

2 Installation

Purpose

This chapter provides operating instructions/procedures for installation and startup of the *StingRay Parts Washer*. Correct installation of the washer is important for the following reasons:

- To ensure that the washer functions properly.
- To ensure that placement of the washer on your shop floor fits into the workflow pattern.
- To validate your warranty.

Prerequisites

Before you begin to install the parts washer, be sure you have followed the recommendations in this section.

- Information:** Read the entire manual before installation.
- Expert Help and Equipment:** For leveling, anchoring, installing, and startup have the following on hand:
 - Qualified, trained personnel
 - Proper lifting equipment
 - Anchoring materials
 - Steel shims
 - Flue pipe (for gas heated machines only)
 - Auto Steam Exhaust (ASE) pipe
 - Power supply wires, ground, conduit & fittings.
 - Water-tight hub for incoming power & conduit.
 - Rain cap(s)

- Hand-Tools, including masonry drill (Continued)
- Voltmeter and amp meter
- ❑ **Steam-Exhaust PVC Kit:** Order your kit through StingRay. Refer to section "*Steam Exhaust (Output)*" in this chapter.
- ❑ **1/2-inch NPT water regulator,** if your water pressure is greater than 125 PSI (862 kilopascals).
- ❑ **Compressed Air Filter and Regulator:** 1/2-inch NPT size. (You will need this only if compressed air is required for your washer.)
- ❑ **Placement Planning:** Refer to your *Services to be Provided by Others and Service Requirements (SBO)* letter from StingRay for specific utilities required for your parts washer, and its overall dimensions. Here is a checklist to use as you plan placement:
 - **Route:** Plan the route you intend to use to move the washer from the loading dock to its installation location. Refer to the SBO for the washer's overall dimensions and weight. Be sure the washer will fit through all doorways.
 - **Maintenance and Service Access:** Leave enough access space around the washer in the installation location to reach all system components for maintenance and service, especially the pump area (pump removal). StingRay recommends a minimum of 3 feet. Allow for cleanout with the door in full-open position (180° angle from the cabinet doorframe).
 - **Operations Access:** Leave adequate space to work with the washer during normal operations. Allow sufficient room for loading and unloading the washer with the door in a half-open position (90° angle from the cabinet doorframe).
 - **Overhead:** Allow for easy installation of flue pipes and steam-exhaust pipes. Be sure the area is clear of overhead shop equipment. Plan for the shortest and most direct run, to avoid needing a larger steam-exhaust motor or more complex piping.
 - **Roof:** If you intend to run the steam-exhaust and gas flue pipes through the roof, be sure this is feasible. Plan for the shortest and most direct run, to avoid needing a larger steam-exhaust motor or more complex piping.

Ensure that flue-pipe clearances from combustible material are in accordance with NFPA, local, state, and national standards and/or the flue manufacturer's instructions.

- *Utilities:* Check how far utility sources are from the washer -- gas, water, compressed air, and electricity. Plan for the *exact* route you intend to use -- the shortest and most direct run -- to avoid complex wiring and piping.

CAUTION! Do not run electrical or other utility conduits over the pumps as they may prevent removal of the motor or pump.

- *Combustion Air:* If you have a gas-type burner as a heat source, ensure there is an adequate supply of combustion air in the area in which the burner is located to assure complete combustion at all times.

If the parts washer is installed in a room by itself, the room should have its own combustion air supply. This should take the form of louvers through an outside wall, or, if the room is in the center of a building, properly sized ductwork to a source of outside air.

If the Parts Washer is located in a large open area of a plant, it will normally draw its combustion air from inside the plant. However, problems will arise if there is an imbalance between exhaust and makeup air in the plant such that there is a positive or negative pressure relative to outside.

Refer to the latest issue of the *National Fuel Gas Code* (American National Standard ANSI Z223.1) for details. In general, it specifies that a permanent opening or openings have a total free area of not less than 1 square inch (2.5 sq. cm) per 4,000 BTU per hour total input rating of all appliances is required.

- *Floor:* Plan to set the washer flat on the floor, so that it can be anchored to the floor for safe door loading.
- *Options:* If you have ordered optional equipment, such as the sludge scraper, allow adequate space in the washer area for operation and maintenance.
- *Grounding -- Electrical:* Plan for a proper grounding system to reduce the risk of electric shock.
- *Earthground -- Corrosion:* Plan for an earthground to prevent corrosion.

Results of Correct Installation

If you plan the placement of your washer and follow other StingRay-recommended installation procedures, you should achieve the following results:

- A safe installation
- Proper accessibility to the washer for operations and maintenance
- Proper and efficient functioning of all utilities
- Proper functioning of all cycles, according to specifications
- Assurance that your warranty is valid and in effect

Safety/Precautions

Before you begin installation, read and follow these recommended safety/precaution instructions:

CAUTION! GROUNDING INSTRUCTIONS: The washer must be grounded! Grounding provides a path of least resistance for electric current, thus reducing the risk of electric shock during maintenance, troubleshooting, or repair.

CAUTION! GROUNDING INSTRUCTIONS: The washer must be connected to a grounded, metal, permanent wiring system. The equipment-grounding conductor must be run with the circuit conductors and connected to the equipment-grounding terminal on the washer.

WARNING! IF YOUR PARTS WASHER USES A GAS BURNER: If you do not follow installation and operating instructions exactly, a fire or explosion may result, causing loss of life, personal injury, or damage to property. Do not store or use gasoline or other flammable vapors and liquids in the vicinity of the Parts Washer.

WARNING! VENTING OF EXHAUST GASES: Do NOT vent exhaust gases into a wall, a ceiling, or a concealed space of a building. Refer to the instructions in this chapter for correct vent installation instructions.

WARNING! Be sure that the people installing the equipment and the Parts Washer are qualified and trained for the task. They should meet any licensing standards required in your area.

WARNING! Set up your Parts Washer installation to conform to all local, state and national code requirements.

WARNING! Do NOT add water, chemical, or turn on the power during installation! These steps are part of the startup procedure: Wait until "Startup Procedure," at the end of this chapter, to add water, chemical, or turn on the power!

WARNING! The parts washer is designed to be installed inside a building, not outside.

What You Will Learn In This Chapter

In this chapter you will learn the following about installing the washer:

- Lifting and moving
- Placement
- Unpacking
- Leveling and Anchoring
- Services and Connections
- Startup Procedure
 - * Power-up
 - * 7-Day clock initialization



1. Lifting and Moving

After you have planned the placement of the washer and selected a suitable site, use one of the following methods to lift and move the washer:

1. Use a **forklift** to lift and move the washer: lift only on the machine perimeter base frame. The forks must be long enough to reach to the opposite side of the base frame.

WARNING! *Be sure the forks extend far enough. DO NOT lift on the floor of the washer. Lifting the washer in such a way that the ends of the forks hit the floor of the washer will damage the floor.*

2. You may also use **machinery rollers**. Be sure to lift or support the washer on the perimeter of the base frame only.
3. Use a **crane** to raise the washer by the *lifting eyes*, located on the top left and top right sides of the cabinet, as shown in FIG. 2-1.

WARNING! *Use lifting equipment rated for the weight of your parts washer. To find out the weight, refer to the StingRay Parts Washer specification section in the Services to be Provided by Others and Service Requirements (SBO) letter that you received from StingRay.*

WARNING! *Lift the washer by the lifting eyes only. DO NOT attach chains or cables to a central point from the washer lifting eyes as the sidewalls and roof of the cabinet may collapse or you may bend the lifting eyes. Use a spreader beam to divide/spread the vertical load to each eye.*

WARNING! *Stand clear of the washer during lifting and moving.*

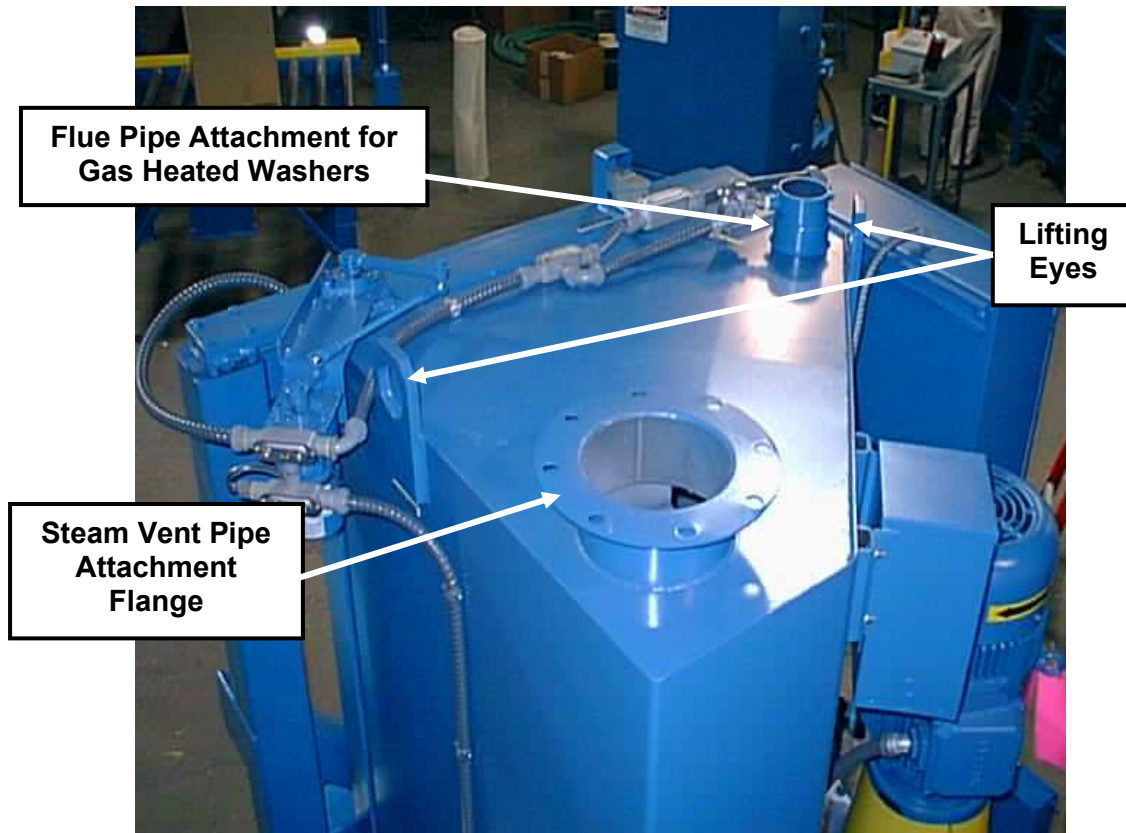


Fig. 2 - 1: Raising the Parts Washer by the Lifting Eyes

2. Placement

After you have moved the washer to the installation location, place it according to your plan. Watch the overhead and side areas around the washer as you place it. Walk around the washer and verify clearances.

Refer to section "*Prerequisites, Placement Planning*" at the beginning of this chapter for placement guidelines and recommendations.

You may want to jot down special placement notes here as you plan:

3. Unpacking

After you have placed the washer in the installation site, unpack it. Check the packing slip (attached to the washer) to see *what* to look for.

Note: Many items and accessories are shipped in the washer cabinet on the turntable.

Follow this general procedure:

1. Remove the packing material from the outside of the washer cabinet.
2. Remove the tie wrap securing the door latch. Unlatch the cabinet door and open door slowly and carefully.

NOTE: Some items secured to turntable may have shifted during shipment.

3. Remove the cartons strapped to the turntable.
4. Check all standard items, accessories, and documentation against the packing slip. Refer to Fig. 1-1 and Fig. 1-2 to identify major components.
5. Remove the rubber grommet and tie from the stainless steel rod coming out of the top of the Water Level Solution Control box. The grommet is used to protect the float ball during shipment and can be discarded.
6. Open the electrical control panel. Inside the enclosure you will find a manila pouch with the following:
 - Vendor Cut Sheets and Manuals
 - *Field Startup Procedure (FSP)* form
 - SBO (Service By Others)
 - Electrical Ladder Diagram and Panel Layout
 - Washer Manual
 - Replacement parts BOM (Bills Of Material)
 - Cover Letter
 - Service Schedule

After you have moved, placed, and unpacked the washer you are ready to perform the following parts of the installation process:

- Leveling and anchoring
- Connection procedures
- Services and connections verification
- Startup procedure

IMPORTANT! Before you go any further, get the *Field Startup Procedure (FSP)* form (it is in a pocket on the inside of the electrical control panel door). You will use the form as a checklist to ensure correct installation as you follow the steps in the next several sections.

Use the Field Startup Procedure (FSP) form in this way:

1. As you install the washer, fill in the *Field Startup Procedure (FSP)* form.
2. After you have completed a successful installation, sign and date the form.
3. Make 1 copy and keep for your records. Mail/FAX to StingRay the other copies being sure it is properly signed and dated.
4. Keep your copy in your maintenance records. You will need it during maintenance procedures, and any time you call StingRay.

NOTE: Information gathered on the **Field Startup Procedure Form (FSP)** is **critical** in verifying initial performance and in providing a benchmark for future diagnostic and troubleshooting efforts! **Be sure to fill in the FSP during installation!**

4. Leveling and Anchoring

The parts washer should be placed on a flat floor suitable for "anchoring" the washer. For example:

- Concrete floor
- Concrete pad
- Steel structure

4.1. Leveling

Follow this procedure:

1. Find the leveling and anchoring feet (at each corner of the washer at floor level).
2. Find the leveling bolt/nut and the anchor hole on each leveling and anchoring foot.

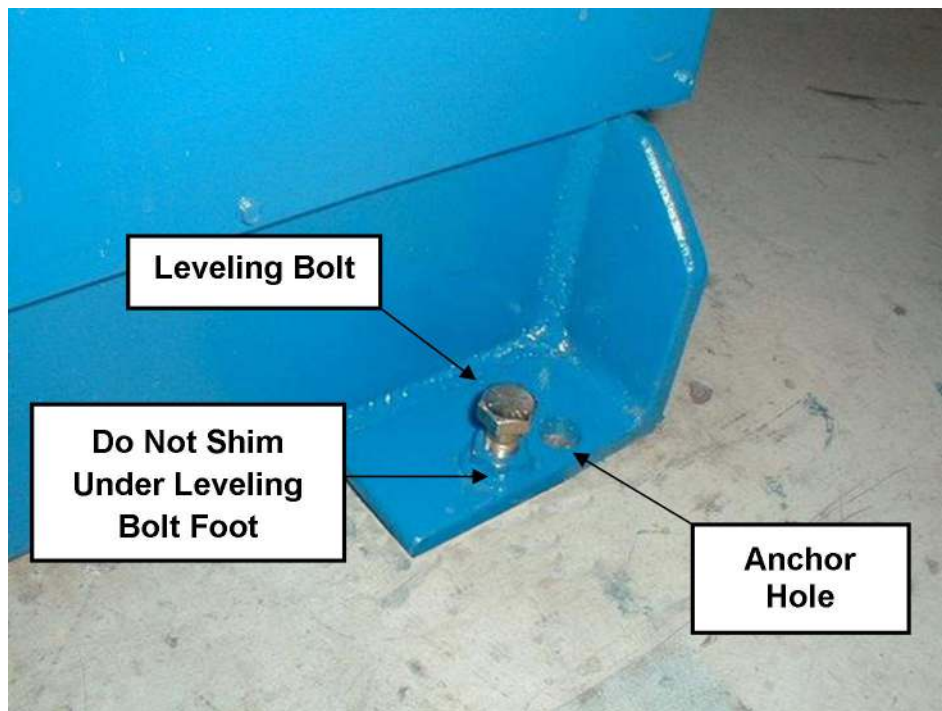


Fig. 2 - 2: Leveling and Anchoring Feet

3. Adjust the leveling bolts so the cabinet door will stop and remain in any open position with minimum "creeping" to a more open or closed position. Do **NOT**

level the machine using a bubble level on the reservoir or other part of the machine.

Turn the leveling bolt *clockwise* to *raise* the corner of the cabinet. Turn the leveling bolt *counterclockwise* to *lower* the corner of the cabinet.

4. Level the washer from front to back first, then side to side.
5. After leveling, shim under the frame of the washer, so that the washer frame is supported by the shims, NOT by the leveling bolts. Shim under the door post, door frame, and at each corner. Place additional shims under the entire frame, at least three feet apart (quantity required will depend on machine size (refer to Fig. 2-3). For clamshell-style washers, place shims under the vertical turntable support tube.

Follow this procedure:

A. Start with all leveling bolts adjusted so machine frame is sitting on the floor. While holding the door open slightly away from the door seal

Note: If the door swings closed, raise the rear leveling bolts. If the door swings open, raise the front leveling bolts. Continue to adjust the front or rear leveling bolts until the door stays in position.

B. Open the Door to a position that is 90° to the doorframe. Determine if the door swings to the left or right.

Note: If the door swings right, raise the right side leveling bolts, raising the leveling bolts together. If you add three turns to the front side bolt, add three turns to the level bolt in the rear on the same side. Continue raising the bolts until the door stays at the 90° open position.

C. Recheck the door swing with the door slightly open. Adjust the front or rear leveling bolts in tandem to keep the door motionless.

D. Position the door so it is open to a 45° angle from the doorframe. The door should remain motionless in this position. If it does, you have a perfectly level doorpost. If not, repeat the previous steps until the door remains motionless at any open position.

Note: This procedure positions the upper and lower doorpost shafts so they are in plane both front to rear, and left to right.

5. After leveling, ***shim under the frame*** of the washer, so that the washer frame is supported by the shims, *not* by the leveling bolts. Shim under the door post, door frame, and at each corner. Place additional shims under the entire

frame at least every three feet apart (quantity required will depend on machine size) (Refer to Fig. 2-3).

WARNING! Do not shim under the leveling/anchoring feet. This will interfere with the leveling bolts. Shim under the frame of the washer only.

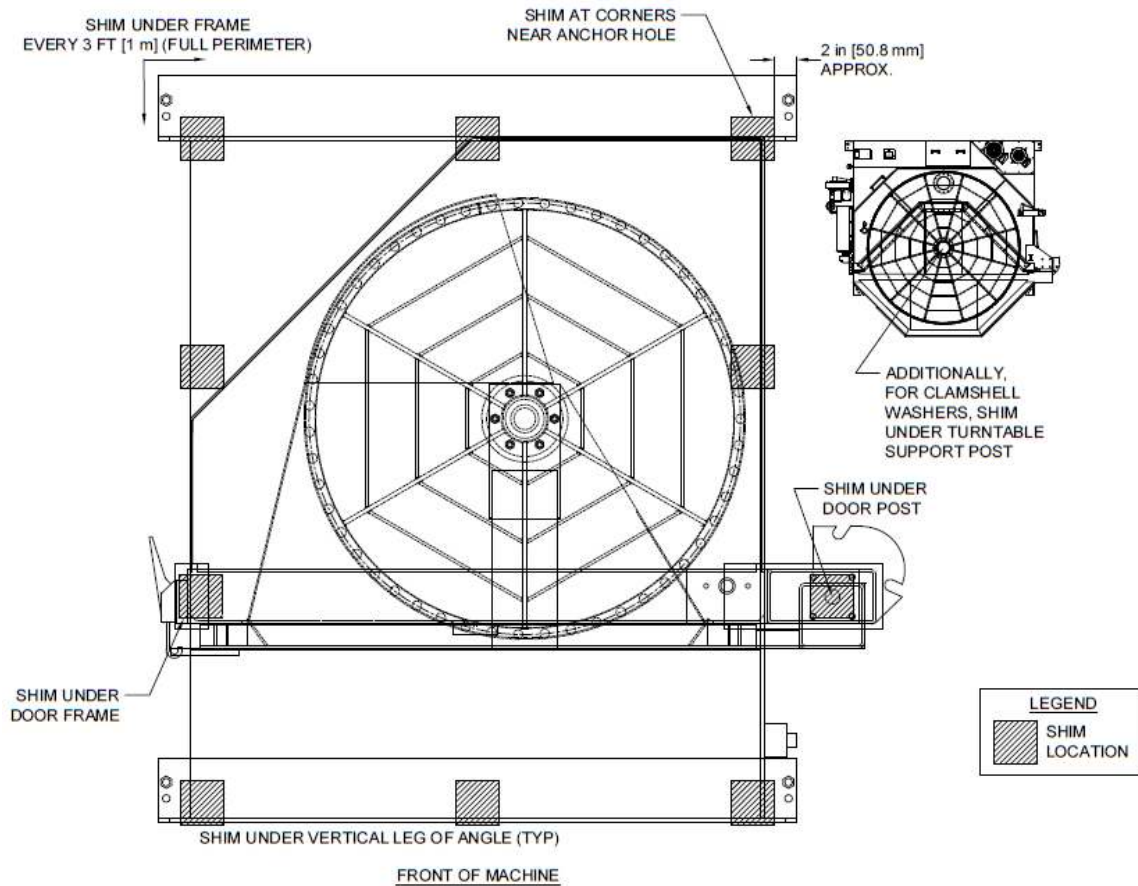


Fig. 2 - 3: General Shim Placement, Top View of Base Frame

6. When the washer is level and the shims are in place, back off the tension of the screws on the leveling bolts, so that the washer rests solidly on the shims.
7. Re-check the door to be sure it does not "creep." If it does, repeat the leveling and shimming procedure.

4.2. Anchoring

After you have properly placed, leveled, and shimmed the parts washer, anchor it to the floor.

Follow this procedure:

1. Use the anchor holes provided. Generally, there is an anchor bolt location on each leveling/anchoring foot. Depending on the washer size and configuration, there may be additional anchor bolt locations, i.e. SR72, SR84 & SR100 washers have additional anchor bolt holes on the rear base angle. Washers with the optional Jib Crane have anchor bolts at the base of the vertical I-beam.
2. Use anchor bolts whose diameter equals the diameter of the anchor holes. Consult your local distributor of anchoring products for an anchoring system that meets your requirements.
3. Install the anchor bolts solidly and completely into the floor, so that each bolt can carry its full tensile strength. (StingRay recommends an epoxy-injection bolt-anchoring system.)
4. You may wish to grout the washer's base angle, and on clamshell-style washers, the turntable vertical support tube, also. If so, keep the following in mind:

Grouting is designed to fill the area between the base angle and the concrete -- permanently and completely -- and securely bond the base angle to the concrete. However, grout is not "glue," nor does it do the work of the anchor bolts. It is meant to provide vertical support and absorb operating forces. Additionally, grout seals the base angle to the floor, so that water and moisture cannot get under the washer and cause corrosion.

When placing grout, follow the manufacturer's detailed instructions to the letter! This will help prevent voids and other grout-repair problems later.

In general, use only non-shrink grout. The distributor should be able to tell you whether the grout has been tested for shrinkage, before and after hardening. And remember that most epoxy grouts require bone-dry concrete.

For example, for concrete flooring, StingRay recommends an epoxy grout. To test for dryness of concrete, tape a rubber mat or plastic sheet to the concrete; check for condensation after 24 hours. Don't apply the epoxy if there is any moisture.

Your distributor should give you the manufacturer's detailed instructions for:

- Preparing the base angle

- Equipment needed
- Mixing the grout
- Application

5. Services and Connections

Begin services and connections *only after* you have leveled and anchored the washer.

5.1. Introduction

You are now ready to connect the utilities to the washer, and install options. To do this, use your utilities connection plan, devised during placement planning. (Refer to section "Prerequisites, Placement Planning" at the beginning of this chapter.)

Your plan and the SBO tell you which of the following utility connections and options' installations you must make. Use this manual to locate the connections on the parts washer.

WARNING! Be sure that the people who install the parts washer and make connections are qualified and trained for the task. They should meet all licensing standards required in your area.

Utility connection procedures are divided into two major parts:

- Inputs
- Outputs

These are discussed in the sections that follow.

After you have connected utilities, install any options you may have purchased from StingRay.

5.2. Connection Procedures - Inputs

This section describes *input* connection procedures. The next section describes *output* connection procedures.

Use your placement plan and the SBO form to determine which of the following utility connections you must make.

Input Utility Connections:

- Heat source
 - Gas (natural and propane)
 - Electric
 - Steam
- Water
- Compressed air
- Electricity

Depending on your parts washer configuration and optional equipment, refer to the applicable sections in this manual for information on making the necessary connections.

5.2.1.Heat Source

Depending on the washer's configuration and options, it will use one of the following heat sources:

- Gas (natural and propane)
- Electric
- Steam

A description of each type of heat source follows.

Gas & Oil Heat Source

For proper connection of the gas heat source, natural or propane, refer to the specifications in the SBO and to the vendor manual provided with the burner.

Burner Mounting

The parts washer is equipped with a burner, as shown in one of the following figures. Locate the figure that refers to your burner size. **NOTE:** After burner mounting is completed, check to be sure there is a close fit between the burner and the combustion chamber.



Fig. 2 - 4: Mounting the Combustion Burner (Up to 180,000 BTU)

For combustion burners up to 180,000 BTU

Follow this procedure

1. Bolt the heat exchanger adapter to the burner with the gasket and hardware provided.
2. Install the burner assembly into the heat exchanger with four bolts and washers. **CAUTION:** Do NOT over-tighten the bolts to the point where the adapter distorts!

Now go to the "Burner Fuel and Electrical Connection" section.



Fig. 2 - 5: Mounting the Combustion Burner (Up to 400,000 & 990,000 BTU)

For combustion burners up to 400,000 BTU and 990,000 BTU

Follow this procedure

Most Eclipse Combustion Burners come pre-mounted on the Parts Washer and do not require mounting.

Note: Now go to the "Burner Fuel and Electrical Connection" section (Page 2-19)

Burner Fuel and Electrical Connection

For all combustion burners, follow this procedure: (*Eclipse Burners are pre-wired to the Parts Washer and require no further wiring.*)

1. Locate the *unconnected 1/2-inch (13-mm) PVC conduit* containing:
 - *One orange wire*
 - *One white wire*
 - *One green wire*

and install it in the *burner junction box conduit fitting*. (The conduit was secured for shipment on the right side of the washer.)

2. Terminate the orange, white, and green wires to the wires in the burner junction box as shown in the following figure. (Please note that for Riello Burners the orange wire lead connects to L, the white wire connects to N, and the green wire connects to the green ground screw in burner junction box).

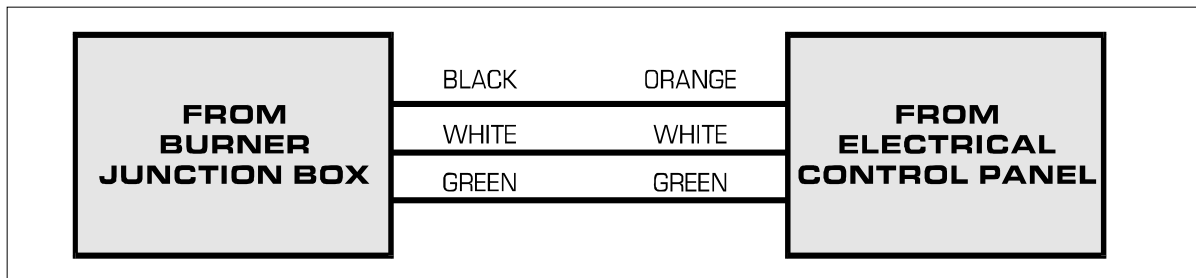


Fig. 2 - 6: Burner Junction Box -- Wiring

3. (**Gas**) Connect the gas supply pipe to the *combination gas valve inlet* for burners with 180,000 BTU/hr rating or *gas regulator inlet* for larger Eclipse burners (natural or propane gas).

Note: *Be sure the gas supply line is of adequate size for the firing rate of your burner and for the length of the gas pipe supply run. Refer to the gas burner vendor manual for information on pipe capacities versus run lengths. Be sure to support the gas supply line with supports to avoid strain on the burner gas train*

WARNING! NEVER apply gas pressure above 12 w.c.i. to the combination gas valve inlet, or damage may occur! If incoming gas pressure is above 12 w.c.i., a proper gas pressure regulator is required. A lock-up type regulator stops gas flow above set-point without venting gas to atmosphere. Do NOT use an internal relief-type regulator without running the vent to a safe discharge area.

4. Turn *ON* the *main gas supply*.
5. Perform leak tests at all fuel pipefittings and joints, including all connections on the burner, and all piping installed to the burner. To do this, spray a solution of soap and water around all fittings and look for bubbles. If you see bubbles, the fittings and joints are not tight, and are leaking.
6. Turn *OFF* the *main gas supply*.

Electric Heat Source

The electric heating elements have already been installed at the factory. No further connection procedures are required.

Steam Heat Source

For proper connection of the steam heat source, you need to know:

- Your plant steam pressure;
- The length of run from the steam source to the washer;
- The steam flow rate required.

Find the steam flow rate in your SBO specification. Longer runs from your steam source require larger pipes. Use the following table to size your supply piping:

SIZING STEAM PIPING

Pipe Size, Inches (Schedule 40)	Lb/hr steam for piping pressure drop of 1 psi/100ft					
	Steam Pressure, psig					
	5	10	25	50	100	150
3/4	31	34	43	53	70	84
1	61	68	86	110	140	170
1-1/4	135	150	190	235	310	370
1-1/2	210	230	290	370	485	570
2	425	470	590	750	980	1,150
2-1/2	700	780	980	1,250	1,600	1,900
3	1,280	1,450	1,800	2,250	2,950	3,500
4	2,700	3,000	3,800	4,750	6,200	7,400
6	8,200	9,200	11,500	14,500	19,000	22,500
8	17,000	19,000	24,000	30,000	39,500	47,000

Fig. 2 – 7: Steam Heat Source: Piping Size

Follow this procedure:

1. Install the steam supply line to the *steam solenoid* on the side of the washer. Install an in-line strainer before the steam solenoid control valve to prevent dirt and debris from clogging the control valve. Install a shut-off valve in-line ahead of the strainer. Install a pressure gauge in the supply line.
2. Install the condensate line to the *steam trap* on the right side of the washer. The condensate is gravity feed from the heat exchanger. Be sure your condensate system is designed to handle the output from the heat exchanger and trap.
3. Make *connections* to your in-plant steam power system, according to your plant codes and other local codes.

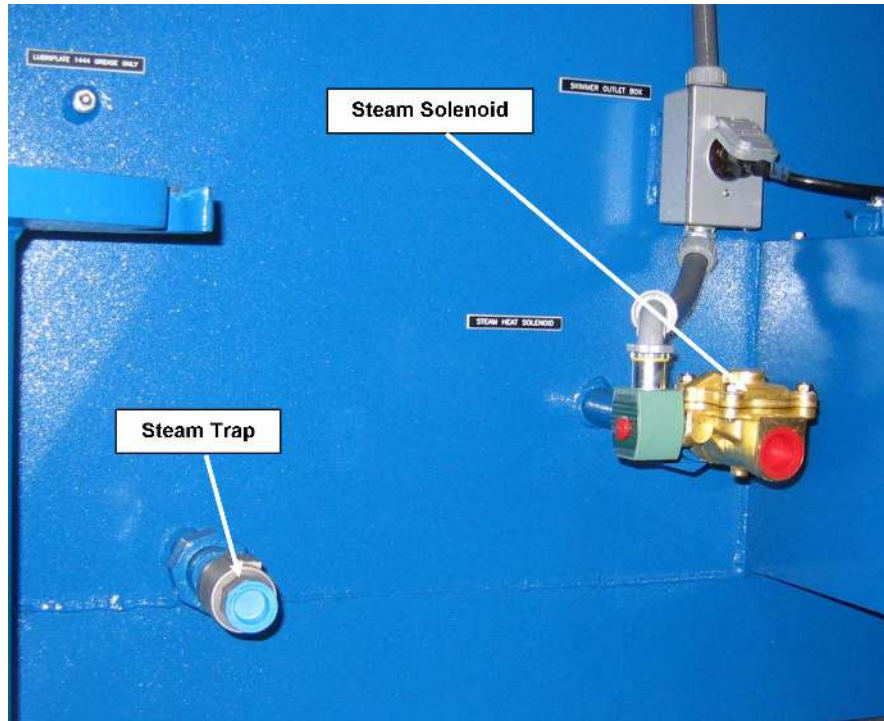


Fig. 2 - 8: Steam Solenoid and Steam Trap Installation

5.2.2. Water (Input)

Refer to the specifications in the SBO form for correct water-line sizes. A 1/2-inch-diameter NPT (13 mm) water line is required for automatic water-fill and the optional Auto Rinse Cycle (ARC).

Follow this procedure:

1. Install a *water regulator*, if incoming water pressure is greater than 125 PSI (862 kilopascals). The regulator should regulate water pressure to 100-125 PSI (690-862 kilopascals). (**NOTE:** The water regulator is *not* provided by StingRay.) (Note: Minimum water pressure required is 25 PSI).
2. Connect a 1/2-inch-diameter (13 mm) water supply line to the washer inlet. (**NOTE:** The washer water supply inlet is a **BRASS** fitting. Refer to the following figure for the connection location.)
3. If you have a rinse system, install the brass drain plug. The drain plug is shipped in the control panel. Do not overtighten.

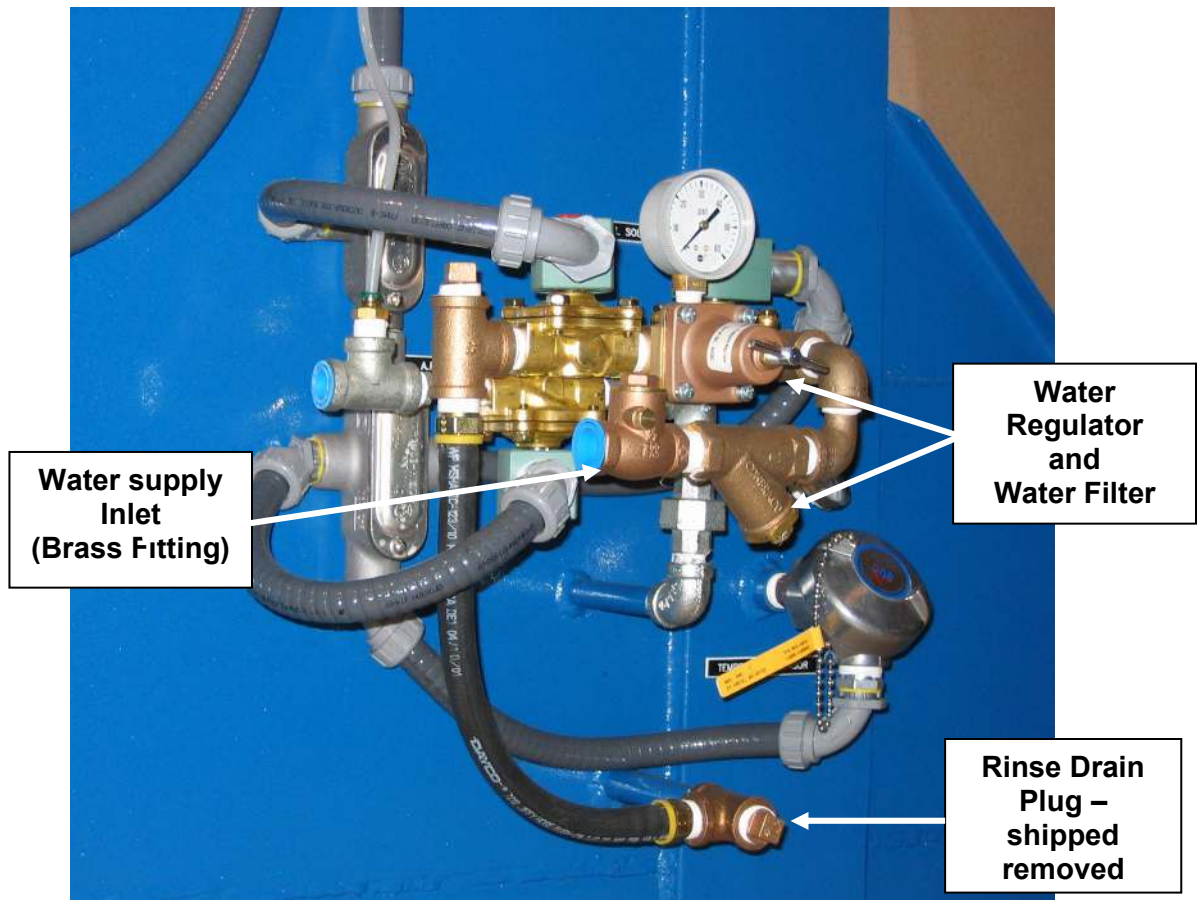


Fig. 2 - 9: Water Connection Location

5.2.3. Compressed Air (Input)

NOTE! Do NOT connect a compressed air line to a BRASS fitting on the machine. The compressed air-line connection is a GALVANIZED fitting. If you do NOT have a galvanized fitting you will not need a compressed air line.

If washer requires compressed air, follow this procedure:

1. Install a compressed-air line to the washer. The connection size is specified on your SBO document and is most often a 3/8 inch NPT fitting. (The incoming pressure range should be between 60-125 PSIG 414-860 kilopascals).
2. Connect an air filter and regulator in-line with the washer's compressed-air inlet. Refer to the following figure.

3. Connect the air-supply line to the filter.

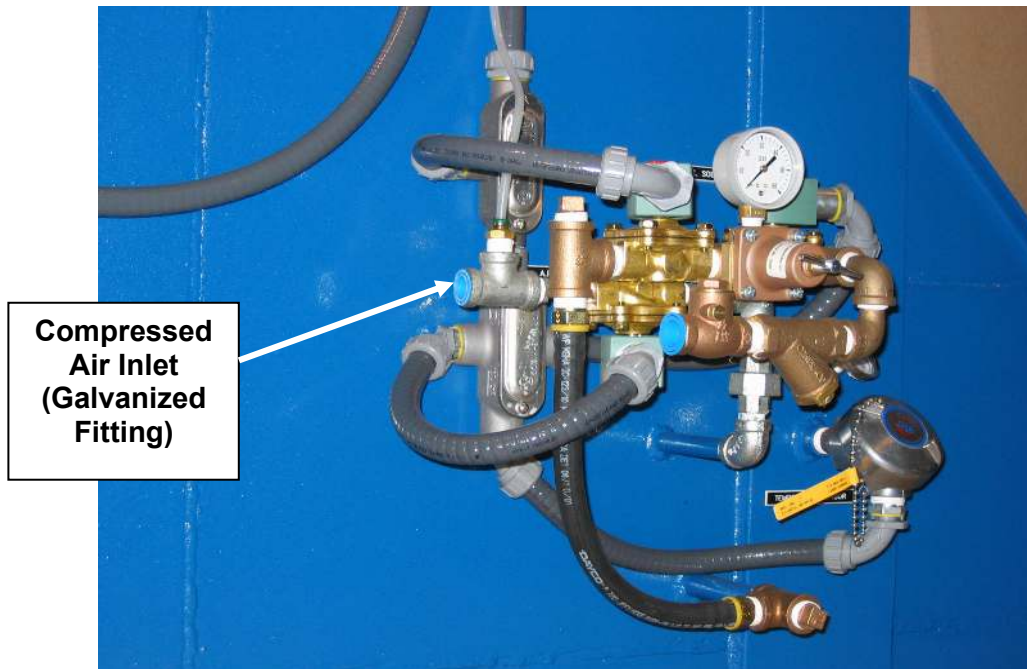


Fig. 2 - 10: Compressed-Air Connection

5.2.4. Electricity (Input)

NOTE: You are responsible for meeting all local and national electrical codes that apply to the power source and to the wiring from the power source to the StingRay Parts Washer. *Be sure that* people who are qualified and trained for the task do all electrical installation and connections. *They should meet all local licensing requirements.*

NOTE: If your washer is NOT equipped with an electrical disconnect, the NEC (*National Electrical Code*) requires a main disconnect.

CAUTION! GROUNDING WARNING: *The washer must be grounded! Grounding provides a path of least resistance for electric current, thus reducing the risk of electric shock during maintenance, troubleshooting, or repair.*

CAUTION! GROUNDING INSTRUCTIONS: *The washer must be connected to a grounded, metal, permanent wiring system; the equipment-grounding conductor must be run with the circuit conductors and connected to the equipment-grounding terminal in the washer electrical control enclosure.*

Earthgrounding to Prevent Corrosion

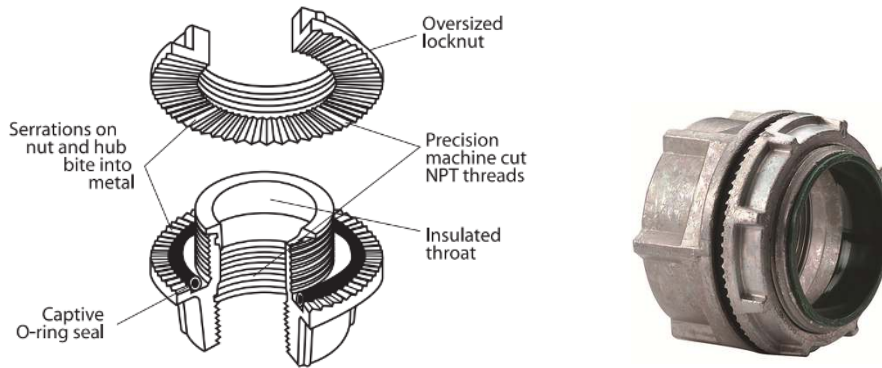
The washer must be securely grounded to prevent stray electrical fields from causing galvanic corrosion. Under some circumstances, such corrosion can very quickly cause serious structural damage to the washer (in only several months).

WARNING! *Use the proper equipment-grounding circuit per the National Electrical Code Article 250.*

The Parts Washer must be grounded using a copper conductor. Do **NOT** depend on raceways or a conduit as an equipment ground. Install an equipment-grounding conductor connected to the Parts Washer's ground lug in the Control Panel *and* connected to your electrical service system ground according to the National Electrical Code Article 250. Use a conductor **EQUAL or GREATER** in size to the equipment service conductor to reduce the resistance to ground. A low-resistance path-to-ground is required to minimize the potential for galvanic corrosion.

To connect power to the washer, follow this procedure:

1. Verify washer *voltage* and *amperage* requirements (in the SBO form).
2. Select a *feeder-wire size* that meets approved *national* and *local code* requirements.
3. Use a ground conductor of **EQUAL or GREATER** size (to the feeder wire).
4. Select a location on the electrical enclosure for the incoming power wires and ground conductors. If you have the optional NFPA 79 electrical system the best place is normally above the disconnect in your enclosure. **Install** a liquid tight conduit hub for your incoming conduit type and size. Conduit hubs provide a liquid, oil and dust tight



termination of electrical conduit through the walls of the sheet metal enclosure. Hubs provide oversized locknuts for a strong vibration-proof termination and a captive O-ring seal to keep moisture out of the enclosure. Serrations on the hub body and locknut provide an effective positive ground path. The insulated throat protects conductors from sharp edges.

5. Connect *power* from the *main power supply* to the *washer*, following NEC methods. Use proper size *wires* in the conduit, and make watertight connections to the *electrical control panel*.
6. Attach the *feeder wires* to the *power distribution block OR disconnect switch*, located in the *electrical control panel*. (Refer to the following figure for the location of the power distribution block.)

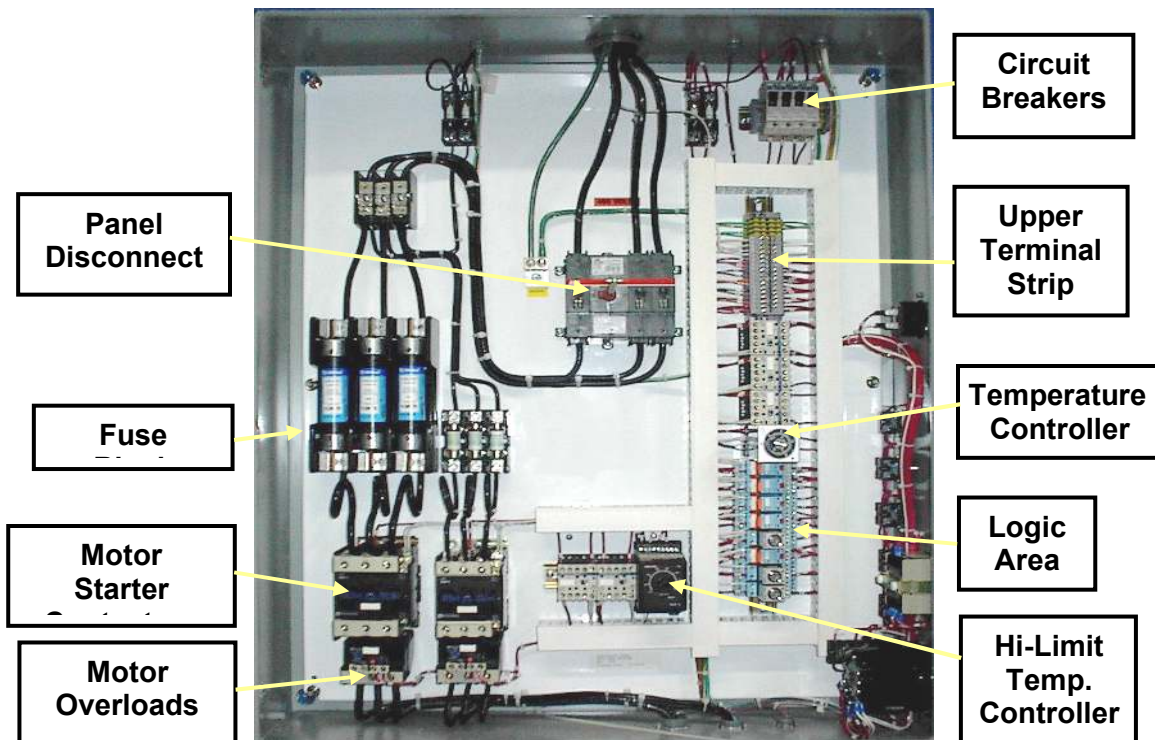


Fig. 2 - 11: General Layout of the Electrical Control Panel (Block Diagram)

WARNING! Do NOT turn the main power supply ON at this point!

5.3. Connection Procedures - Outputs

This section describes *output* connection procedures. The previous section describes *input* connection procedures.

Use the SBO form to determine which of the following utility connections you must make.

Output Utility Connections:

- Steam exhaust
 - Pipe
 - Fan
- Flue pipe
- Drain

Depending on your parts washer configuration and optional equipment, refer to the applicable sections in this manual for information on making the necessary connections.

5.3.1. Steam Exhaust (Output)

For the size of the steam exhaust, refer to the specifications in your SBO (Services by Others).

The following materials can be used for steam pipe:

- **Schedule 40 or 60 PVC pipe** (see "*Prerequisites, PVC Kit*", at the beginning of this chapter). StingRay washers are set up to use PVC pipe for the steam exhaust. Your washer and ASE (auto steam exhaust) blower unit arrive equipped for using PVC fittings. **StingRay highly recommends PVC**, because it is simpler to install, requires no welding, is lighter, and does not rust.
- Schedule 20 or 40 black iron pipe or stainless steel can be used instead of PVC. However, they lack PVC's advantages. If you opt to use metallic pipe, you will need special adapters to modify the flanges on the ASE blower unit. Any piping used must be water tight and leak-proof. Do NOT use PVC duct or Stainless Steel duct.

PVC thick wall pipe is a proven solution for discharging the hot steam vapors from the StingRay Washer. It is easy to cut and install. Unlike metal, PVC fittings never rust, scale, or pit, and provide many years of maintenance-free service. Substantially lower material costs versus steel alloys or lined steel, combined with lighter weight and ease of installation, PVC pipe and fittings reduce installation costs by as much as 60% over conventional metal systems. PVC is simple to bond together. StingRay recommends using silicone RTV silicone adhesive rather than tradition PVC cement. RTV provides much longer working times to properly align pipe and fittings. You can also add a fillet of RTV at each join to add extra assure of leak-free performance. PVC fittings and PVC pipe are in use in hundreds of installations demonstrating its appropriateness for the vapor service temperatures seen in the StingRay Parts Washers.

*The following steam-exhaust **installation instructions assume the use of PVC pipe.*** If you use metallic pipe instead, installation steps will be similar to those given here. However, you will have to adapt and modify flanges and fittings as necessary to complete the assembly.

NOTE: *If your washer is equipped with a hot-air blow-off (HABO) system, refer to that option in the “Options”, Chapter 7, for special instructions for steam-exhaust installation.*

General installation consists of the following procedures:

1. Install piping.
2. Install the ASE blower unit in piping.
3. Provide rain cap.

WARNING! *The steam-exhaust pipe connection must be independent of any other pipe connection. It cannot share a steam vent pipe with any other equipment.*

Steam-Exhaust Pipe

Refer to the following figure for the location of the steam-exhaust vent pipe flange. The pipe flange is located on the roof of the washer cabinet for steam exhaust attachment.

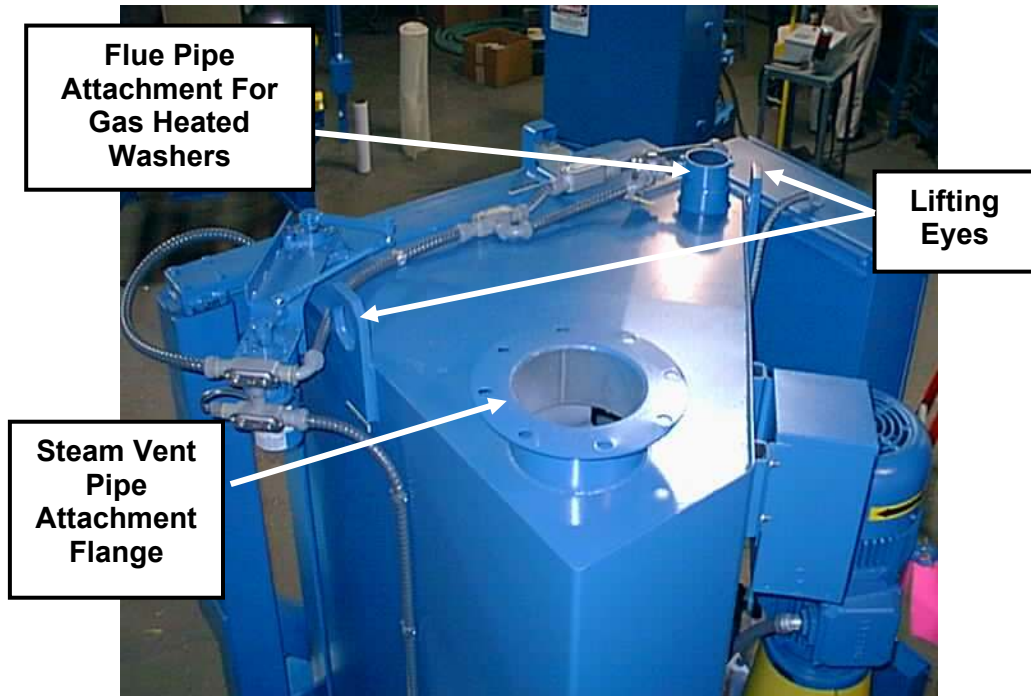


Fig. 2 - 12: Steam-Exhaust Vent Pipe and Flue Pipe Attachments

The steam-exhaust pipe may exit your building either vertically or horizontally, as shown in the following figure. This figure does not show you how to install the ASE blower unit in the piping (see ASE Assembly Figure 2-13); rather, it represents a general view of the two possible configurations (vertical or horizontal). You will select one of these configurations when you install the piping and blower. **Note:** Install venturi such that fan motor shaft is horizontal. Use a twist transition supplied from StingRay, if required.

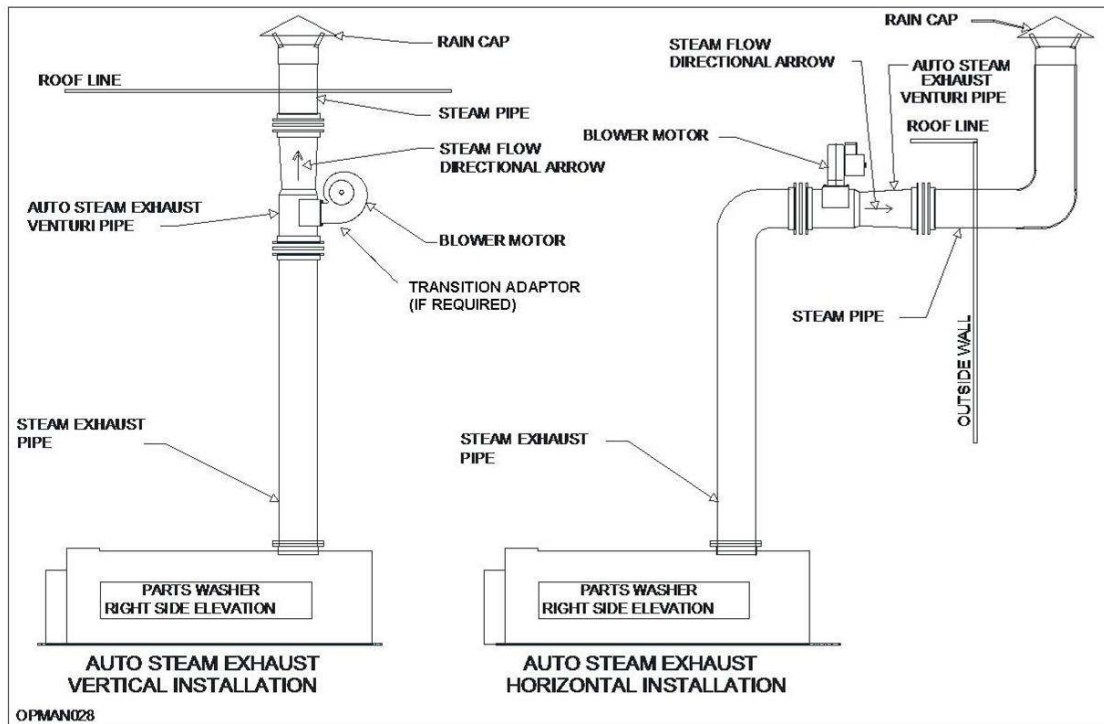


Fig. 2 - 13: Auto Steam Exhaust (ASE) Piping and Blower Installation Configurations

Note: Any horizontal section of steam exhaust pipe must rise by 1/2-inch (13 mm) per foot (30.5 cm) of pipe. This is necessary for proper condensation drainage back to the washer.

Steam-Exhaust Fan

The auto steam exhaust (ASE) Venturi and blower assembly is provided by StingRay. It is provided separate with the washer and must be mounted in the steam-exhaust piping. Mount blower and fan to the venturi as shown in the diagrams using hardware provided. Use RTV silicone adhesive as a form-in-place gasket to seal all connection points. Do not mount fan housing such that it is below blower inlet, as condensation may collect in blower housing.

Note: The ASE blower assembly is provided with one of these motors:

- 1/10-HP motor for StingRay 30s and 40's;
- 1/4-HP motor for StingRay 52's to 8473's;
- 2-HP motor for StingRay 10073's and Clamshells.

If your steam exhaust vent pipe exceeds 30 feet (9 m), a 1/4-HP or larger motor is required and can be obtained from StingRay. If your vent pipe is extremely long, or if there is extreme negative pressure in your shop area, StingRay may need to assist you in determining the proper size venturi blower and motor assembly. (When calculating pipe length, each 90°-angle bend equals 10 feet [3 m] of straight pipe.)

CAUTION! *You must mount the ASE assembly in line with the steam-exhaust pipe, and as far away from the washer as possible, at least 20 ft. if possible. – It's best to install where the steam-exhaust pipe leaves the building. ***DO NOT INSTALL ASE ASSEMBLY DIRECTLY ON TOP OF THE WASHER!****

CAUTION! *If you are mounting the Venturi Tube in a horizontal position, mount it such that the fan is above the tube 45° from the vertical, as shown in Figures 2-13 through 2-15. This position allows condensation to drain back into the washer and not remain in the blower unit.*

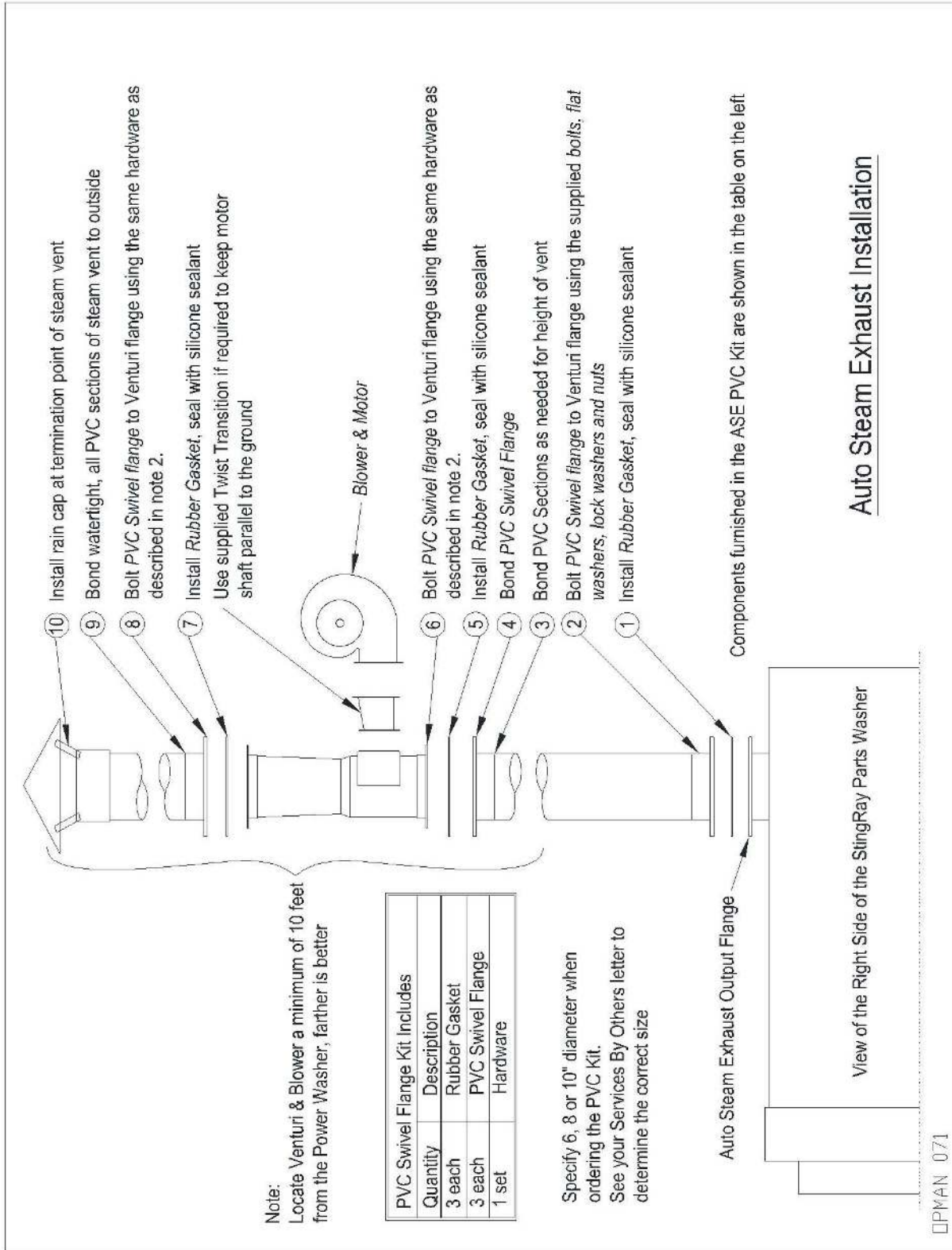


Fig. 2 - 14: Auto Steam Exhaust (ASE) Piping and Blower Assembly

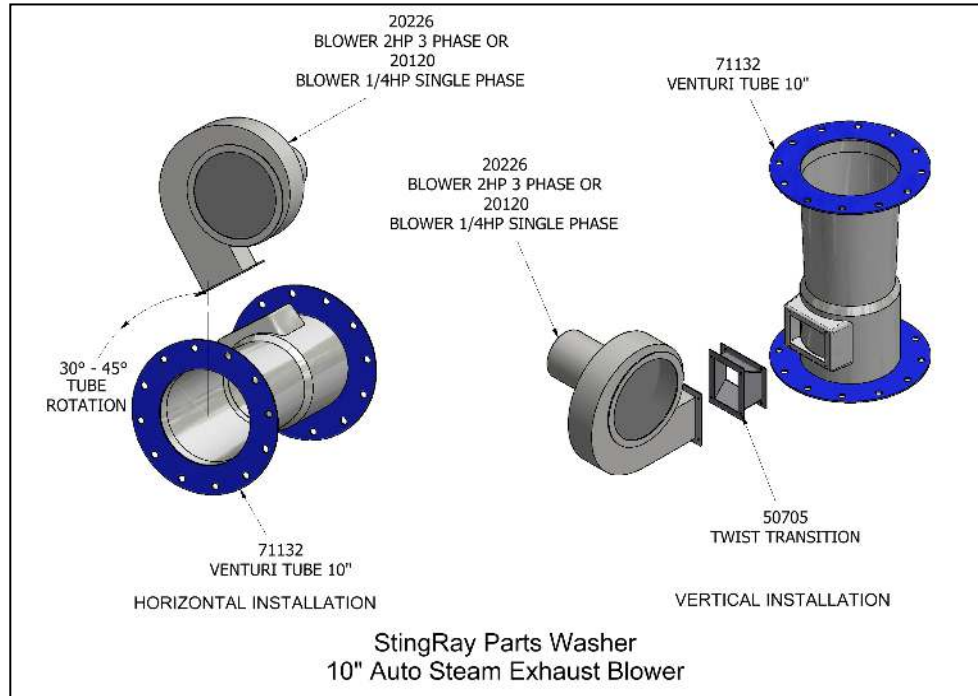


Fig. 2 – 15: Installation for 1/4-HP or 2-HP Transition

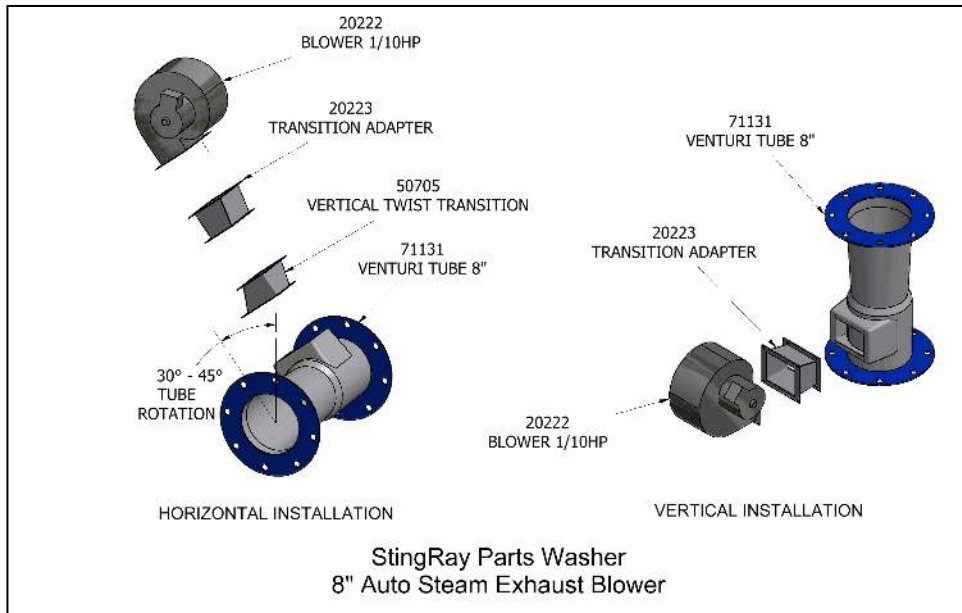


Fig. 2 – 16: Installation for 1/10-HP Transition

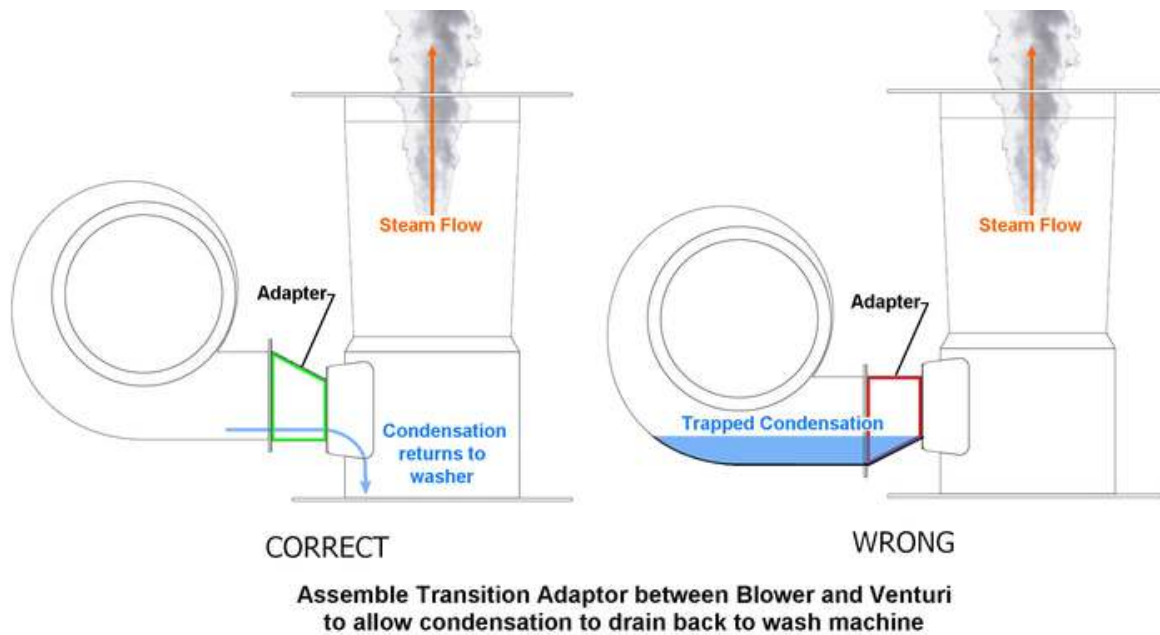


Fig. 2 – 17: Proper ASE Transition to Avoid Condensation

After you have installed the piping and the blower; follow this procedure to complete the electrical connection of the blower to the washer.

1. Install an approved liquid-tight *conduit* containing *three wires* (red - hot; white - neutral; green - ground; all wires #14-gauge stranded THHN copper, minimum) from the ASE *blower assembly* to the upper terminal block in the Control Panel. (Attach the *three wires* as indicated in the accompanying figure.)
2. Attach one end of the red wire (hot) to the ASE motor circuit overload device located at the top of the control panel next to the terminal blocks. Refer to your machine's panel layout drawing on the inside of the enclosure door for the exact location. Splice the other end of the red wire to one of the black wires on the ASE motor.
3. Attach one end of the white wire (neutral) to an N (Neutral) terminal. Splice the other end of the white wire to the second black wire on the ASE motor.
4. Attach one end of the green wire (ground) to a green ground terminal. Connect the other end of the green wire to a screw on the ASE motor.

NOTE: You must supply the length of wire, fittings, and conduit required to extend from the ASE motor to the Control Panel.

Note: The wiring diagram as shown is for the standard 115 volt A. C. motor.

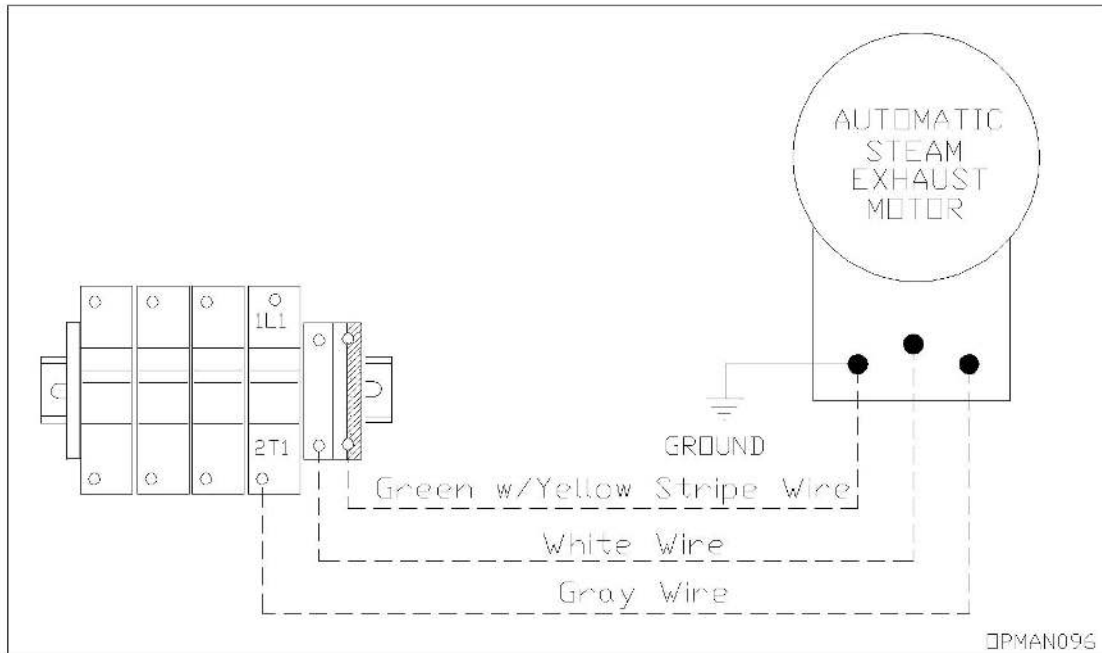


Fig. 2 - 18: Wiring the ASE Blower Assembly

5.3.2. Flue Pipe (Output)

NOTE: A flue pipe is used ONLY for gas burner heated machines.

WARNING! The flue pipe connection must be independent of any other pipe connection. It cannot share a heating-system flue pipe with any other equipment.

WARNING! Be sure that people who install and adjust the burner are qualified and trained for the task. Be sure they use appropriate flue-gas monitoring instruments for measuring oxygen, carbon dioxide, AND CARBON MONOXIDE. The immersion tube firing gas burner is difficult to install and set properly. GET PROFESSIONAL help. You MUST set the burner with a FLUE GAS Analyzer. You MUST use a slack tube WATER MANOMETER to measure pressure in water column inches (wci). Your Flue Gas Analyzer must read CO₂, CO, O₂, and efficiency to properly set the burner. The flue gas analyzer must be CALIBRATED and working properly. If you cannot read the proper amount of oxygen in atmospheric air then your analyzer is NOT working. If you do not have the proper equipment, then DON'T TRY to set the burner.

WARNING! VENTING OF EXHAUST GASES: Do NOT vent exhaust gases into a wall, a ceiling, or a concealed space of a building. Refer to the instructions in this chapter for correct vent installation instructions.

Flue Pipe installation

Standard StingRay Gas Burner installations must conform to specific requirements in order to avoid failures in the field and/or less than specified performance. StingRay will not warranty operation of the standard gas burner in any installation that does not strictly adhere to these requirements. If all of the requirements cannot be met, upgrading to the StingRay/Eclipse High Output burner system is required. See StingRay Engineering Standard Specification **ESS 058** for specific requirements. (ESS 058 is reproduced at the end of this chapter for your convenience.)

Your StingRay Parts Washer is capable of producing exhaust gas temperatures up to 1000 deg F.

The gas burner flue installation must comply with all applicable local, state and/or national gas codes for **materials, pipe size, and installation** procedures.

Note: StingRay recommends a minimum of 16-gauge double wall steel for the flue pipe.

IMPORTANT:

The flue pipe system installed on the StingRay Parts Washer must be sized to create the proper draft during burner firing. The draft required is $\pm .25$ WCI pressure at the flue-pipe stub during burner firing.

Typical installations with an equivalent 10-50 foot flue exhaust run generally will function properly with a flue pipe size 2" larger than the exhaust stub to obtain the required draft pressures of $\pm .25$ WCI at the flue pipe stub.

NOTE: Do NOT install a flue pipe that is the same size as the washer flue stub pipe!

StingRay Manufacturing does not recommend the use of draft inducers or barometric dampers in a properly designed exhaust system.

To install the flue, follow this procedure

1. Find the *flue pipe attachment* on top of the *washer* cabinet. (Refer to Fig. 2-10 for the location of the pipe stub. On some washers, the flue pipe attachment is by the steam-exhaust pipe attachment.)
2. Route the approved flue pipe from the Parts Washer to the outside of the building, taking care to maintain minimum clearances to combustible materials as specified by the National Fuel Gas Code (American National Standard ANSI Z223.1) and other applicable codes.

Refer to "*Placement Planning/Roof*" at the front of this chapter.

Note: Horizontal flue runs are NOT recommended. If a horizontal flue-pipe section is required it must rise a minimum of 3 inches (75 mm) per pipe foot (per 30.5 cm of pipe).

3. Be sure the exhaust vent ends in a *vertical* position. The vent termination point must be a minimum of 3 feet (1 meter) above the roof peak or more as required by local and/or national codes.
4. Install a *rain cap* at the *end* of the pipe. (**NOTE:** The rain cap is *not* supplied by StingRay.)

5.3.3. Drain (Output)

A capped drainpipe connection is located on the machine frame at the low point of the washer reservoir floor.

You may use the drain to hook up the washer to a water-treatment system, or to a pumping system.

However, your washer is easily serviced using a diaphragm pump equipped with a hose and an appropriate strainer. This configuration allows you to pump solution from the washer into approved containers for disposal according to local regulations. StingRay offers an air diaphragm pump used for this purpose.

For more information, refer to chapters *"Advanced Operations: Process Control,"* and *"Maintenance"* in this manual.

5.4. Installation of Options

If you purchased any options with your washer, such as an Oil Coalescer, Pure Rinse, Sludge Scraper, Jib Boom, etc., refer to Chapter 7, *"Options"* for information on installation.

5.4.1. Removable Door Position Lock Plate:



Fig. 2 – 19: Removable Door Position Lock Plate

Assembly Instructions:

The door position lock plate is removed from some StingRay Parts Washers to reduce the machine width for reduced shipping cost. The position lock plate must be re-installed on the machine to use the lock feature. Follow these instructions for installing the lock plate on your machine.

1. The position lock plate is packed with the other accessories of your new StingRay. Unpack the lock plate and the two (2) ½” diameter bolts, washers and lock washers.

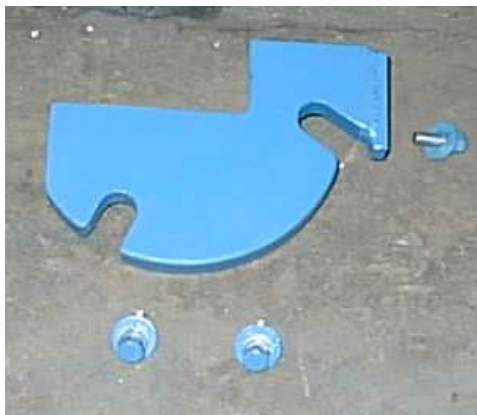


Fig. 2 – 20: Door Position Lock Plate and Attachment Hardware

- The lock plate attaches to the machine door post support. The doorpost support is shown in the picture below on the left. Position the lock plate on the door post support. Line up the two holes with the mounting holes on the doorpost support as shown.

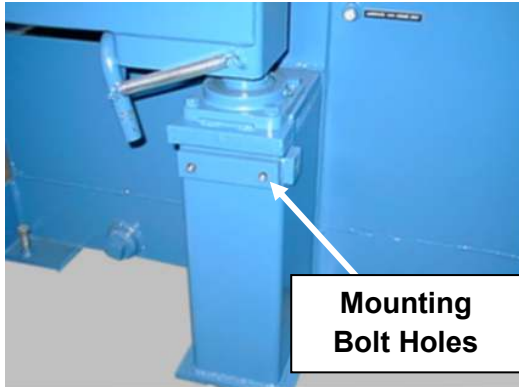


Fig. 2 - 21: Doorpost Support Without Lock Plate Attached



Fig. 2 - 22: Positioning the Door Lock Plate

- Install the $\frac{1}{2}$ " diameter bolts into the mounting holes and tighten the bolts. The completed installation should appear as shown on the right.



Fig. 2 - 23: Tighten the Mounting Bolts



Fig. 2 - 24: Completed Lock Plate Installation

- Open the door and check that the position lock holds the door in the load/unload and service positions.

5.5. Inspection and Verification

Now you have completed the services and connections required for your washer. Before performing the startup procedure, inspect all services and connections made on the washer during installation. Use the following information:

- *Services to be Provided by Others and Service Requirements (SBO)* letter from StingRay
- *Field Startup Procedure (FSP)* form

Fill in the Physical Installation section of the Field Startup Procedure (FSP) form as you inspect what you have done and ensure that all connections have been properly made. During this inspection you will inspect the following items and document your inspection results on the *FSP*:

- Visual inspection
 - Leveling
 - Anchoring
- Physical Inspection of Installation
 - Water Supply
 - Electrical Supply
 - Gas Supply
 - Gas Burner Flue
 - Steam Exhaust

- Check placement and leveling. Fill out the FSP form (*Field Startup Procedure*)
- If a combustion burner is used complete “Gas Burner Test “ in the FSP form
- Inspect electrical connections. Fill out the FSP form
- Inspect the ASE assembly. Fill out the FSP form
- Verify your water connection. Fill out the FSP form
- Inspect the drain and pump systems. Fill out the FSP form

Fig. 2 - 25: Services and Connection Inspection

If you note any problems that cannot be solved by making minor adjustments, refer to chapter "Troubleshooting," or call StingRay Tech Services.



6. Startup Procedure

A StingRay factory-trained technician is optionally available to perform startup and customer training. Call StingRay Technical Services to request this service. As part of this service, the StingRay technician will fill in the *Field Startup Procedure (FSP)* form to begin your warranty coverage.

If you perform the startup, training your staff to operate the parts washer is your responsibility.

The startup procedure consists of the following activities, in this order:

- Electrical Connections Inspection
- Lubrication Procedure
- Power-Up Procedure
 - Preliminary Checks
 - Supply Voltage
 - Water Fill
 - Water Level Control Validation
 - Control Voltage Measurement
 - Heat – Gas, Electric, Steam Test
 - Pump/s Rotation Direction
 - Temperature Control setting
 - Voltage Readings
 - Water Hammer Test
 - Amp Readings of all loads
 - Standard Operational Checks
 - Pump Low-Low Water Shutdown
 - Door Close Limit Switch Operation
 - Heater Low-Low Water Shutdown
- Chemical-Charging Procedure
- Test-Wash Procedure

NOTE: Fill in the **Field Startup Procedure (FSP) form** as you perform startup. Send it to StingRay Tech Services when complete. After verification and acceptance, your warranty period begins. **This form must be received by StingRay within 60 days after receipt of your washer!**

WARNING! Be sure that people who perform the startup procedure are qualified and trained for the task. They must follow all procedures exactly as described.

6.1. Electrical Connections Inspection

WARNING! Be sure the electrical power to the washer is turned OFF.

Open the electrical control panel door.

Check ALL electrical connections and components for tightness. It is common for some to loosen during shipping as copper wires settle quite easily.

Inspect timers and relays in the electrical control panel to be sure they are "seated" in their sockets.

Close the electrical control panel door.

6.2. Lubrication Procedure

Your parts washer is pre-lubricated at the factory. If you install the washer within a six-month period after delivery, no lubrication is necessary before startup.

However, **you must establish a lubrication schedule**, based on hours of operation. Refer to chapters "*Advanced Operations: Process-Control*" and "*Maintenance*".

If the washer has been sitting for more than one year after delivery, see Chapter 5, "*Maintenance*" for information on the proper lubrication procedure before startup.

6.3. Power-up Procedure

NOTE: If you need to stop the power-up procedure at any point, press the *stop button* on the washer's control panel or *turn off the main power supply*.

Follow this procedure:

Preliminary Checks:

1. Is the cabinet *door closed*?
2. Is the *clock-override switch set to Bypass*?
3. Is the *wash timer* set to "0"?
4. Verify that the rubber grommet used for protecting the float ball during your washer shipment is removed from the water level control float rod.

Supply Voltage:

CAUTION: *This procedure exposes personnel to dangerous voltages and the risk of electrocution. Be sure the people performing this task are qualified and trained for the task.*

1. Verify that the electrical panel door is closed and latched.
2. Turn on the building main power supply to the Parts Washer.
3. Turn electrical disconnect located on the StingRay Washer Control Enclosure door to the "OFF" position.
4. Open electrical enclosure door.
5. Measure and record incoming voltage available to the washer. Perform this test at the *supply side* of the *main disconnect* or at the *distribution block*.

Water-Fill:

1. Set the *temperature controller adjustment* to "32°F -or- 0°C." This will prevent the burner or heating elements from activating when the washer is empty of water, should damage to the washer have occurred in shipping. Refer to chapter "*Advanced Operations: Process-Control*" for more information.
2. Close electrical panel door.
3. Turn the electrical disconnect located on the StingRay Washer Control Enclosure door to the "ON" position. If the pump/s come on, turn the disconnect "OFF" and **immediately** contact StingRay for additional instructions.
4. Turn the 7-day clock control switch to *Bypass*.
5. Verify by visual inspection or by sound that the washer reservoir begins to fill with water (the water-fill solenoid should open when you turn the main power supply and the clock-override switch ON). Refer to Fig. 2-7 for the water-supply connection location.
6. After about two hours, check the washer reservoir to verify or adjust the set-point water level. (While the reservoir fills, you can continue with the power-up procedure.)

Water-Level Control:

The water-level control system is fully installed in the parts washer and requires only verification that the set-point water level is correct for operation of the machine.

Follow these steps to verify or adjust the set-point water level:

1. Remove the float control box cover by removing four (4) screws. Refer to the following figure:

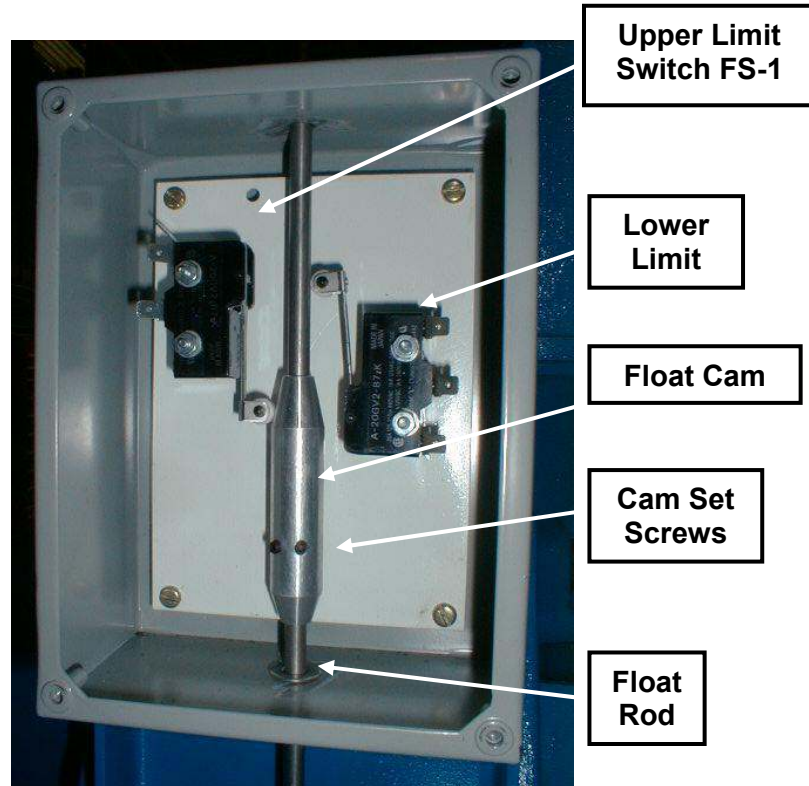


Fig. 2 - 26: Float Control Box

NOTE: Do NOT leave fresh water in the washer without chemical for more than a few hours.

2. During the initial startup of your parts washer the washer will fill itself to the set-point water level. This water level is controlled by the position of the cam on the float rod.

Moving the cam **down** on the float rod **raises** the water level, while moving the cam **up** on the float rod **lowers** the water level.

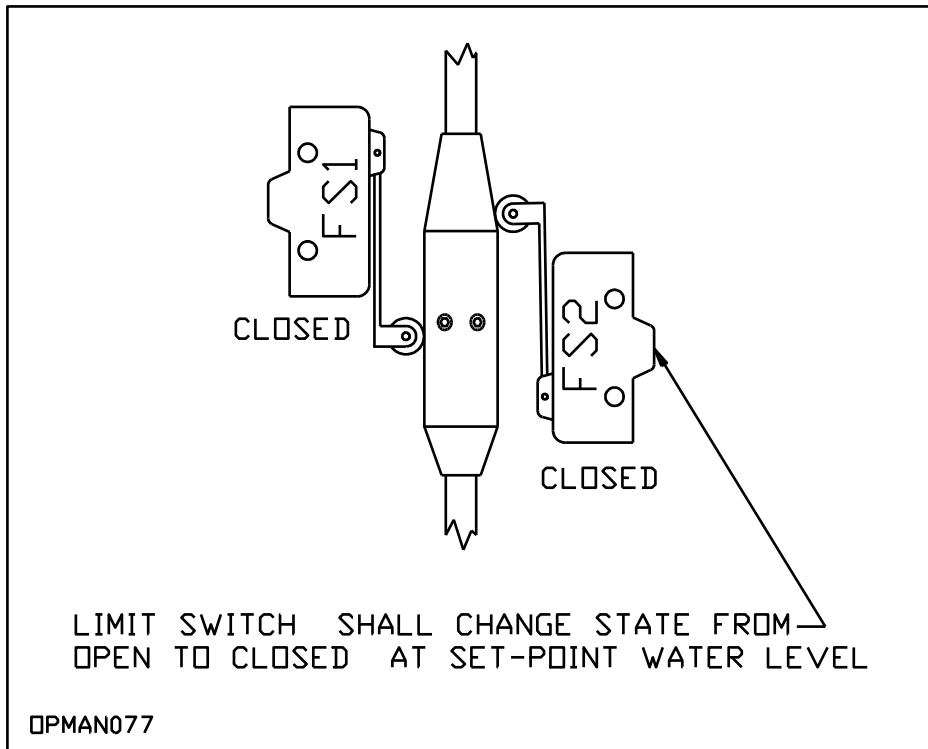


Fig. 2 - 27: Float Cam at Set-Point Water Level

When the washer completes filling to the set-point water level, the cam and float limit switches should appear as shown in figure 2-26.

Turn *OFF* power to the washer.

- Make sure the water is calm.
- Remove the front reservoir cover.
- Verify the water level in the machine when the cam is in relationship to the limit switches as shown in the figure above.
- Find the water-level indicator (a 3/8"-square rectangular bar) welded to the right wall at the front of the reservoir. Refer to the following figure.

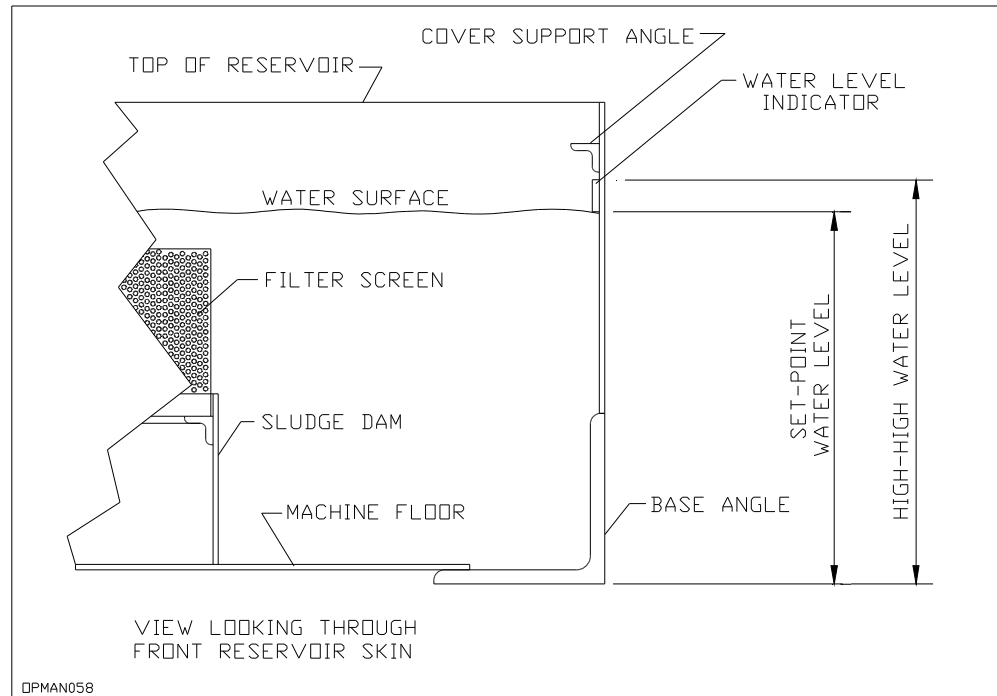


Fig. 2 - 28: Water-Level Set-Point Dimensions and Measurement Location

NOTE: The top of the water-level indicator shows the HIGH HIGH water level. The bottom shows the SET POINT.

3. *If the water level is more than 1/8" inch above or below the bottom of the water-level indicator, you will need to adjust the cam on the float rod. Follow the steps below.*

-Or-

If your water level is correct, skip to step 6.

4. Mark the current location of the cam on the float rod with a marker or a piece of tape before making any adjustments.

*If the water-level measurement you made is higher than the indicator, you will need to move the cam **up** the float rod by the difference between the indicator and the measured value.*

*If the measurement is lower than the indicator, you will need to move the cam **down** the float rod by the difference between the indicator and the measured value.*

Measure the distance to the new position and mark it on the float rod.

Next, loosen the two set-screws on the cam with an Allen wrench.

Finally, slide the cam to the new location and re-tighten **both** set-screws.

5. Turn power on to the washer and test the new level by allowing the washer to fill to the new set point.

NOTE: It will be necessary to remove water from the washer if the new level is lower than the old set point.

Verify that the set-point level is correct. If necessary, repeat the above steps until the set-point level is at the indicator, plus or minus 1/8 inch.

6. Replace the cover on the float box and tighten the four screws.

NOTE: *If your washer has a rinse system, once cleaning operations start, water levels in the washer can be higher than the set-point water level. This happens whenever the washer automatically uses the rinse-bank for longer rinses.*

To verify the correct set-point water level after operations started, you must allow the washer to fill to the set point. You can check this by observing the position of the float cam relative to the limit switches in the float box. (Refer to Fig. 1-3: Float-Level Mechanics) If the cam is higher than the set point, you have to remove solution from the washer and allow the washer to fill to the set point to check set-point water level.

Control Voltage:

CAUTION: *This procedure exposes personnel to dangerous voltages and the risk of electrocution. Be sure the people performing this task are qualified and trained for the task.*

1. Measure and record the control voltage to establish a baseline reading by taking readings from #10 wire on fuse #3 to any *neutral terminal* (on the terminal strip at the top of the electrical control panel). Refer to Fig. 2-9 for terminal-strip location.
2. Verify that voltage readings at each additional #10 terminal are between 110 to 130 volts.

6.3.1. Heat – Gas (180,000 BTU): (if applicable)

WARNING! IF YOUR PARTS WASHER USES A GAS BURNER:
 You must follow installation and operating instructions exactly to prevent a fire or explosion that may result, causing loss of life, personal injury, or damage to property.

WARNING! Proper setup and adjustment of gas-combustion equipment requires combustion-analysis tools (gas manometers and gas combustion analyzer) and knowledge of gas combustion.

If you do not have the proper expertise or equipment, seek professional help.

Improper adjustment of gas-combustion equipment can cause carbon monoxide discharge, fire, or explosion, resulting in loss of life, personal injury, or property damage.

1. Measure and record the incoming gas pressure to the burner. (**NOTE:** In the power-up procedure, the burner will not fire until correct water level is reached, and the clock-override switch is turned *ON*.)
2. Verify that the incoming pressure is within the range specified in the table below. Lower gas pressures can reduce the burner firing rate and increase the time it takes for the machine to heat. Gas differential pressures other than those in the table below will cause firing rates other than those obtained at the factory. Use the gas pressures in Fig. 2-18 as an initial starting point for burner adjustments.
3. If your washer has a burner with one of the firing rates listed in Fig-2-18, make initial flue damper and burner air-inlet shutter settings as shown.

NOTE: Gas pressures below are expressed in WCI.

Firing Rate (K/BTU)	Burner Number	Maximum Incoming Gas Pressure Unfired	Minimum Incoming Gas Pressure Field	Manifold Gas Pressure Fired	Burner Air Shutter Opening	Burner Air Shutter Opening	Burner Head Setting	Machine Flue Damper Opening
180	40P200 PROPANE	14	12	3.5	3.75	B6	4	30°
180	40N200 NAT'L GAS	7	5	3.5	3.75	B6	4	30°

Fig. 2 - 29: Initial Burner Settings

NOTE: At this point, all manual gas valves should be closed.

4. Verify that the washer reservoir is filled to the factory pre-set level with water. The burner cannot fire until correct water level is reached.
5. Set the temperature controller according to the following table. After you set the controller, the burner will begin a purge trial for ignition and attempt to fire.
NOTE: *The set-point on the controller can differ from the actual temperature.*

At this point you should follow the startup procedure in the burner vendor's manual.

NOTE: Due to various installation variables, it may be necessary to adjust operating parameters to obtain consistent burner performance.

Maximum Operating Temperature	
<u>Altitude in Feet</u>	<u>Temperature ° F</u>
0- 2000	190° F (88° C)
2000 - 4000	185° F (85° C)
4000 - 5000	180° F (82° C)
5000 and above	call StingRay

WARNING! Do NOT exceed recommended settings, or serious damage can occur to the wash pump (cavitation).

Fig. 2 - 30: Maximum Operating Temperature

6. Take a sample of flue gases where the flue pipe attaches to the roof of the washer cabinet. There is a port at the flue damper for this measurement. You need a flue gas analyzer to make this measurement. NOTE: If you are unsure about the proper operation of the flue gas analyzer, a simple test is to measure the oxygen percent of air outside of the plant. The percent oxygen in our atmosphere is relatively constant at 20.9% regardless of altitude. Even though at higher altitudes air is less dense the percentage of oxygen remains the same. If your flue gas analyzer doesn't measure the percentage of atmospheric air at 20.9% it is not working properly. Oxygen sensors in flue gas analyzers need regular replacement and are a common maintenance item.

WARNING! A certified burner technician, using flue-gas-analyzing equipment must make any adjustments to the burner.

7. Verify that the fuel/air mixture is correct, by comparing your readings with the following table. Refer also to your vendor-supplied burner manual.

WARNING! Proper air/fuel mixture is imperative for efficient operation and safety.

Correct Air/Fuel Mixture

Unburned combustibles	0%
Carbon dioxide (natural gas)	9% -10%
Carbon dioxide (propane gas)	10% -12%
Oxygen	3% to 5%
Combustion efficiency	70% or more
Stack temperature	350° F to 1000° F (177° C to 371° C)
Carbon monoxide	200 PPM or less

8. Record the water temperature by reading digital temperature read out on the control panel. **NOTE:** Generally, it takes less than two hours for water to heat from 70° F (21° C) up to 190° F (88° C). While the water is heating, you may continue with the power-up procedure.

6.3.2. Heat – Gas (400,000 BTU to 990,000 BTU): (if applicable)

IJ3 & IJ4 Models Start-up Procedure (See Fig. 2-30)

Electrical Set-up – Verification:

1. Turn off the gas supply valve to your burner.
2. Verify main power is on at main disconnect.
3. Set reservoir water temperature controller in the main washer control panel to 150°F (65°C).
4. Verify the temperature controller is calling for heat. (this is verified by the illuminated red LED light on the temperature controller)
5. Verify the washer reservoir is filled to set-point water level.
6. Verify burner control disconnect is in the on position (IJ4 models only).
7. Verify the “power on” (IJ4 Models Only) light located on the burner control enclosure is illuminated.
8. Turn the Burner power selector to the off position on the burner control enclosure.

Supply Gas (Natural or Propane) Settings – Verification:

1. Verify the gas supply valve provided with your burner is turned off.
2. Open the gas pet cock valve and attach a manometer hose to the gas pet cock valve of the incoming side of the StingRay provided gas train.
3. Turn gas on (Slowly) at the gas supply valve.
4. Adjust factory in-coming gas pressure by reading the manometer. **Set in-coming gas pressure between 18 W.C.I. (46 mbar) and 50 W.C.I. (124 mbar)** using your factory regulator.
5. Turn gas off at the gas supply valve.
6. Remove manometer hose and close the gas pet cock valve.

Gas Pressure Limit Switches (Verify / Set):

1. Verify and adjust if required the low gas pressure limit switch to 14 W.C.I. (35 mbar).
2. Verify and adjust if required the high gas pressure limit switch to 22 W.C.I. (55 mbar) or 4 W.C.I. higher than incoming gas pressure (whichever is greater).

Air Damper Settings – Verification:

1. Remove the actuator (damper control) cover by removing the 4 screws on the outside of the cover.
2. Verify the ignition orange cam adjuster setting is at 30°. If the orange adjuster is not set to 30°, adjust the cam using a small flat head screw driver and turn the white plastic screw counterclockwise to decrease the angle or clockwise to increase the angle.
3. Verify the damper is physically at 30° degrees by viewing the slot on the damper shaft located on the opposite side of the air inlet. The slot should be 30° from horizontal with the lowest end of the slot pointing towards the burner head (pointing away from the washer cabinet).
4. Verify the high fire; red cam adjuster setting is at 90°. If the red adjuster is not set to 90°, adjust the cam using a small flat head screw driver and turn the white plastic screw counterclockwise to decrease the angle or clockwise to increase the angle. The pre-operational test setting should be 90°.

Spark Rod Verification – Setting:

1. With the spark rod cap removed, verify and adjust if required the distance from the end of the spark rod to the face of the brass reducer bushing screwed into the burner head.
 - IJ3 Models – 2.67 Inches (68 mm)
 - IJ4 Models – 3.42 Inches (87 mm)

Trial for Ignition:

1. Attach the 1st water manometer to read gas pressure differential across the orifice plate by using a small screw driver to unscrew the two pet cock valves on either side of the orifice plate at least one full turn counterclockwise and attaching the manometer hoses.
2. Attach the 2nd water manometer to read air pressure differential between the damper inlet and the combustion chamber by unscrewing the pet valve located below the damper shaft at the air inlet and the remaining pet cock valve on the face of the burner head at least one full turn counterclockwise and attaching the manometer hoses.
3. The ratio regulator located downstream from the main gas train is for setting ignition (low fire) only. The ratio regulator was set at the factory for optimum ignition (low fire).

4. Turn gas on at the StingRay provided gas supply valve.
5. Push the "Pilot Test Button" (latched) on the Vari-Flame controller located inside the Eclipse electrical enclosure to prevent the burner from going to high fire after ignition.

Note: Several seconds following step 6 the burner will start its firing sequence. First the blower starts, then the trial for ignition. The burner will not go to high fire at this point.

6. Turn the "Burner Power" selector switch to the "ON" position.

Note: If the burner ignites skip forward to step #15. If the burner fails to ignite, perform the following steps.

7. Bleed the gas line by disconnecting 1 manometer hose from either pet cock valve until you smell gas, and then reattach the manometer hose. (Turn the burner selector switch to On until trial for ignition occurs then back to Off)
8. Turn the "Burner Power" selector switch to the "OFF" position and back to the "ON" position. If the burner still does not ignite, repeat this step 2 more times.
9. If the burner still fails to ignite verify the damper is physically at 30° as described in air damper settings #3 above.
10. On the ratio regulator, turn the diaphragm adjusting screw counterclockwise until the screw is fully extended, then turn the screw clockwise 6 full (360°) revolutions.
11. Turn the "Burner Power" selector switch to the "OFF" position and back to the "ON" position.
12. If the burner still fails to ignite, turn the ratio regulator diaphragm screw clockwise ½ (180°) revolution.
13. Turn the "Burner Power" selector switch to the "OFF" position and back to the "ON" position.
14. If the burner still fails to ignite, repeat steps 12 and 13 until the burner ignites.
15. At successful ignition, repeat step 13 two additional times to ensure stable ignition.
16. Verify the LED lamps on the proving switch (if equipped) are visible through the switch cover.

High Fire:

1. Turn the “Burner Power” selector switch to the “OFF” position.

Note: Steps 2, 3, 4 are for field start-up only

2. Using a 9/16” wrench remove the flue gas test port located on the top of the parts washer in the flue pipe stub.
3. Insert the flue gas analyzer adapter into the test port.
4. Insert a calibrated flue gas analyzer probe (set for the proper gas type application) into the adapter. NOTE: If you are unsure about the proper operation of the flue gas analyzer, a simple test is to measure the oxygen percent of air outside of the plant. The percent oxygen in our atmosphere is relatively constant at 20.9% regardless of altitude. Even though at higher altitudes air is less dense the percentage of oxygen remains the same. If your flue gas analyzer doesn't measure the percentage of atmospheric air at 20.9% it is not working properly. Oxygen sensors in flue gas analyzers need regular replacement and are a common maintenance item.
5. Push the “Pilot Test Button” (unlatched) on the Vari-Flame controller to allow the burner to go to high fire from ignition (low fire).

Note: Several seconds following step 6 the burner will start its firing sequence. First the blower starts, then the trial for ignition, and then ramps up to high fire.

6. Turn the “Burner Power” selector switch to the “ON” position.
7. Once burner has stabilized at high fire, compare the gas pressure differentials to that listed on the parts washer birth plate. Ideally the manometer pressure differential should closely match that of the listed pressure differential.
8. If the Gas Pressure differential differs from that listed on the birth plate continue with instruction #9, otherwise continue at instruction #10
9. Adjust the red (high fire) damper control cam using a small flat head screw driver and turn the white plastic screw clockwise to decrease the angle (reduces the gas pressure differential) or counterclockwise to increase the angle (if original setting is less than 90°), (raises the gas pressure differential) until the manometer differential matches that listed on the birth plate.
10. At successful high fire, verify air pressure differential matches that of the birth plate, allow the burner to operate for two minutes.
11. Turn the “Burner Power” selector switch to the “OFF” position and back to the “ON” position.
12. Repeat steps 10 and 11 two additional cycles to ensure stable ignition and high fire.

Field Start-up:

1. Use the Combustion flue gas analyzer to verify proper combustion:
 - Unburned combustibles 0%
 - Carbon dioxide (natural gas) 9% 10%
 - Carbon dioxide (propane gas) 10% - 12%
 - Oxygen 2% - 5% (Target 3%)
 - Combustion efficiency 78% or greater
 - Stack temperature 350°F to 650°F (180°C to 350°C)
 - Carbon monoxide 100PPM or less (0-10PPM is expected)
2. At successful flue gas analysis, document actual results on the StingRay provided "Field Start-up form", retain for StingRay Customer Care and customer records.
3. Remove flue gas analyzer, and replace the test port plug.
4. Notify the responsible customer representative or the StingRay Service Technician for further requirements or powering down the StingRay Parts Washer.

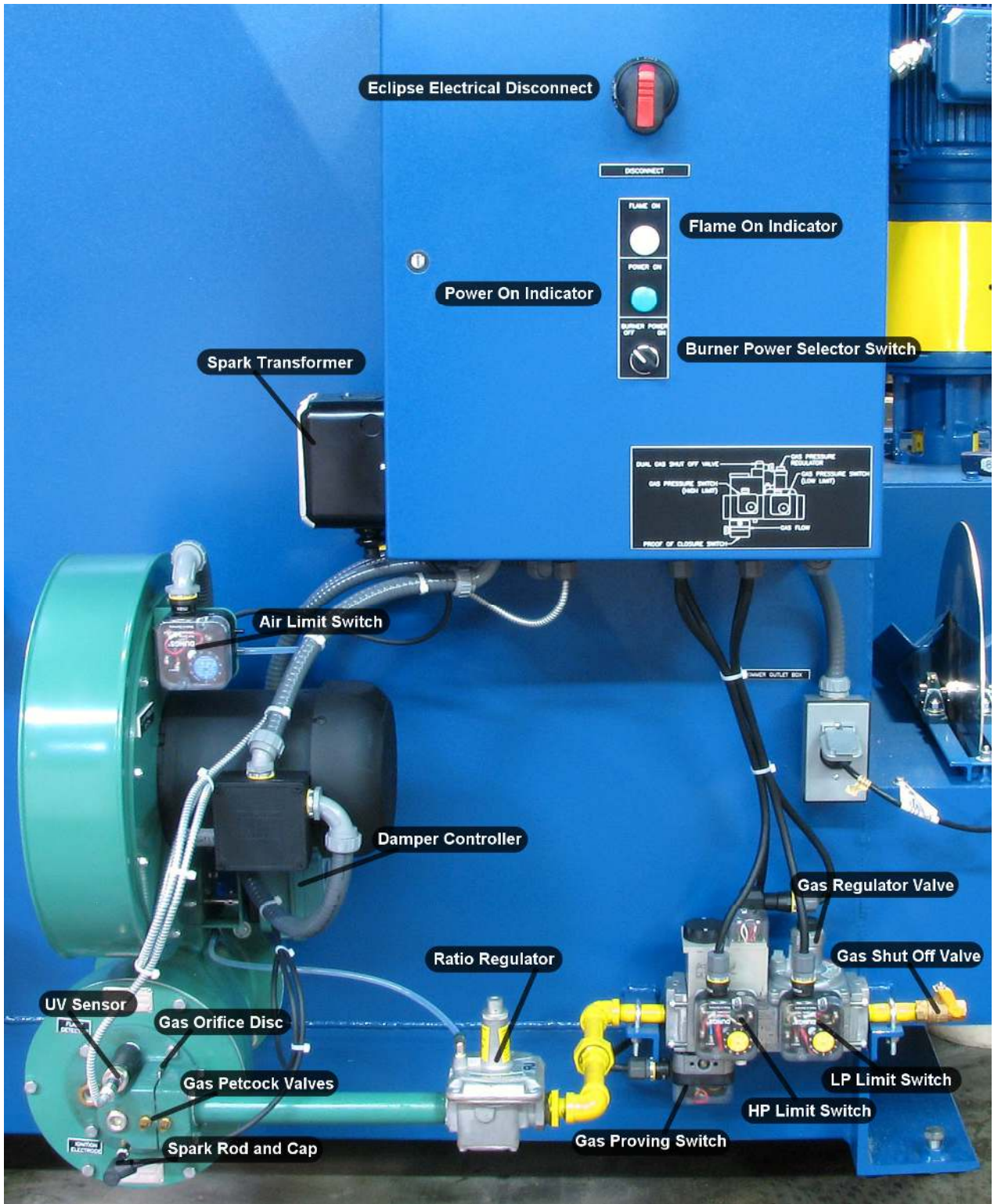


Fig. 2 - 31: 400,000 to 990,000 BTU Burner Diagram

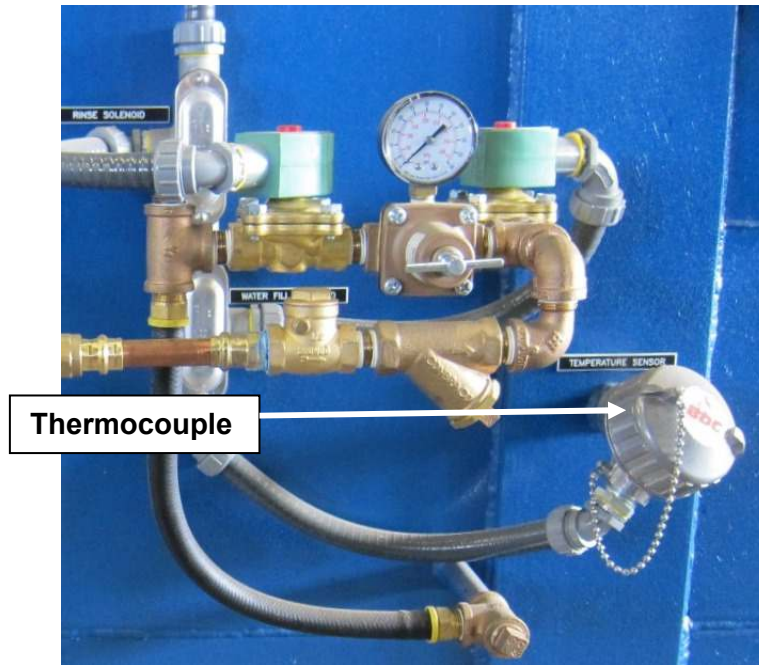


Fig. 2 - 32: Water Temperature Thermocouple Location

Hi-Limit Controller Adjustment:

StingRay Parts Washers are equipped with a safety control system to prevent over temperature of the gas heating system. A temperature sensor is located in the flue gas stack and connected to a hi-limit controller in the electrical control enclosure. If the flue temperature exceeds the set point on the hi-limit controller, the heating system will shut down.

NOTE: StingRay Parts Washers are shipped with the Hi-Limit Control set to a predetermined value for your machine size. YOU ARE RESPONSIBLE for accurate adjustment of the Hi-Limit Controller. All set-up adjustments are to be done only by people who are qualified and trained for the task.

NOTE: The Hi-Limit control adjustment should be performed as an integral part of the burner start-up procedure.

To set-up the Hi-Limit controller, proceed as follows:

1. Adjust the temperature control unit to 220 degrees F.
2. Allow the burner to operate until the water temperature reaches 200 degrees F.
3. Measure and record the exhaust stack temperature.
4. Adjust the Hi-Limit controller 100 degrees F. over the measured exhaust temperature.
5. Reset the temperature control unit to the proper temperature (see Fig. 2–26).

The Hi-Limit control is now properly adjusted.

NOTE: The set-up and proper adjustment of the HI-LIMIT controller is the responsibility of the end user. Failure to perform the proper set-up will render the HI-LIMIT control system inoperative and may violate local codes.

Heat - Electric: (if applicable)

1. Set the temperature controller.
2. Check to be sure that the washer is heating.

Heat - Steam: (if applicable)

1. Set the temperature controller.
2. Check to be sure that the washer is heating.

Heat - Oil: (if applicable)

1. Set the temperature controller.
2. Follow the instructions in your vendor-supplied oil-burner manual.

Temperature:

1. Verify that the washer continues to heat up properly. ***NOTE: Generally, it takes about two hours for water to heat from 70° F (21° C) up to 190° F (88° C). While the water is heating, you may continue with the power-up procedure.***

Pump Rotation Direction:

1. Close and latch the washer cabinet door. (Door to remain closed for balance of this test).

2. Verify proper rotation of the pumps by the following procedure:
 - Set a 15 minute wash time on the *0-30 minute timer*.
 - Press the *start* button.
 - Immediately press the *stop* button.
 - Observe rotation direction of the wash pump shafts. Verify the *clockwise rotation of the pumps when looking from the top down*. (**NOTE:** If not correct, have an electrician reverse the direction of the pump by swapping any 2 of the 3 main power-supply wires at the disconnect or main distribution block. Swap the main power supply wires and not the wires at the pump motor contactors as this correctly “phases” the whole machine.)
 - Repeat test to verify correct rotation of pump/s.
3. If the pump direction is correct, set the *wash time* for *10 minutes*.

Water Hammer Cycle Test:

Perform the water hammer cycle test *after* the reservoir is completely filled *and after* the washer is fully heated. **During winter time**, "water hammer" may occur more frequently, or be more severe, due to lower ambient temperatures. Refer to steps below to eliminate water hammer.

Note: Water hammer is the result of cooler ambient air entering a hot washer cabinet. When the pump system comes on, this cool air is rapidly heated by the hot water solution, which results in a rapid expansion in excess of the normal exhaust system capacity. The excess air pressure generated may cause ejection of hot solution from the washer.

4. Open washer cabinet door wide open for a minimum of 30 seconds. Close and latch the door.
5. Stand to the side of the washer and press the start button.
6. If water is ejected from under the front reservoir cover:
 - Press the *stop* button.
 - For duplex pump systems: Add additional time to the wash delay timer. Simplex pump systems use a motor soft-starter to prevent water

hammer. The soft-starter is factory set to 10 seconds and not user changeable. Call StingRay Tech service if water hammer is an issue for simplex pump systems.

- Repeat steps #4 thru #6 until the water hammer stops.

Verify Power Utilities under full load:

CAUTION: *This procedure exposes personnel to dangerous and hazardous voltages. Be sure the people performing this task are qualified and trained for the task.*

7. Turn the electrical disconnect on the control enclosure door OFF. Open electrical enclosure door.
8. With door open, turn the disconnect ON.
9. Press start. Measure and record the incoming voltage to the washer *with wash pump(s) running, and all equipment on the washer operating*, so you have the maximum amperage draw.

NOTE: Take the measurements inside the electrical control panel, at the power distribution block. Refer to Fig. 2-9. If the voltage is more than 10% below the voltage stated on the nameplate of the washer, stop the startup procedure. You must correct the low voltage condition before proceeding with the start-up.

10. With pumps running, measure and record the amp draw from the wash pump motor(s), using a clamp-on amp meter.

NOTE: Take the amperage measurement at the load side of the wash pump starter(s) on each power leg. If the washer is equipped with a duplex pump system or multiple pumps, take amp readings separately on each wash pump motor, with all pumps running.

Compare amperage readings with the maximum amp load, which is calculated as follows:

- a) On each pump motor, find the manufacturer's specification tag. The tag indicates two things: **(1)** Full-load amperage draw at your specified voltage; and **(2)** The service factor, which is stamped on the motor nameplate.
- b) Multiply the full-load draw (as indicated on the motor tag) by the service factor in order to calculate the maximum allowable amp load.
- c) The actual amperage draw reading on each motor is to fall *below* the maximum calculated allowable amp load.

Verify the factory pre-set times for the optional Auto Rinse Cycle (ARC) and the Auto Steam Exhaust (ASE) timers per the following tables.

<u>Timer for:</u>	<u>Factory Setting:</u>
Auto Rinse Cycle (ARC)	1 minute
Auto Steam Exhaust (ASE)	1 minute

Additional Operational Checks:

1. With machine running a wash cycle, manually depress the float rod down. Verify wash cycle stops immediately. Wash cycle should not be able to be restarted until float rod is released and allowed to return to its normal position and the wash door is opened and re-closed.

WARNING! Stand to the side of machine for this test.

2. With machine running a wash cycle, CAREFULLY release the door latch handle only enough to allow the door to open slightly (1/4" / 6 mm). Wash cycle should stop immediately. Wash cycle cannot be restarted until door is properly closed and secured.
3. With machine not running a wash cycle, but with heating system on, manually depress the float rod down. The heating system should immediately shut off. When rod is allowed to return to its normal position, the heating system should again become functional.

If any of the proceeding operational checks steps do not function as described, correct the problem before proceeding.

6.4. Chemical-Charging Procedure

If you have successfully completed the startup procedure to this point, you are ready to charge the washer with cleaning chemical.

When you charge the washer with chemical, always follow the chemical manufacturer's recommendations.

In general, most manufacturers recommend 4-6 oz. (120ml - 180ml) of chemical per gallon of water.

WARNING! When handling chemicals, always wear gauntlet-type thermally protected and water-repellent protective gloves, protective eyewear, a filter-type air mask, and a full body apron that is thermally protected and water-repellent. Use a long-handled shovel only when working with or dispensing granular chemical. (Some chemical is liquid.)

For granular chemical, follow this procedure:

1. Open and secure Parts Washer door.
2. Using a Long-handled shovel and wearing protective gear and clothing, slowly pour or shove chemical onto the drip pan under the turntable of the StingRay Parts Washer. Do not dump chemical directly into washer reservoir. Violent exothermic (heat released) reactions, splashing of chemically and physically heated solutions, and the premature release of fumes may occur. Avoid contact with chemical and solution. Avoid inhaling dust and fumes. Note: For higher chemical concentrations or larger parts washers it is best to add powder chemical in batches. Do **not** add chemical past the bottom of the turntable spokes and do **not** add more than 100 pounds (45 kg) of chemical at a time.
3. Close the washer door and run a 15-minute wash cycle to dissolve the detergent. Operate the wash cycle @ 160 to 190 degrees F.
4. After wash cycle completes verify that the entire chemical on the drip pan is dissolved into the washer reservoir. If not it may be necessary to run additional wash cycles or stir the chemical with a steel rod to break-up any clumps.

For liquid chemical, follow this procedure:

1. Turn the **main power supply OFF**.
2. Pump out a volume of water equal to the volume of liquid chemical planned for addition. If you fail to do this you may over fill the washer.

3. Pump the liquid chemical **SLOWLY** from drums over the washer doorframe onto the internal reservoir cover or through the internal reservoir cover screen. Close the washer door.

CAUTION! Use extreme caution when pumping liquid chemical! The operator should stand back from the washer and wear gauntlet-type thermally protected and water-repellent protective gloves, protective eyewear, a filter-type air mask, and a full body apron that is thermally protected and water-repellent.

WARNING! Do NOT pour liquid chemical into the front reservoir.

4. Turn the *main power supply ON*. Run a 10 minute wash cycle to mix the chemical.

6.5. 7-Day Dual-Circuit Clock Initialization

After you have completed the chemical-charging procedure, initialize the 7-day dual-circuit clock.

Follow these instructions:

1. Set the 7-day clock. Refer to the vendor-provided manual for details. Also refer to section "Setting the 7-Day Dual-Circuit Clock" in Chapter 4, "Advanced Operations: Process-Control" in this manual.
2. Re-set the clock-override switch, located on the control panel, from the *on* position to the *off* position: this allows the 7-day clock to automatically operate the heating circuit.
3. To perform a test wash of actual parts, see Chapter 3, "Basic Operations".

6.6. Rinse System Chemical Injector (Optional)

This option arrives factory-installed. All you have to do is open a rust inhibitor chemical bucket, place the strainer tube in the bottom of the bucket, and prime the injector pump.

To prime the injector pump, follow these guidelines:

1. Shut off the incoming water supply.
2. Turn off the main-power-supply disconnect switch, located on the outside of the door of the electrical control panel and open the door.
3. Set the rinse timer to the maximum rinse time. (The rinse timer is located inside the electrical control panel.)
4. Close the door of the electrical control panel.
5. Turn on the main-power-supply disconnect switch.
6. Put the washer in to the rinse cycle.

To do this, press *start*, then turn the wash timer to *0*.
(When the washer begins a rinse cycle, the injector pump turns on.)

7. Turn injector-pump speed to *10*, until solution enters injector discharge.

CAUTION! Do not adjust injector-pump speed unless you have already put the washer in to the rinse cycle! Adjust injector-pump speed control ONLY while the injector pump is running.

The injector pump is now primed. NOTE: if you experience trouble getting the pump to prime loosen the compression fitting on injector and temporarily remove the discharge hose. See figure below.

8. Press *stop*.
9. Turn off the main-power-supply disconnect switch, located on the outside of the door of the electrical control panel.
10. To set the rinse timer and injector-pump speed control, refer to Chapter 4, "*Advanced Operations: Process-Control*".

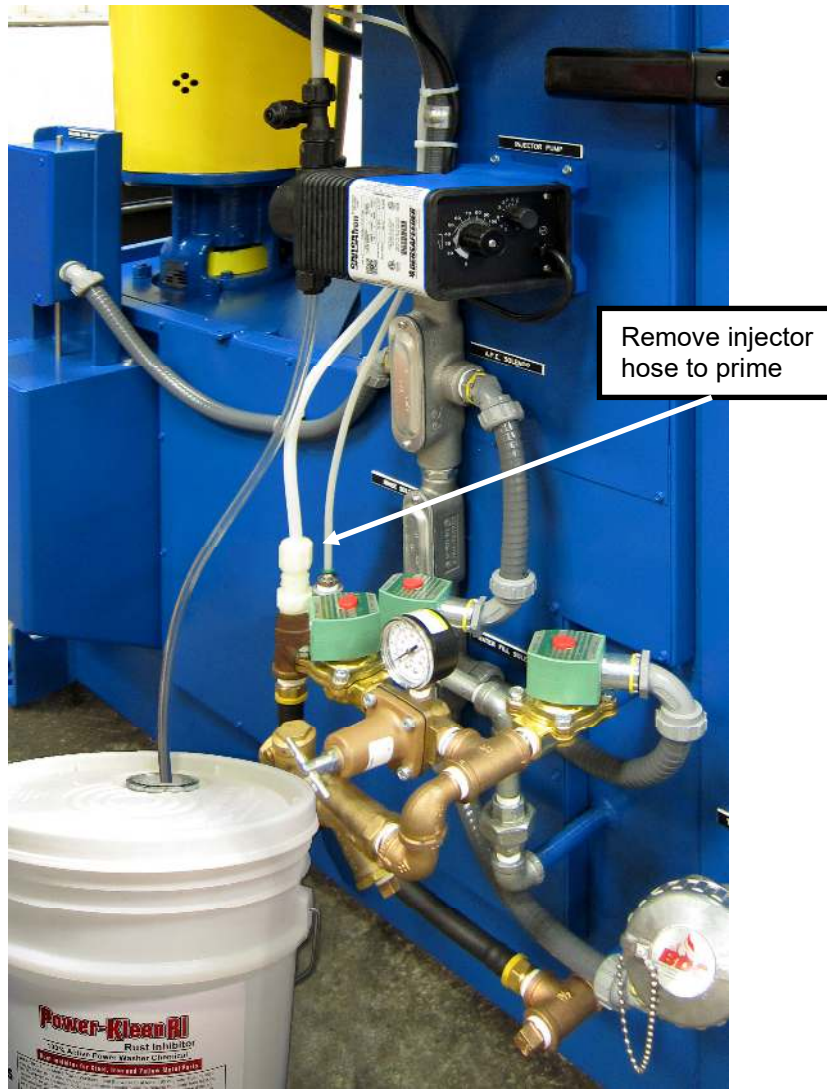


Fig. 2 – 33: Rinse Chemical Injector System

6.7. Startup Problems

If you have any problems during the startup procedure, do the following:

- Re-read this chapter "*Installation*".
- Refer to chapter "*Troubleshooting*".
- Call StingRay.

After you have completed startup with no problems, you are ready to run a wash cycle. Refer to chapter "*Basic Operations*".

Reference: StingRay ENGINEERING STANDARD: ESS 058

Requirements for Gas Burner Flue & Venting Installation

Standard StingRay Parts Washer Flame Gas Burner installations must conform to each of the following requirements in order to avoid failures in the field and/or less than specified performance. StingRay will not warranty operation of the standard gas burner in any installation that does not strictly adhere to these requirements.

WARNING: IMPORTANT: CRITICAL

The immersion tube firing gas burner is difficult to install and set properly. GET PROFESSIONAL help. You MUST set the burner with a FLUE GAS Analyzer. You MUST use a slack tube WATER MANOMETER to measure pressure in water column inches (wci). Your Flue Gas Analyzer must read CO₂, CO, O₂, and efficiency to properly set the burner. The flue gas analyzer must be CALIBRATED and working properly. If you cannot read the proper amount of oxygen in atmospheric air then your analyzer is NOT working. If you do not have the proper equipment then DON'T TRY to set the burner.

YOUR INSTALLATION **MUST** COMPLY WITH THE FOLLOWING GUIDELINES:

DO:

DO ensure that no part of the flue is installed at an angle more than 45° from the vertical.

DO ensure that the flue diameter is not less than 2" larger than the diameter of the washer outlet.

DO ensure that the effective height of the flue stack with bends (vertical distance between washer and terminal) is at least twice the horizontal distance between the washer and terminal.

DO try to position the flue exhaust pipe inside the building to avoid excessive cooling.

DO ensure that the flue pipe connection from the washer rises vertically for at least (36") before any change of direction is contemplated. The reason for this is that the initial draft is crucial nearer the washer because of the higher flue gas temperature. Any horizontal or angled runs at the bottom of the flue will create severe restriction to gas movement and affect the washer gas burner operation.

DO ensure that the end of the exhaust pipe is vertical and is at least 15 feet above the outlet of the washer.

DO ensure that the end of the exhaust pipe is above the roof peak a minimum of 3 feet or installed in accordance with the National Gas Code.

DO ensure that the end of the exhaust pipe has an AGA approved rain cap.

DO ensure that the gas supply pipe is at least the following minimum diameters for a run 40 feet or less. If the run is longer than 40 feet call StingRay Tech Services to discuss the proper size.

Burner Output (BTU/hour)	Supply Pipe Diameter (inches)
180,000	1.00"
380,000	1.25"
750,000	2.00"

Use the minimum number of elbows in the gas supply pipe possible. In no case shall more than 4 elbows be used unless the supply pipe is the next size larger than the above minimums.

DO ensure that all joints are properly, securely, and efficiently made.

DO ensure the EXACT gas pressure required is available at the burner regulator. If your pressure drops more than 0.30 wci between the conditions of firing the burner and shut-off then your supply pipe is too small.

DON'T:

DON'T run horizontal flue from the washer.

DON'T run horizontal flue anywhere in the system.

DON'T use bends if they can be avoided.

DON'T position the flue exhaust pipe run externally of the building if it can be avoided.

DON'T connect the gas to the washer until the installation has been checked and approved by a gas engineer registered with the local gas company.

DON'T end the flue exhaust duct less than 3 feet above the roof peak or in accordance with the national gas code.

DON'T use single wall galvanized ducting as a flue system.

DON'T use un-insulated flue systems externally (outside the building).

DON'T allow any combustible materials to come into contact with any flue pipe.

DON'T install the burner system at an elevation more than 1000 feet above sea level; contact StingRay.

DON'T install the system in a location with changing air pressure caused by exhaust fans, ventilation equipment or exhaust blowers. Anything that causes positive or negative pressure in the building will affect the performance of the burner.

Additional considerations regarding DRAFT:

Natural Draft is Never a Constant

Temperature, the flue exhaust pipe height, and the total length of run including all elbows have the greatest impact on natural draft in flue, vents, and stacks. The draft will constantly change as the burners modulate, start up or shut down. The draft is also affected by outdoor temperature, barometric pressure and wind, so a flue exhaust pipe is not a very good draft controller. Draft variations due to fluctuations in outdoor air temperature alone can be substantial. During the operation, the flue exhaust pipe will be "oversized" most of the time, which can lead to inefficient and erratic operation.

Changes in weather, barometric shifts or draft conditions caused by building heating/ventilating/air conditioning may necessitate readjustment of the burner air/fuel settings. This condition is virtually eliminated with the StingRay Eclipse Burner system because the burner has an extremely powerful fan and fires at above atmospheric pressure to overcome draft changes. The StingRay Eclipse firing pressure is 3 to 4 times higher than the StingRay standard burner.

Efficiency and Emissions

For a gas burner heating a washer to be efficient and produce the lowest possible emission level, it must maintain a perfect flame and maximize heat transfer. A perfect flame can only be obtained by maintaining a precise fuel-to-air ratio. The correct air-to-fuel ratio can only be achieved with a proper air supply and proper draft. It is not uncommon to see high-efficiency burners operate at efficiency levels of low-efficiency burners. This is purely a result of lack of draft control making the additional investment in high-efficiency wasted. The StingRay Eclipse Burner system utilizes a ratio regulator that varies the air-to-fuel ratio under varying atmospheric anomalies and firing conditions to maintain an optimum ratio for maximum efficiency.

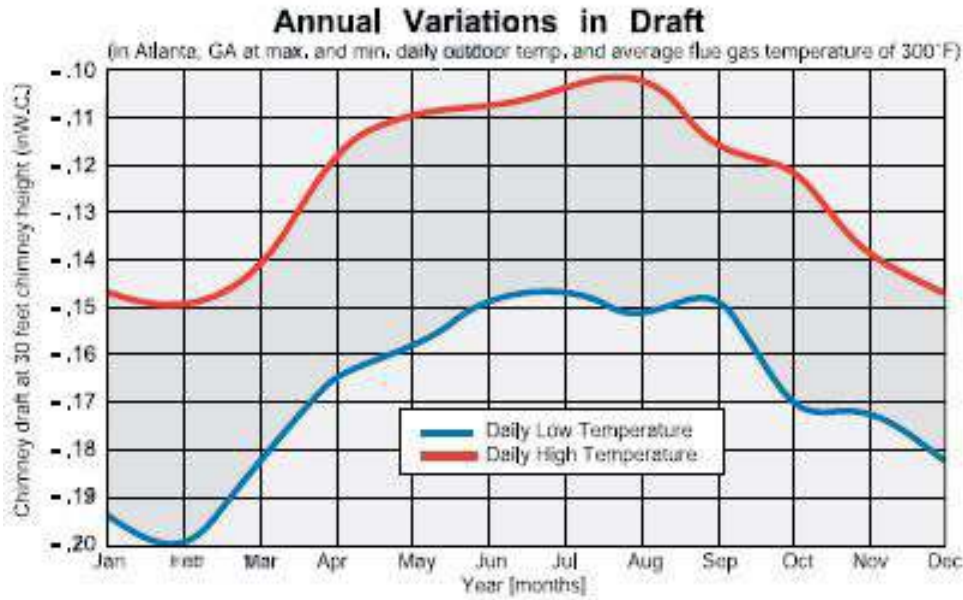


Fig. 2 - 34: Annual Variations in Draft

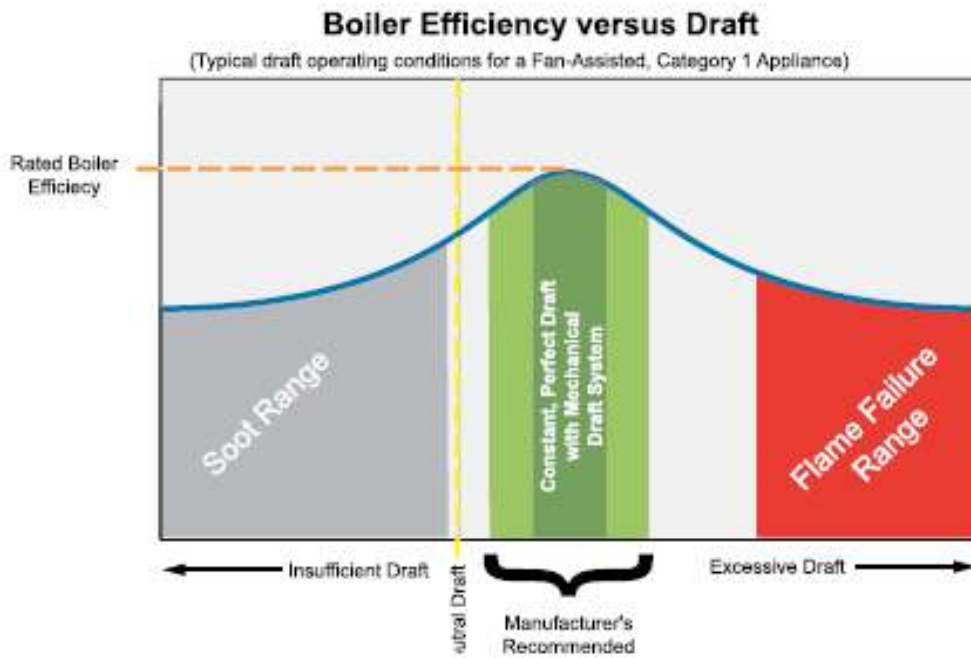


Fig. 2 - 35: Boiler Efficiency vs. Draft