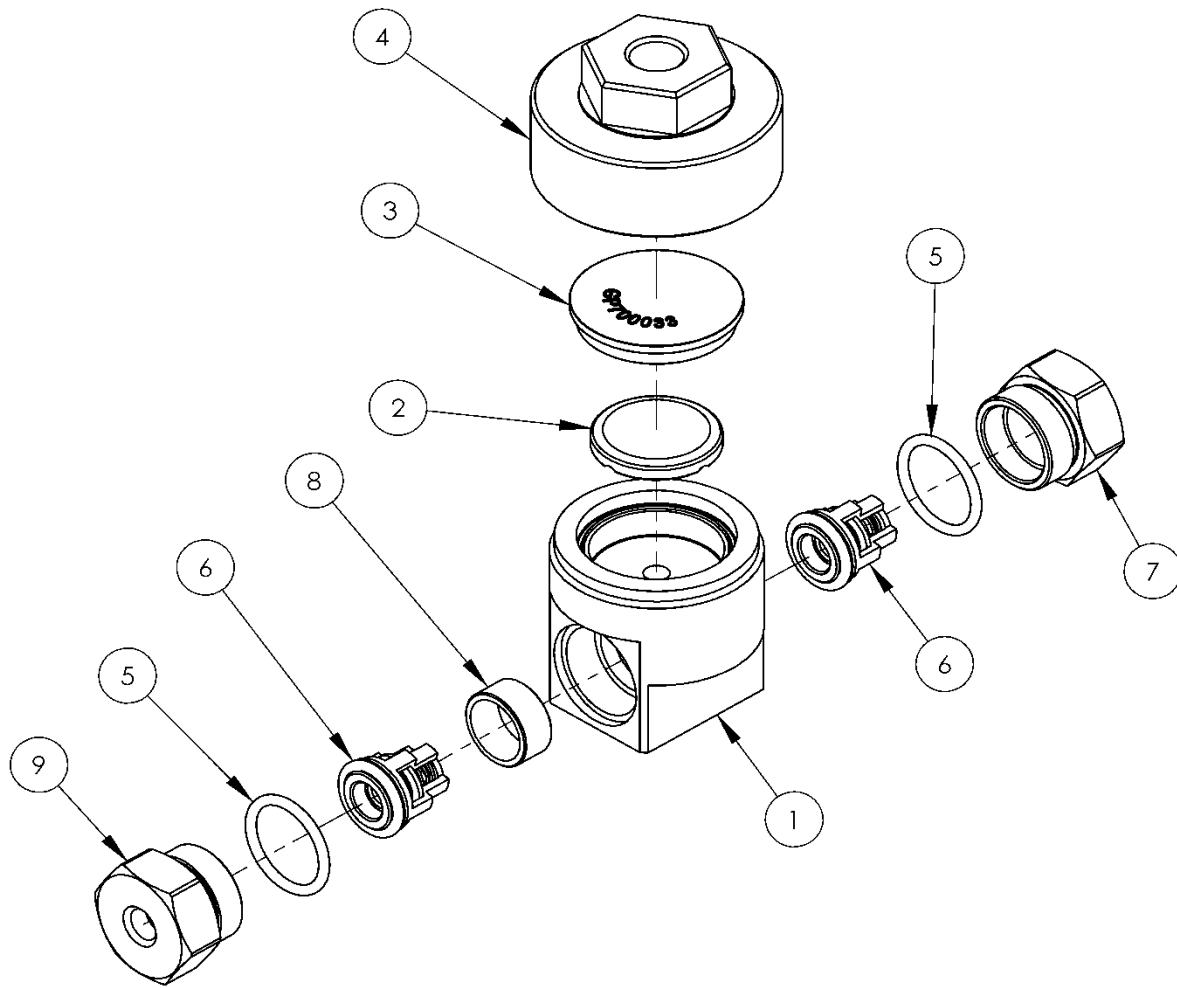
SECTION 5



CHEMICAL PUMPING SYSTEM

Item No.	Part Number	Qty	Description
1	20-002	1	STRAINER, SUCTION END 1/8FP
2	21-007	1	FTTG,BRB 1/8 PX 5/16 H BR
3	46-056	1	PUMP, CHEMICAL, MFD BY GENERAL PUMP
4	26-003	1	FLOWMETER, 1/8P
5	23-027	1	VLV, 3-WAY BALL 1/8 FP SS
6	23-028	1	VLV, BYPASS SS

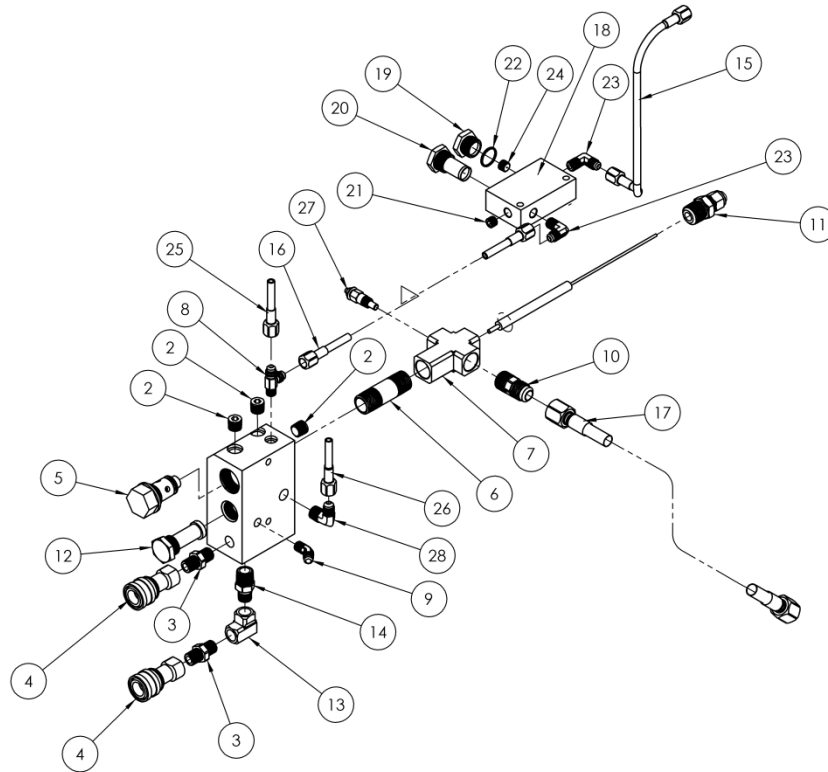
SECTION 5



46-056 PUMP, CHEMICAL, GENERAL 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	36-355	2	VALVE CAP 303SST, GP PULSE PUMP
7	36-356	1	ASSY, VALVE KIT, GP CHEMICAL 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

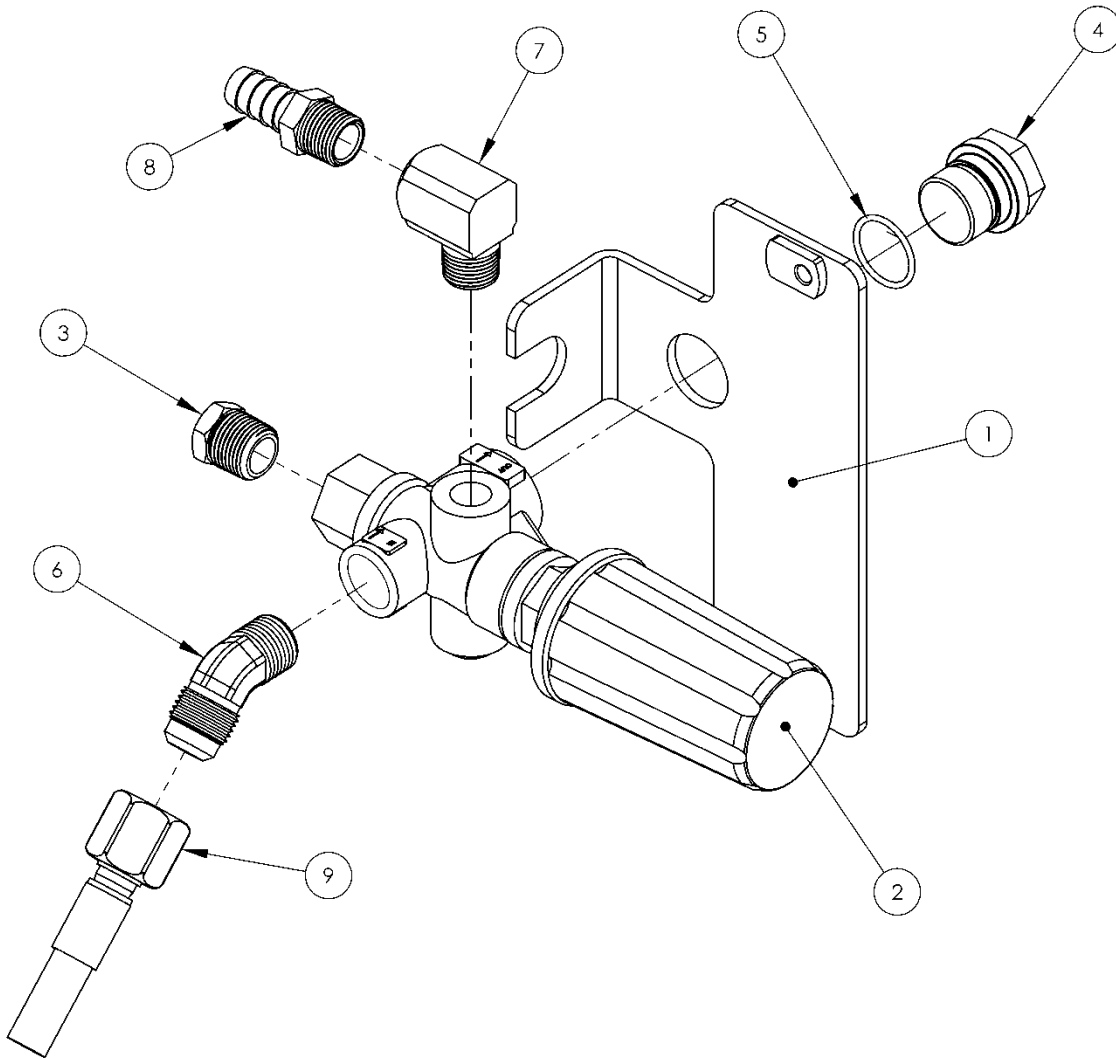
SECTION 5



69-217 ASSEMBLY, MANIFOLD BOLCK

Item No.	Part Number	Qty	Description
1	66-205	1	MANIFOLD BLOCK
2	21-264	3	PLUG, 1/4 NPT BRASS
3	21-026	2	NIPPLE, 1/4 NPT NPT HEX BRASS
4	25-001	2	QUICK DISCONNECT, .25 NPT, SOCKET, HANSEN SERIES B2-HK
5	23-063	1	CHECK VALVE MANIFOLD
6	21-374	1	NIPPLE, 1/2 NPT X 2-1/2L 304SS
7	66-277	1	MANIFOLD, TEMPERATURE SENSOR
8	21-336	1	TEE, 1/8 NPT X 1/4 JIC X 1/4 JIC BRASS
9	21-055	1	ELL, 1-8 P X 1/4 T 45 DEG BRASS
10	21-012	1	CONN, 1/2 NPT X 1/2 T BRASS
11	66-286	1	ADAPTER, THERMOCOUPLE
12	20-018	1	SCREEN, CHECK VALVE MANIFOLD
13	21-037	1	FITTING, ELBOW, .25 IN NPT, BRASS
14	21-052	1	NIP, 3-8 X 1-4 HEX BRASS
15	18-215-06	1	HOSE ASSEMBLY, 3/16 ID X 04 FJIC X 04 FJIC X 13.5L
16	18-215-07	1	HOSE ASSEMBLY, 3/16 ID X 04 FJIC X 04 FJIC X 14.75L
17	18-214-04	1	HOSE ASSEMBLY, 7/16 ID X 08 FJIC X 08 FJIC X 18.0L
18	66-011	1	MANIFOLD, BYPASS
19	66-017	1	CAP, CHECK VALVE
20	20-015	1	SCREEN, BYPASS MANIFOLD
21	21-029	1	PLUG, 1/8 NPT SOCKET HD BRASS
22	41-003	1	ORING, .676 ID .816 OD
23	21-054	2	ELL, 1-8P X 1-4 T BRASS
24	66-019	1	ORFICE, BYPASS MANIFOLD, .024 RED
25	18-215-10	1	HOSE ASSEMBLY, 3/16ID X 04FJIC X 04 FJIC X 18.0L
26	18-215-08	1	HOSE ASSEMBLY, 3/16 ID X 04 FJIC X 04 FJIC X 15.5L
27	34-000	1	SENER, TEMP, 140-320 DEGREE
28	21-064	1	ELL, 1/4 P X 1/4 T BRASS

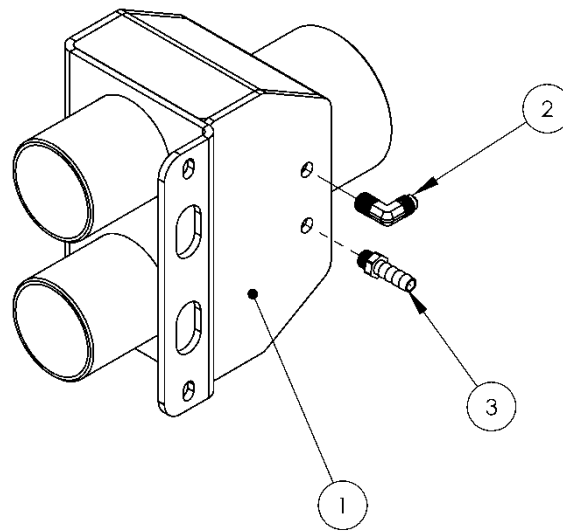
SECTION 5



69-209 ASSEMBLY, REGULATOR BRACKET, 454 SS

Item No.	Part Number	Qty	Description
1	61-541	1	BRACKET, REGULATOR MOUNTING
2	23-021	1	REGULATOR, PRESSURE CAT #7670 VITON
3	21-361	1	PLUG, .375 NPT X HEX HEAD BRASS
4	66-252	1	FITTING, REGULATOR MOUNTING
5	41-086	1	O-RING, VITON (MC 9263K584)
6	21-059	1	ELL, 3/8 P X 1/2 T 45 DEG BRASS
7	21-040	1	FITTING, ST ELL .375 IN NPT, BRASS
8	21-014	1	FTTG, BRB .375 X .50H BR
9	18-214-03	1	HOSE ASSEMBLY, 1/2 IDA X 1/2 FJIC X 1/2 FJIC 15.0 L W/SLEEVE

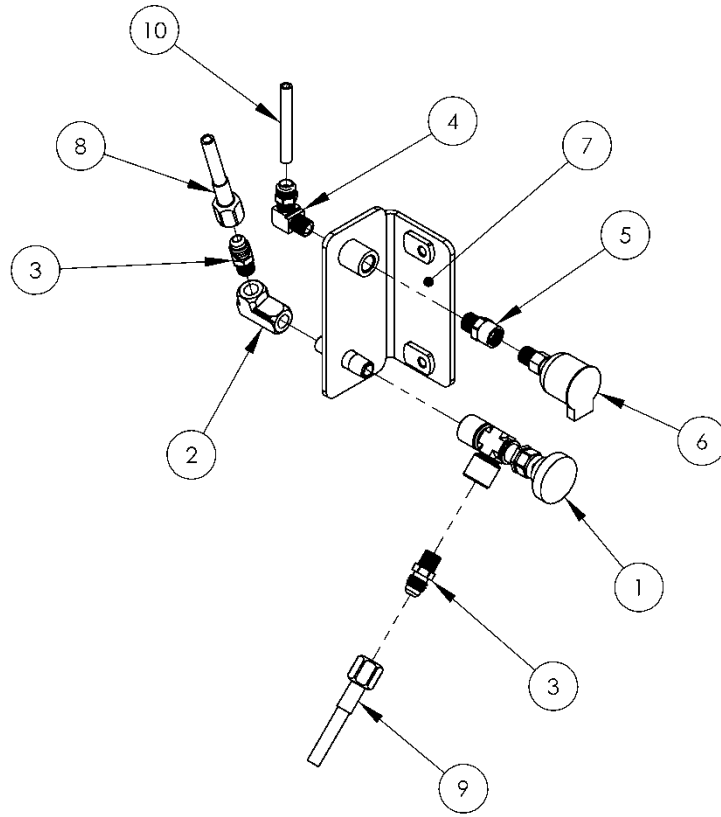
SECTION 5



69-258, ASSEMBLY, VAC BRACKET

Item No.	Part Number	Qty	Description
1	61-592	1	WELDMENT, DUAL 2.5 TO 3.5 IN VAC BRACKET PC CIRCUIT GRAY
2	21-054	1	ELL, 1-8P X 1-4 T BRASS
3	21-007	1	FTTG, BRB 1/8 P X 5/16 H BR

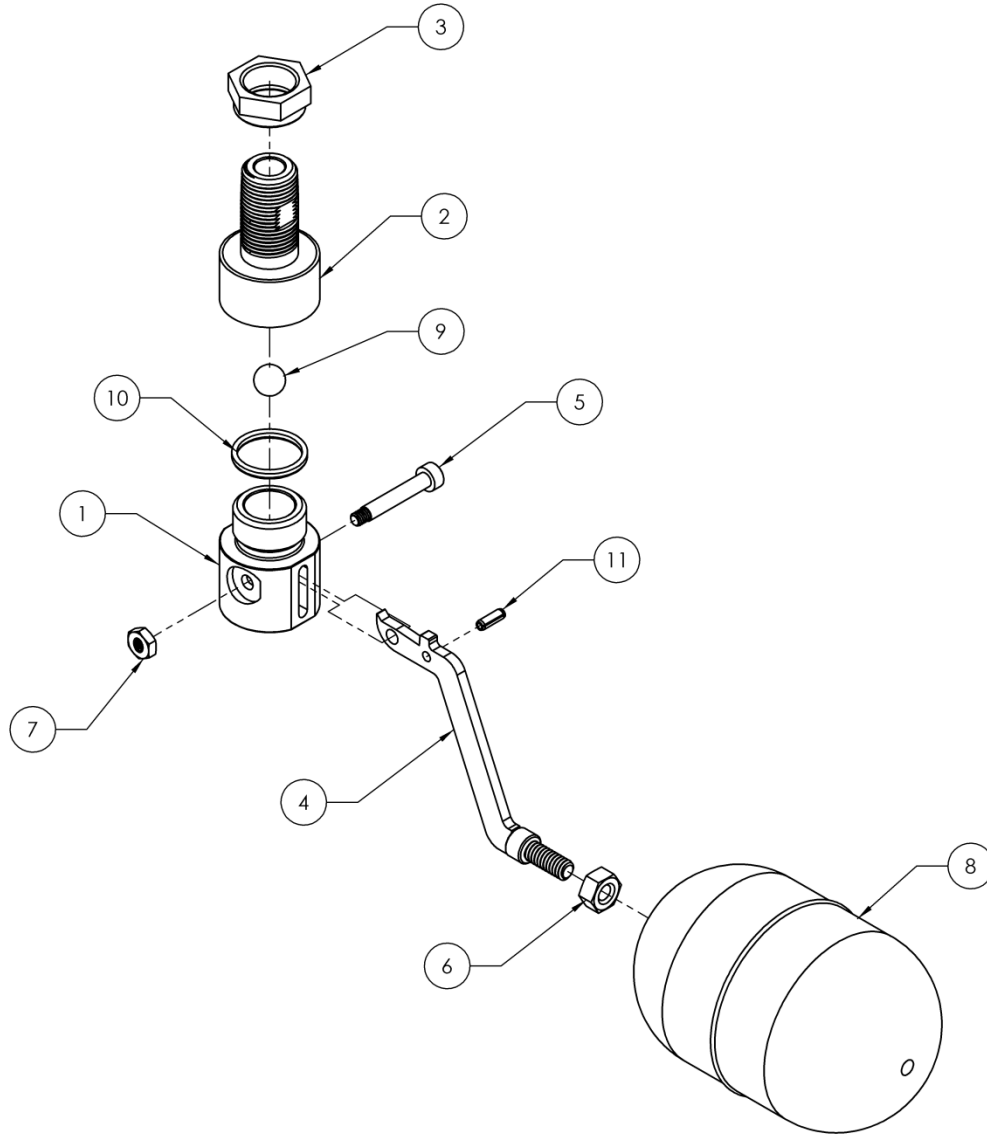
SECTION 5



69-210, ASSEMBLY, OIL CUP AND BYPASS VALVE

Item No.	Part Number	Qty	Description
1	23-028	1	VLV, MET18 FP (CHEM) RT ANG SS
2	21-090	1	ELL, 1/8 FNPT X 1/8 FNPT BRASS
3	21-001	2	CONN, 1/8 P X 1/4 T BR
4	21-011	1	ELL, 1/8 NPT X 1/4 POLY BRASS
5	21-333	1	COUPLING, 1/8 FNPT X 1/8 MNPT BRASS
6	28-000	1	CUP, OILFILL, 1/8 NPT
7	61-514	1	WELDMENT, OIL CUP AND BYPASS VALVE
8	18-215-12	1	HOSE, 3/16 DIA X 1/4 FJIC X 1/4 FJIC X 22.0 L W-CVR
9	18-215-05	1	HOSE, 3/16 DIA X 1/4 FJIC X 1/4 FJIC 12.5 L W/CVR
10	16-017	1	TUBING, 1/4 IN IMPOLENE 250 FT BULK

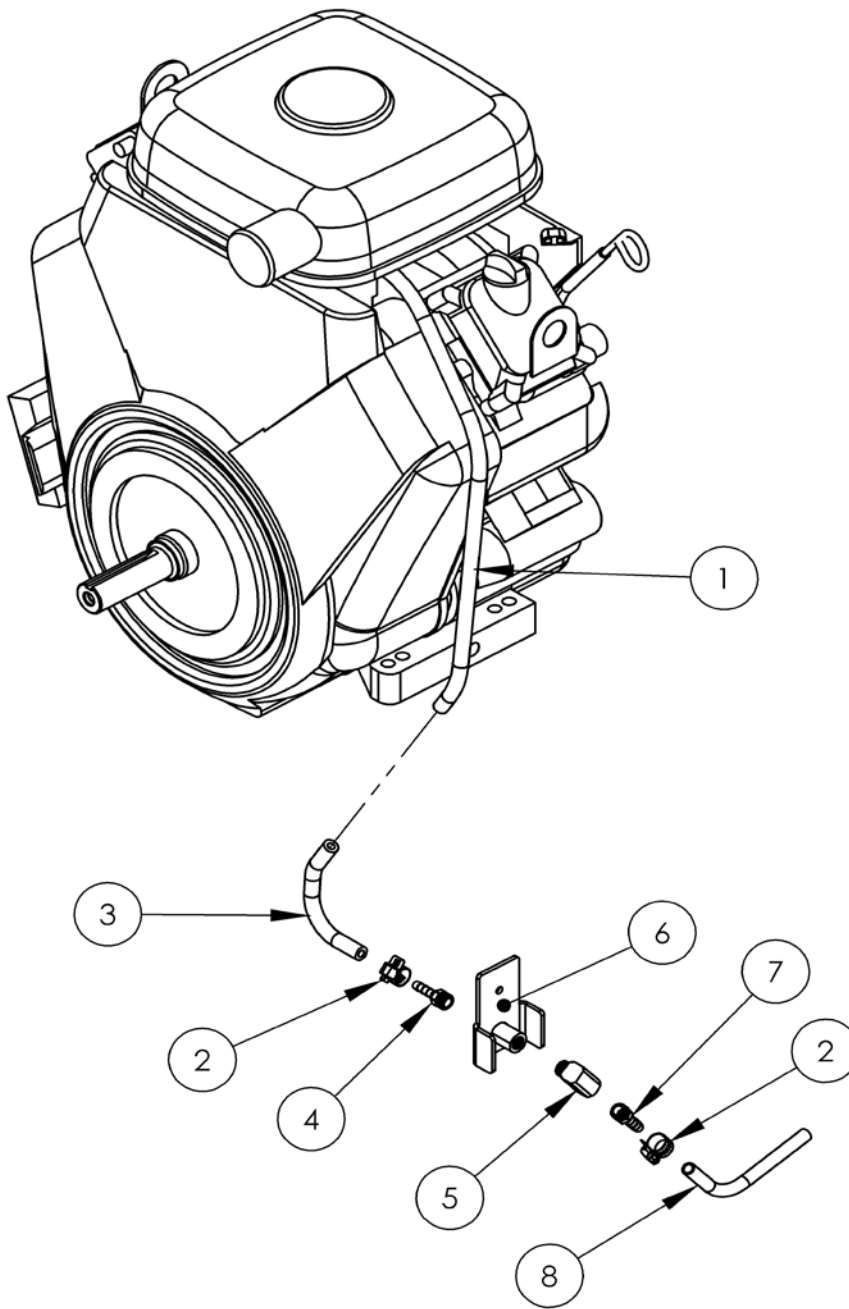
SECTION 5



69-230 ASSY, FLOAT VALVE

Item No.	Part Number	Qty	Description
1	66-256	1	BODY, FLOAT VALVE BOTTOM HALF
2	66-257	1	BODY, FLOAT VALVE TOP HALF
3	66-235	1	NUT, FLOAT VALVE MOUNTING
4	61-565	1	WELDMENT, FLOAT VALVE LEVER
5	10-148	1	SCREW, SHOULDER, 8-32 X Ø3/16 X 1.0L
6	11-001	1	NUT, 1/4-20 SS
7	11-067	1	NUT, 8-32 HEX LOCK SS
8	28-009	1	FLOAT, OBLONG BALL 2.5 X 4.0, 7 OZ
9	28-010	1	BALL, .375 HARDENED SS
10	41-085	1	O-RING, SILICONE AS568A DASH NO. 910
11	15-031	1	PIN, SPRING, .125 X .375 SS

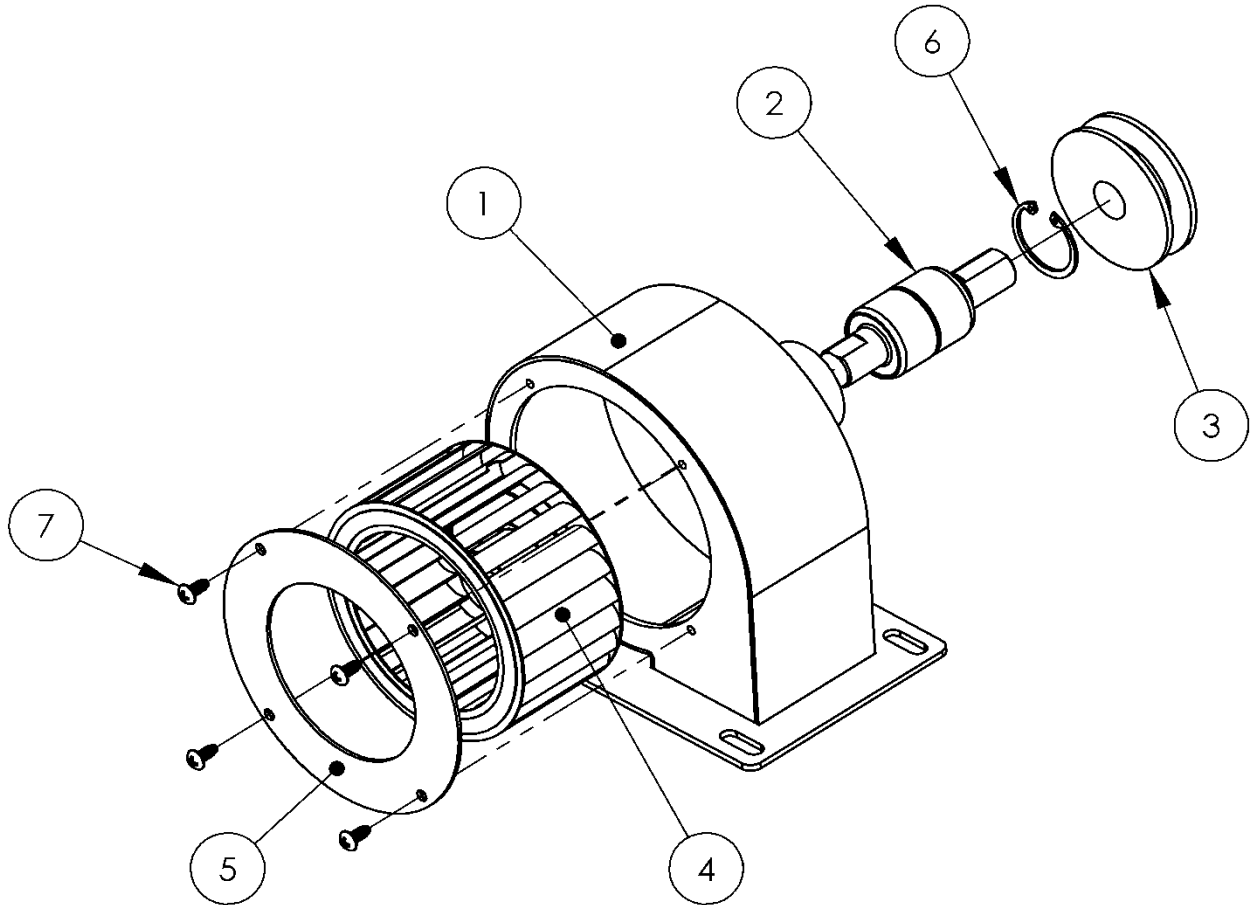
SECTION 5



69-259, ASSY, GAS LINE BRACKET

Item No.	Part Number	Qty	Description
1	16-086	1	HOSE, FUEL 1/4 30R7
2	14-007	2	CLAMP, HOSE FUEL #4
3	16-086	1	HOSE, FUEL 1/4 30R7
4	21-166	1	1/4 MP X 1/4 H BARB
5	21-039	1	ELL, 1/4 IN STREET BRASS
6	61-489	1	ASSY,GAS LINE BRACKET
7	21-006	1	FTTG, BRB 1/4P X 5/16H BR
8	16-065	1	HOSE, FUEL 5/16 30R7

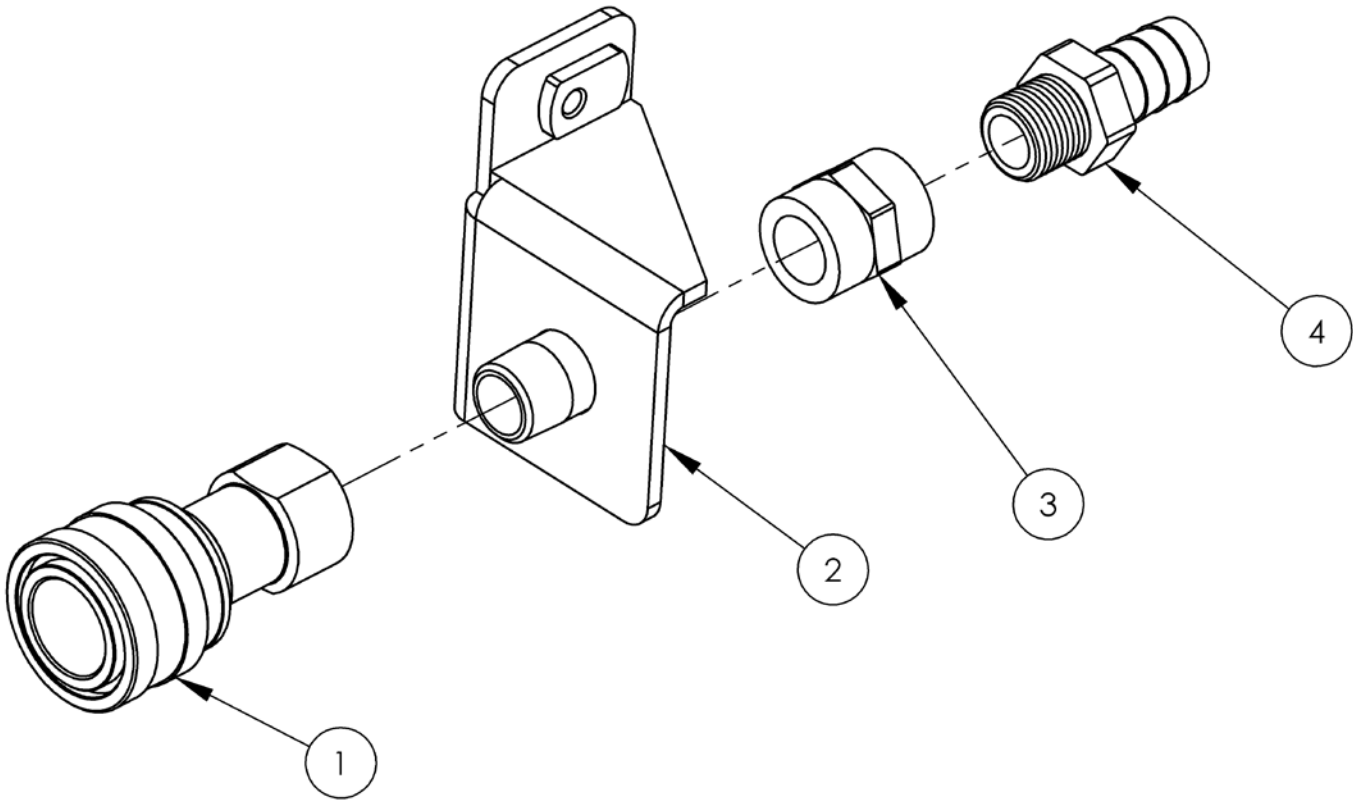
SECTION 5



69-184 ASSEMBLY, BLOWER, BELT GUARD

Item No.	Part Number	Qty	Description
1	61-465	1	WELDMENT, BLOWER HOUSING
2	39-008	1	ASSY, BEARING & SHAFT
3	66-215	1	PULLEY, 3L BELT X 2.340 OD
4	36-335	1	IMPELLER, BELT GUARD BLOWER
5	60-398	1	PLATE, BLOWER HOUSING FRONT RING
6	15-027	1	SNAP RING, 1.187 INTERNAL
7	10-146	4	SCREW, 8-32 X .375 PHP F THREAD CUTTING ZP

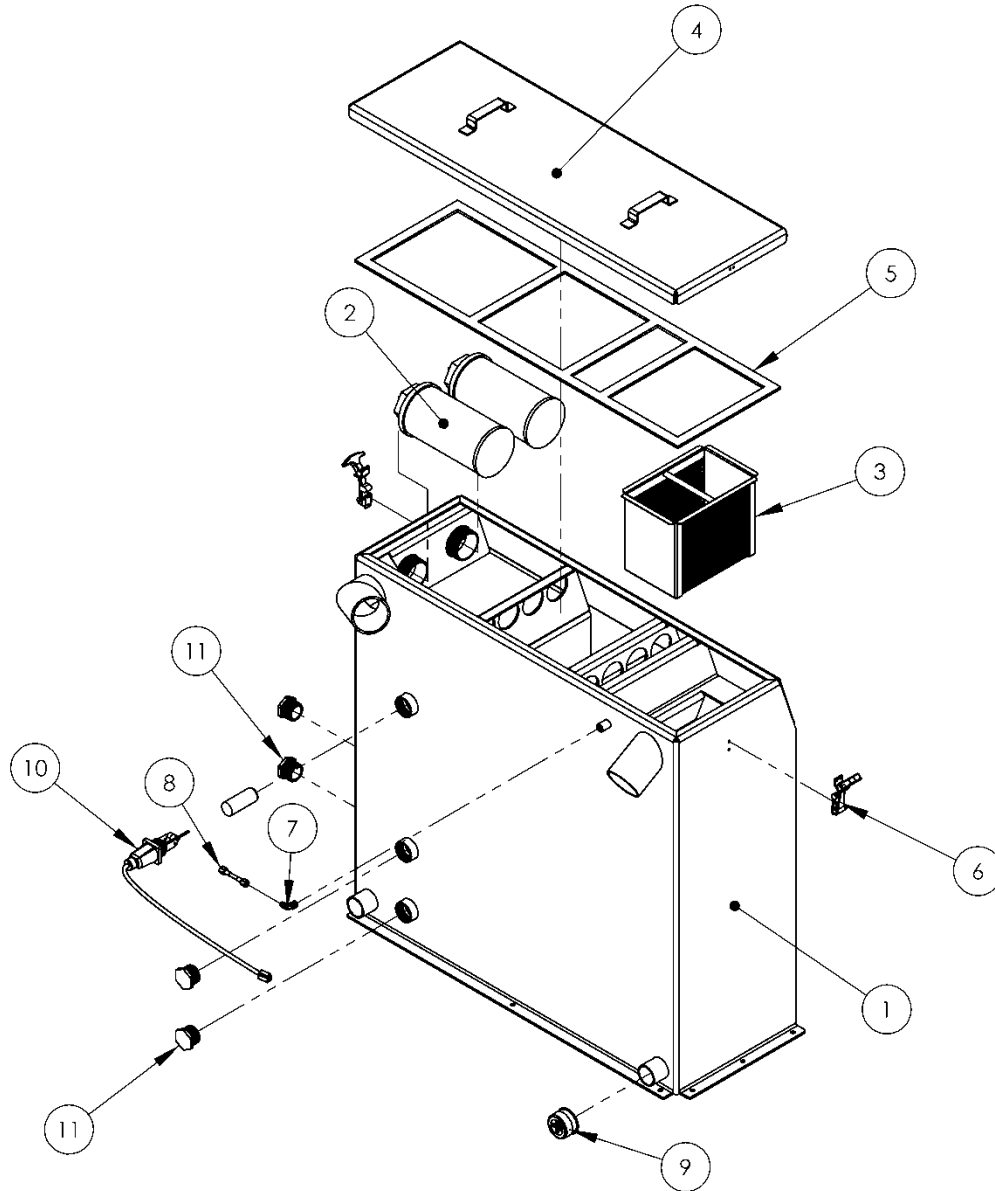
SECTION 5



69-211 ASSEMBLY, BRACKET QD FITTING

Item No.	Part Number	Qty	Description
1	61-507	1	WELDMEN, BRACKET QD MOUNTING
2	25-005	1	QUICK COUPLING, .375F X .375FP, BRASS
3	21-073	1	COUPLING, 3/8 NPT BRASS
4	21-261	1	FITTING, 5-8 H BARB X 3-8 NPT BRASS

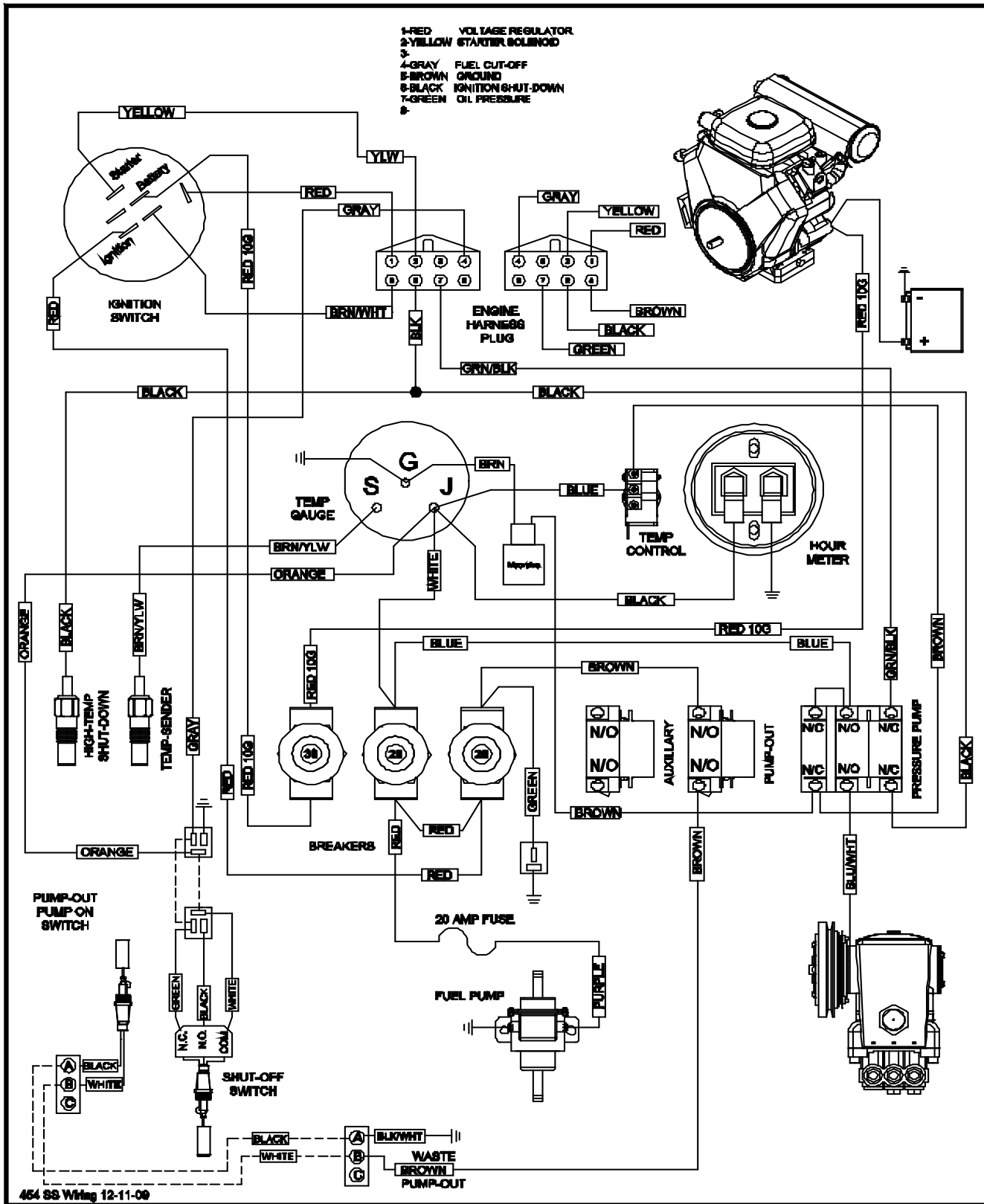
SECTION 5



69-250, ASSEMBLY, WASTE TANK

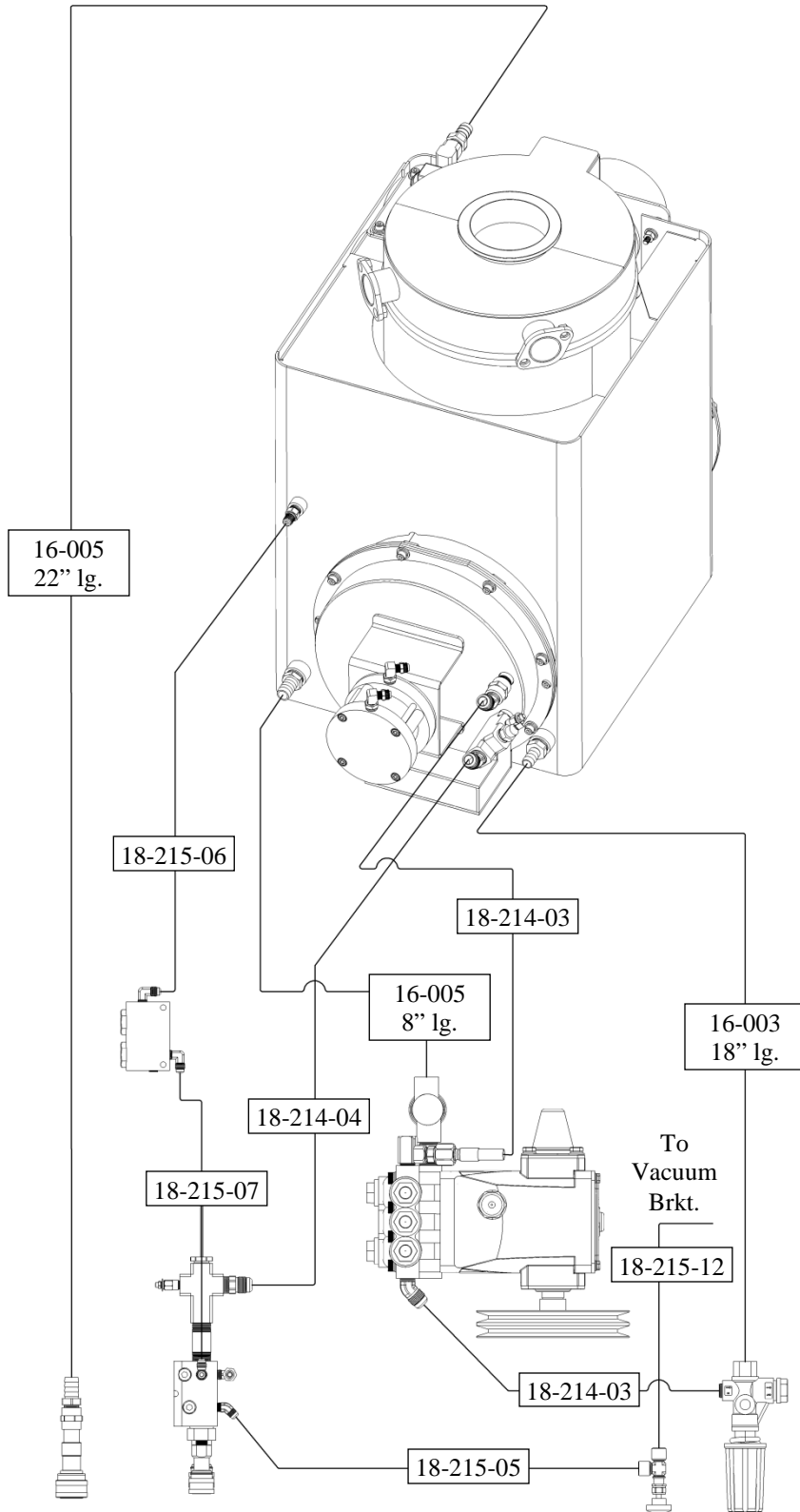
Item No.	Part Number	Qty	Description
1	61-593	1	WELDMENT, WASTE TANK
2	20-009	2	2.5 NPT X 5.0 FILTER SCREEN
3	61-002	1	WELDMENT, STRAINER BASKET
4	61-587	1	WELDMENT, LID
5	41-018	1	GASKET, SPONGE 1 IN X 45 IN
6	40-003	2	LATCH, PRE-FILTER BOX
7	21-064	1	ELL, 1/4 P X 1/4 T, BRASS
8	18-215-16	1	HOSE ASSEMBLY, 3-16 ID X 38 OL
9	19-009	1	CAP, PLUG 2IN RUBBER
10	69-000	1	FLOAT SWITCH
11	21-097	4	PLUG, 1-1/4 IN PVC

SECTION 5 ELECTRICAL DIAGRAM



SECTION 5

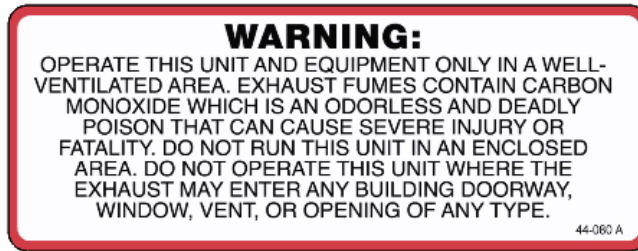
Hose Identification



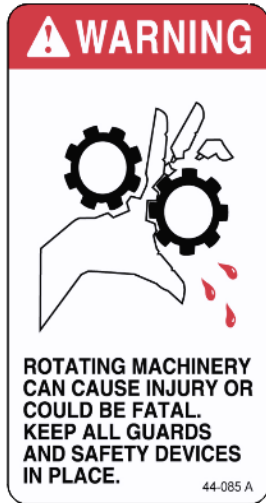
SECTION 5



44-084 DECAL,
CAUTION, HOT SURFACE



44-080 DECAL,
WARNING, USE IN WELL VENTILATED AREA



44-085 DECAL,
WARNING, ROTATING MACHINERY



44-067 DECAL,
WARNING READ MANUAL



44-066, DECAL
WARNING ELECTRICAL SHOCK



44-090 DECAL, MANIFOLD MAINTENANCE



44-079 DECAL, UNLEADED FUEL ONLY



44-077 DECAL, 454 SS®

11. ACCESSORIES

67-014 STRYKER WAND

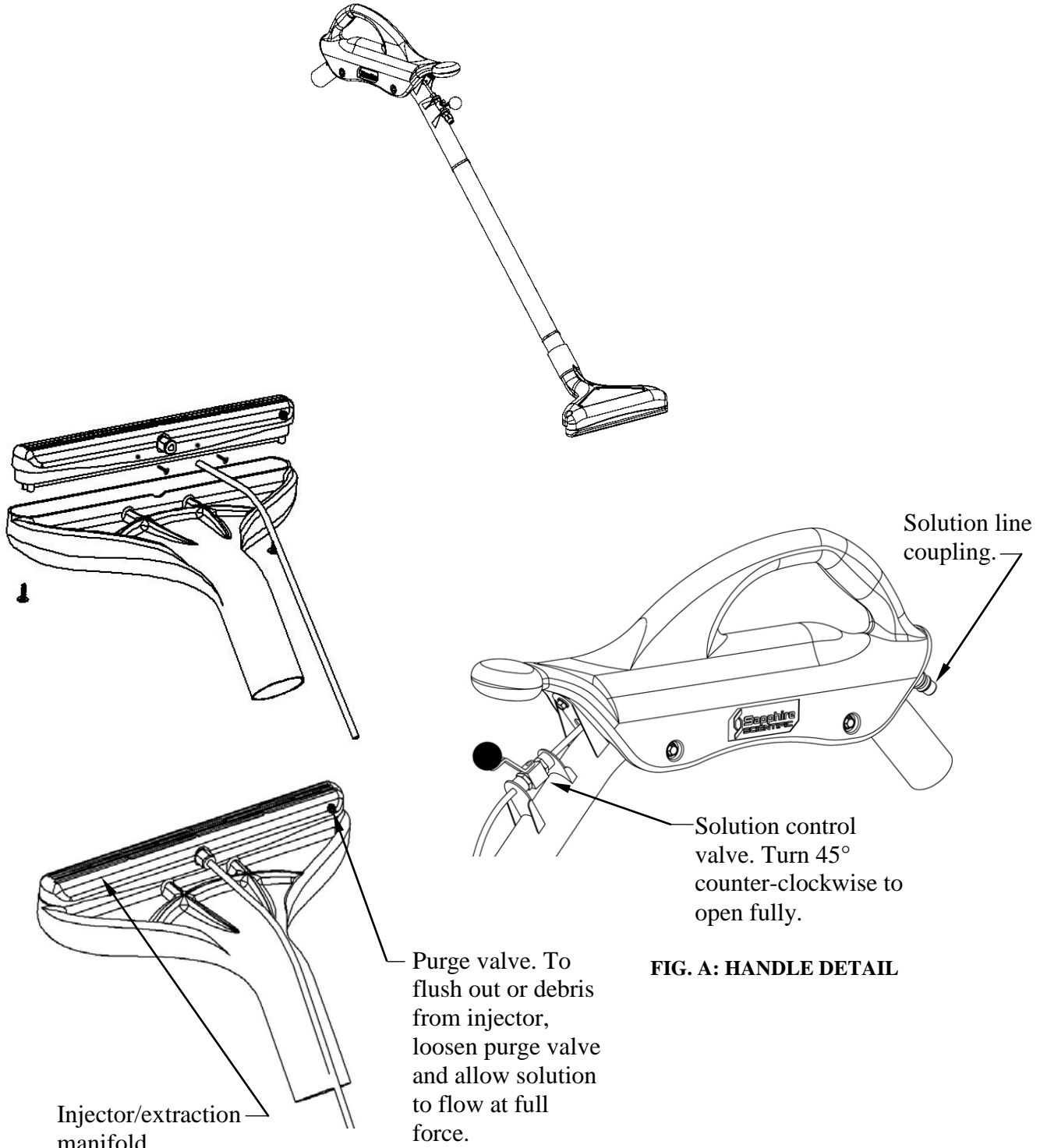
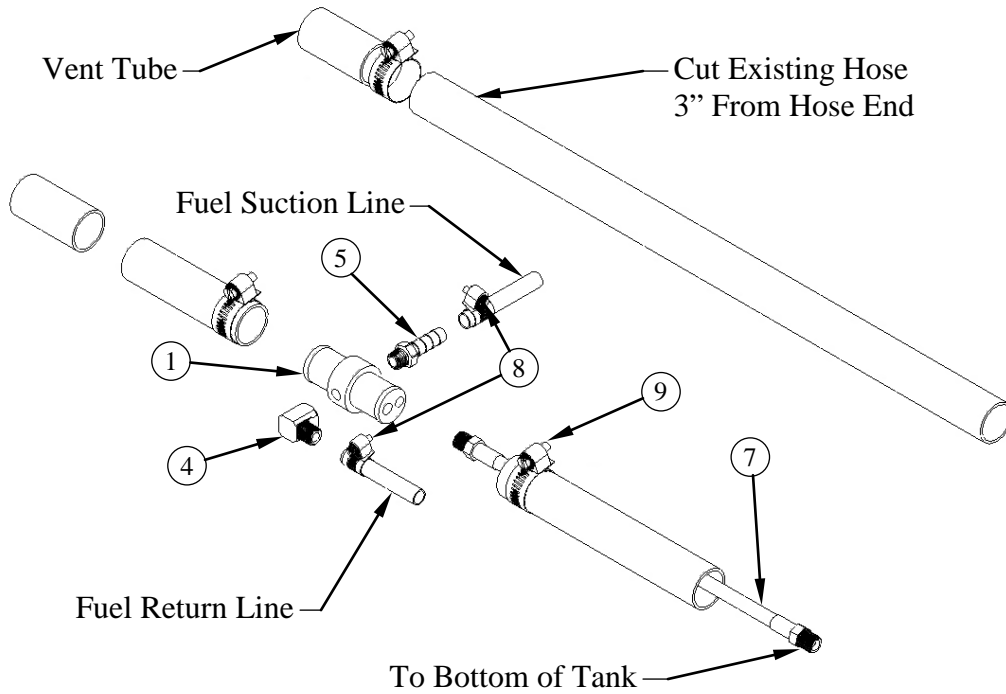


FIG. B: EXTRACTION HEAD (Bottom view)

FIG. A: HANDLE DETAIL

SECTION 5

1992 TO 2002 FORD FUEL LINE INSTALLATION

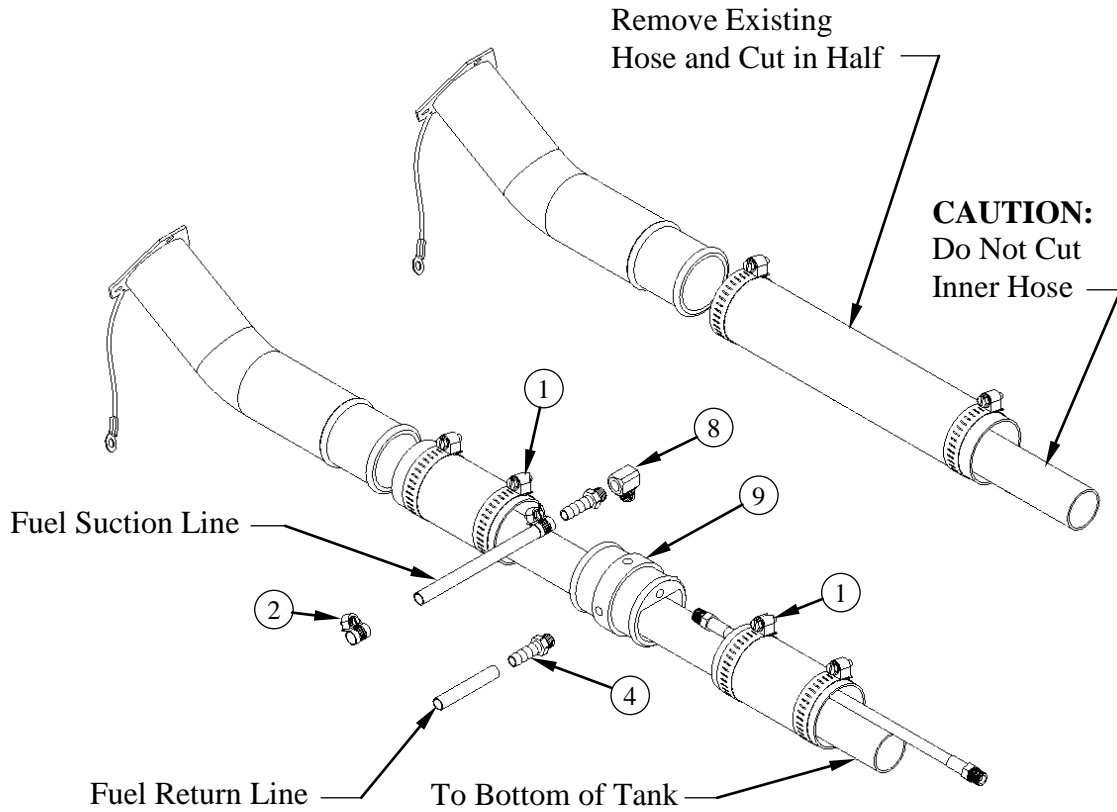


69-005 KIT, FUEL HOOKUP FORD FI

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

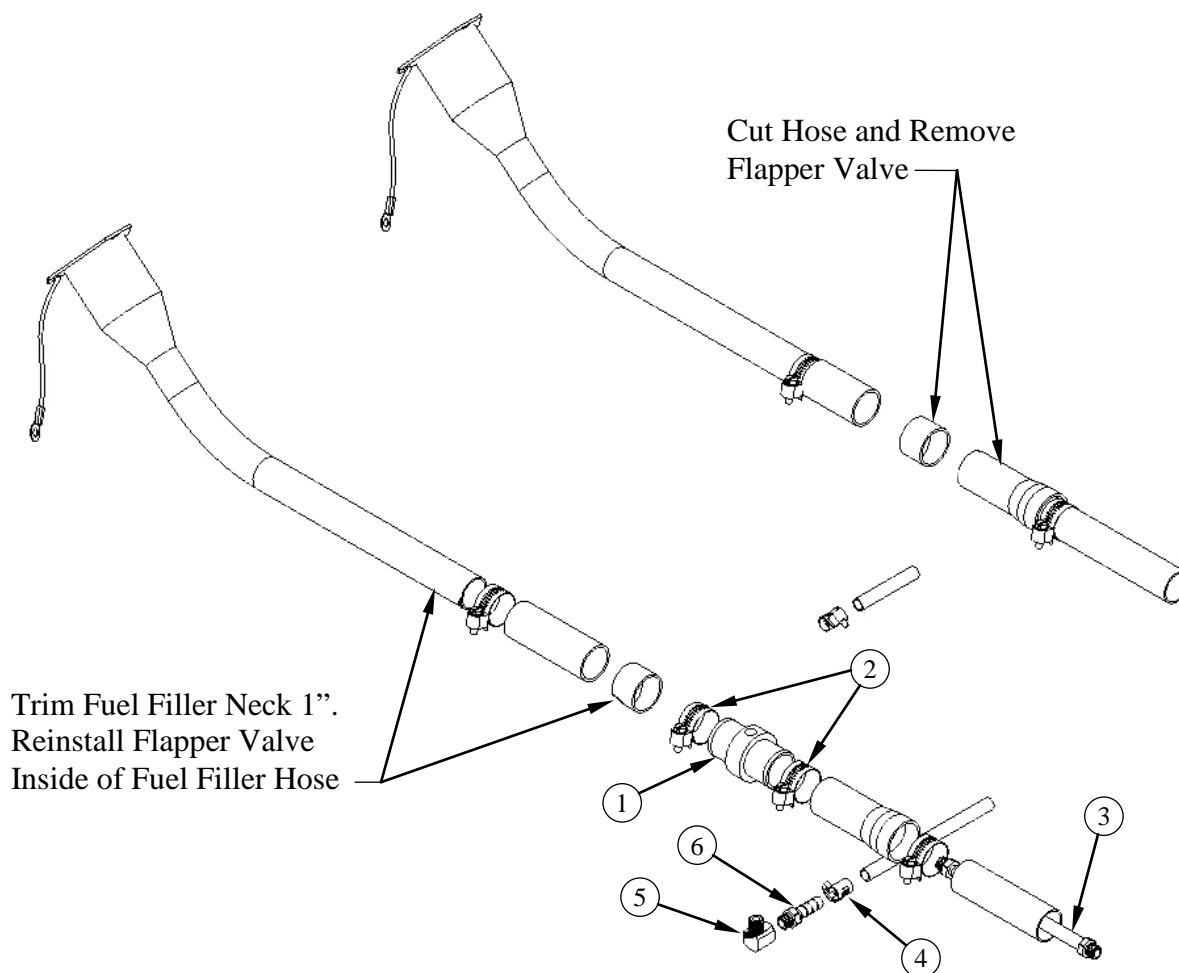


69-003 KIT, FUEL HOOKUP 97 & 2002 FI

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

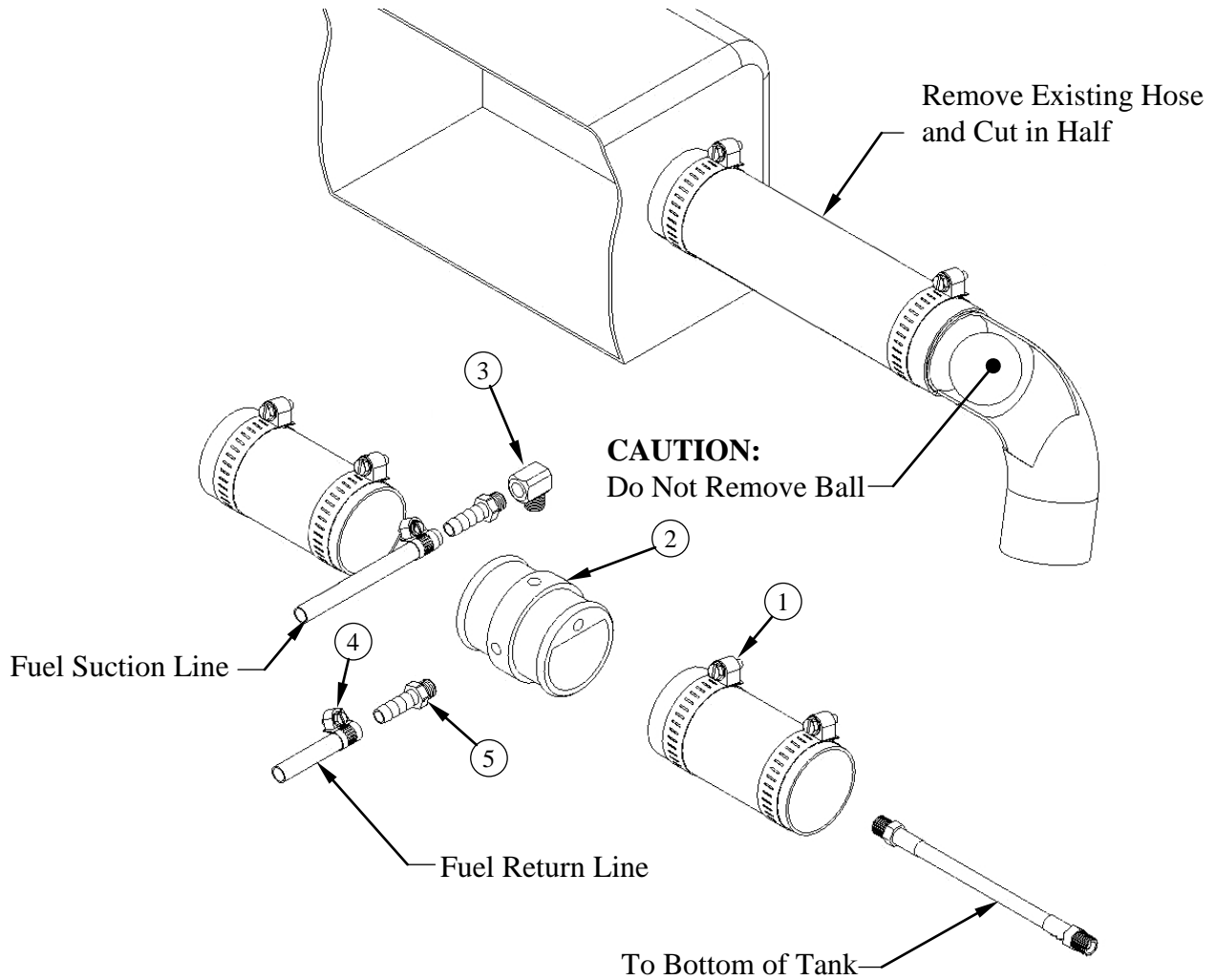


69-018 KIT, FUEL HOOKUP 2003 CHEVY FI

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

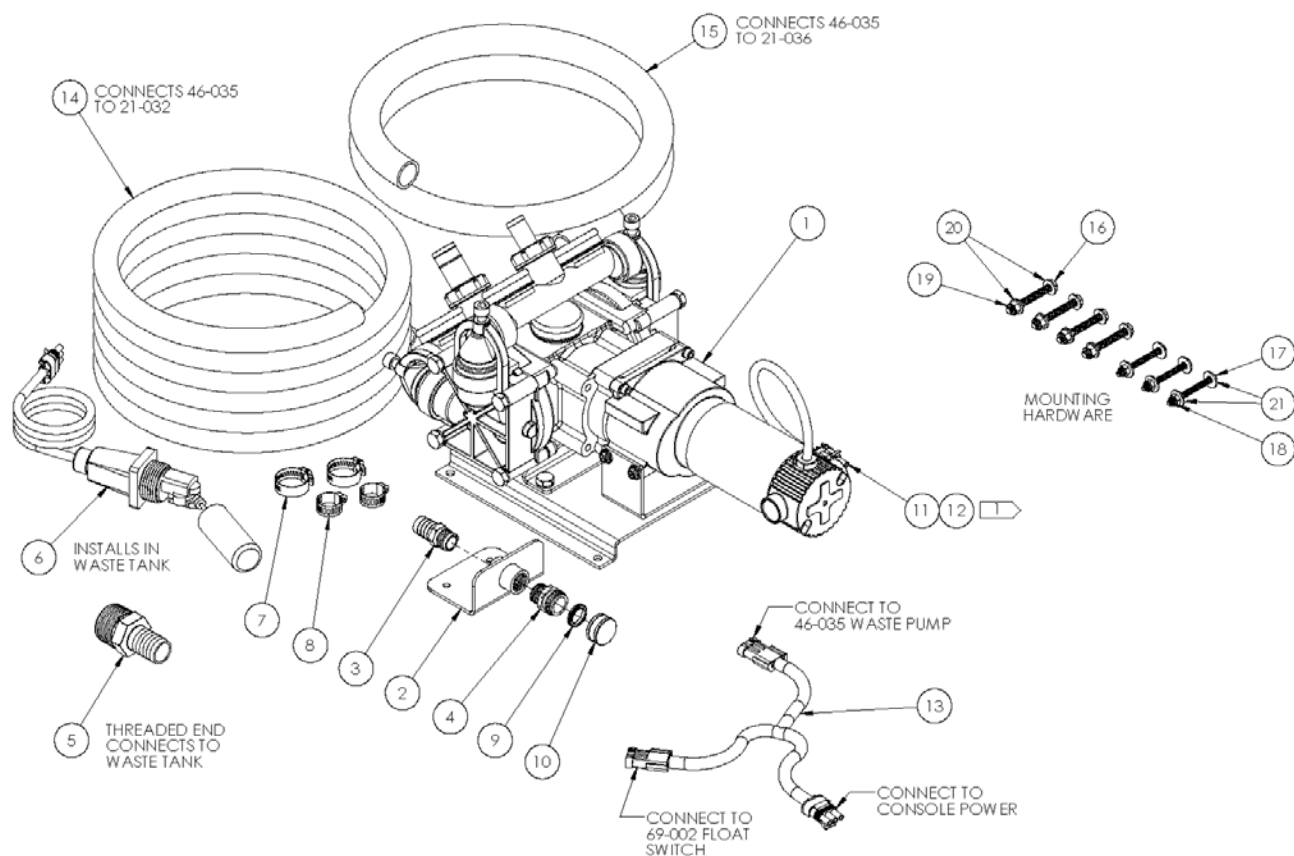
1997-2002 DODGE FULL SIZE VAN FUEL LINE
INSTALLATION



69-004 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



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 ½ P X ¾ H BRASS
4	21-398	1	FTTG, GRDN HOSE ½ P X ¾ 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 ¾ BRASS
11	31-016	1	CONN, 3 PRG ½ TWR #38045 WAYTEK
12	31-019	3	PIN, FEMALE #31035 WAYTEK
13	47-031	1	HARNES, WASTE PUMP OUT
14	16-004	6 FT	HOSE, WTR ¾ 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 ¼-20 X 2-1/2
18	11-013	3	LKNUT, ¼-20 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 ¼ USS