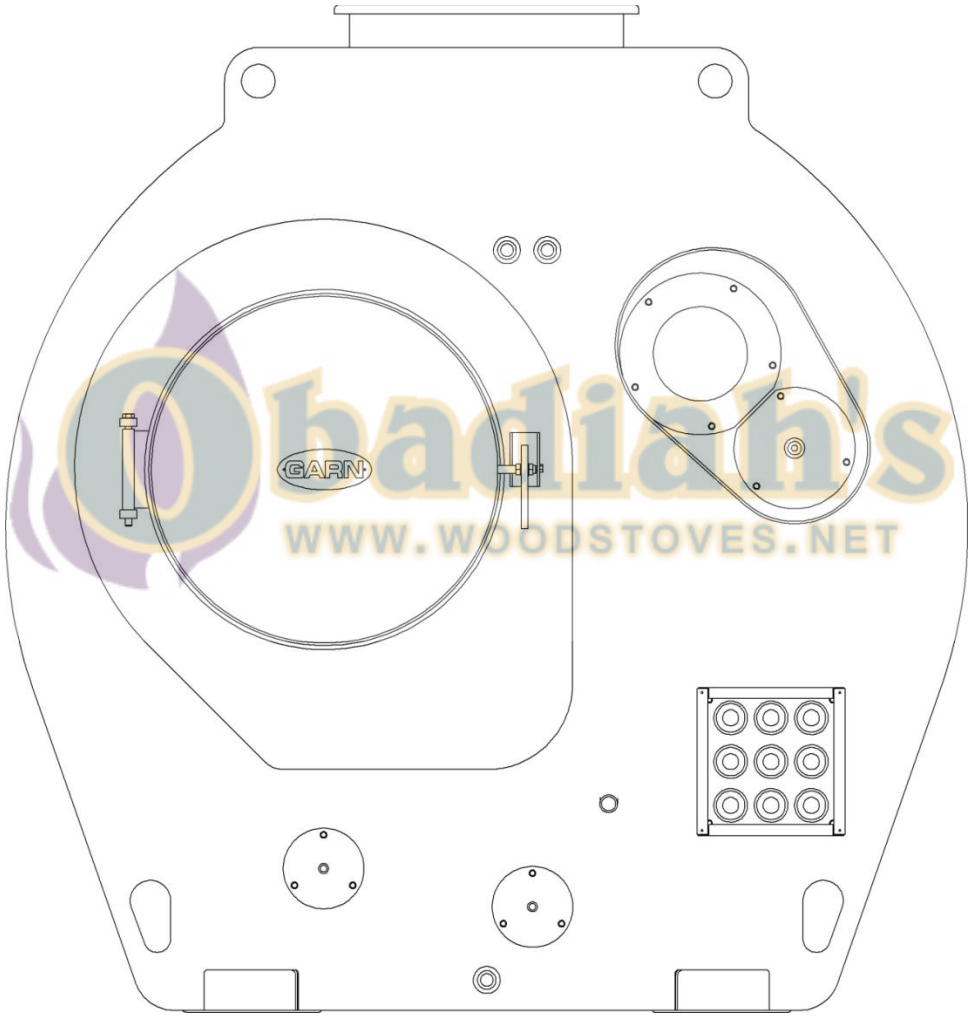
GARN® WHS 1000/1500/2000 Owner's Manual

This manual is updated periodically as continual product improvements are made. For the latest version of the manual, visit www.garn.com. It is not uncommon for the manual to have minor revisions a couple of times per year.



OWNER'S MANUAL FOR GARN® MODELS: WHS 1000, 1500 & 2000

THIS MANUAL ALSO APPLIES TO DISCONTINUED MODELS: WHS 1350, 1450, and 1900

Thank you for purchasing GARN® equipment. Carefully read this manual. It contains instructions about how to unpack, install, operate, and maintain your GARN® WHS. Please compare your packing list with the delivered items. Contact your dealer, DECTRA CORPORATION, and shipper immediately if any items are missing or damaged.

Table of Contents

A. WELCOME TO THE WORLD OF GARN® WOOD HEATING:

The GARN® Wood Heating System (WHS) is unlike any other piece of wood heating equipment. As you use your GARN®**,** you will come to appreciate its quality construction, unique features and many benefits. The purpose of this manual is to give the installer and operator the necessary information for proper installation, operation, and maintenance of a GARN® WHS. For proper sizing and selection, please refer to the GARN® System Design Manual.

GARN® WHS WOOD HEATING PACKAGE (STANDARD):

Every GARN® WHS wood heating package comes standard with the following components:

- WHS/ETS Digital Controller
- Low Water Sensor Stem
- Flue Temperature Sensor
- Tank Temperature Sensor
- Outdoor Air Temperature Sensor
- Hot Water Supply Sensor
- Hot Water Return Sensor
- Air intake hood
- Water treatment test kit
- Water filter and housing
- Cleanout plates and gaskets
- Bent flow stabilizer
- Motor and blower wheel
- Motor mount plate

GARN® WHS ELECTRIC HEATING PACKAGE (OPTIONAL):

Every GARN® WHS is shipped with 9 threaded electric element flanges in the lower-right corner of the front head/face of the unit. The flanges provide the opportunity to purchase the electric heating package and turn the GARN® WHS unit into an electric heating system. Electric heating can be used in conjunction with wood heating to provide a dual-fuel heating system. There are 3 electric heating package sizes to choose from. The correct size for your application depends on the utility/coop off-peak electric program, heating load, and GARN WHS unit size:

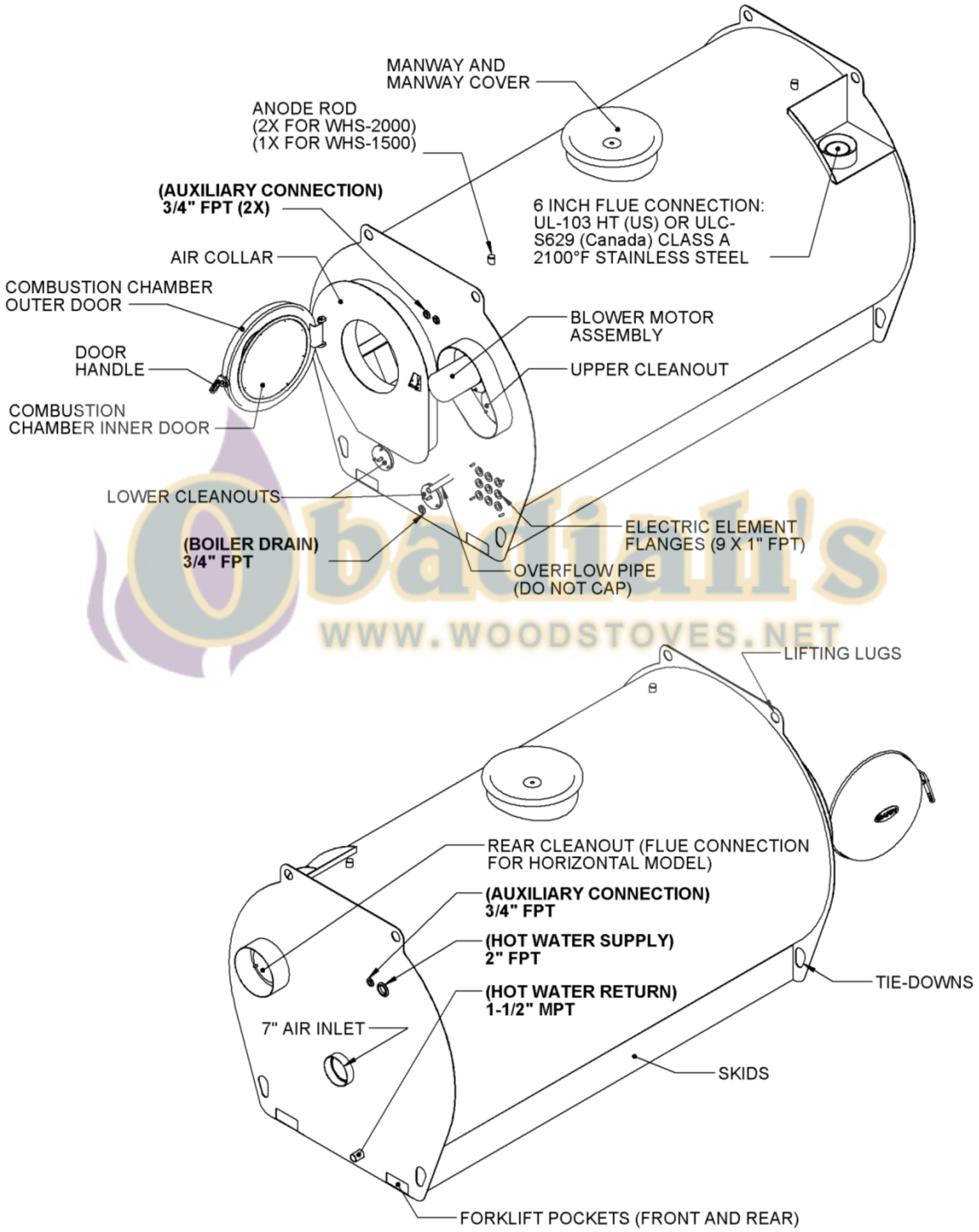
Electric Heating Package Size	Number of Electric Elements
16.5 kW	3
33.0 kW	6
49.5 kW	9

The Complete GARN Electric Heating Package comes standard with the following components:

- Electric Elements (3, 6, or 9 depending on heating package size selected)
- O-rings for elements
- Electric Element Junction Box
- Electric Element Junction Box Face Gasket
- Electric Element Junction Box Cover, Label, and Fasteners
- Element Sequencer (powers the elements on one-at-a-time)
- High Limit Switch
- Newest available Processor Chip for the Digital Controller

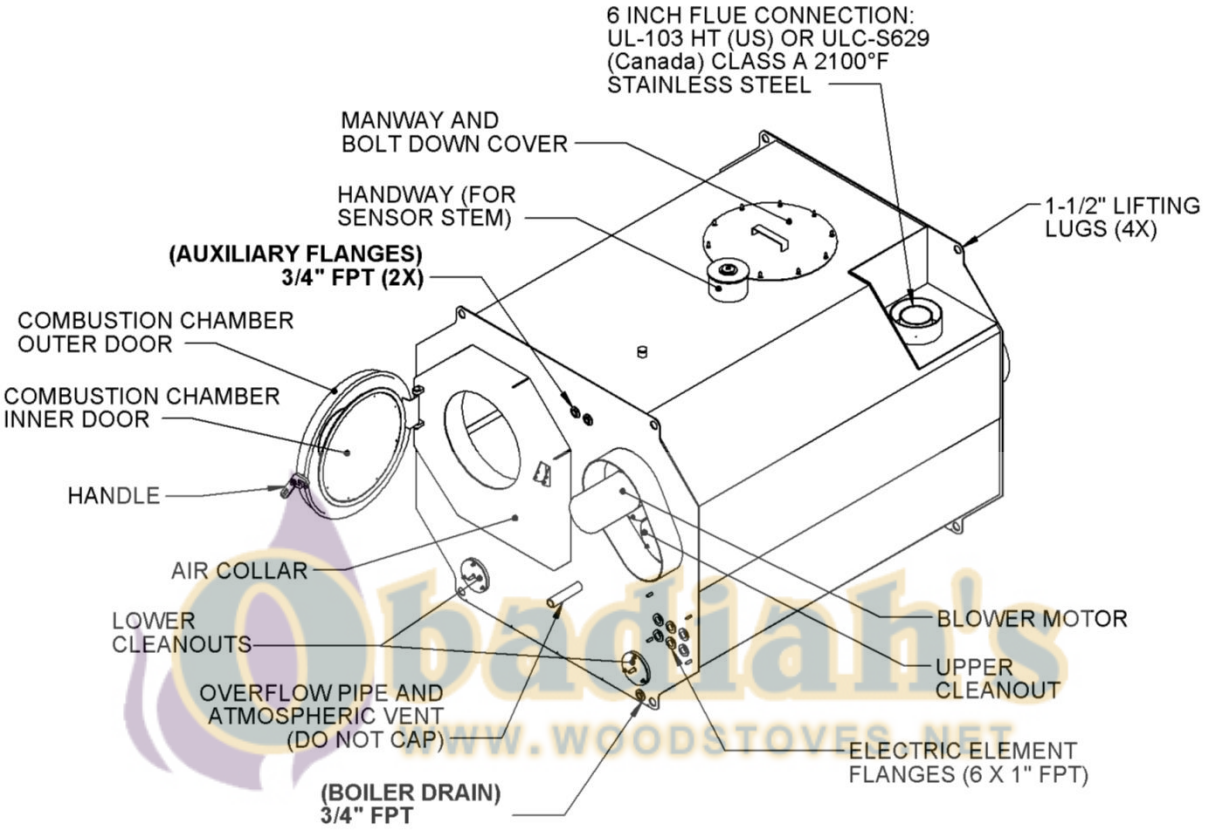
OVERVIEW OF GARN® COMPONENTS: WHS-1500V/2000V

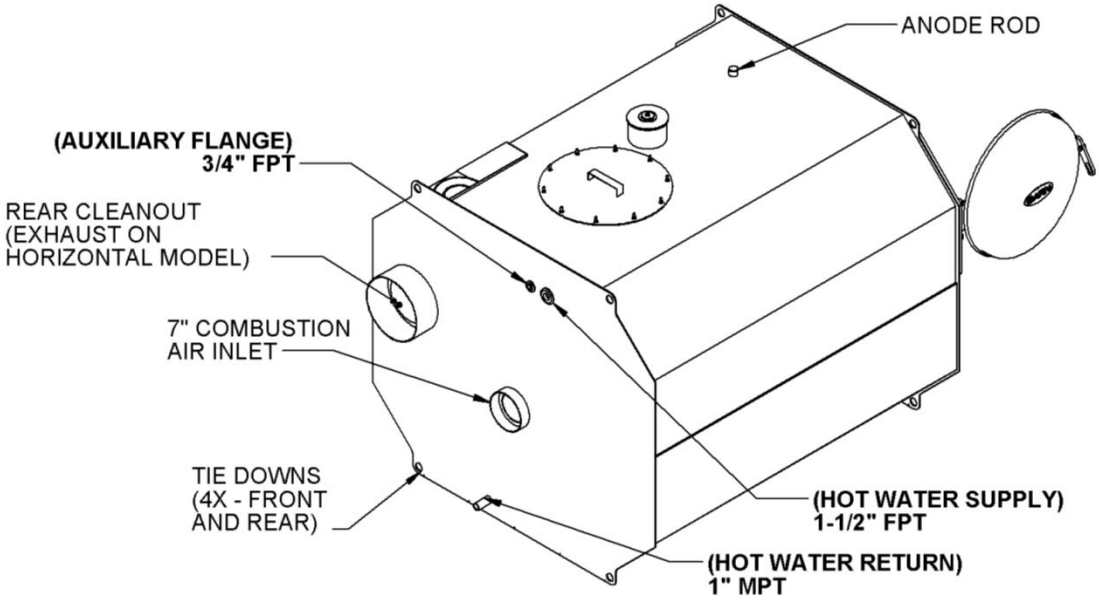
For additional detail and dimensions of the WHS-1500H/V and WHS-2000H/V, see the Dimensions section of this manual.



OVERVIEW OF GARN® COMPONENTS: WHS-1000V (Junior)

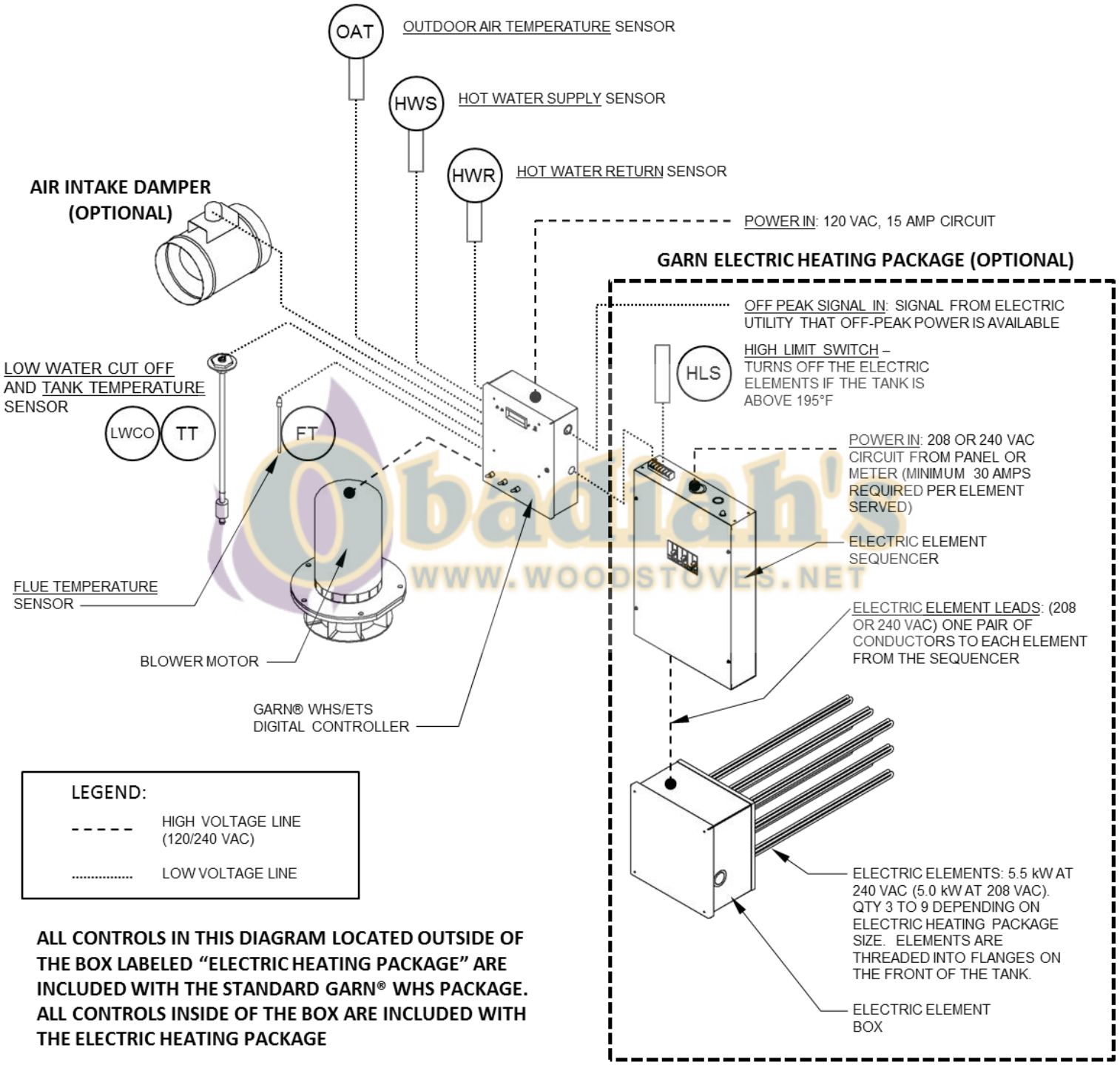
For additional detail and dimensions of the WHS-1000H/V (Junior), see the Dimensions section of this manual. In addition see the separate document "WHS-1000 Manual Addendum" available at www.garn.com





OVERVIEW OF GARN® CONTROLS

The diagram below shows the controls and sensors that are part of the basic GARN® WHS Wood Heating Package and the optional Electric Heating Package.



ALL CONTROLS IN THIS DIAGRAM LOCATED OUTSIDE OF THE BOX LABELED "ELECTRIC HEATING PACKAGE" ARE INCLUDED WITH THE STANDARD GARN® WHS PACKAGE. ALL CONTROLS INSIDE OF THE BOX ARE INCLUDED WITH THE ELECTRIC HEATING PACKAGE

B. CODES, INSURANCE, AND SAFETY SYMBOLS

The GARN® WHS Wood Heating System is a direct-vented wood-burning appliance that stores heat in a non-pressurized vessel. It is listed by ITS/Warnock Hersey Testing Laboratory, Madison, Wisconsin according to ANSI/UL-391, UL-726 and CAN/USA B366.1-11. It is to be installed according to this manual, on-line technical bulletins, Federal, State and local codes, and your insurance underwriter's guidelines.

The GARN® unit, all related heating equipment (including pumps, piping, fan coils, hot water baseboard, radiant floor heating systems, etc), and all electrical equipment (including power wiring, controls, control wiring, back up electric heating, etc) must be installed by a qualified installer or licensed personnel in strict compliance with all Federal, State and local codes. All electrical equipment, devices and wiring installed with the GARN® unit must be UL/CSA listed. The installer is to supply and install all code required electrical over current and disconnect devices.

Local building and fire inspectors are given discretion to determine if construction and heating installations are safe. They use recommended guidelines developed by various national organizations, such as NFPA (National Fire Protection Association). Your insurance company may also have specific guidelines concerning the installation of wood heating equipment. Follow all local and national codes. The installation must comply with applicable sections of Canadian CSA Standard B365 or U.S. NFPA Standard 211.

The design of the GARN® Wood Heating System is unique and was developed under the following patents: United States Patents #4,401,101 and #4,549,526; Canadian Patents #1,163,880 and #1,220,686.

This manual is intended to comply with NEMA Z535.6-2006 (the standard for *Product Safety Information in Product Manuals, Instructions, and Other Collateral Material*). Throughout the manual, a series of safety symbols are intended to call to attention the following types of information:

NOTICE A **notice** provides a piece of information to make a procedure/process easier or clearer.

⚠ CAUTION A **caution** emphasizes where equipment damage might occur. Personal injury is not likely.

⚠ WARNING A **warning** emphasizes areas where personal injury or death may occur but is not likely. Property or equipment damage is likely.

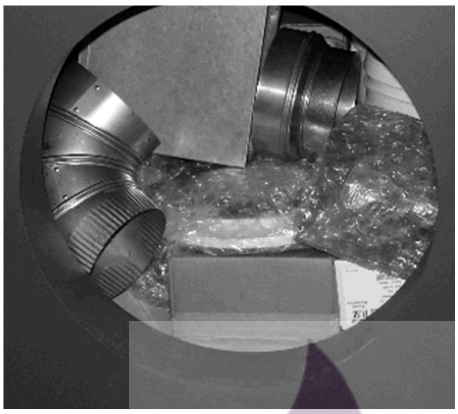
⚠ DANGER A **danger** emphasizes areas or procedures where death, serious injury, or property damage is likely if not strictly followed.

C. UNPACKING AND ASSEMBLY:

The GARN® unit is shipped with most of its components inside the combustion chamber.

NOTICE **DO NOT REMOVE THE FIREBRICK**. It is preinstalled correctly at the factory.

The following components should be removed from the combustion chamber:



- Digital controller
- Digital controller sensors
- Air intake hood
- Water level sensor stem
- Water treatment test kit
- Water filter and housing
- Motor and blower wheel
- Motor mount plate
- Cleanout plates and gaskets
- Bent flow stabilizer

NOTICE **COMPONENTS TO UNPACK CAN VARY WITH TYPE OF INSTALLATION AND ACCESSORIES ORDERED.** Compare the packing slip that came with your unit to the components unpacked.

FACTORY PREINSTALLED ITEMS:

The following items are assembled and properly installed at the factory:

- Firebrick with insulation backing
- Ceramic reaction chamber tube (2 sections) with rear insulating ring
- Lower cleanout plates and gaskets
- Rear cleanout plate and gasket (on vertical units only)

MANWAY COVER AND GASKET

A galvanized steel manway cover is provided with all GARN® WHS equipment. The manway cover:

- Provides mounting for the sensor stem.
- Prevents debris from entering the tank.
- Is a pressure relief for the GARN® WHS.
- Minimizes evaporation of the storage water.

CAUTION **DO NOT FASTEN THE MANWAY COVER TO THE MANWAY ACCESS RING**. The GARN® WHS unit is non-pressurized hydronic heating unit. An internal overflow/vent will prevent the development of internal pressure that results from the gentle expansion and contraction associated with the varying temperature of the water. In cases where accidental over-firing results in rapid boiling, the manway cover is designed to rise slightly to relieve internal pressure. If undesirable evaporation occurs, a 10 lb weight (or cement block) can be placed on top of the manway without compromising its function as a pressure relief. This will seat the gasket better and prevent unwanted evaporation.

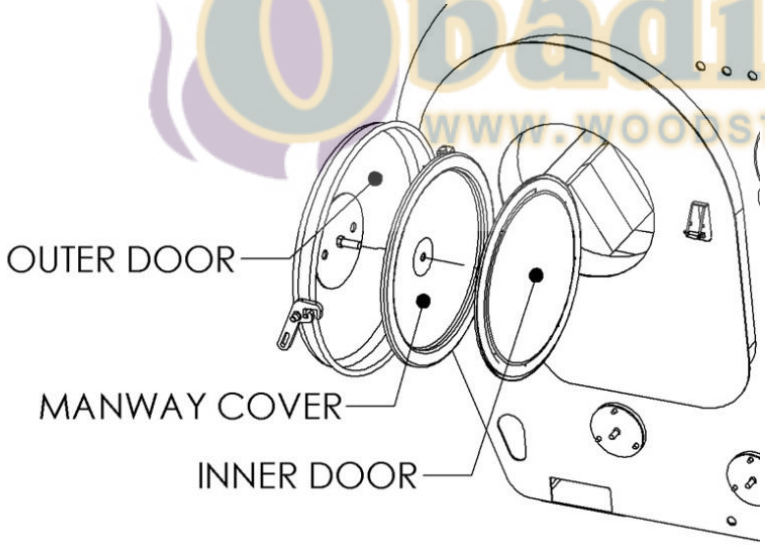
WHERE IS THE GARN® MANWAY COVER?

SPLIT COVER

Units produced **after September 2015** are shipped with a "split" manway cover. The manway cover is shipped in a box in the combustion chamber. For installation instructions, see the LOW WATER CUT-OFF AND TANK TEMPERATURE SENSOR STEM section on page 62 of this manual.

SPUN COVER

Units produced **prior to September 2015** were shipped with a "spun" manway cover. The manway cover is shipped sandwiched between the inner door assembly and the outer door on the front of the GARN® WHS unit.



To remove the manway cover from its shipping position, simply grasp the inner stainless door assembly and rotate it **counterclockwise** until the assembly is free of the unit (approximately 3 to 10 full revolutions).

CAUTION **THE INNER DOOR IS HEAVY, APPROXIMATELY 20 LBS. DO NOT DROP THE INNER DOOR ASSEMBLY AS YOU MAY SEVERELY DAMAGE IT**.

Carefully set the inner door assembly aside and remove the manway cover. Reinstall the inner door assembly by threading it (rotating clockwise) back onto the large bolt that protrudes from the center, inside face of the outer door. Adjust the door per the "Aligning the Combustion Door" section of this manual.

ALIGNING THE COMBUSTION DOOR:

The combustion door consists of an inner insulated door on a threaded shaft and an outer door which acts as a heat shield. The outer door is designed to function as a spring. It maintains pressure on the high-temperature, flexible gasket along the edge of the inner door. These were positioned properly at the factory, but movement during shipping may necessitate adjustment on site. Periodic adjustments may also be required.

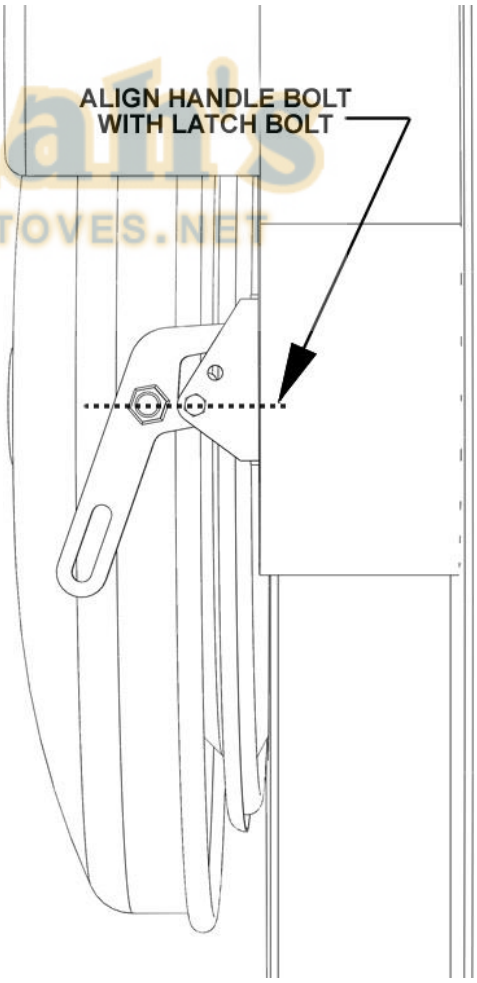
SQUARING THE INNER DOOR TO THE UNIT:

If the inner door is not square with the air collar, it should be adjusted. Grab the inner door on its gasketed edge with hands on opposing sides. Push with one hand and pull with the other.

Rotate the inner door to verify that it has been brought roughly to within square of the outer door. Visually, the inner door should rotate without moving out-of-square with the outer door and air collar. This doesn't have to be perfect. Within 1/4" of square should allow the inner door gasket to seal properly.

ALIGNING THE HANDLE WITH LATCH BOLT:

The door handle bolt should be level with the latch bolt on the air collar. To adjust this, use a pry bar between the handle bolt and latch bolt and pry in the direction necessary to make them align (see figure to right).



If the latch is not far out of alignment, the handle can be used for adjustment. Hook the handle on the latch bolt and push the handle up. Repeat until the door handle bolt and the latch bolt are aligned.

ADJUSTING THE DOOR SEAL:

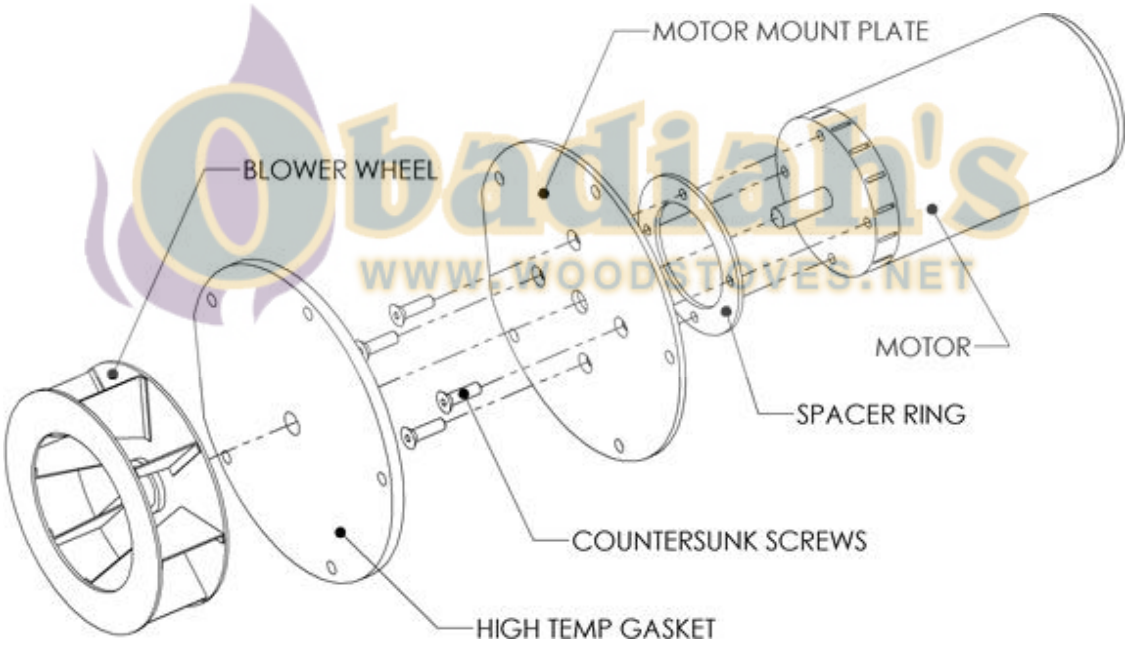
The outer heat shield should flex when the door latch is secured. The flexing indicates that the outer door is acting as a spring and keeping the inner door properly sealed. The inner door can be rotated to adjust the amount of tension on the inner door seal. The door latch can be rotated on its bolt to adjust its position right or left in relation to the latch bolt.

INDUCED DRAFT FACE MOUNTED BLOWER ASSEMBLY

Unpack the following blower assembly components:

- Blower wheel and shaft key
- Allen wrench
- Motor (with power cord attached)
- Motor mount plate
- Motor mount spacer ring
- Motor mounting screws (4 x countersunk, socket head cap screws (SHCS))
- Motor mount gasket (approximately 12" in diameter x ½" thick)
- Upper clean out cover and gasket (approximately 9" in diameter)
- Bent flow stabilizer

NOTICE **THE MOTOR AND BLOWER ASSEMBLY IS HEAVY, APPROXIMATELY 45 LBS. DO NOT DROP AS YOU MAY SEVERELY DAMAGE IT.** Each blower wheel is statically and dynamically balanced at the factory.



1. Place the motor mount spacer ring over the shaft end of the motor and align the bolt holes with the threaded sockets on the motor body. Remove the rubber washer on the shaft of the motor if there is one.

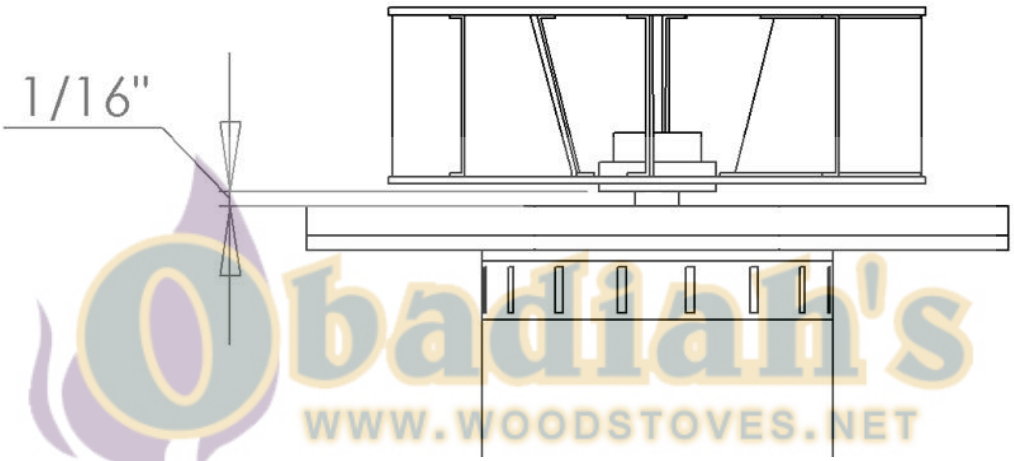
2. Place the motor mount plate over the shaft end of the motor and align the counter sunk holes with the motor spacer ring and the threaded sockets on the motor body.

3. Insert the 4 countersunk, socket head cap screws and tighten.

4. Slide the motor mount gasket over the shaft and align the flat on the perimeter to the motor mount plate. If the holes of the gasket do not line up, flip the gasket over. The gasket only fits one way.

5. Apply high temperature anti-seize lubricant to the motor shaft, place the key in the keyway, and slide the blower wheel onto the shaft, making sure that the keyway notch in the blower wheel hub aligns with the key on the motor shaft. If the blower wheel will not slide over the shaft, use a ½" outside wire brush (such as those used for cleaning the outside surface of copper tubes) and remove any minor burrs from the shaft of the motor.

6. Slide the blower wheel down on the shaft until the back surface of the hub is approximately 1/16" clear of the motor mount gasket. The blower wheel should turn freely without touching the gasket. The motor shaft will not protrude past the hub of the blower wheel.

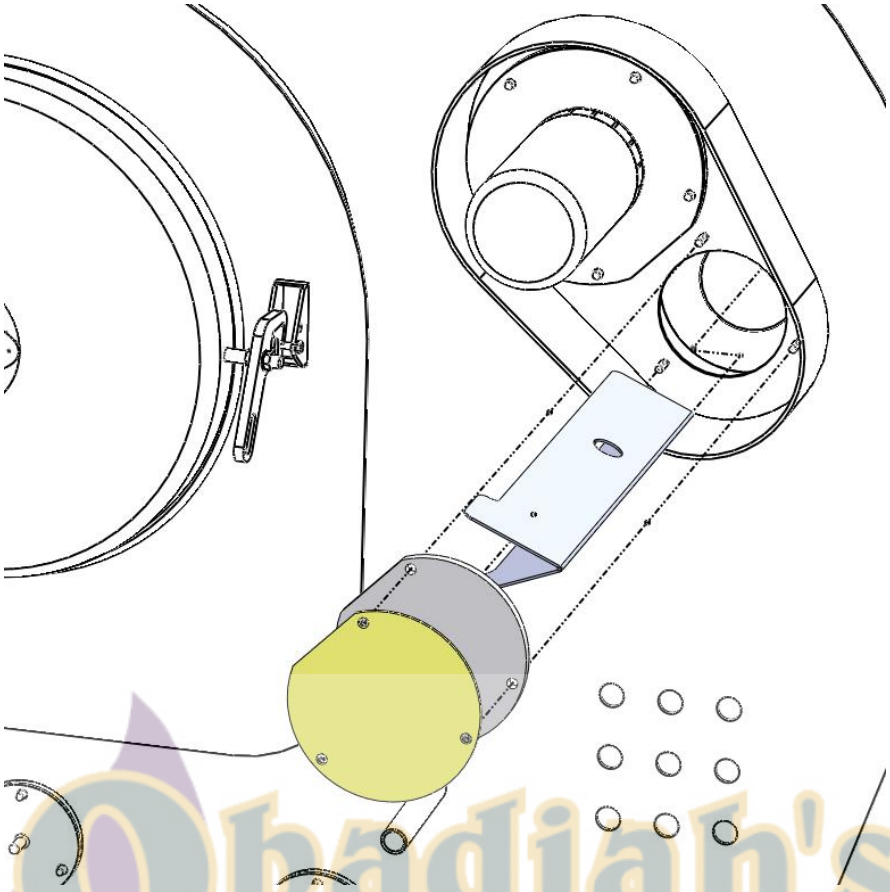


7. Tighten the two set screws in the hub of the blower wheel with the supplied allen wrench to secure the wheel to the shaft. **BOTH SET SCREWS MUST BE TIGHTENED.**

8. Position the blower assembly by sliding it into position on the five (5) mounting studs in the blower housing located on the front head of the GARN®. Hold the assembly in place and install the 3/8-16 castellated nuts (those with teeth on one side). Tighten the nuts securely, compressing the motor mount gasket **SLIGHTLY**.

9. Manually rotate the blower wheel by hand. Access the wheel through the upper clean out. Ensure that there is no contact between the blower wheel and the blower housing. If there is contact, remove the blower assembly, adjusting the clearance between the blower wheel hub and the motor mount gasket, and repeat the assembly procedure.

10. The bent flow stabilizer should be pushed as far as possible into the upper cleanout with the bend at 3 o'clock.



11. Position the upper clean out gasket and upper clean out cover on the blower housing. Hold the assembly in place and install 3/8-16 castellated nuts. Tighten the nuts securely, compressing the gasket **SLIGHTLY**.

12. It is now safe to temporarily plug in the blower motor to check its operation. The motor should operate without any rubbing or grinding noise. Significant air flow should exit from the exhaust flue at the rear of the GARN® WHS unit.

NOTICE Review the motor manufacturer's literature packaged with the motor for proper care and maintenance.

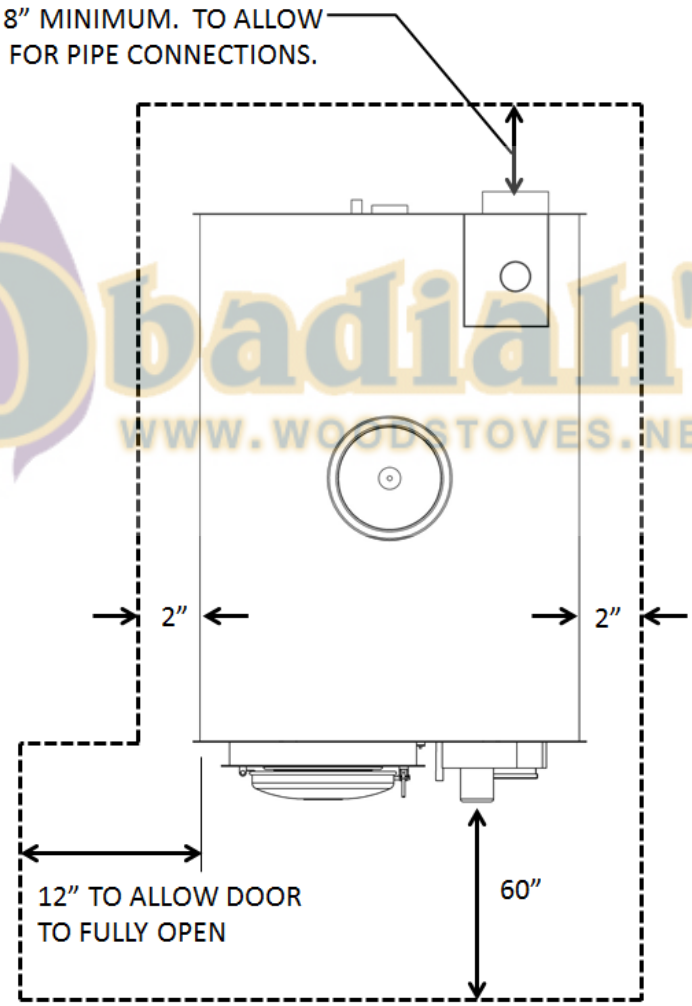
D. INSTALLATION

UNIT PLACEMENT

WARNING **THE UNIT MUST BE PLACED IN A ROOM WHERE THE ENTIRE FLOOR IS NON-COMBUSTIBLE.**

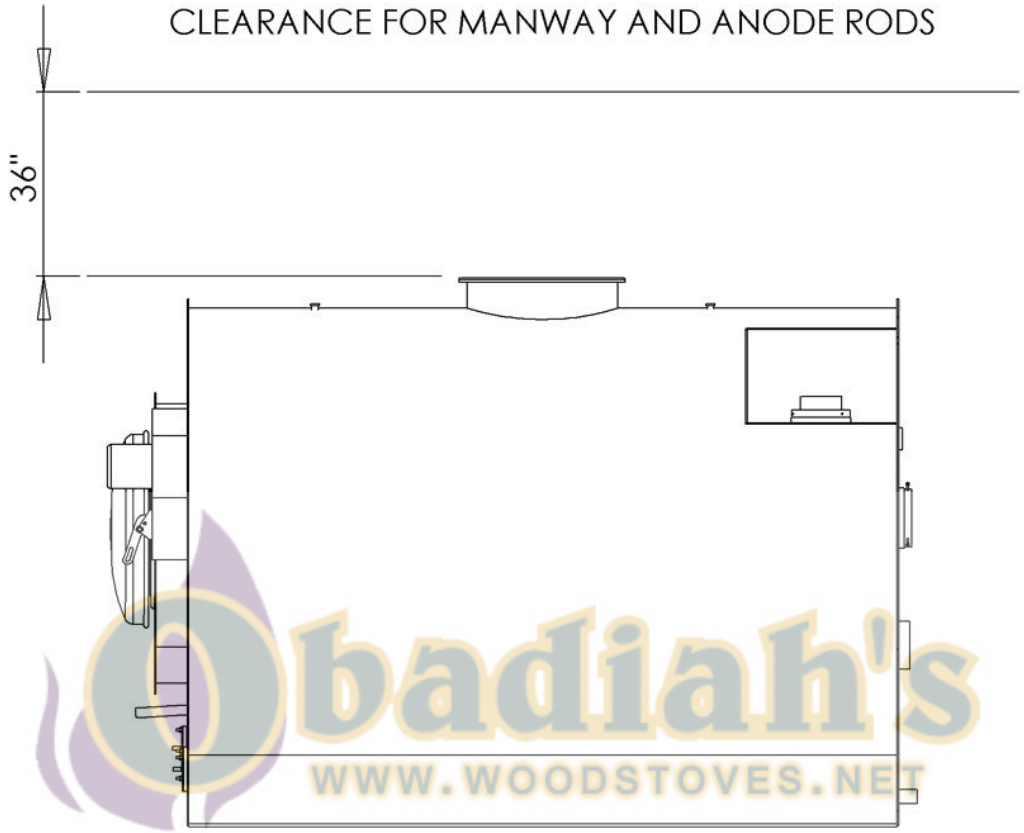
- All GARN® WHS equipment must be placed in a sheltered, enclosed space (heated or unheated). Clearance to combustibles must be no less than 2” from the sides and back and 60” in front.

CLEARANCE TO COMBUSTIBLES



CLEARANCE TO CEILING

- Vertical space requirements for access to the manway cover and anode rods (anode rods are no longer supplied with the purchase of a new GARN unit) on top of the unit:

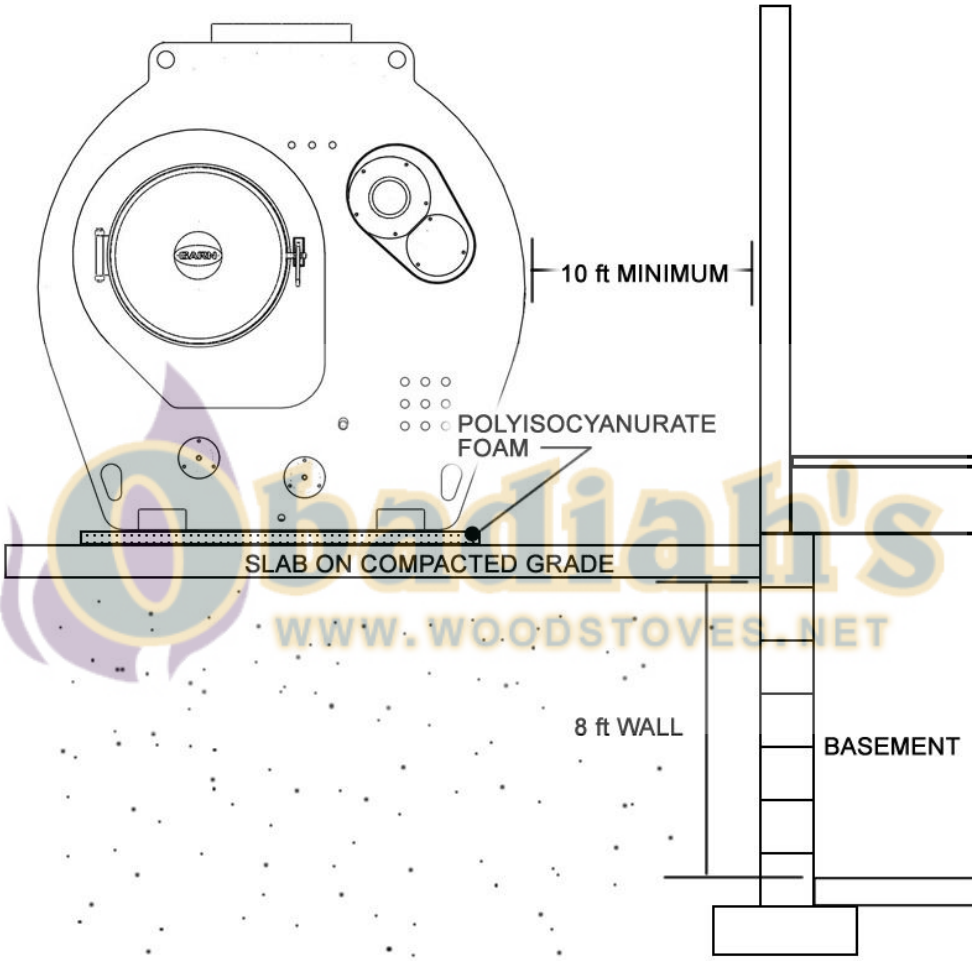


When locating the GARN® WHS unit, consider the following carefully:

- Traffic patterns past the unit: service doors, any overhead doors, pump locations, etc.
- Source of electrical power and location of electrical panel.
- The routing and insulation of piping to the heating system.
- Location of the wood fuel storage.
- Unit position with regard to where heat is to be delivered (i.e. distance to other buildings, etc).
- Sufficient space for heating system pumps and controls.
- Position and type of flue (horizontal or vertical) with reference to other nearby buildings.

CAUTION **IF UNIT IS LOCATED ABOVE GRADE WITHIN 10' OF AN 8' DEEP BASEMENT WALL, THE WALL WILL NEED TO BE REINFORCED IN ORDER TO PREVENT COLLAPSE OF WALL DUE TO TOTAL WEIGHT OF THE GARN® WHS UNIT.** Check with your local code official if you have any questions concerning proper placement of the unit.

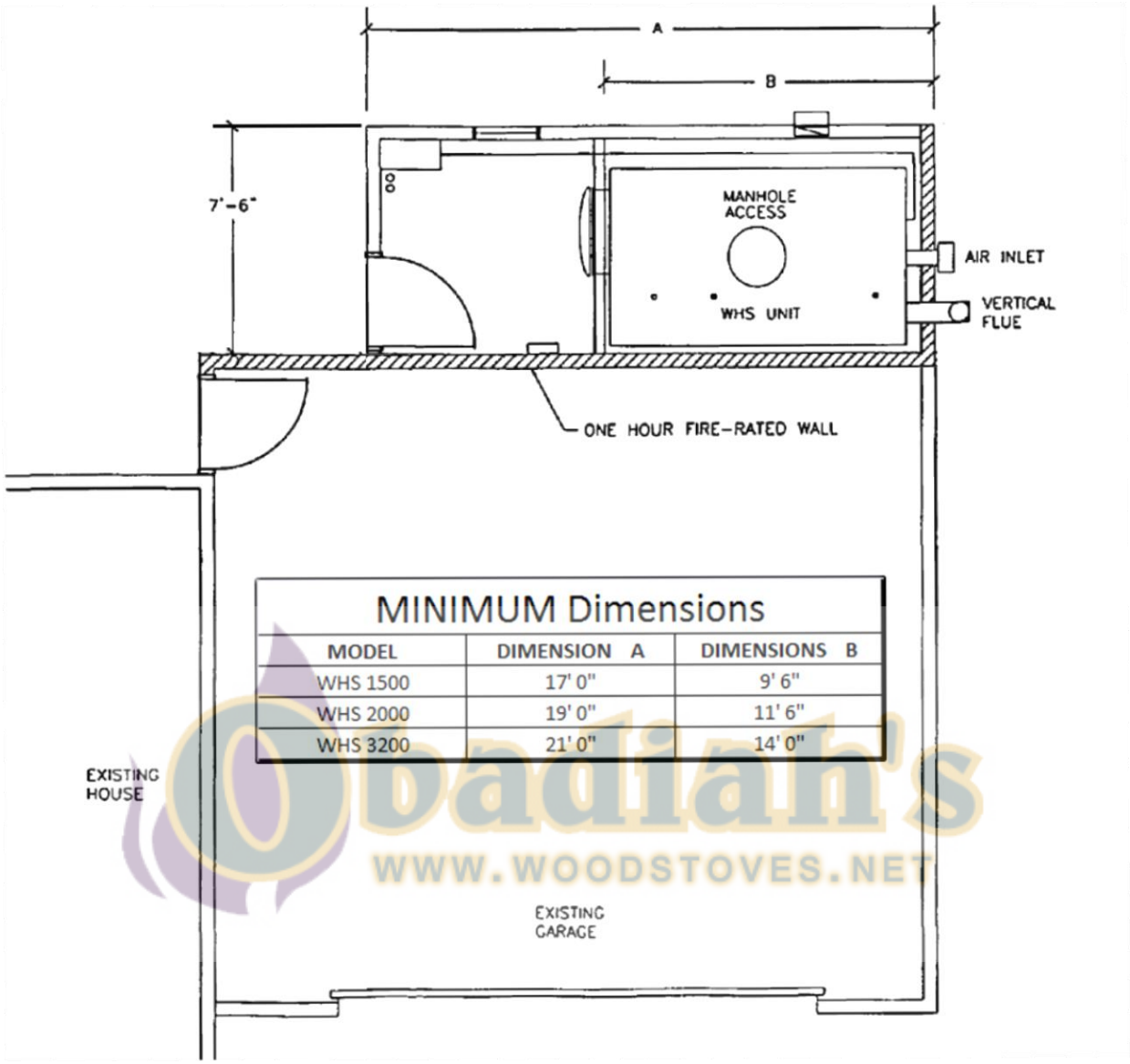
NOTICE **LOCATE THE UNIT ACCORDING TO YOUR LOCAL AIR SHED CODES.** Minimum setback requirements from houses, roadways, and schools, may exist.



GARAGE PLACEMENT

Locate the GARN® WHS unit in a separate room with no passageway to the garage. It can be placed in a lean-to type of addition to the garage. Provide a fully sealed 1 hour fire rated 5/8" sheetrock wall between the lean-to and garage. The firewall must extend from floor to ceiling and for the full length of the addition.

WARNING **THERE MUST BE NO DIRECT CONNECTION OR PASSAGEWAY (I.E. NO WINDOW OR PERSONNEL DOOR) BETWEEN THE GARAGE AND THE LEAN-TO.**



MINIMUM Dimensions

MODEL	DIMENSION A	DIMENSIONS B
WHS 1500	17' 0"	9' 6"
WHS 2000	19' 0"	11' 6"
WHS 3200	21' 0"	14' 0"

REMOTE BUILDING PLACEMENT & SLAB REQUIREMENTS

The GARN® WHS unit must be set on a concrete slab on grade. The table below provides slab thickness requirements.

SOIL TYPE	MINIMUM SLAB REQUIREMENTS
Rock, Gravel, Compact Sand (>2000 psf)	4" thick, 3000 psi with 6 x 6 x 10/10 welded wire mesh
Loose sand, clay (<2000 psf)	5 ½" thick, 3000 psi, with 6 x 6 x 10/10 welded wire mesh

The slab width and length should at least equal the enclosure size and have reinforced edges. The maximum skid pressure for any GARN® WHS unit is 1850 psf.

SETTING THE UNIT

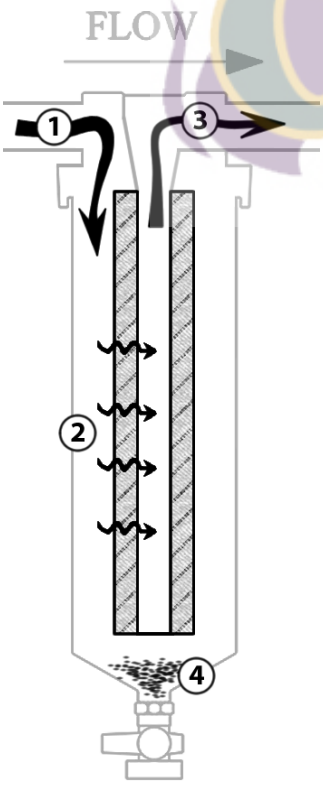
Once the location is determined, set the unit's skids on a *minimum* of 1-1/2" foil-faced polyisocyanurate foam insulation (Thermax® or equivalent) with a *minimum* allowable compression strength of 25 psi. The foam should be cut to the width of the skids plus a *minimum* of 2". Raise each side of the tank off the ground and slide the foam under the skids. The concrete slab that supports the GARN® unit must be relatively flat. The entire flat surface may slope slightly, but skids under the unit must be fully supported over their entire area.

CAUTION **DO NOT USE WHITE BEADBOARD.** It will melt and crush causing physical damage to the flue and piping system.

BYPASS/SIDE-STREAM FILTER INSTRUCTIONS

Installing a bypass filter is highly recommended with every GARN unit. The bypass filter package (available at www.garnparts.com) comes with a bypass/side-stream filter and four 5-micron filters (pictured below).

The purpose of a bypass filter is to continuously remove particles from the GARN unit's water. Removing this material improves the effectiveness of the water chemistry, helps extend the life of the GARN unit, and keeps the system operating at peak performance.



NOTICE **The bypass filter should not be used as a replacement for strainers in front of heat exchangers or other equipment.** Strainers are effective at removing large chunks of dirt and debris. Filters are made for removing small particles. Large debris chunks will cause the filter to plug quicker.

A description of how the filter is installed and operates is as follows:

(1) The bypass filter must be installed such that the flow of water moves into the filter housing on the outside of the filter (not into the core/center).

(2) The water then penetrates the filter on the outside of the filter and moves towards the core of the filter.

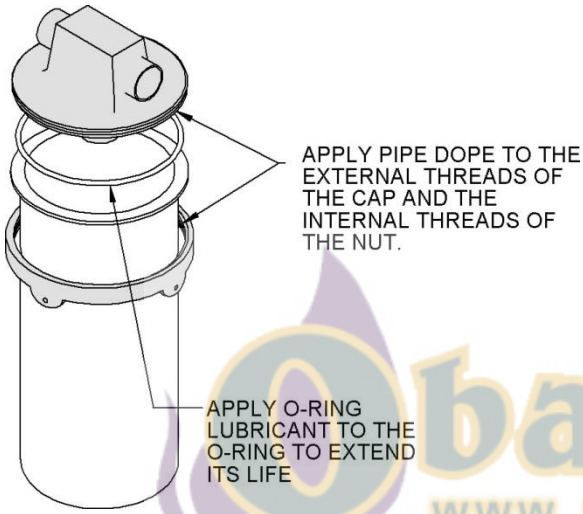
(3) The water moves upwards in the core to the top of and then out of the outlet of the filter housing.

(4) Dirt will accumulate over time at the bottom of the filter housing. A ¼" FPT fitting is welded into the bottom of the housing. Attaching a small valve allows for easy flushing/removal of crud from the bottom of filter housing. The ¼" NPT plug (included) can also be effectively used for flushing purposes. Flush the filter housing once per month during the first 6 months of operation. After the 6 month break-in period, flush as necessary to keep crud from accumulating.

INSTALLATION INSTRUCTIONS:

The bypass/side-stream filter must be located in the piping and water that directly connects to the GARN unit. The purpose is to remove particles from the GARN tank. We recommend only 1 method of installation: Independent Piping Circuit. In an Independent Circuit a dedicated pump is installed that circulates water from the tank through the filter and back to the tank.

We recommend using a Taco-0015, 3 speed circulating pump (shown at right) with the filter. An equivalent pump from another manufacturer can also be used. Use the pump on the HIGH speed setting.



NOTICE It is also important to apply NON-HARDENING pipe dope to the threads of the ring nut and housing to ease the installation and removal of the housing for filter replacement. The filter housing is stainless steel and, like aluminum, the oxide layer on the stainless can sometimes make it difficult to remove the nut if pipe dope isn't present. Applying o-ring lubricant (such as silicone lubricant) to the o-ring will help extend its life.

ALLOWABLE FLOWRATE AND SPECIFICATION OF THE BYPASS FILTER:

Connections: ¾" FPT (inlet and outlet)

Filter Material: The filters are made from a high temperature Polyester string wound around a stainless steel core. The filters and housing are rated to 300°F.

Allowable Range of Filter Flowrate:	1 to 10 GPM

PIPING CONFIGURATIONS:

The following diagrams show acceptable ways to install the bypass filter. Choose the configuration best suited for the application and space requirements.

NOTICE **WE RECOMMEND PIPING THE BYPASS FILTER AS AN INDEPENDENT CIRCUIT AND USING A TACO-0015, 3 SPEED CIRCULATING PUMP (OR EQUIVALENT) WITH THE FILTER**. Use the pump on HIGH speed.

INDEPENDENT CIRCUIT PIPE CONFIGURATIONS:

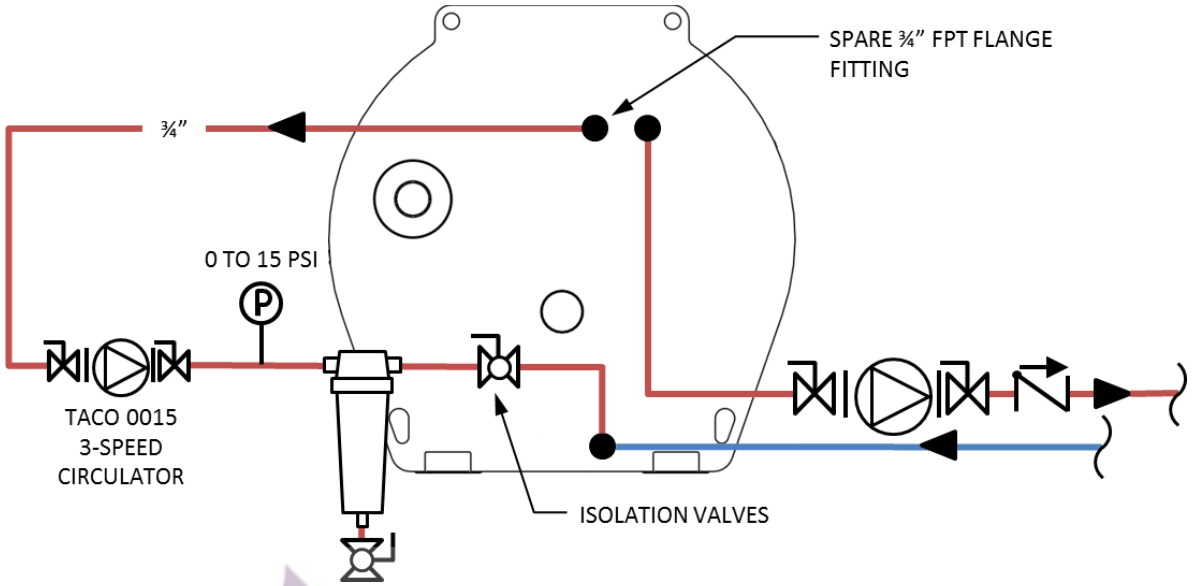


Figure 1: HWR to Spare Flange

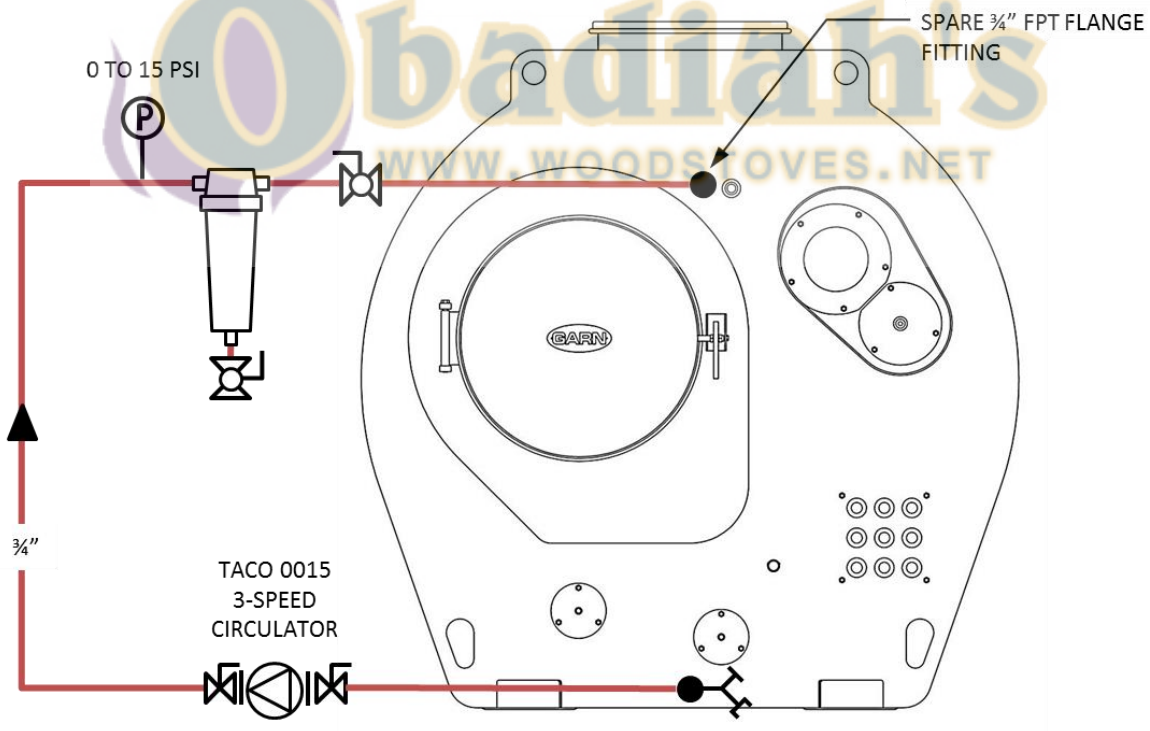
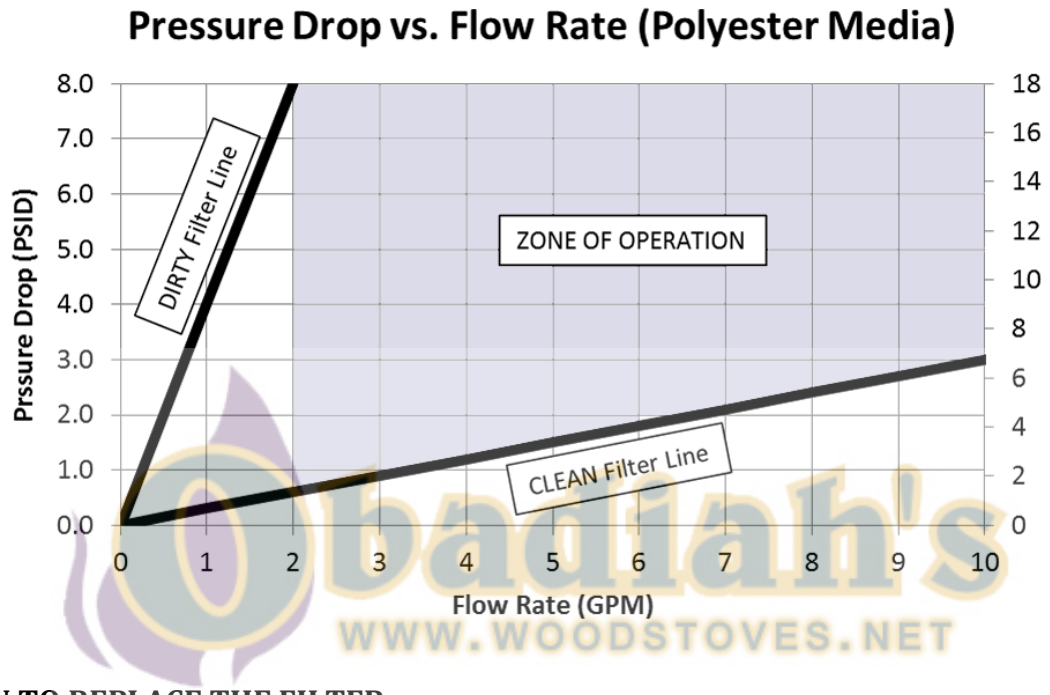


Figure 2: Boiler Drain to Spare Flange

HOW TO TELL IF THE FILTER IS WORKING:

PRESSURE:

The installation of a single pressure gauge on the upstream side of the filter is all that's required to determine if flow is moving through the filter. As long as the pump is running and the pressure gauge shows pressure, then flow is going through the filter. The chart below relates pressure drop to a flow rate and is for reference purposes only:



WHEN TO REPLACE THE FILTER:

The filter requires replacement when it is sufficiently plugged and little to no flow (less than 2 GPM) is moving through it. **Check the pressure gauge, if the pressure differential reaches 8 PSID (with a Taco 0015, 3-speed circulator on HIGH speed), then the filter is considered plugged**. Periodically check to ensure the filter is not plugged. Spare filters can be purchased from www.garnparts.com. A stainless steel core is required for the filter to function at higher temperatures.

OPERATING INSTRUCTIONS:

The filter is only actively protecting the GARN water when water is flowing through the filter. So, the simplest rule of thumb for using the filter is:

- Pump water through the filter as frequently as possible.

Circulate continuously if possible. Using a Taco-0015 3 Speed Circulator on HIGH speed for the entire heating season costs roughly $15 (assuming $0.10 per kWH)

DURING THE 1ST MONTH OF OPERATION:

Run the pump feeding the filter continuously. During the first month, check every week to see if the filter is plugged. Replace the filter with a new filter as required.

NORMAL OPERATION:

Run the pump feeding the filter continuously. After the first month of operation, check as frequently as possible, but at minimum 3 times per heating season to ensure that filter is operating correctly. The filter is very effective at removing cloudiness and suspended particles in the water. It will not remove dissolved compounds (such as salts or dissolved water treatment chemical).

IF THE GARN WATER IS CLOUDY/MURKY:

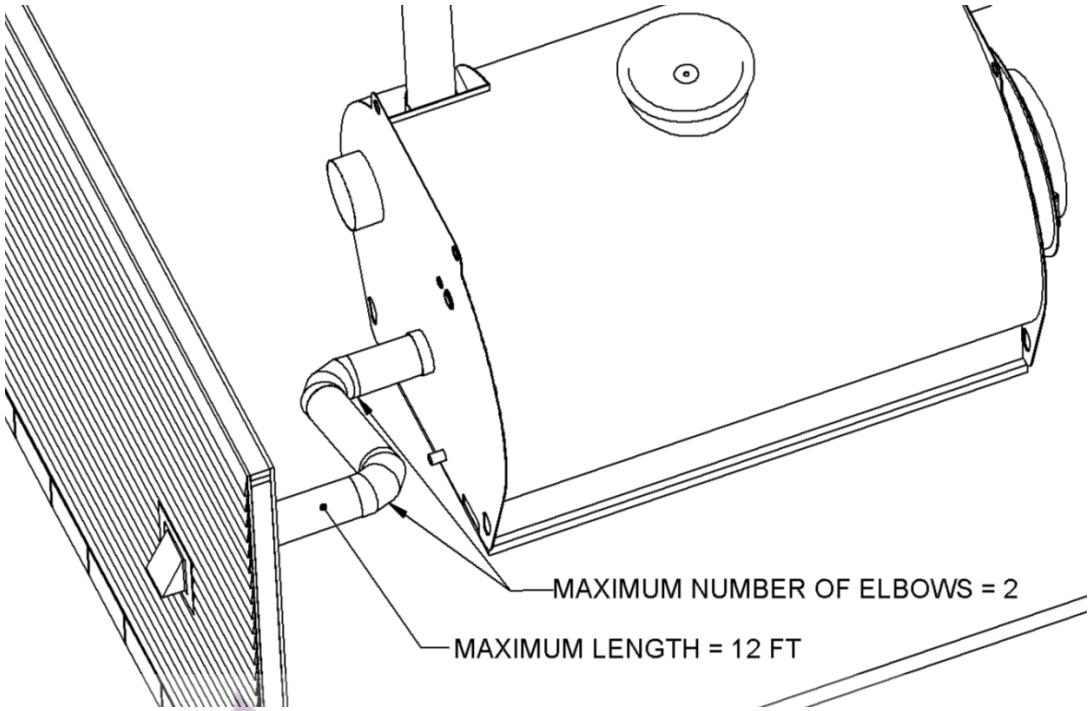
If the GARN unit's water is cloudy or murky, the filter should adequately remove the suspended particles with continued use. Allow a couple months of continuous filtering operation to remove the cloudiness from the water.

COMBUSTION AIR INLET

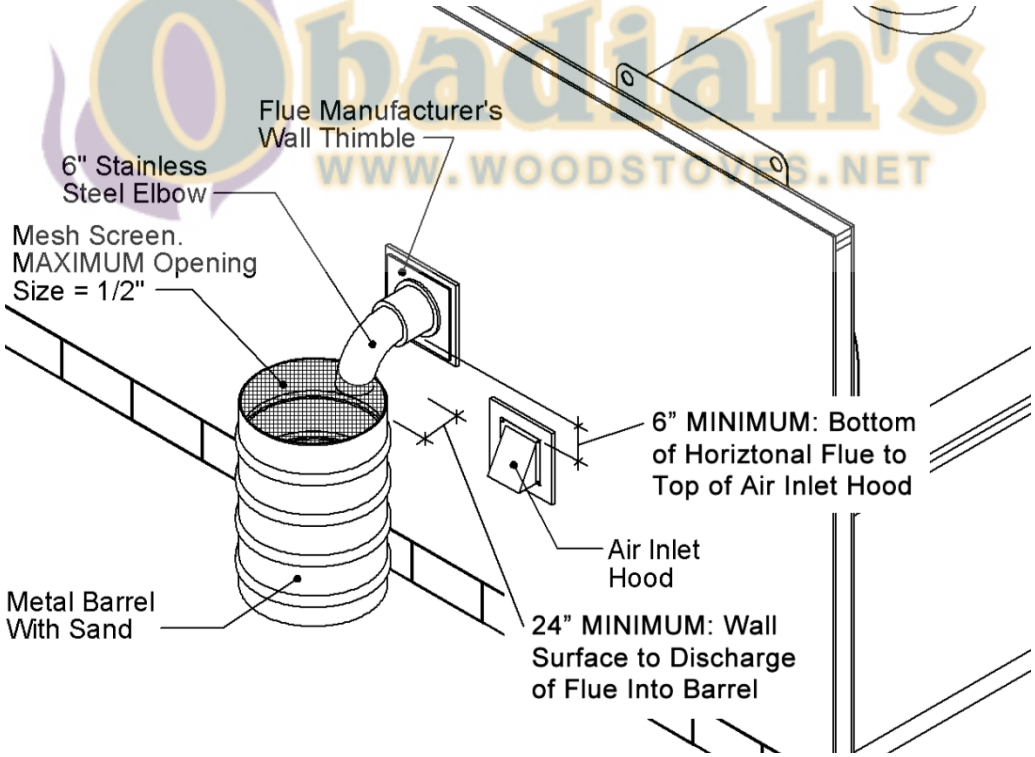
The outdoor portion of the inlet duct consists of a 7" diameter fresh air intake hood with a galvanized mesh screen. The hood is provided with your GARN® WHS; the other items (screws, tape, caulk) must be provided on site.

MAXIMUM LENGTH AND NUMBER OF ELBOWS

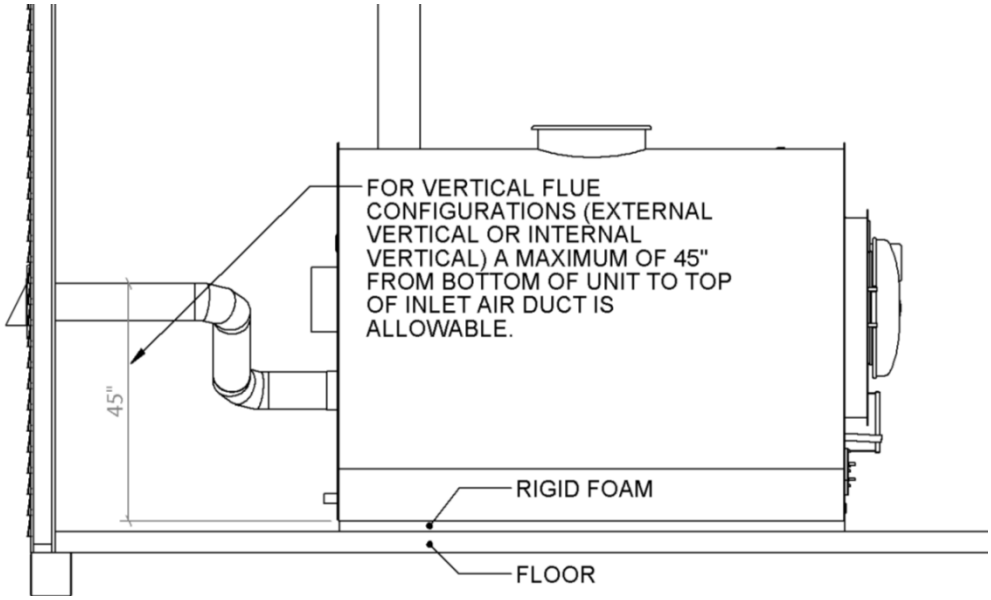
Combustion air for the GARN® is ducted from outside through a dedicated 7" diameter single wall duct. The GARN® must be connected to an outside air source. The air duct may have no more than two (2) 90-degree bends and its total length cannot exceed 12' when using 7" diameter duct. The combustion air inlet duct does not require a wall thimble. The air inlet should extend above any obstructions and possible snow drifts.



WALL LOCATION REQUIREMENTS (HORIZONTAL EXHAUST)



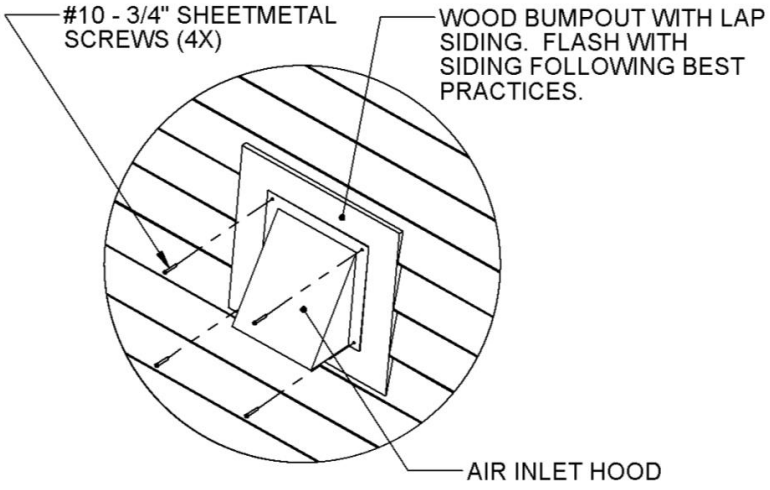
WALL LOCATION REQUIREMENTS (VERTICAL EXHAUST)



WARNING **DO NOT POSITION THE AIR INLET DUCT HIGHER THAN THE DIMENSIONS SPECIFIED ABOVE**. Doing so may create a condition such that the unit may backdraft through the inlet duct and create a fire hazard.

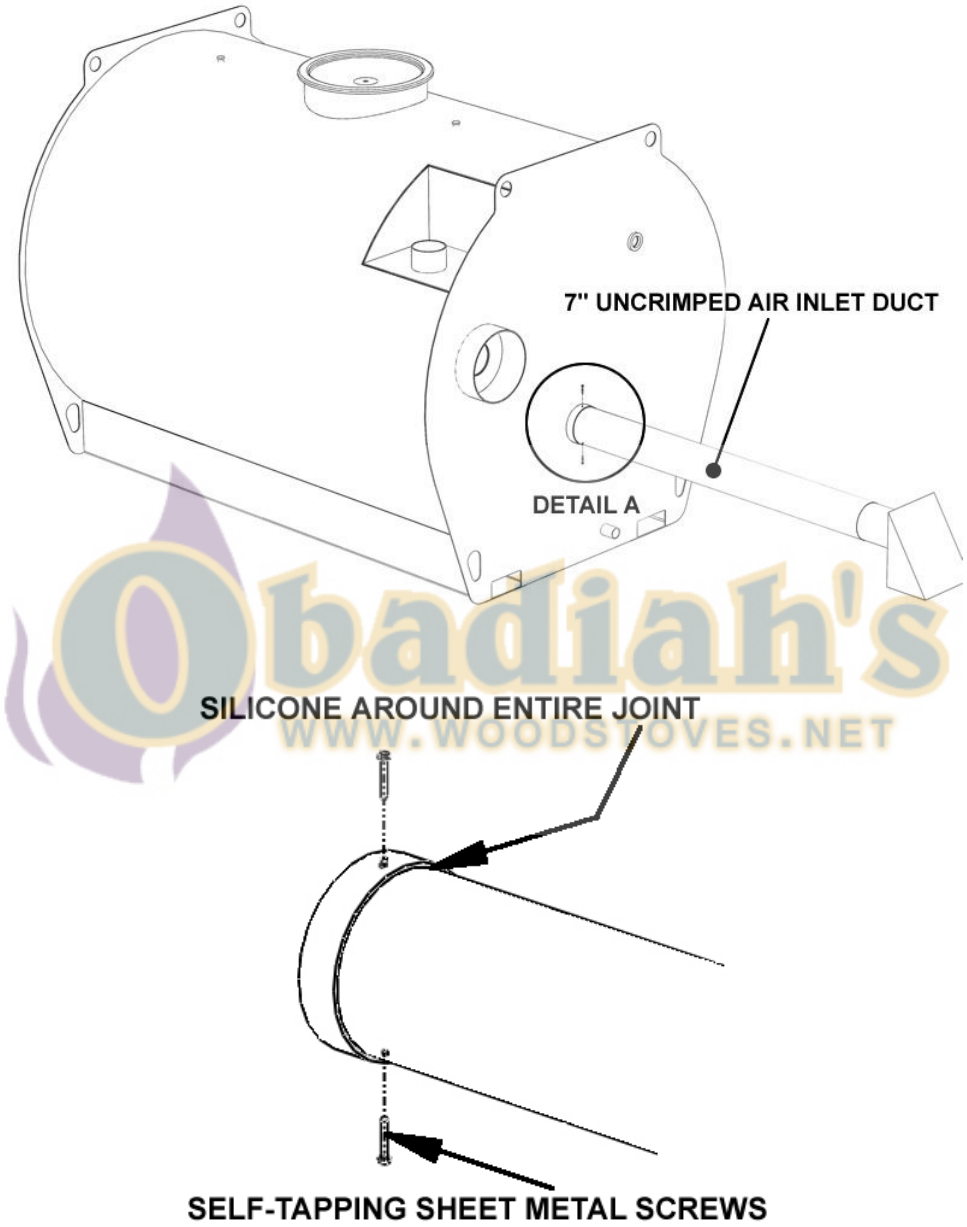
INLET HOOD INSTALLATION WITH LAP OR UNEVEN SIDING

If the siding on the exterior does not create a flat surface, cut a rectangle in the siding large enough to fit a bumpout for the hood. Seal, flash, and caulk the bumpout following best practices to ensure that the bumpout does not become a weather/moisture entry point to the building or building wall assembly. Secure the hood with 4 screws, one near each corner of the hood.



CONNECTING THE AIR INLET DUCT AT THE GARN® UNIT

1) Drill two holes for screws in the 7” collar ring connected to the GARN®
2) Install two self-tapping sheet metal screws to connect the inlet duct to the collar ring.
3) Silicone seal the air inlet joint at the collar ring.



DETAIL A

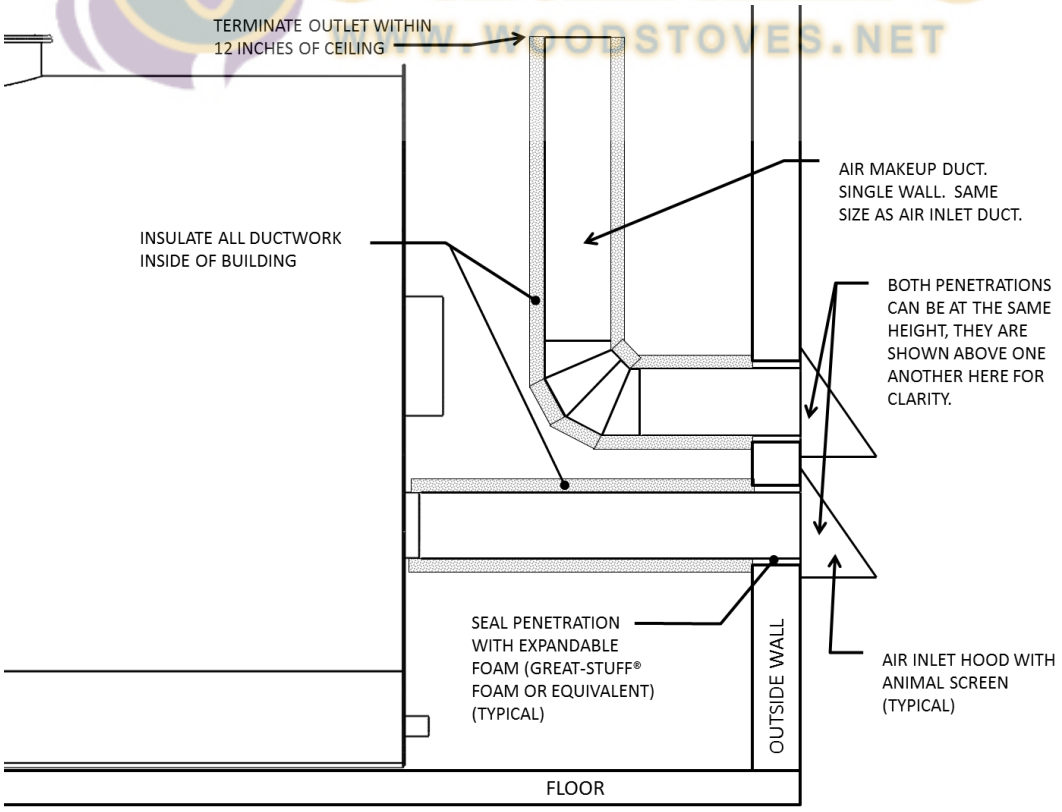
NOTICE Operating the GARN® without an inlet hood or without the specified inlet hood will significantly decrease airflow resulting in inefficient operation and the creation of creosote.

ADDITIONAL AIR INLET FOR MAKEUP AIR IN A RELATIVELY "AIR TIGHT" BUILDING (INCLUDES MULTIPLE UNIT INSTALLATION)

When the GARN® unit (or multiple units) is installed in a relatively "air tight" building, a makeup air duct is required. Such a structure is usually newer construction with an air barrier that has been installed with attention to detail, seams have been caulked, and windows and doors have good weather stripping. Air makeup must be provided to the room because when the GARN unit's combustion chamber door is opened during firing, air is being drawn from the room into the combustion chamber and out through the flue. Drawing air from inside depressurizes the room. When there are other combustion appliances in the same structure, such a condition could backdraft the other appliances.

WARNING **INSTALL A MAKEUP AIR DUCT IF THE GARN UNIT IS INSTALLED IN A STRUCTURE WITH OTHER COMBUSTION APPLIANCES.** Otherwise, backdrafting of the other appliance make occur, and a hazardous condition will result.

Using an additional air inlet hood, install the air makeup duct penetration as low as possible in the wall (while still avoiding possible snow drifts, obstructions, etc). Installing at the same height as the combustion air inlet hood of the GARN unit is acceptable. Route the air makeup duct inside the building, turn the duct towards the ceiling, and route a vertical section of duct until it terminates within 12 inches of the ceiling. The reason for installing a tall, vertical section of duct inside the structure is to create an effective air lock. The air lock will ensure that cold air is not entering the room at all times; only when the combustion door is open. An air makeup duct is acceptable for single or multiple unit installations in the same building. Insulate all of the air makeup ductwork. See the diagram below:



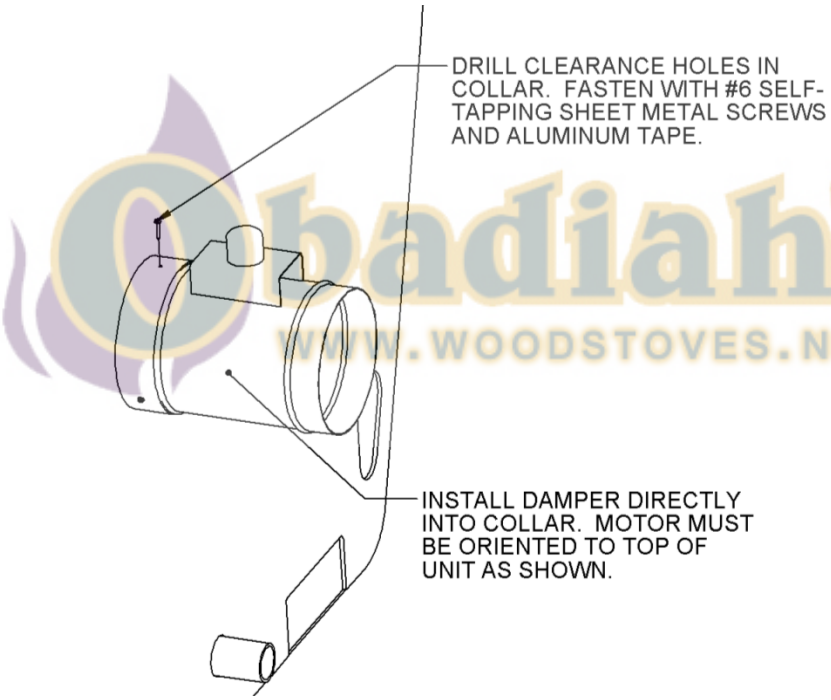
AIR INTAKE DAMPER

An air intake damper is typically used with an internal or external vertical flue installation. Because of the height of the vertical flue, a natural draft effect is created. During times when the GARN® WHS unit is not being fired and the tank is hot, air will be drawn from the air inlet hood, through the unit, and out of the flue. Without an air intake damper, a significant draft effect can rapidly remove heat from the tank. In all vertical flue configurations, installation of an air intake damper is advised.

INSTALLING THE AIR INTAKE DAMPER

Install the damper directly to the collar on the unit. Drill holes in the collar for the installation of sheet metal screws. Insert the damper into the collar, fasten with sheet metal screws, and tape the damper to the collar with aluminum tape. Orient the damper so that the motor is on top of the duct.

NOTICE The damper must be installed directly to the unit to prevent the damper from freezing.

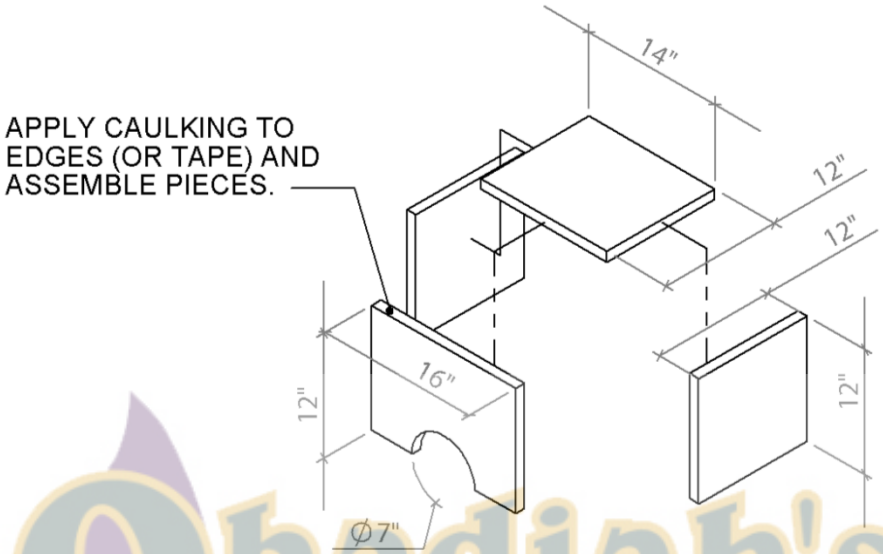


INSULATING THE AIR INTAKE DAMPER

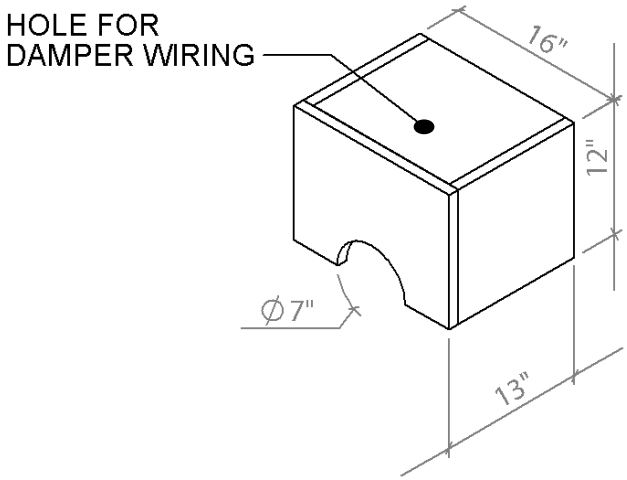
The cold air temperatures that enter through the air inlet hood make the damper susceptible to freezing. A damper "freeze-up" typically prevents the damper from operating correctly. A simple insulated, field-fabricated box should be installed around the damper to help prevent freezing. The damper can freeze-up because the air entering the intake is cold (outdoor temperature) and the room air temperature, where the GARN WHS unit is located, is warmer than the outdoor air temperature. The warmer, humid air in the room will condense onto the sheet metal surfaces and metal shaft of the intake damper. As condensation occurs, it will freeze (depending on the outdoor temperature entering the damper). If the following precautions are taken, it should prevent any problems related to freezing

and operation of the damper. Construct an insulated enclosure for the intake damper using a 1” or 2” rigid foam (XPS, PolyIsoCyanurate, etc). Caulk or tape the joints between the pieces. Assemble 2 of the following enclosures:

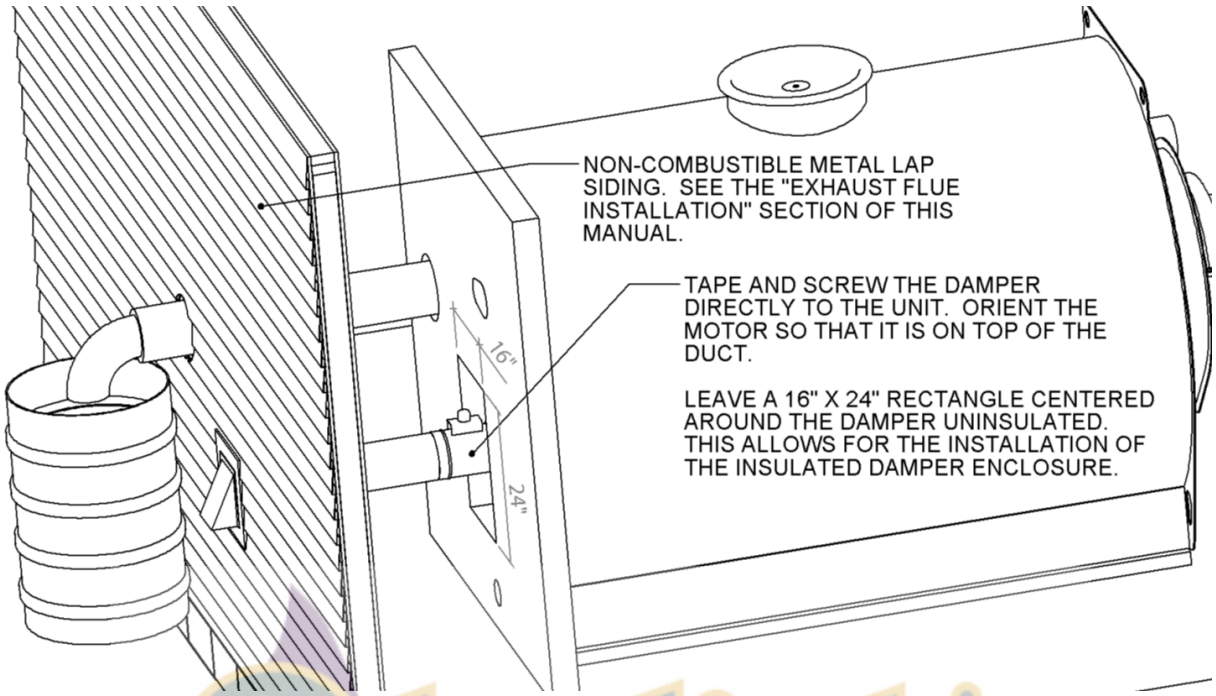
INTAKE DAMPER ENCLOSURE
CONSTRUCT FROM 1" OR 2" RIGID FOAM BOARD (XPS)
QTY 2 ARE REQUIRED



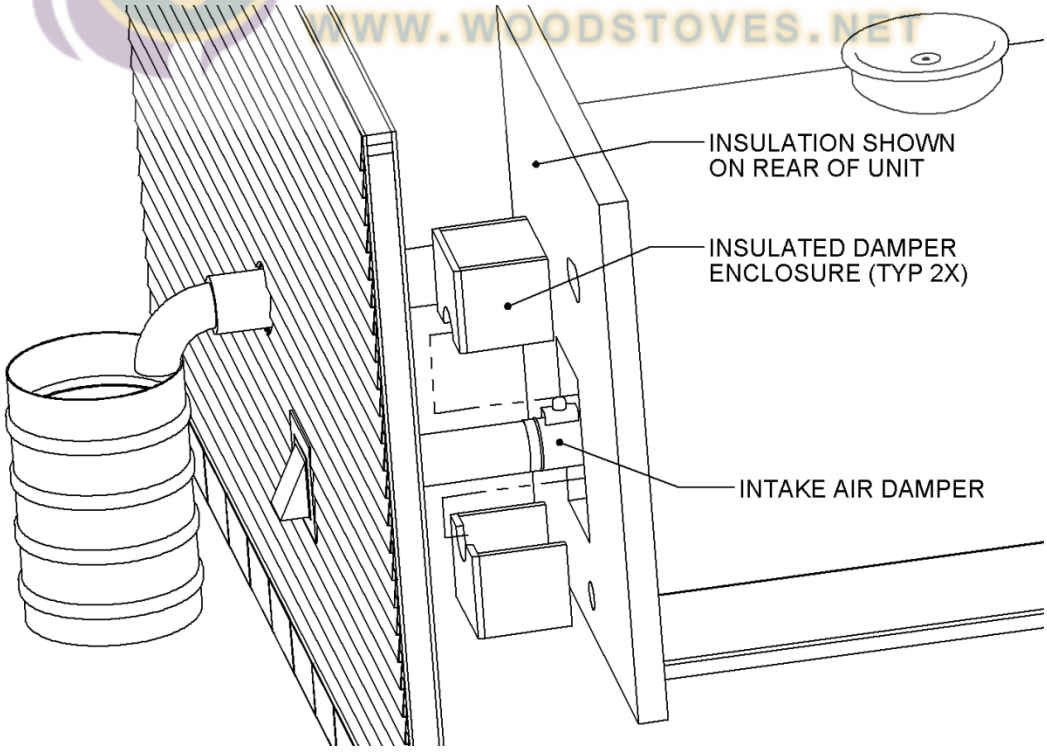
ASSEMBLED INTAKE DAMPER ENCLOSURE
QTY 2 ARE REQUIRED



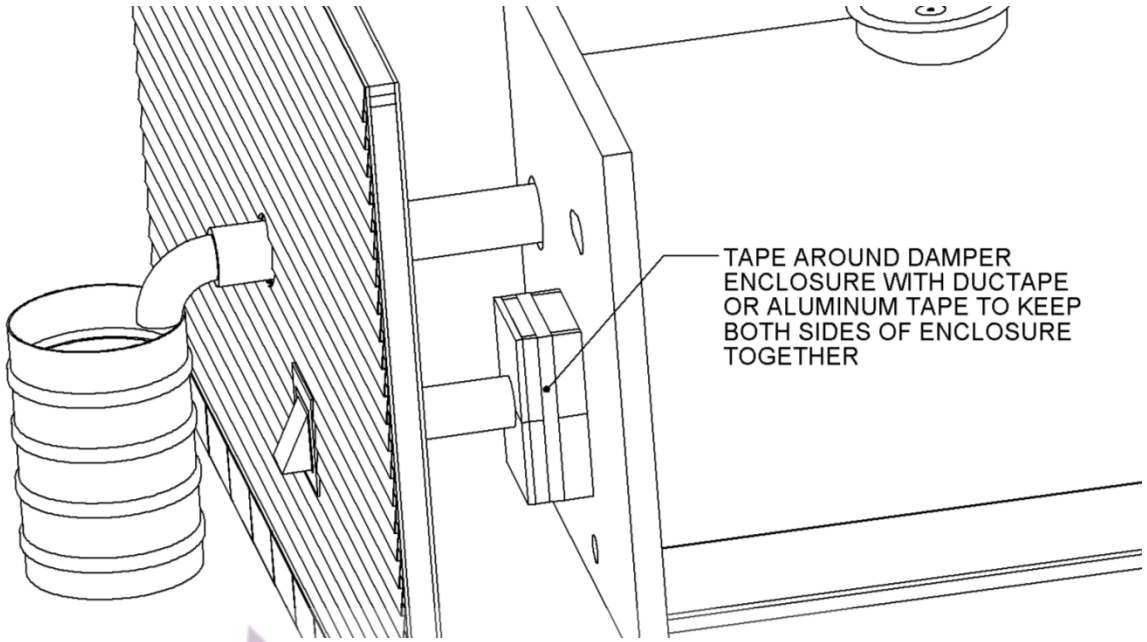
Leave a rectangular cutout in the unit insulation around the intake duct large enough to fit the fully assembled enclosure.



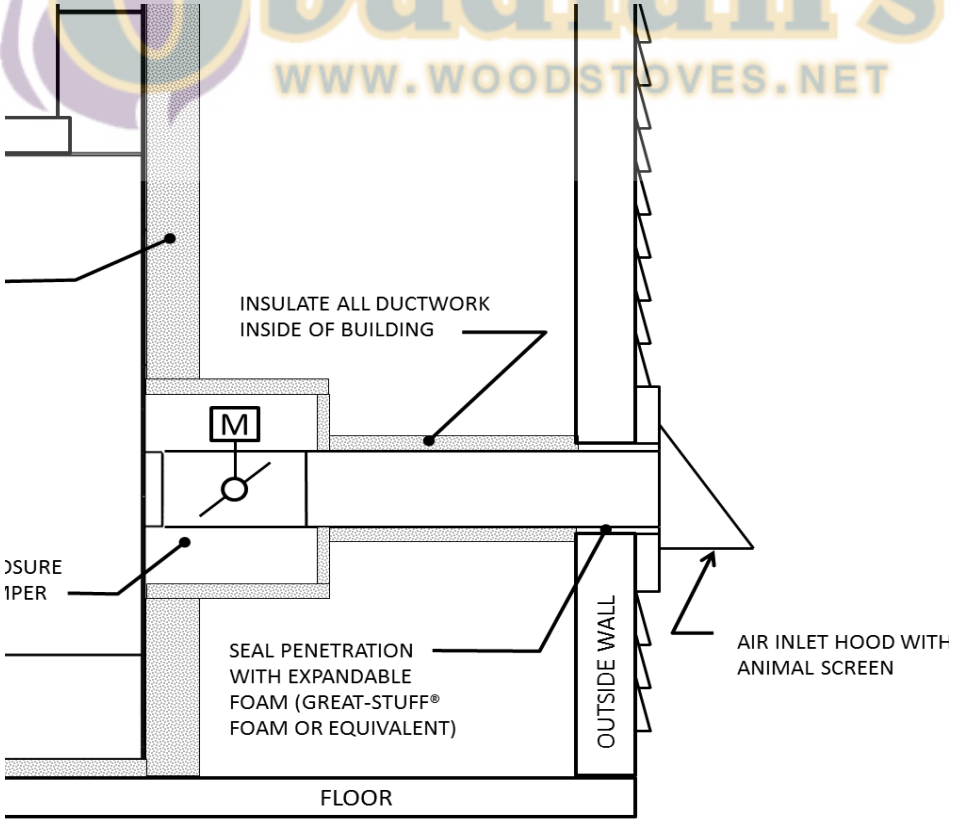
After wiring the intake damper (see the WIRING WITH COMBUSTION AIR DAMPER section of this manual), slide the enclosure around the damper and into the unit insulation:



Using aluminum or duct tape, tape around both halves of the enclosure to keep them together.



After installation of the damper and enclosure, insulate all the remaining single-wall ductwork for the air inlet and seal the wall penetration with rigid foam or an expandable foam product (GreatStuff® or equivalent).



WIRING THE AIR INTAKE DAMPER

Refer to the WIRING WITH COMBUSTION AIR DAMPER section of this manual for wiring details.

ELECTRIC HEATING PACKAGE INSTALLATION

For instructions on installing, wiring, and operating the Electric Heating Package, please reference the ELECTRIC HEATING PACKAGE OWNER'S MANUAL available at www.garn.com

A paper copy of the *Electric Heating Package Owner's Manual* is included with the purchase of the Electric Heating Package.

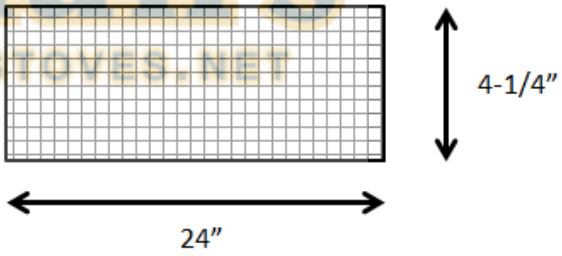
SPARK ARRESTOR

Each GARN® WHS unit is supplied with a spark arrestor. The spark arrestor is manufactured from high-quality 316 stainless steel mesh for high temperature application and corrosion resistance. The spark arrestor complies with NFPA 211 "Standard For Chimneys, Fireplaces, Vents, And Solid Fuel-Burning Appliances"(2013) section 4.6.4 *Spark Arrestors*.

WARNING **DO NOT USE A SUBSTITUTE SPARK ARRESTOR. THE SPARK ARRESTOR MUST COMPLY WITH NFPA 211 SECTION 4.6.4**

The spark arrestor is installed in the upper cleanout area of the blower housing and can be accessed for cleaning by removing the upper cleanout plate and gasket.

A spark arrestor is required for every installation with one specific exception: horizontal exhaust units that discharge in to a barrel with a metal screen. For the horizontal exhaust units that discharge into a metal barrel with a screen (see the picture in the HORIZONTAL SIDEWALL FLUE section on page 44 of this manual), then the barrel screen acts as the spark arrestor.

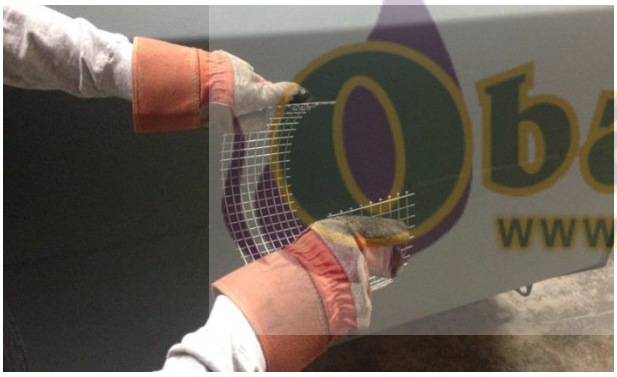


The spark arrestor is factory cut to approximately 24" x 4-1/4".

CAUTION **USE SAFETY GLOVES WHEN HANDLING THE SPARK ARRESTOR. THE SPARK ARRESTOR MAY HAVE SHARP EDGES.**

INSTALLATION:

1. Roll the flat screen into a cylinder of approximately 6” to 8” in diameter.



2. Overlap the edges of the screen, DO NOT trim the screen.

3. Remove the upper cleanout plate and gasket.
4. Insert the coiled screen into the cleanout. Allow the coil to expand (like a spring) into the upper cleanout opening.

5. Allow the coil to expand (like a spring) into the upper cleanout opening.

6. Reinstall the flow straightener.

7. It is ok if the barbs on the one side of the screen are proud of the gasket mounting surface. The gasket will still seal and it helps hold the screen in place.

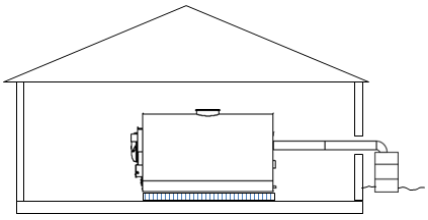
INSPECTION AND CLEANING:

1. Periodically check the upper cleanout for a build-up of ash and debris around the spark arrestor. The larger chunks of debris that the spark arrestor blocks will accumulate at its base.
2. If any debris is noticed, remove the spark screen, remove the debris, and re-install the spark screen.
3. Always ensure that debris is not piling up to the point of blocking the heat exchanger tubing or airflow path

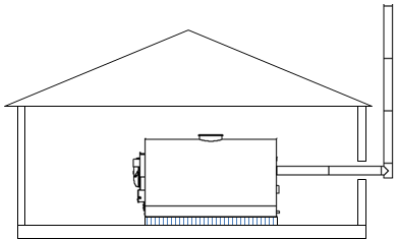
EXHAUST FLUE INSTALLATION

GENERAL NOTES (READ THIS FIRST)

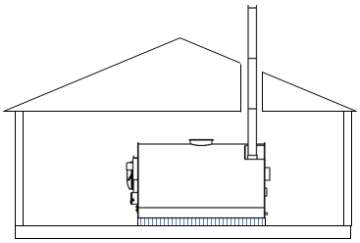
The GARN® WHS unit itself can be ordered in one of two venting options: **horizontal** or **vertical** exhaust. The two options can be setup in one of the following three configurations:



HORIZONTAL exhaust into metal barrel



HORIZONTAL exhaust with an External Vertical Tee



VERTICAL exhaust through the roof

GENERAL NOTES – FOR HORIZONTAL FLUE INSTALLATIONS

Horizontally vented GARN® WHS units must use the 6 inch, double-wall DuraTech® UL-103HT product produced by DuraVent®. The reason that DuraTech® is required versus any other manufacturer is because a DuraTech® ring is factory welded to the unit. Only DuraTech® flue will screw into the factory welded ring. An 8 inch DuraTech® ring can be custom ordered if desired.

GENERAL NOTES – FOR VERTICAL FLUE INSTALLATIONS

Vertically vented GARN® WHS units are designed with a universal flue collar system. The universal flue collar will accept any manufacturer's UL-103HT (US) or ULC-S629 (Canada) flue that is double-wall with packed insulation between the walls. The flue is set into the collar, connected to the collar with sheet metal screws, and then sealed with stove gasket/rope and hi-temperature silicone caulk.

FLUE TERMINOLOGY: CLASS A, UL-103HT, ULC-S629, WHAT DO THEY MEAN?

Here is an explanation of some of the different terminologies used when talking about flue.

UL-103 is a testing standard for flues. Specifically it is the "Standard for Safety Factory-Built Chimneys for Residential Type and Building Heating Appliances". It's a lab test that flue manufacturers have to pass to say their flue can be used with a solid fuel burning device. The standard covers testing of two types of factory-built flue:

1. A flue that allows gas temperature up to 1700°F (UL-103 flue)
2. A flue that allows gas temperatures up to 2100°F (UL-103 HT flue)

HT simply indicates that the flue is rated for higher temperature operation (up to 2100°F intermittent).

Class A is older terminology, but it still hangs around as an industry standard term. It's basically like saying "Kleenex" or "Xerox". Warnoch-Hersey (Dectra's safety listing company) stipulates that the terms "UL-103 HT" and "ULC-S629" flue must be used instead of "Class A".

ULC-S629 is a Canadian standard that is essentially equivalent in purpose to UL-103. Specifically it's the "Standard for 650°C (1200°F) Factory-Built Chimneys" that applies to *solid fuel burning devices* (such as wood burning). GARN® units have been safety tested and listed in the US and Canada to use UL-103HT flue product, so that is what is supplied with GARN® horizontally vented units form the factory. But, some areas in Canada specifically require the ULC-S629 marking on the flue. In that case, a vertical unit is required so that the correct flue can be purchased locally.

ULC-S604 is another Canadian standard. It's the "Standard for 540°C (1000°F) Factory-Built Chimneys". It only covers safety related to gas and liquid fuel devices, not solid fuel. This type of flue cannot be used.

Fittings for UL-103HT flues, generally speaking, come in: straight sections of various lengths, 15° offsets, 30° offsets, 45° offsets and tees. 90° fittings are not manufactured or allowed. It is also illegal to combine, for example, two 45° offsets to create a 90° bend.

GENERAL NOTES – SAFETY AND BASIC INSTALLATION GUIDLINES

⚠ CAUTION **DO NOT CONNECT THE GARN® WHS PRESSURIZED FLUE TO A CHIMNEY/FLUE THAT SERVES ANOTHER APPLIANCE.** It is illegal to do so and could result in a fire inside the building.

⚠ WARNING **FOR HORIZONTALLY VENTED UNITS USE ONLY DURATECH® DOUBLE-WALL, PACKED INSULATION UL-103 HT (US) CLASS A 2100°F STAINLESS STEEL FLUE SECTIONS AND ACCESSORIES TO VENT THE GARN® WHS**. Attempting to connect any other brand or type of flue is not safe, will void the ITS/Warnock Hersey listing, and could result in a fire or other hazardous condition.

⚠ WARNING **FOR VERTICALLY VENTED UNITS USE ONLY DOUBLE-WALL, PACKED INSULATION UL-103 HT (US) OR ULC-S629 (Canada) CLASS A 2100°F STAINLESS STEEL FLUE SECTIONS AND ACCESSORIES TO VENT THE GARN® WHS**. Attempting to connect any other type of flue is not safe, will void the ITS/Warnock Hersey listing, and could result in a fire or other hazardous condition.

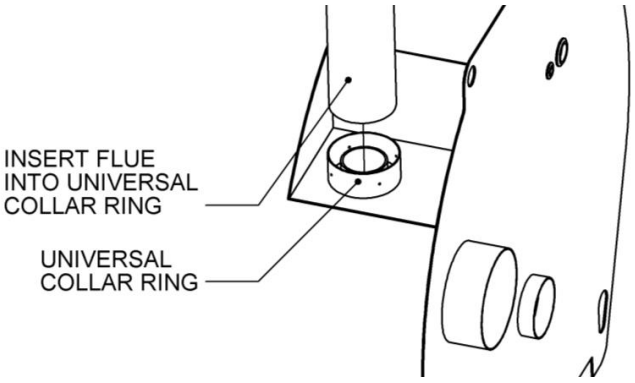
NOTICE Check with your local building inspector for regulations concerning flue installations. Some areas may only allow a vertical flue and some may have minimum flue height requirements.

- **All joints, both inside and outside of the building, must be caulked with silicone caulk and sealed with self-adhesive aluminum tape.**
- Strictly follow the flue manufacturer's installation instructions. A 2" clearance must be maintained between the flue and any combustible material.
- Support all flue components to ensure structural integrity during the life of the flue. Use only non-combustible (i.e. steel, aluminum, etc) materials for such supports and generally follow the flue manufacturer's recommendation.

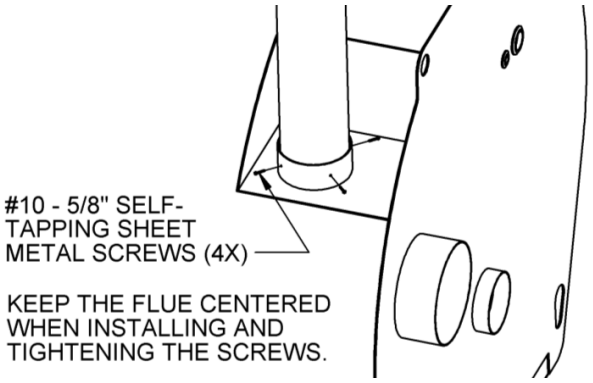
CONNECTING THE FLUE TO THE UNIT

WARNING **THE FIRST FLUE SECTION CONNECTED TO THE GARN® WHS MUST BE SILICONE SEALED TO THE UNIVERSAL FLUE RING.** In addition, #10 self-drilling/self-tapping SS screws are to be driven thru the collar ring into the outer wall of the flue to prevent separation of the flue.

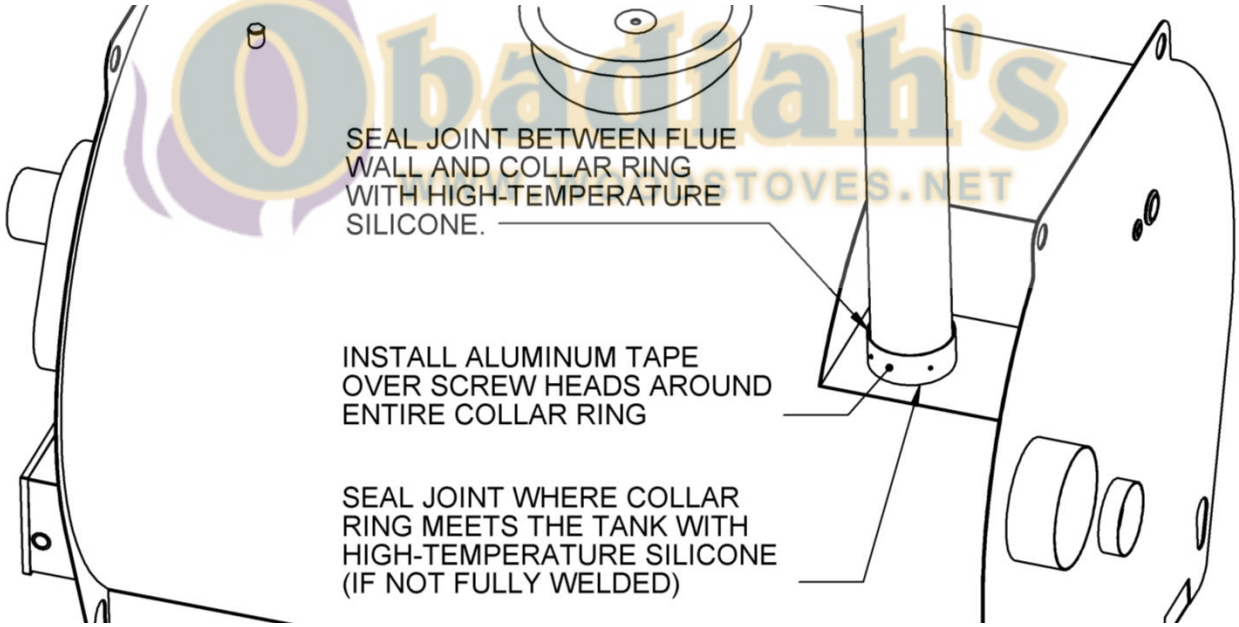
VERTICAL FLUE CONNECTION



VERTICAL FLUE - FIGURE 1:

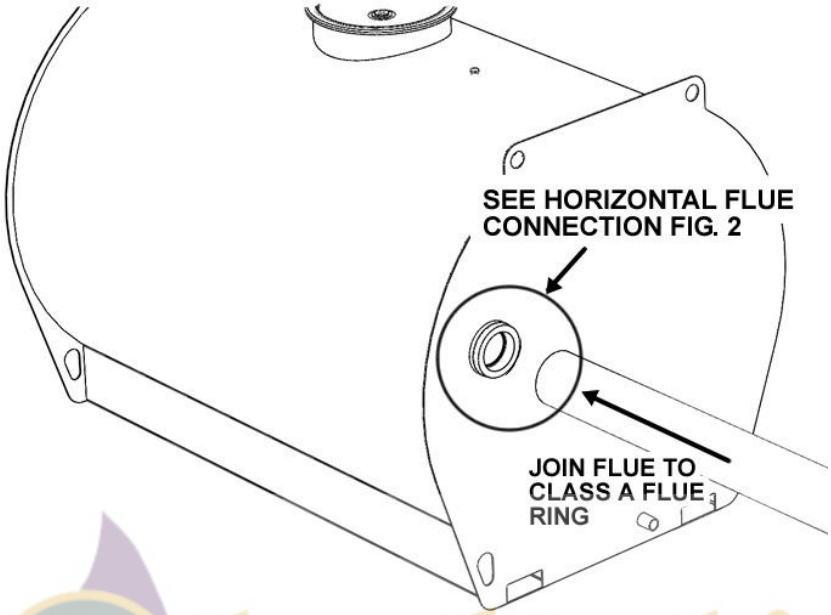


VERTICAL FLUE - FIGURE 2:

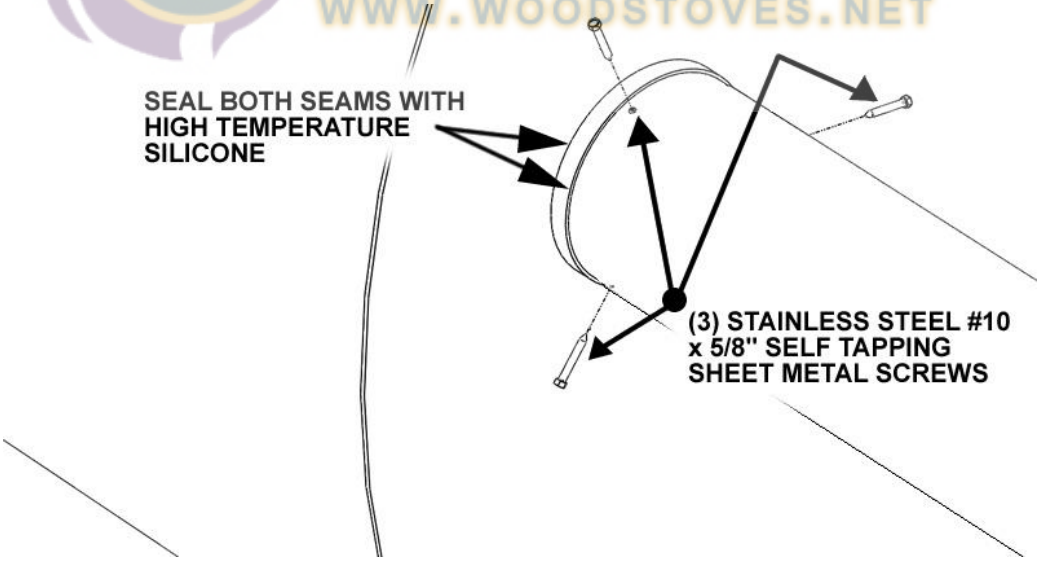


VERTICAL FLUE - FIGURE 3:

HORIZONTAL FLUE CONNECTION FIG. 1



HORIZONTAL FLUE CONNECTION FIG. 2



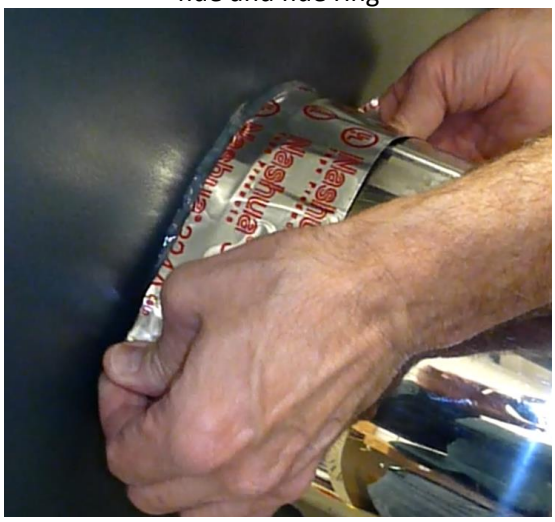
Step 1: use high-temperature silicone for sealing

Step 2: apply silicone to welded seam between flue ring and tank head

Step 3: Secure the flue to the flue ring and attach with sheet metal screws.

Step 4: Apply silicone to the seam between the flue and flue ring

Step 5: Seal flue joints with aluminum tape or silicone (tape can be more easily removed)



Step 5: Seal the flue joint to the flue ring.

FLUE GAS DISCHARGE CLEARANCES

As with any wood heating device, sparks may be occasionally expelled from the flue of GARN® WHS equipment; therefore it is important to comply with the following requirements. Flue gas discharge clearances are defined in NFPA 211 as well as national and state codes:

- Flue gas shall be discharged a minimum of 36" above grade.

A horizontal flue shall NOT be installed and flue gas should NOT be discharged horizontally:

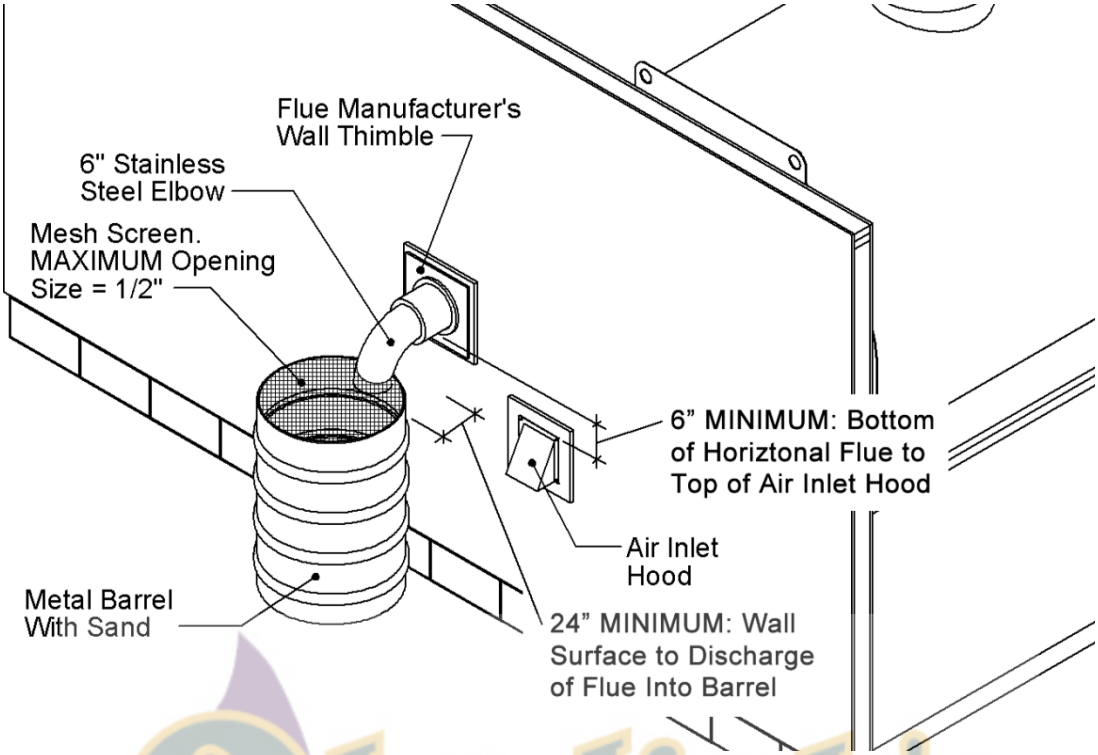
- Within 20' of any air inlet into any building or structure (except for the GARN® WHS combustion air inlet).
- Within 20' horizontally of any door, window, inside corner or gravity air inlet into any building or structure.
- If a window, door or air inlet is located above the horizontal flue.
- Less than 8' above grade when located adjacent to public walkways.
- Into a confined space between two buildings or structures.
- Into an area that naturally collects leaf, paper or other air borne debris that is combustible.
- Onto a parking lot or into an area where vehicles may park.
- Closer than 24" from building siding when the discharge is aimed away from the building.
- When the siding is wood, vinyl, or any combustible material.
- When soffit is vented or constructed of combustible material.
- Into the wind as sparks may blow back against the building during higher wind conditions. Always locate the horizontal flue so that exhaust gases move away from the building in the downwind direction during the heating season.

Flue gas shall NOT be discharged vertically:

- Less than 2' above any building component within a 10' radius of the flue. The vertical flue must extend at least 3' above the roof surface where it penetrates the roof.
- From a building with wood shingles, cedar shakes, or other combustible roofing materials due to fire hazard.
- If the chimney is under a tree due to fire potential.
- Where flue exhaust gases may enter an upper story window or door.

⚠ CAUTION **FAILURE TO FOLLOW THE ABOVE INSTALLATION DIRECTIONS WILL CAUSE REDUCED UNIT PERFORMANCE AND A FIRE OR OTHER HAZARDOUS CONDITION MAY RESULT.**

HORIZONTAL SIDEWALL FLUE



The flue can extend horizontally through the wall using the DuraTech brand Wall Radiation Shield. The flue should terminate no closer than 24" from building siding. A single wall, 6" diameter, adjustable stainless steel elbow is used to divert the flue gases downward into the metal container. Fasten the elbow to flue with two self-tapping sheet metal screws.

WARNING **FOR A HORIZONTAL FLUE INSTALLATION, A METAL CONTAINER PARTIALLY FILLED WITH SAND MUST BE PLACED BELOW THE ANGLED STAINLESS STEEL ELBOW TO CATCH ANY FLY ASH OR SPARKS THAT MAY EXIT THE EXHAUST. DO NOT USE A PLASTIC OR ANY COMBUSTIBLE CONTAINER. A ½" MESH WIRE SCREEN MUST BE FASTENED OVER THE TOP OF THE CONTAINER TO PREVENT THE ENTRANCE OF DRY LEAVES, ANIMALS, BIRDS, ETC INTO THE CONTAINER.**

The metal container must be at least 2' laterally from any surface and the top of the container must be 6' below any surface (such as a soffit). Cut a hole the size of the elbow in the screen where the flue enters the container.

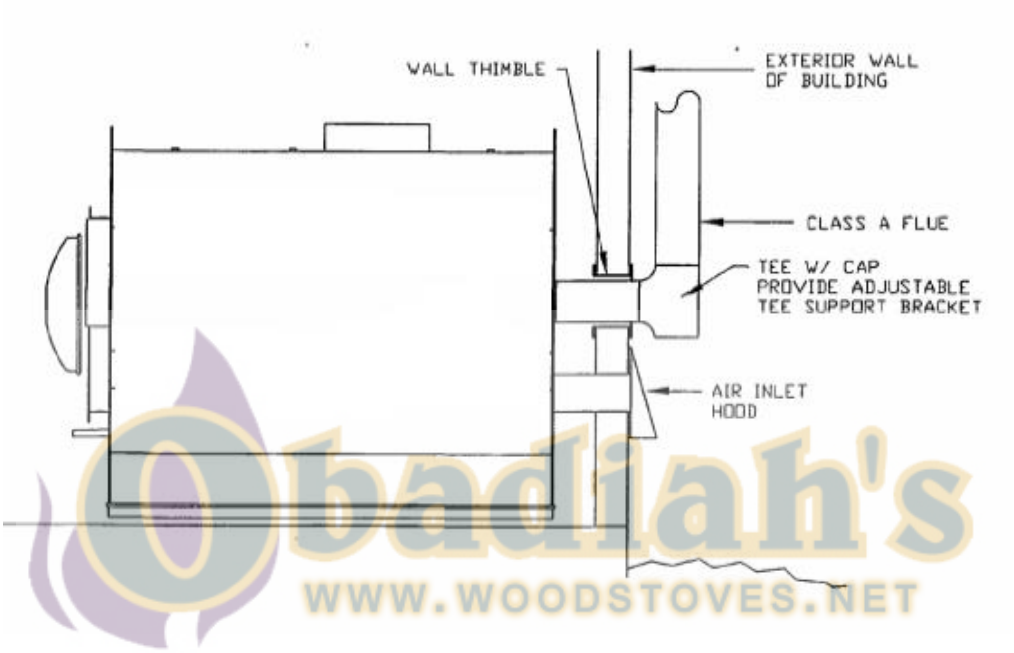
Care should be taken that the hot surfaces and gases do not present a hazard to any person who might frequent the area. Support all flue components to ensure structural integrity during the life of the flue. Use only non-combustible (i.e. steel, aluminum, etc) materials for such supports.

Depending on the fuel used and frequency of firing, the volume of initial smoke coming from a horizontal sidewall flue may be a nuisance. If windows or doors are in or near the smoke path, a vertical flue must be used. Some staining of siding materials will occur.

⚠ WARNING **MAINTAIN A CLEAN AREA FREE OF ANY COMBUSTIBLE DEBRIS SUCH AS LEAVES, TREES, PLANTS, GRASSES, PAPER, WOOD, TIRES, OIL, ETC FOR A MINIMUM DISTANCE APPROXIMATED BY A CIRCLE WITH A RADIUS OF AT LEAST 20' CENTERED ON THE FLUE ELBOW DISCHARGE.**

⚠ CAUTION **ANY ACCUMULATED ASH AND CREOSOTE ON THE METAL CONTAINER SHOULD BE REMOVED PERIODICALLY TO MINIMIZE THE POTENTIAL OF A CREOSOTE FIRE.**

EXTERNAL VERTICAL FLUE USING AN EXTERIOR TEE

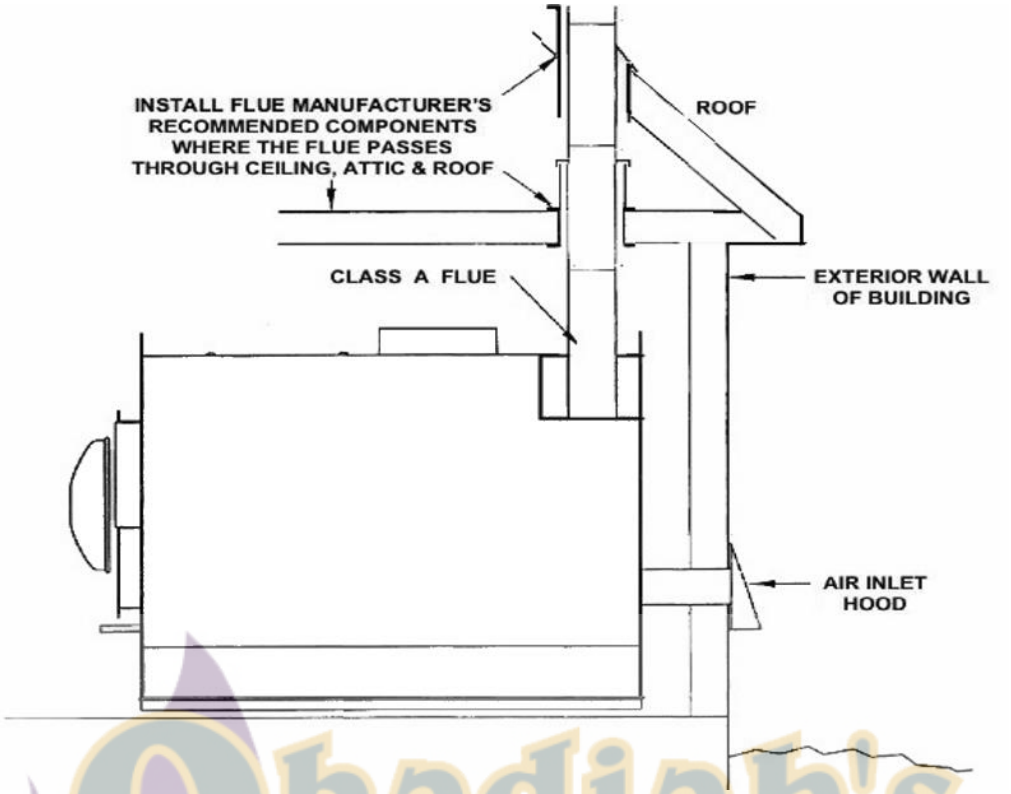


If the GARN® unit has a horizontal flue connection, but a vertical flue is required or desired, mount the vertical flue on the exterior of the building. Installation will require the use of the following additional double-wall DuraTech® UL-103 HT (US) or ULC-S629 (Canada) Class A 2100°F stainless steel flue components:

- Tee with bottom clean out cap
- Adjustable tee support bracket
- Wall thimble
- Adjustable wall supports

⚠ WARNING **DO NOT INSTALL AN EXTERNAL VERTICAL FLUE CONFIGURATION INSIDE OF A BUILDING OR A HAZARDOUS CONDITION MAY RESULT.**

INTERNAL VERTICAL FLUE



Installation will require the use of double-wall UL-103 HT (US) or ULC-S629 (Canada) Class A 2100°F stainless steel flue components to pass through the ceiling, attic and roof. Connect and seal all flue connections as indicated at the beginning of this section.

VERTICAL FLUE - HEIGHT ABOVE NEARBY BUILDING COMPONENTS

The vertical flue must extend to a height not less than 2' above any building component within a 10' radius of the flue. If the vertical portion of the flue penetrates the roof overhang, a DuraTech Firestop radiation shield and adjustable roof flashing are required. The vertical flue must extend at least 3' above the roof surface where it penetrates the roof. **DO NOT INSTALL A FLUE CAP** as it will unduly restrict the flow of pressurized exhaust gases. Check with your local building inspector about any additional height restrictions.

⚠ CAUTION **DO NOT USE A VERTICAL FLUE IF THE BUILDING HAS A COMBUSTIBLE ROOFING MATERIALS OR IF TREE BRANCHES ARE ABOVE IT.**

CONNECTION TO A MASONRY CHIMNEY

Only under limited circumstances may a GARN® be connected to a masonry chimney. Masonry chimneys are designed for heating devices that burn continuously in cold weather. Because the GARN® is only burned periodically, the masonry chimney must have a continuous, insulated minimum 6" diameter stainless steel liner. It must be surrounded with fireproof insulation and it must be no taller

than 24'. The maximum total static pressure loss in the vertical portion of the existing flue must not exceed 0.10" of water column at a flow rate of 375 CFM.

WARNING **ONLY USE STAINLESS STEEL LINED COMPONENTS.**

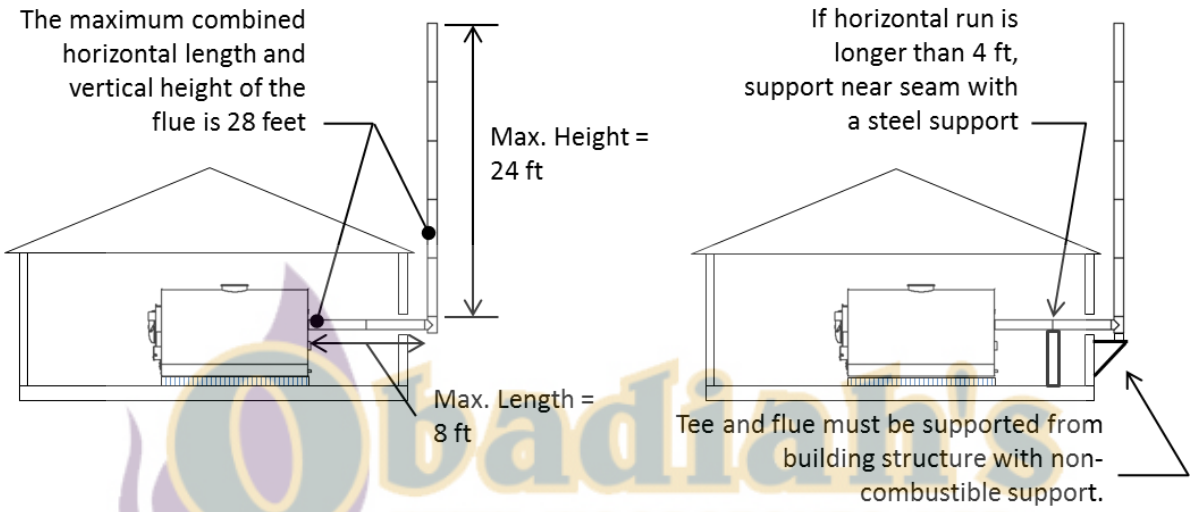
Existing chimneys must be inspected and certified safe for use as a pressurized chimney by a licensed professional engineer or licensed chimney specialist. In addition, the installation must comply with all state and local codes. If the GARN® WHS is located in a recessed area such as a basement, a carbon monoxide detector is required.

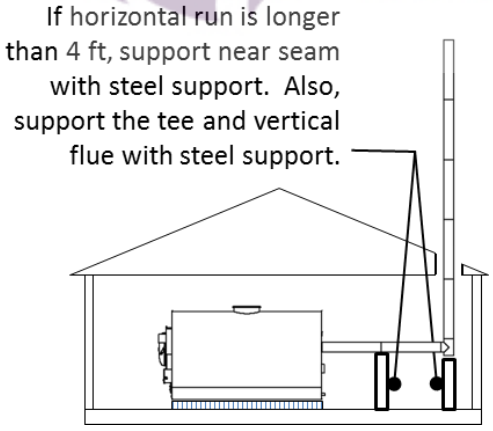
CAUTION **FAILURE TO SEAL ALL FLUE JOINTS INSIDE A BUILDING MAY RESULT IN HARMFUL LEVELS OF CARBON MONOXIDE AND CARBON DIOXIDE BEING PRODUCED.** If a strong smell of wood smoke is noticed leave the room and ventilate the space immediately.

MAXIMUM FLUE LENGTH (HORIZONTAL RUN AND VERTICAL HEIGHT)

Horizontal Units with an External Tee:

The maximum combined horizontal length and vertical height of the flue is 28 feet. The maximum allowable flue height is 24 feet, and the maximum allowable horizontal length is 8 feet. The vertical height is measured from the tee connection to termination of the stack. Only two sections of flue are allowed in the horizontal run, so that there is only one seam between the unit connection and the external tee. If the horizontal run is longer than 4 feet, then the flue must be supported inside of the building near the seam. The tee can only be located indoors if the GARN unit is located in a building NOT normally occupied by humans. See the illustrations and table below:





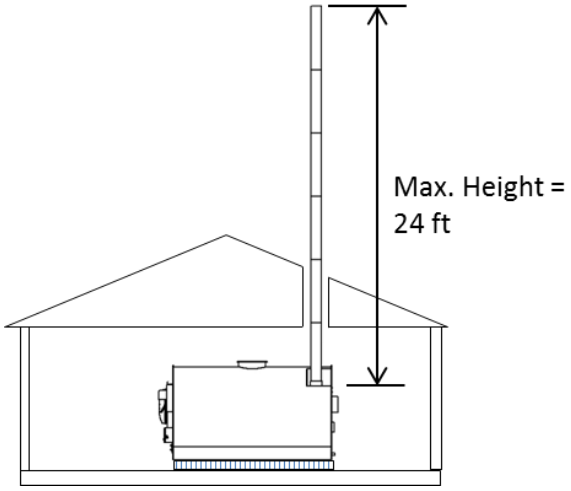
Horizontal Run Length (feet)	Max. Allowable Height (feet)
4	24
5	23
6	22
7	21
8 (Max)	20

CAUTION **STRICTLY FOLLOW THE FLUE MANUFACTURER'S INSTALLATION INSTRUCTIONS WHEN INSTALLING FLUE THROUGH THE BUILDING STRUCTURE.**

WARNING **THE TEE CAN ONLY BE LOCATED INDOORS IF THE GARN UNIT IS IN A BUILDING NOT NORMALLY OCCUPIED BY HUMANS.**

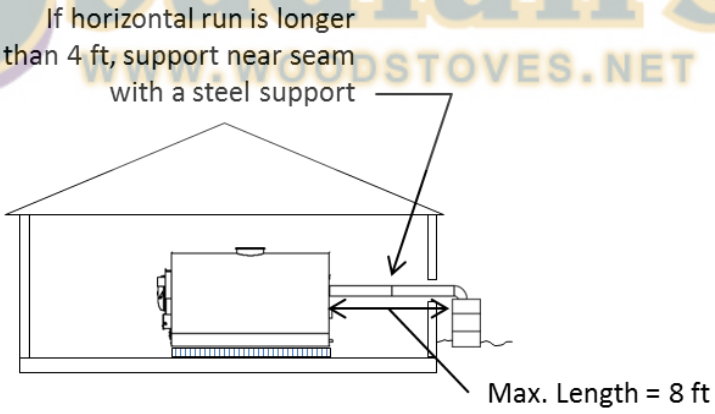
Internal Vertical Units:

The maximum allowable flue height is 24 ft. The height is measured from the flue collar connection to the termination of the stack.



Horizontal Units:

The horizontal length cannot exceed 8 feet from the rear of the unit. Only two sections of flue are allowed in the horizontal run, so that there is only one seam between the unit connection and stainless steel elbow into the metal barrel. If the horizontal run is longer than 4 feet, then the flue must be supported inside the building near the seam.



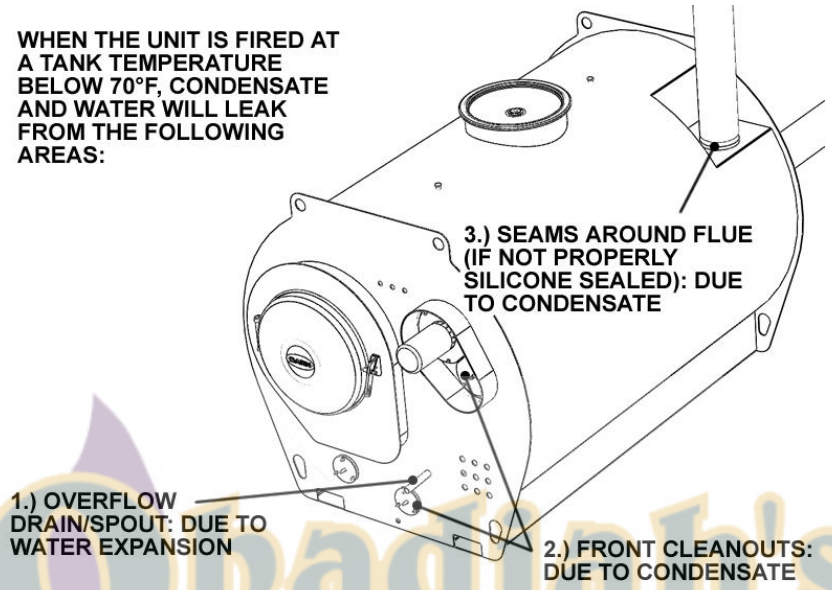
WARNING **ALL FLUE SEAMS (JOINTS) INSIDE THE BUILDING MUST BE CAULKED AND SEALED WITH HIGH-TEMPERATURE RTV SILICONE SEALANT AND ALUMINUM TAPE.**

Extending Maximum Height to 40 feet:

Where additional height is needed, a unit can be custom-ordered with a collar that allows connection to an 8 inch flue. The maximum combined horizontal length and vertical height of the flue is then extended to 48 feet. The maximum allowable height is extended to 40 feet but the maximum horizontal run remains at 8 feet.

INSULATING YOUR GARN®

NOTICE When firing your GARN® with a tank temperature below 70°F, condensate water will leak out of the upper cleanout and/or flue. Water will also leak from the overflow pipe due to thermal expansion. Both are normal. **It is STRONGLY suggested to perform the first two cold firings before the unit is insulated or enclosed.** Damage or staining of sheetrock may occur otherwise.



⚠ CAUTION **USE ONLY NON-COMBUSTIBLE MATERIALS WHEN CONSTRUCTING AN INSULATED ENCLOSURE FOR YOUR GARN®** (sheetrock, galvanized metal studs and sheet metal for all wall surfaces). Do not use: wood, plywood, particle board, oriented strand board, etc.

Construct the insulation enclosure around the GARN® WHS unit using 2.5" x 1 5/8" x 18 gauge galvanized steel studs and 5/8" sheetrock. Install per stud manufacturer's directions. Tape all joints after the sheetrock is securely fastened into final position.

1) Place a layer of tarpaper between the concrete floor and the bottom steel stud plate to minimize possible corrosion of the bottom plate. Use power driven fasteners to attach the plate to the floor.
2) At the front of the unit, cut the sheetrock around the air collar, draft inducer housing and electric element box. Slip the sheetrock behind the 2" steel flange that surrounds the air collar. Fasten the sheetrock to the flange using the predrilled air collar holes and short lengths of steel studs behind the sheetrock (essentially forming a sandwich that will draw the sheetrock to the flange). Maintain a minimum 3/4" clear dimension between the edge of the sheetrock and the barrel of the air collar and ½" clear around the draft inducer housing. Install galvanized steel stud framing to safely support the sheetrock face. Tuck ONLY UNFACED rock wool or non-binder fiberglass insulation between the sheetrock face and the front of the GARN® WHS unit.

3) Provide access to the two lower cleanout covers as access for flue cleaning will be required on a routine basis. Construct a box from non-perforated metal studs large enough to accommodate the cleanouts, extending from the tank face to the rear surface of the sheetrock face. Install as part of the framing; however, do not cover with sheetrock and do not insulate.
4) If the GARN® WHS is positioned against a concrete or block wall (with the block wall forming one portion of the insulation enclosure), install a 6 mil poly vapor barrier against the concrete or block wall before installing any insulation. The poly will prevent the insulation from absorbing water from the concrete or block wall.
5) DO NOT INSTALL any electrical wiring, fixtures, switches, etc within the enclosure, as such wiring may overheat creating a fire hazard. Rather, install all electrical wiring in light gauge metal conduit run on the exposed exterior surface of the enclosure. Wiring is to be installed by a Licensed Electrician.
6) Properly ground the GARN® WHS to help avoid corrosion due to a "floating ground." DO NOT USE THE STEEL CONDUIT AS A GROUND CONDUCTOR. Provide a dedicated driven ground rod and wire, in addition to the normal ground that is connected to the electrical service panel.
7) Completely surround the GARN® WHS unit with insulation using only the following types of non-combustible insulation:
    - Vermiculite or perlite
    - Dense pack blown in non-binder fiberglass or rock wool
    - Unfaced glass fiber batts
    - Unfaced rock wool batts

Vermiculite and perlite insulation will naturally "flow" beneath the unit. If blown-in or batt insulation is used, be sure to slide unfaced batt insulation beneath the GARN® unit as far as possible.

DO NOT USE FOAM BOARD OR FOAM BEADS TO INSULATE THE TANK ITSELF. Both will melt and are a fire hazard. Insulating under the metal skids at the bottom of the tank with foam board is acceptable (see "Unit Placement").

DO NOT USE CELLULOSE INSULATION. The acid treatment of the cellulose will corrode the steel tank. Use only fiberglass insulation in the electric element box.

8) Fill the insulation enclosure to 6" above the tank portion of the GARN® WHS.
9) In an industrial setting, the GARN® WHS may be wrapped with pre-formed, high-density non-combustible fibrous insulation covered with a fireproof canvas and plaster overcoat. This would eliminate the construction of an insulation enclosure and allow ongoing easy access to all sides of the unit.

GARN® WHS/ETS DIGITAL CONTROLLER

NOTICE **REFER TO THE "OVERVIEW OF THE DIGITAL CONTROLLER" UNDER THE "OPERATION" SECTION OF THIS MANUAL FOR A DESCRIPTION OF THE CONTROLLER BUTTONS AND LCD DISPLAY MESSAGES.**

The GARN® WHS/ETS digital controller was developed to perform the following functions:

- Increase unit efficiency by eliminating blower operation beyond the termination of combustion.
- Provide measurement (+/-0.5°F) of flue gas, thermal storage, hot water supply, and hot water return temperatures.

NOTICE **ONLY CONNECT AS INDICATED IN THESE INSTRUCTIONS.** There are several connections that are not used on the controller circuit board.

The GARN® WHS/ETS Controller does not play any role in the control or distribution of the heated water, other than monitoring water temperatures. The digital controller uses a pre-programmed chip that is upgradeable as control improvements are developed. With minor alterations the controller and sensors can be retrofitted to almost all existing GARN® WHS units dating back to 1990.

The digital controller will terminate blower operation when the flue gas temperature (FGT) is within 5°F of the thermal storage temperature (TST) for 10 minutes. When the controller terminates the blower, little to no firewood should remain in the firebox. The 10 minute delay:

- Allows time for reloading if the operator wants to add additional fuel to the combustion chamber.
- After reloading the FGT will be greater than 5° F above the TST and the controller will continue under normal operational protocol.

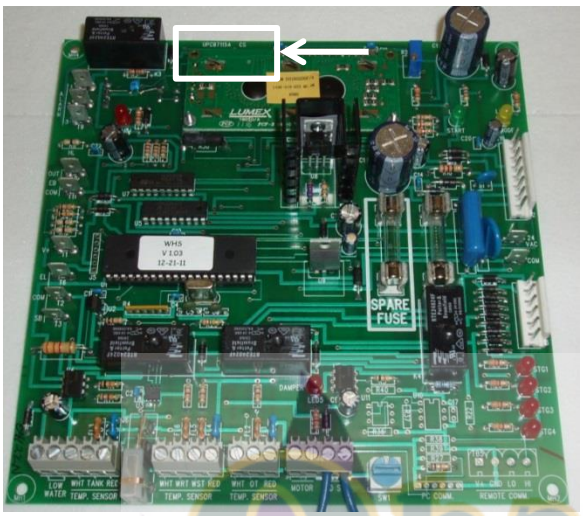
The following components are included with the basic Wood Heating Only version of the WHS/ETS Digital controller:

1. Low Water Cut-Off (LWCO) & Thermal Storage/Tank Temperature Sensor (TST) – UL listed with brass stem, 5-wire lead, 2- piece plastic fitting, and an integrated tank temperature sensor.
2. Flue Gas Temperature Sensor (FGT) –Type K thermocouple with 60" lead and ¼ x ¼ brass compression fitting.
3. Outdoor Temperature Sensor (OT) – RTD temperature device with 25' 3 wire lead.
4. Hot Water *Supply* Sensor (HWS) - RTD temperature device with 25' 3 wire lead.
5. Hot Water *Return* Sensor (HWR) - RTD temperature device with 25' 3 wire lead.

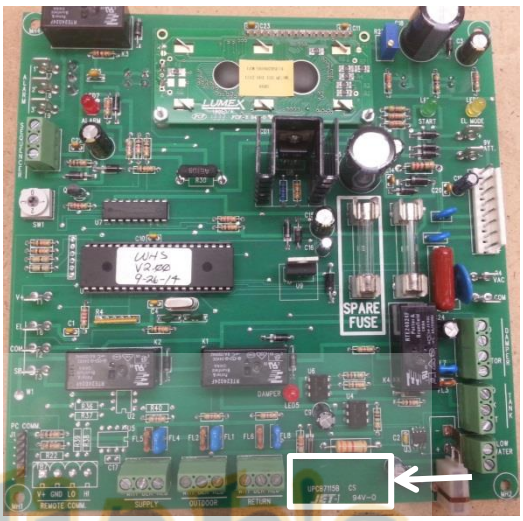
IDENTIFYING YOUR BOARD REVISION

The board revision determines the location of the wiring terminals for the unit's sensor and how the board interfaces with the electric heating package (optional). The identification for your board is located in one of two spots. The board number begins with "UPC7115" followed by the letters A or C. The letter indicates the revision of the board.

Revision UPC7115**A** has the label located here:

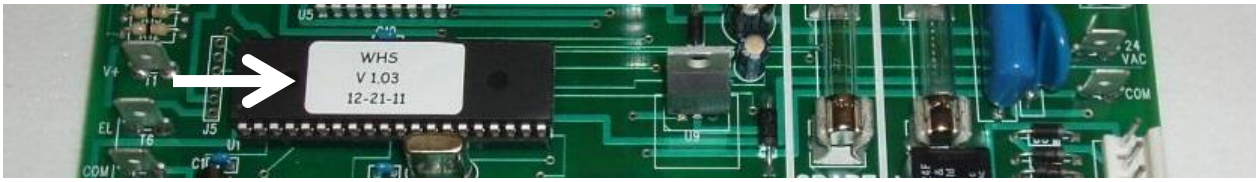


Revision UPC7115**C** has the label located here:



IDENTIFYING YOUR CHIP REVISION

The digital controller has the feature of being upgradeable. The latest version of the chip is supplied with the purchase of the electric heating package or can be purchased separately. To identify the version of chip that is installed in your board, read the label adhered to the chip:



INSTALLING THE GARN® WHS/ETS DIGITAL CONTROLLER

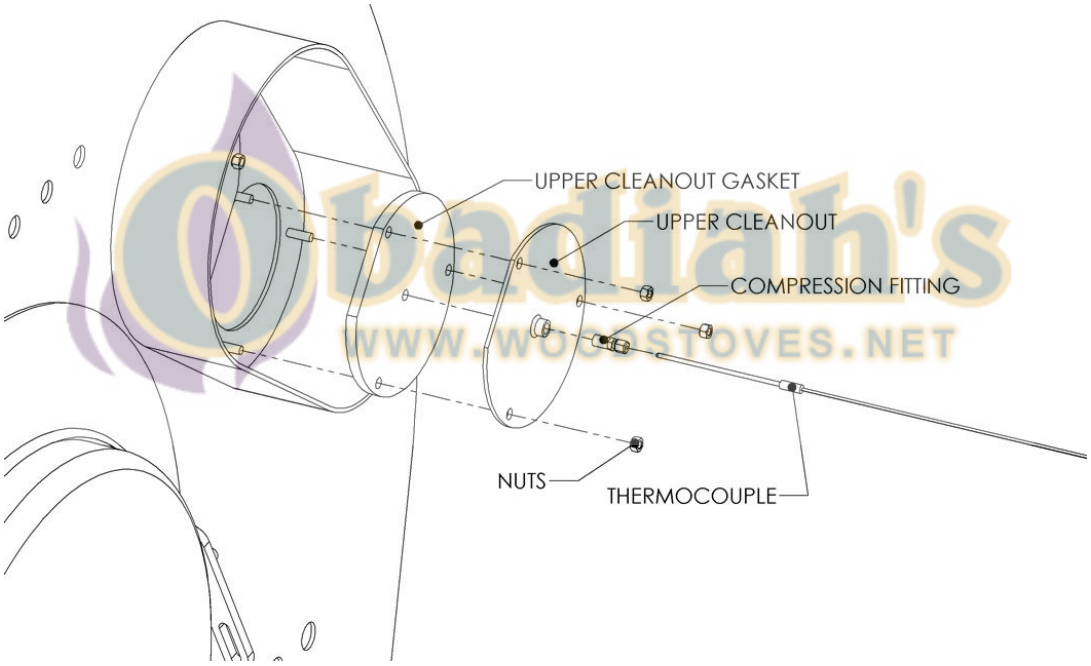
NOTICE **RUN ALL OF THE SENSOR WIRES ASSOCIATED WITH THE DIGITAL CONTROLLER OUTSIDE OF ANY INSULATION THAT IS CONTACT WITH THE UNIT.**

NOTICE **DO NOT RUN ANY SENSOR WIRES WITHIN 2 INCHES OF ANY POWER SOURCE OR CURRENT CARRYING WIRES.** Do not zip-tie or attach sensor wires to any power sources or other high current wires.

1) LOW WATER CUT-OFF: Install the stem on the manway cover as detailed in the "LOW WATER CUT-OFF AND TANK TEMPERATURE SENSOR STEM" section of this manual.

2) FLUE GAS TEMPERATURE SENSOR:

The FGT sensor comes with the compression nut already in place. The threaded portion of the fitting is screwed into the fitting on the upper clean-out plate next to the motor.



Slide the sensor into the fitting in the cleanout plate and snug. If during firing flue gases are observed seeping out of the fitting, snug until fully sealed.

3) OUTDOOR TEMPERATURE SENSOR (OTS – outdoor temperature sensor and 25' 3 wire lead)

The sensor functions best when mounted at chest height, on the north side of building, protected from direct sunlight, and when kept away from heat sources.

4) HOT WATER SUPPLY and HOT WATER RETURN SENSORS:

Use a nylon tie to fasten the sensor to the supply and return piping. Tape some insulation over the sensor. The HWS sensor is best located after the system mixing value if one is used.

5) MOUNTING THE DIGITAL CONTROLLER:

Installation and wiring of the controller or any electrical equipment is to be completed by a licensed electrician. All electrical equipment, fixtures and wiring must be installed in compliance with the National Electric Code.

Securely mount the controller within reach of the motor power cord and flue gas sensor lead. If there is no suitable mounting location within reach of the motor power cord and flue sensor leads, use an extension cord for the motor and refer to the

EXTENDING THE SENSOR WIRES section of this manual for the flue temperature sensor. All sensor wires route through the opening above the outlet on the side of the controller. After wiring, seal the opening to prevent dust and insects from entering the controller.

NOTICE The controller must be powered by a dedicated 15 amp, 120 vac single phase circuit.

6) CONNECT SENSOR WIRES TO CONTROLLER CIRCUIT BOARD:

There are currently (2) version of the control board. The location of the wiring is different for each board revision. Identify the board revision and then refer to the appropriate wiring pictures.

NOTICE All sensors are low voltage and are wired on-site. The color of wiring for the fresh air damper and end switch may vary from what's shown in the manual.

Connect as shown in the following figures. The yellow two prong mini connector on the flue sensor only fits with the correct orientation: the pins are polarized (one large pin and one small pin).

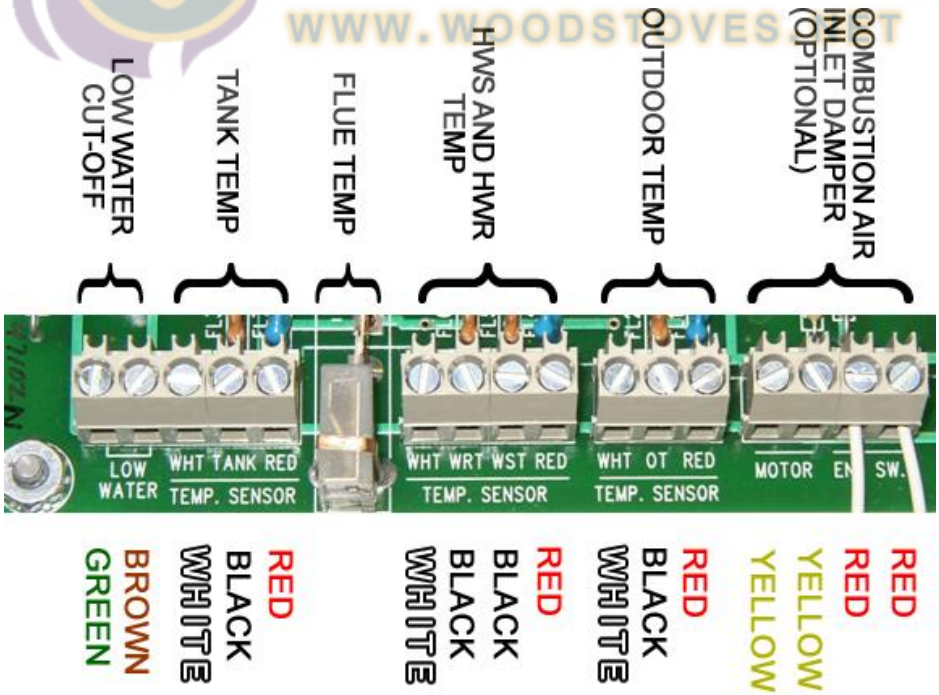
The controller will still operate if the Outdoor Sensor, Hot Water Supply Sensor and Hot Water Return Sensors are not connected, but the digital display will flash.

NOTICE The controller will NOT operate unless the low water cut-off, flue temperature sensor, and tank temperature sensor are properly connected and functioning.

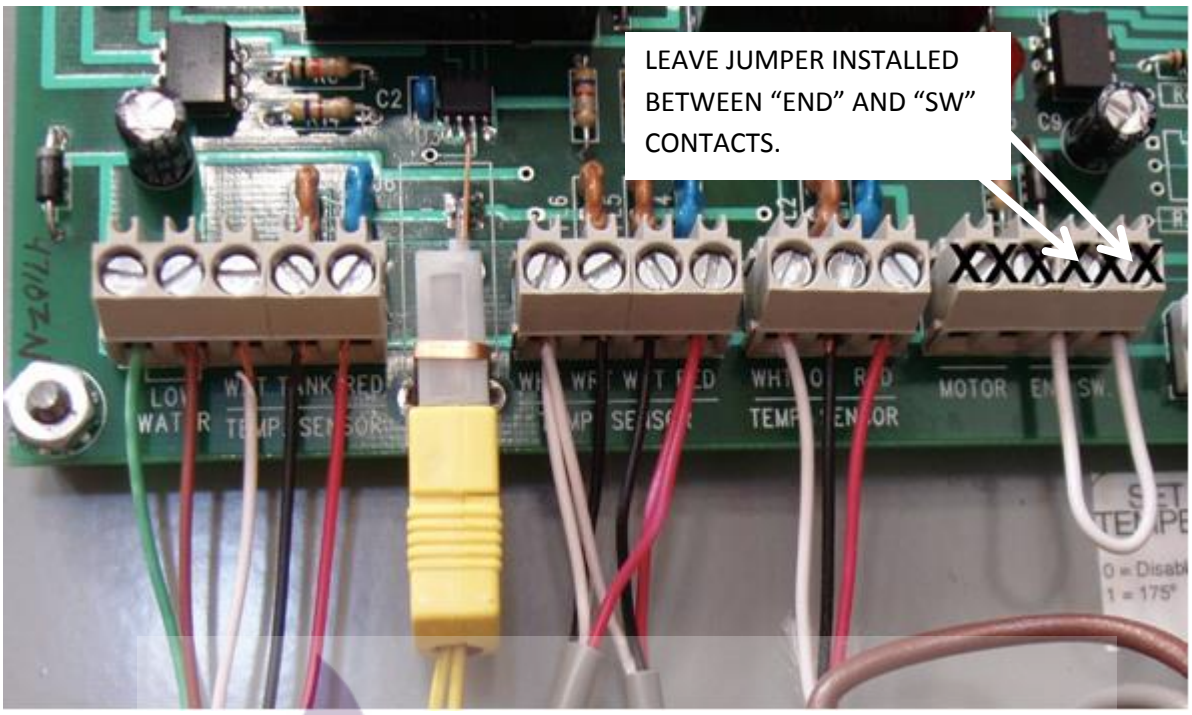
NOTICE Tighten all wiring connections firmly. Loose connections may prevent the controller from operating correctly. Leave the pre-installed white jumper wire connected on the contacts labeled "END SW" if the optional combustion air damper will NOT be used.

REV A WIRING PICTURES:

Both red and both white wires for the supply and return sensors are connected to the same terminal screws. The black wire from each sensor lead goes to its respective terminal.

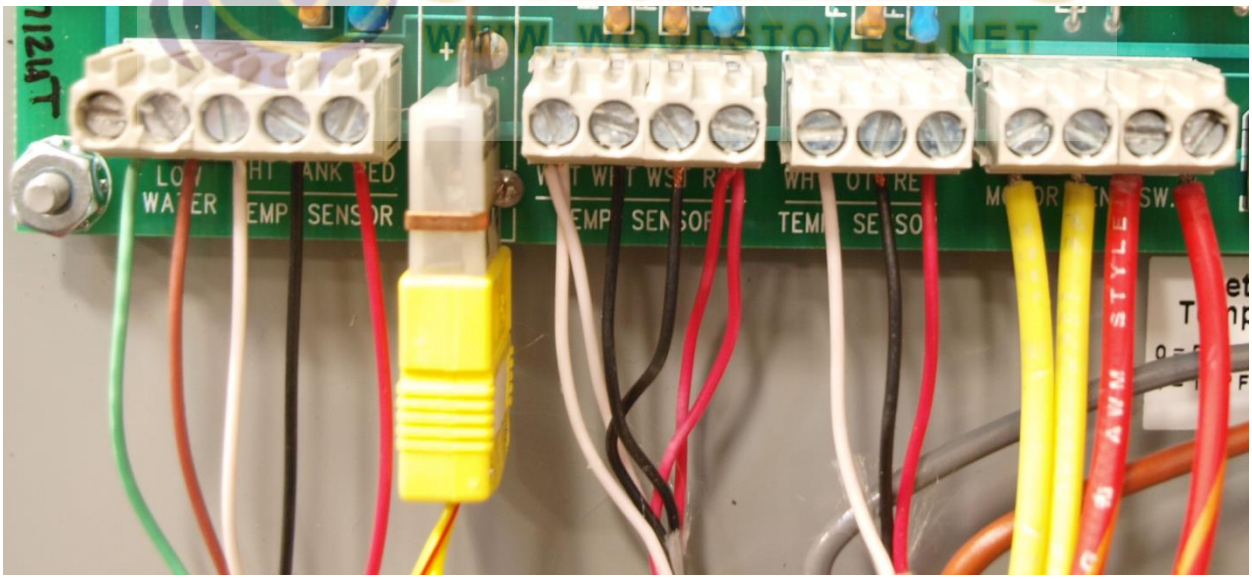


WIRING <u>WITHOUT</u> COMBUSTION AIR DAMPER

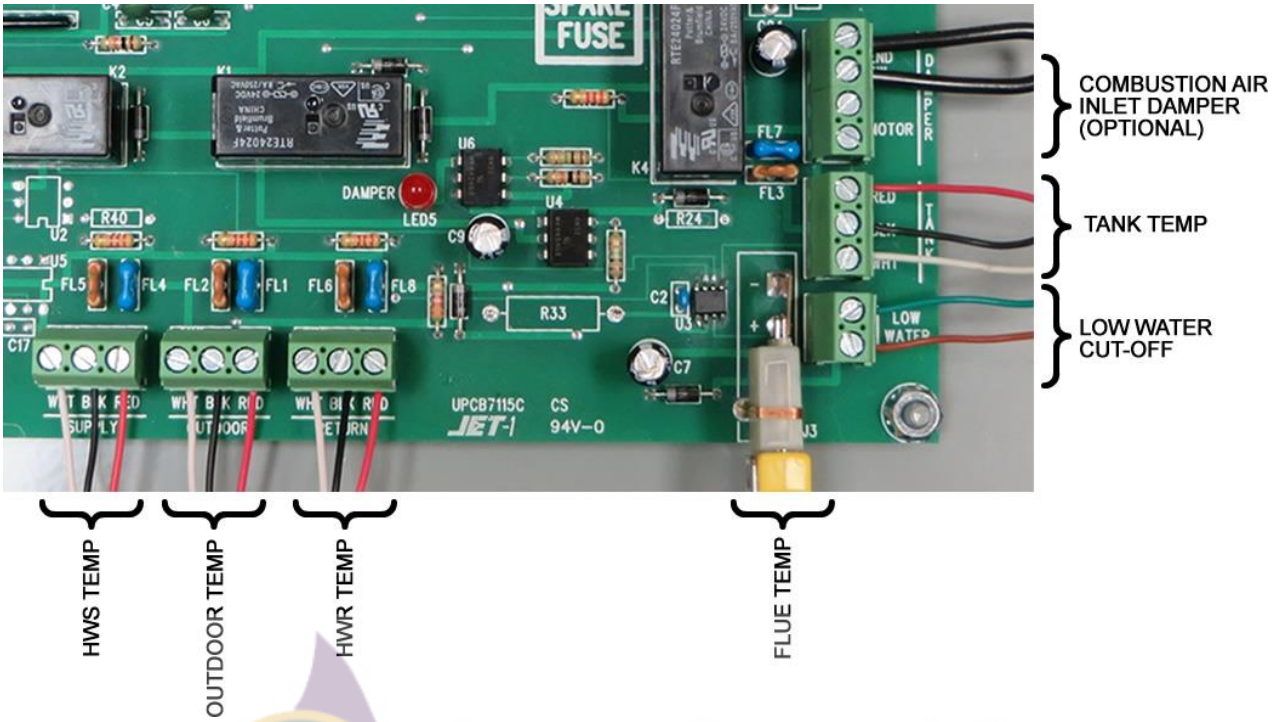


WIRING <u>WITH</u> COMBUSTION AIR DAMPER

Remove the white jumper wire on the "END SW" contacts. Connect the yellow leads from the damper motor to the "MOTOR" contacts and the red leads from the damper to the "END SW" contacts.

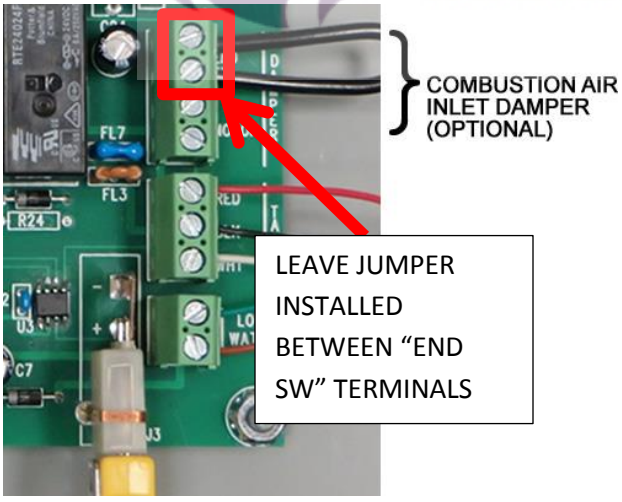


REV C WIRING PICTURES:

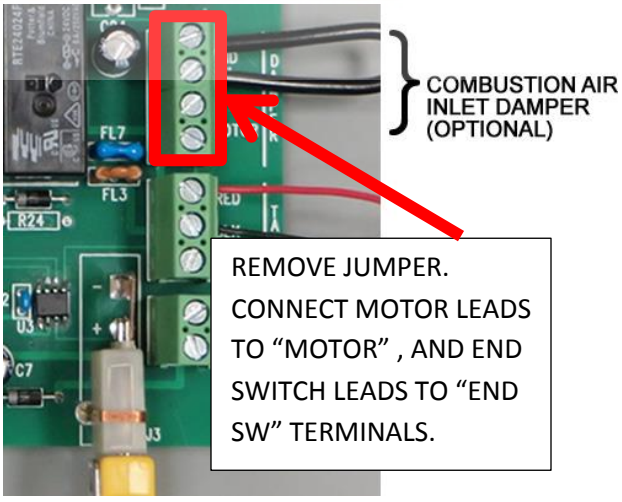


WIRING THE COMBUSTION AIR DAMPER

WIRING WITHOUT COMBUSTION AIR DAMPER



WIRING WITH COMBUSTION AIR DAMPER



EXTENDING THE SENSOR WIRES

It is acceptable to extend the sensor wires for some of the sensors that connect to the Controller. Strictly comply with the following criteria:

- Use stranded wire only for extensions, thermostat wire is not acceptable.
- Sensor wires must not run parallel with or be attached to high voltage lines.
- Making sure that the correct wire colors are continued for proper termination connections on the circuit board.
- Do not run any sensor wires within 2 inches of any power source or current carrying wires. Doing so will induce current on the sensor wire resulting in erroneous reading and improper controller operation.
- Do not zip-tie or attach sensor wire (or wire extensions) to any power sources or other high current wires.

Refer to the following table for acceptable extension lengths:

Sensor	Minimum Wire Gauge of Extension (stranded)	Total Allowable Length (includes exension and lead)
HOT WATER SUPPLY	18 AWG	35 ft
HOT WATER RETURN	18 AWG	35 ft
OUTDOOR TEMPERATURE	22 AWG	50 ft
LOW WATER CUTOFF AND TANK TEMPERATUR SENSOR	18 AWG	35 ft
COMBUSTION AIR DAMPER (OPTIONAL)	18 AWG	50 ft
FLUE GAS TEMPERATURE **DO NOT EXTEND WITH COPPER WIRE!**	Use *Flue Temperature Sensor Extension* kit (12 ft) available at www.garnparts.com	18 ft

DO NOT MODIFY THE DIGITAL CONTROLLER OR ADD ADDITIONAL COMBUSTION CONTROLS

DANGER **DO NOT MODIFY THE GARN® WHS/ETS DIGITAL CONTROLLER.** Doing so will prevent the GARN® unit from operating correctly and result in: creosote formation in the heat exchanger tubes and exhaust flue; create a fire hazard; damage the GARN® unit; void all manufacturer warrantees.

Modifications to the GARN® WHS/ETS digital controller include, but are not limited to:

- Additional controls to cycle the induced draft blower on/off or modulate its speed.
- The addition of any other control device that modifies the combustion process.
- Bypassing the low water cut-off and/or tank temperature sensor

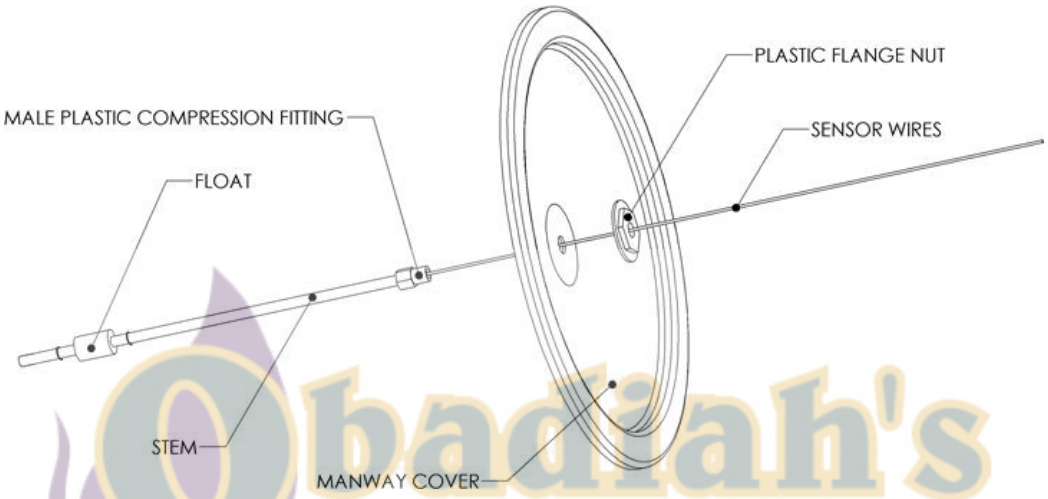
LOW WATER CUT-OFF AND TANK TEMPERATURE SENSOR STEM

NOTICE **DO NOT KINK OR DAMAGE THE CABLE OR STEM DURING ASSEMBLY OR INSTALLATION.**

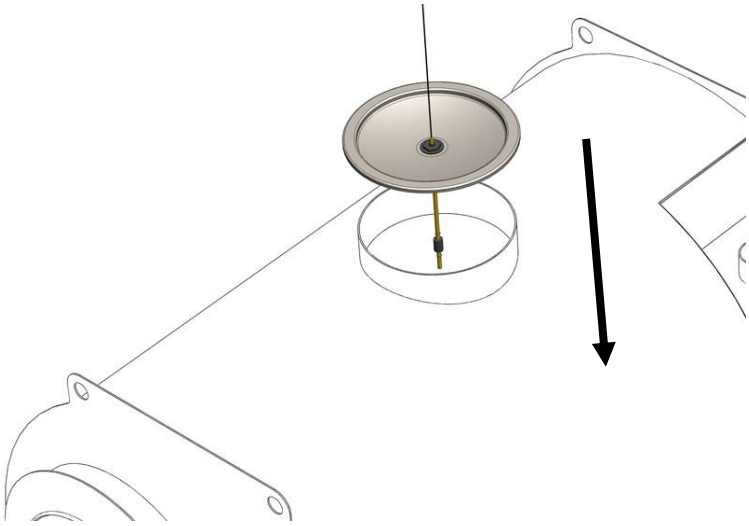
WARNING **CHECK ALL SENSOR CONNECTIONS.** Incorrectly connected wires may cause permanent electrical damage to the stem or PC board. Loose connections may also pose a fire risk.

SPUN MANWAY COVER:

The sensor stem is connected to the spun manway cover as follows:



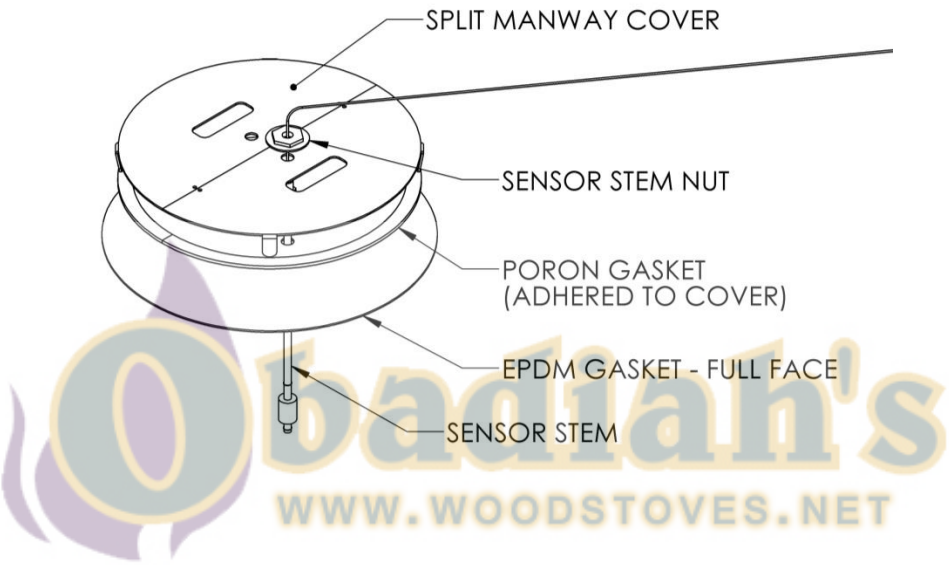
1) Unscrew the large plastic flange nut from the plastic fitting at the top of the stem.
2) Slide the nut off the cable and insert the free end of the cable through the manway cover.
3) Insert the threaded portion of the plastic stem fitting into the manway cover.
4) Slide the large plastic nut back over the black cable onto the fitting and snug.
5) Place the manway cover and stem assembly onto the manway access at the top of the GARN®.



SPLIT MANWAY COVER

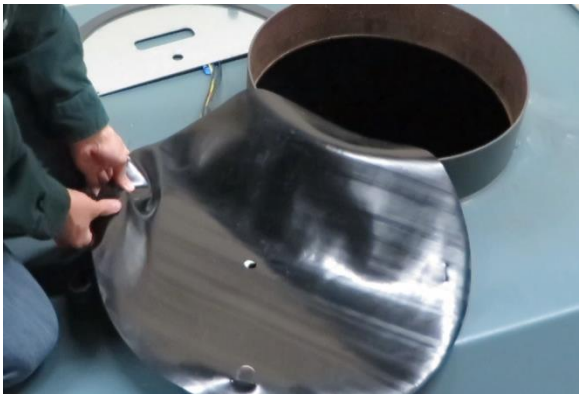
The *split* manway cover is a new generation manway cover that adds a number of benefits to the existing *spun* cover design. The split cover comes with a high-temperature, full-face EPDM gasket. The EPDM gasket protects the galvanized cover and soft gasket from corrosion and wear and will provide years of service for both gaskets. The split cover is separated into two pieces allowing the operator to look inside the tank without disturbing the float sensor switch. Older units will have the spun cover but a split cover can be purchased from www.garnparts.com and will retrofit to any GARN WHS unit purchased after 1989.

The split cover is made up of the following components:



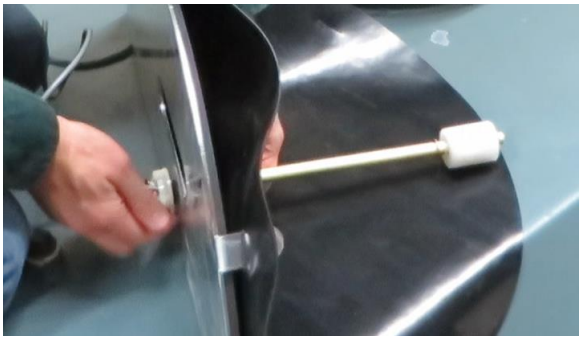
INSTALLING THE SPLIT MANWAY COVER:

1. Start with one half of the split cover. Push the tabs of the cover through the factory pre-cut slits of the EPDM gasket.



2. Feed the sensor stem wire through the hole in the EPDM gasket and cover. Ensure that the stem seats into the EPDM gasket securely:

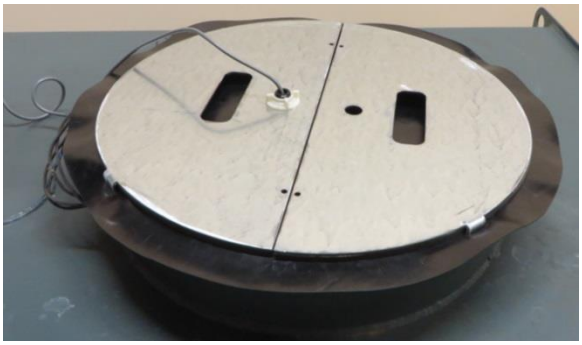
3. Installed the sensor stem nut and tighten the nut by hand until it is snug.



4. Place the assembled half onto the manway ring. Ensure that the tabs are on the **outside** of the ring and that the cover seats properly.

5. Place the other have of the cover onto the ring and push the tabs through the EPDM gasket.

6. The manway cover is fully assembled and ready for service.



7. Optionally, zip ties or wire can be installed in the ¼" holes on the manway cover. Installing the ties will make the manway cover act as one piece.

PLUMBING YOUR GARN®

The key to any great hydronic system is design and planning. At the same time hydronic heating is relatively forgiving and can operate under a variety of circumstances very well. For discussion on designing and planning the hydronic system that the GARN unit is connecting to, see the GARN® System Design Manual (available at www.garn.com). The intent of this section is not to make every customer a competent mechanical installer or plumber. That takes time and experience. Instead, the rest of this section is used to highlight some common pitfalls and mistakes made when plumbing up a GARN® and to make the installer aware of specific requirements.

WARNINGS WHEN CONNECTING TO AN EXISTING SYSTEM OR GLYCOL TREATED SYSTEM

DO NOT CONNECT YOUR GARN® WHS OR ETS UNIT TO AN OLD, DIRTY OR GLYCOL TREATED EXISTING HYDRONIC SYSTEM UNTIL THE EXISTING SYSTEM HAS BE THOROUGHLY CLEANED AND FLUSHED.

Conventional hydronic distribution systems with a steel or cast iron boiler, cast iron radiators, copper hot water baseboard, or water to air coils, may contain a sludge or solution that can attack the steel in your GARN heat storage system. Over time bacteria, debris and/or glycol can transform into this very corrosive sludge/solution. This liquid SHOULD NOT BE MIXED with the GARN storage water. Rather the existing system MUST be completely drained and flushed with a chemical cleaner before connecting it to the GARN unit. Contact PrecisionChem for proper chemical and procedures.

ANTI-FREEZE USED IN DISTRIBUTION SYSTEMS MUST BE REPLACED AFTER 3 - 5 YEARS.

Anti-freeze slowly degrades over a period of time and transforms into a very aggressive solution that readily attacks steel. Thus any hydronic system that utilizes antifreeze MUST be periodically checked and the antifreeze replaced before it becomes aggressive.

ISOLATE THE GARN® WATER FROM ANY GLYCOL TREATED SYTEM. If the distribution system requires anti-freeze, the distribution system must be isolated from the GARN heat storage water with a flat plate or equal heat exchanger.

THE DESIGN AND INSTALLATION OF YOUR DISTRIBUTION SYSTEM MAY CAUSE THE GARN TANK TO BECOME SACRIFICIAL, IF PROPER PROCEDURES ARE NOT FOLLOWED. Connect only black steel pipe to GARN unit, install dielectric couplings where copper pipe connects to steel pipe, install the chemicals provided and test/maintain your water chemistry twice per year.

E. FILLING AND WATER TREATMENT

⚠ WARNING **REFER TO CHEMICAL MSDS FOR INSTRUCTIONS ON HOW TO SAFELY HANDLE THE PRECLN AND WATER TREATMENT CHEMICALS.**

For questions regarding water treatment and testing services, contact:

PrecisionChem Water Treatment
W7231 State Road 49
Waupun, WI, 53963
precisionchem@powercom.net
1-(920)-324-2007

When you purchase a GARN® Wood Heating System, water testing and chemicals for the first year are included at no charge.* To protect your investment follow the simple GARN Water Treatment Program outlined below. Properly maintained, you should have years of reliable and trouble-free service from your GARN unit.

***LIMITATIONS OF ONE YEAR'S CHEMICAL:** With the purchase of your GARN® unit you are being provided enough PreCleaner and Corrosion Inhibitor Treatment to treat your water with a normal installation. Greater than 95% of all installs fall within this description. **Variables may be present within your particular system installation that may require the additional *purchase* of chemicals to complete your program properly.** Examples of program variables that may require additional chemical purchases include, but are not limited to, additional significant system water volume, biological infestation and attack, and major leaks and/or overflows. However, necessary customer support services including testing and consultation in regards to your water treatment program are included at no charge. Requested services beyond those pertinent to the program may incur additional charges. All questions can be addressed to PrecisionChem Water Treatment.

INITIAL WATER TREATMENT AND FILLING

The GARN® Water Treatment Program begins with the SAMPLE BOTTLE packaged with the water treatment program box. This program combines diligent water testing with chemical treatments tailored to your individual situation.

1) **SAMPLE:** Before filling your GARN® unit, send a sample of the fill water to PrecisionChem for analysis. When drawing a sample, always fully rinse the container twice with the water being sampled before collecting the final sample to be submitted.

NOTICE Analysis of any water sample will take up to **1 week** after the water sample is **received** by the lab. Plan ahead, and schedule accordingly.

2) **TEST**: PrecisionChem will test your sample and determine whether this water can be successfully treated, or whether you might benefit from a different source of water. You will be shipped a pre-cleaning chemical (PreCln) and the appropriate water treatment chemical. The following table shows the maximum amount of chemical that will be shipped to treat the **initial** fill water:

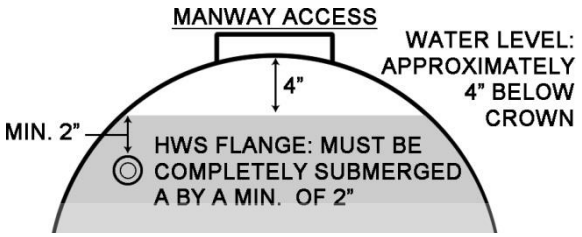
Table 1: Maximum Initial # of Chemical Pails

Model	PreCln Chemical (maximum # of pails)	Water Treatment Chemical (maximum # of pails)
WHS-1000 (Junior)	1/2	1-1/2
WHS-1500/2000	1	2
WHS-3200	2	4

3) **CLEAN**: Vacuum and remove any loose material that has collected inside the tank during manufacturing, shipping, and placement.

4) **FILL AND TEST FOR LEAKS**:

   a. Fill the unit until it's almost full (approximately 4" below the crown at the top of the tank).



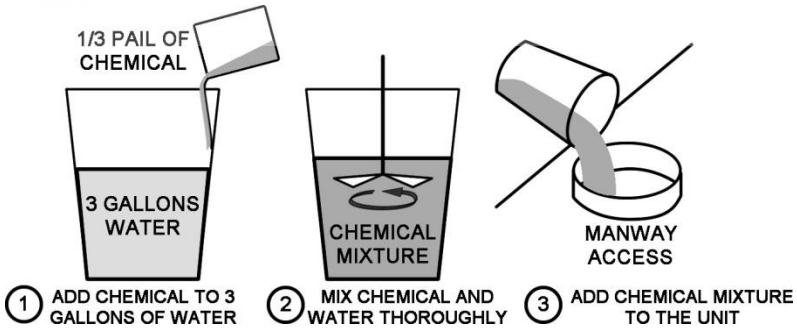
   b. Run pumps and check for leaks in piping system.

5) **PRECLEAN TREATMENT**

   a. Ensure there are no leaks at the unit or any piping system directly connected to the unit.

   b. Ensure that pipe plugs are installed in the couplings on top of the unit.

   c. Premix the PreCln Chemical: Use gloves and eye/face protection. Add a 1/3 of a pail of PreCln chemical with approximately 3 gallons of *warm* fill/tap water and mix thoroughly in clean 5 gallon pail.



   a. Repeat the process of premixing, and adding until the entire PreCln chemical is used.

   b. If you have the GARN Electric Heating Package or other form of backup heat installed, heat the tank to 160°F.

NOTICE

If wood is used to heat the tank to 160°F, significant condensation may occur because the fill water is cold. See the Owner's Manual section on Condensation Leak Points During Cold Firing. We recommend heating the tank as the PreCln dissolves and acts faster when the water is hot. It will still work with cold temperature water, but when possible heat the tank at this step.

c. Run all system pumps for at least twelve (12) hours, but no more than (48) hours, to distribute the water and PreCln chemical. This step cleans and passivates the steel and prepares it for the final water treatment. It is a critical step and should not be skipped.

6) **FLUSH**: Drain and flush the system. Spray all the surfaces with fresh water to remove any accumulated dirt. Drain all water and dirt. Remove sludge from the bottom of the tank by hand or with a wet/dry vacuum. Visually inspect the interior of the tank to ascertain that the unit is OK to be filled with clean water.
7) **RE-FILL & WATER TREATMENT**:
   a. Plug the ¾" fittings on the top of the unit if they will not be used. Use of pipe dope or Teflon tape with the plugs to create a water-tight seal.
   b. Partially Fill the Unit: (using a 5 micron filter) to a water depth of approximately 24".
   c. Premix the Water Treatment Chemical: Use gloves and eye/face protection. Add a 1/3 of a pail of water treatment chemical with approximately 3 gallons of *warm* fill/tap water and mix thoroughly in clean 5 gallon pail (follows the same process as the PreCln).
   d. Add the premixed solution of treatment chemical and fill water to the unit.
   e. Fill the unit with an additional 12" to 24" of water and add another premixed solution of water treatment chemical.
   f. Repeat the process of filling, premixing, and treating until the unit is full (4" below the crown at the top of the tank) and the entire water treatment chemical is used.
   g. Run all system pumps for at least four (4) hours to distribute the water and chemicals. Inspect and add filtered, clean water if the water level drops.
8) **HEAT AND CIRCULATE FOR A WEEK**: Circulate the treated water through the entire heating system for a week using the system pumps. During the circulation process, keep the unit hot (around 160°F) by firing it under normal conditions. DO NOT boil the water in the unit.
9) **SAMPLE & TEST**: After a week, use the sample bottle to take another sample and send to PrecisionChem. Collect the test sample according to the instructions with the bottle.
10) **ADD CHEMICAL IF NEEDED**: If the analysis at this time shows that additional chemical is needed and you have already received the maximum amount of chemical (see Table 1: Maximum Initial # of Chemical Pails) then additional chemical will need to be **purchased** from PrecisionChem.
11) **SAMPLE & RE-BALANCE at 6 MONTHS:** After 6 months send in another water sample. PrecisionChem will advise if additional chemical is required to maintain the proper chemical balance. If the analysis at this time shows that additional chemical is needed and you have already received the maximum amount of chemical (see Table 1: Maximum Initial # of Chemical Pails) then additional chemical will need to be **purchased** from PrecisionChem. Test again after one year and continue the process from step 7.

ONGOING WATER TREATMENT PROGRAM

After the initial fill and treatment, participating in the water treatment program requires:

- SAMPLE: Sending a boiler water sample in for testing **twice per year**.
- TESTING AND REPORT: Receiving a test report from the water sample and analyzing the results. Keep records of your testing reports.

- MONITOR AND BALANCE: Purchasing chemical as required from PrecisionChem and maintaining proper water chemistry to protect the GARN unit.

There is a charge for water treatment chemicals after the 1st year but testing is free with continued program participation.

The water in your GARN® unit will be professionally tested twice per year by PrecisionChem Water Treatment to ensure proper and appropriate monitoring. Full participation in the program is vital to the system's protection. Follow the instructions to draw and return a sample to the lab for testing.

SAMPLE: Send a sample of the boiler water to PrecisionChem for analysis. Samples are usually taking from the manway access or from the boiler drain. Collect the sample according to the instructions on the bottle. When drawing a sample, always fully rinse the container twice with the water being sampled before collecting the final sample to be submitted.

Significant accumulation of sludge, "dirty" water, or other observations should be noted when the water samples are sent in. Pictures of any areas of concern also help.

TESTING AND REPORT: PrecisionChem Water Treatment will complete a full analysis of the sample. Results, recommendations, and a new sample kit will be mailed to the owner.

Every water treatment sample is tested for the following: residual chemical concentration for each chemical additive; conductivity; pH; total dissolved solids; total iron; copper; chlorides; nitrite; and the concentration of bacteria (including both iron reducing and sulfur reducing strains) if bacteria tests are positive in the sample. Upon receipt of the test results, adjust the chemical concentration as advised by Precision Chem. Whenever additional water is added to the unit, use a water filter.

MONITOR AND BALANCE: Periodic dosing of additional chemical is to be expected. It may also be required to add other chemicals to remedy specific conditions or problems (i.e. Biocide to kill bacteria following a positive test result for presence of bacteria). These chemical additions will be based on testing and require appropriate and prudent action.

⚠ WARNING **ALWAYS PROVIDE VENTILATION WHEN INSIDE THE TANK & HAVE SOMEONE OUTSIDE THE TANK!**

IF CORROSION IS FOUND...GARN IS FIXABLE - In cases where there has been a gap in testing, followed by a dramatic change in water chemistry and then subsequent corrosion, it has been traced back to: low nitrites, falling total dissolved solids levels, biological growth, poor sample compliance, or sometimes all of these. In most cases the GARN is easily fixable by welding and patching areas of concern or leaking. Fixing, cleaning, and retreatment of the GARN unit remedies the problem in almost all cases.

THE ONLY PREDICTING METHOD WE HAVE IS THE TESTING AND CUSTOMER EDUCATION PERTAINING TO THINGS TO WATCH FOR. HIGHEST ON THE WATCH LIST IS: OVERFIRING (BOILING) THE UNIT; LARGE VOLUMES OF WATER REPLACEMENT; PLUGGING OF SYSTEM STRAINERS AND/OR HEAT EXCHANGERS.

EXAMPLE WATER TESTING SCHEDULE

An example of a water testing schedule is shown below. It is recommended that testing be done at the Start and End of the heating season as that time frame is approximately 5 to 6 months apart (depending on location). It is also a simple way to remember when a water sample must be taken.

Water Treatment Schedule						
	Example	Year 1	Year 2	Year 3	Year 4	Year 5
Sample Sent - **Start** of Heating Season	Yes - 10/1/2012					
Sample Lab Report Received	Yes - 10/20/2012					
Sample Sent - **End** of Heating Season	Yes - 4/15/2013					
Sample Lab Report Received	Yes - 4/30/2013					

CORROSION – WHO'S RESPONSIBLE?

NOTICE **CORROSION PROTECTION IS THE SOLE RESPONSIBILITY OF THE OWNER. THERE IS *NO WARRANTY REGARDING CORROSION* OR CORROSION INDUCED FAILURES OF ANY COMPONENT OF GARN® WHS, ETS OR WHS/ETS EQUIPMENT OR ANY COMPONENTS ATTACHED TO THE GARN® EQUIPMENT.**

GARN® equipment has always been fabricated from quality materials, and using quality methods that inherently reduce corrosion potential. Once delivered, the manufacturer is not able to control the installation, the quality of the fill water, the chemicals added to reduce corrosion potential or the level or frequency of ongoing chemical testing and maintenance. It is strongly suggested that you (the owner/operator) become a proactive participant in the protection of your investment and fully use the water treatment program.

CAUTION **DO NOT ADD OXYGEN SCAVENGING CHEMICAL COMPOUNDS (such as, sodium sulfite, sulfite, meta sulfite, bisulfite).** These materials are inappropriate for GARN® WHS equipment and will result in corrosive conditions and early tank failure.

CAUTION **DO NOT ADD BLEACH OR ANY CHLORINE/BROMINE BASED PRODUCTS TO THE SYSTEM TO ACT AS A BIOCIDE.** The addition of these products will result in severe and quick corrosion problems.

CAUTION If the distribution system requires anti-freeze, the distribution system MUST be isolated from the GARN WHS heat storage water with a flat plate or equal heat exchanger.

CAUTION REFER TO CHEMICAL MSDS FOR INSTRUCTIONS ON HOW TO SAFETLY HANDLE THE PRECLN AND WATER TREATMENT CHEMICALS (available on www.GARN.com).

NOTES ON PREVENTING CORROSION, COMMON TYPES OF CORROSION, AND WATER QUALITY

PROPER CONNECTIONS AND GROUNDING

Properly ground the GARN® WHS unit to avoid electrolytic corrosion due to a "floating ground." The National Electric Code requires the utilization of a dedicated, green electrical ground wire when connecting the unit to the service panel ground. An additional driven ground rod may be required to help establish proper grounding; your licensed electrician can advise you on this.

Do not install a copper, domestic water-heating coil within the tank as this may cause corrosion of the steel shell. Attach only non-galvanized, black steel pipe to the GARN® unit. Maintain 4' to 6' of non-galvanized, black steel pipe between the GARN® unit and any copper pipe. Install dielectric couplings where copper pipe connects to steel pipe. All piping should be flushed with the GARN® unit when the pre-clean is being done.

WATER POLLUTION FROM RURAL WELLS

Generally, GARN® equipment is filled with water from a local, rural well. The pH level and the amount of iron, hardness, suspended particulates, dissolved chemicals, organics, etc. vary greatly in "normal" water. During the past couple of decades, national surveys have shown a significant increase in the number of polluted rural wells. As a result, it has become obvious that corrosion is a complicated issue requiring professional attention and ongoing owner maintenance.

POLYPHOSPHATES AND GARN FILL WATER

WARNING **DO NOT FILL YOU GARN UNIT WITH WATER THAT CONTAINS POLYPHOSPHATES. EARLY TANK FAILURE WILL OCCUR.** Contact your local water department if you are filling your unit with water from a central water system (not a personal well).

The well water in some areas may contain high levels of dissolved and/or suspended iron. A town's public works department has two options in order to prevent iron damage and discoloration of household faucets, tubs, etc for their customers:

- Remove the suspended iron by using a central treatment/filtration system before distribution.
- Add *Polyphosphate* chemicals to "suspend" the iron so it simply passes thru the system without settling on or coating surfaces.

In some circumstances, the town elects to use the polyphosphate additives to "suspend" the iron. Filling a GARN unit with water containing polyphosphates will lead to serious corrosion issues. When water containing polyphosphates is heated above approximately 140°F, the iron that is being held in suspension will settle out creating a thick layer of sludge on the bottom of the GARN unit. As a result, under deposit corrosion will rapidly develop and lead to early tank failure.

If your GARN fill water is to be taken from a central water system (not a personal well), ALWAYS contact the local water department and ask how iron issues are mitigated. If polyphosphates or other "suspension agents" are used **DO NOT** use that fill water. Find another source of water.

COMMON TYPES OF BOILER CORROSION:

GENERAL SURFACE CORROSION - this is similar to the rust you would find on bare steel that has been outdoors for a period of time. Surface rust without pits is not critical. Monitor over time and note any abnormal changes.

UNDER DEPOSIT CORROSION - occurs where water treatment chemicals are not able to directly contact steel. This will occur under sludge that may form on the floor of the tank or other horizontal surfaces. Note any corrosion and wire brush or sand blast to bare steel.

BACTERIOLOGICAL CORROSION - occurs when a bacteria is introduced into the tank water. As the tank water expands and contracts with heat, it "breathes", drawing air into the tank as the water cools and pushing air out as the water expands. This *breathing* can draw in bacteria from the air (sources of airborne bacteria include: animal confinement buildings, agricultural waste, and industrial chemical processing).

Bacteriological corrosion is highly unpredictable; however, once active it can corrode through a tank in a few months. Bacteria that cause corrosion can be common in rural water wells. Visual inspection, periodic testing and periodic cleaning coupled with ongoing chemical treatment is one of the most effective methods for bacteriological corrosion prevention.

If bacteria are found to be present in the GARN® unit, biocide agents can be ordered and used in conjunction with the normal water treatment program.

BLISTERS OVER PITS - is pitting type corrosion and it is not always apparent what causes this to occur at a particular location. Note any corrosion and wire brush or sand blast to bare steel.

GALVANIC CORROSION/ELECTROLYSIS - results from a "noble" metal (i.e. copper, bronze, brass, etc.) in close proximity to steel (a sacrificial material). It can also result from improperly grounded/isolated equipment or an improperly grounded electrical service to a building. No water treatment can prevent this form of corrosion. Connect only non-galvanized steel pipe to GARN® WHS and ETS units, and install dielectric couplings where copper pipe connects to steel pipe. For further discussion see "_____"

APPEARANCE OF CORROSION

Blisters formed by bacteriological action will have either: a shiny, dime color or charcoal color underneath, with a slimy substance within the blister. Oxygen pits are characterized by a black powder inside a blister. Corrosion underneath sludge may be of either type. Shiny dime colored pitting (especially in the vicinity of a tank seam or pipe fitting) is generally electrolysis.

MAINTENANCE PROCEDURES TO MINIMIZE CORROSION POTENTIAL

Water treatment chemicals are consumed in the process of providing corrosion protection. The bottom of the GARN unit should be visible through the full water depth in the tank. One of the major features of GARN is the manway access on the top of the tank. Its benefit is the ease with which the thermal storage tank can be inspected and repaired if necessary.

1. Examine the water in the GARN unit several times per year. If clarity changes, deposits or corrosion is noticed, take a water sample (and/or a deposit sample) and forward it to the water treatment company. Upon receipt of the test results, adjust the chemical concentration as advised by the water treatment company.
2. At the end of each heating season, "top the tank off". Whenever additional water is added to the unit, utilize the water filter provided so that sediment is not carried into the system. Add water treatment chemicals (based upon the volume of water added).
3. Add the recommended biocide at the following times: whenever makeup water is added to the unit; a few days before the end of the heating season; and at the beginning and/or middle of the heating season. Dusty or dirty locations require more frequent biocide additions to minimize sludge build-up and under-deposit corrosion potential.
4. Draw two samples of the treated water per year and send them to the water treatment company for testing and analysis. Upon receipt of the test results, adjust the chemical concentration as advised by the water treatment company.
5. Every 3 to 5 years drain your GARN unit and heating system. Check with local officials to ascertain the safety of draining the treated water onto the ground or into a city sewer system. Do not drain hot water (allow it to cool to 75 F or lower) or water recently treated with biocide (within the last 4 to 6 months). Do not drain the GARN water into a septic system (it will overload the system and possibly destroy it). Prevent animals from drinking the water; simply allow it to be absorbed by the soil. Before draining the unit, draw a treated water sample and set it aside (for testing if required).

   Flush the tank with clean water. Like the cooling system of a car, all chemical suppliers recommend a periodic flushing of the system. Hose down the entire inside of the tank. Flush out any and all sludge that has accumulated in the bottom of the tank. All dirt and sludge must be removed.

   Inspect the cleaned tank. This simple visual inspection is more informative than hundreds of lab tests. Look for and identify any type of corrosion. Save samples of any sludge and corrosion residuals. Forward the water sample, sludge sample and corrosion residual sample to the water treatment company. Upon receipt of the test results, adjust the chemical concentration as advised during refilling. If corrosion spots are found, clean the spots thoroughly by wire brushing and flush the areas with clean water.

6. Refill the GARN unit in compliance with Initial Water Treatment Procedures. Obtain a treated water sample from the manway access and forward it to the water treatment company for an

initial chemical test. Use good sampling procedures when obtaining the sample. Upon receipt of the test results, adjust the chemical concentration as advised.

E. ELECTRIC ISOLATION AND PROPER GROUNDING TO PREVENT ELECTROLYSIS CORROSION

During the fall of 2015, research was completed that showed proper electrical isolation is critical for preventing undirected current corrosion in a GARN® installations. Up until that point, anode rods were supplied with GARN units because they were a simple solution to deal with the possibility of undirected current corrosion. This technique is known as *passive cathodic protection*. But anode rods meeting specifications for use in GARN units are no longer available, so such as solution is no longer possible. **The approach now being taken is to electrically isolate the GARN unit from any ground path. This is done by evaluating various ground pathways and ensuring that the GARN unit is not electrically connected to such pathways.**

UNDIRECTED CURRENT - TERMINOLOGY:

The terms *stray voltage*, *electrolysis, and undirected current* all describe the same concept in the context of a GARN unit. We will use the term *undirected current* because we believe it is the most accurate term. Undirected current is electric current that inappropriately "leaks" through the GARN unit to an electrical ground.

CORROSION FROM UNDIRECTED CURRENT:

All corrosion occurs by an oxidation process. An oxidation process involves the movement of electrons between chemical elements. Electric current is a measurement of the amount of moving electrons. Therefore, corrosion and electric current are fundamentally linked together.

Undirected current can amplify corrosive effects of galvanic corrosion or it can, by itself, generate corrosive effects, both of which can affect a GARN unit. In almost all cases, if undirected current affects an installation, diagnosis and troubleshooting by a qualified electrician is generally required to find the root cause and correct it.

PROTECTION METHODS (OPTIONS FOR PROTECTION):

There are two options available to accomplish undirected current protection in a GARN unit:

1. **FULL ISOLATION (RECOMMENDED)**: Electrically isolate the GARN unit from any wired ground path. That means that the GARN tank will not be electrically connected to any wired device that is connected to power or to ground.

------- OR -------

2. **SINGLE POINT GROUNDING**: Have a single ground point for all wired electrical devices in electrical contact with the GARN unit.

Our recommend solution is *full electric isolation* (Option 1). But, depending on the installation, full electric isolation may be difficult or impossible to implement, so *single point grounding* (Option 2) may be the most reasonable approach.

FOR EXISTING CUSTOMERS:

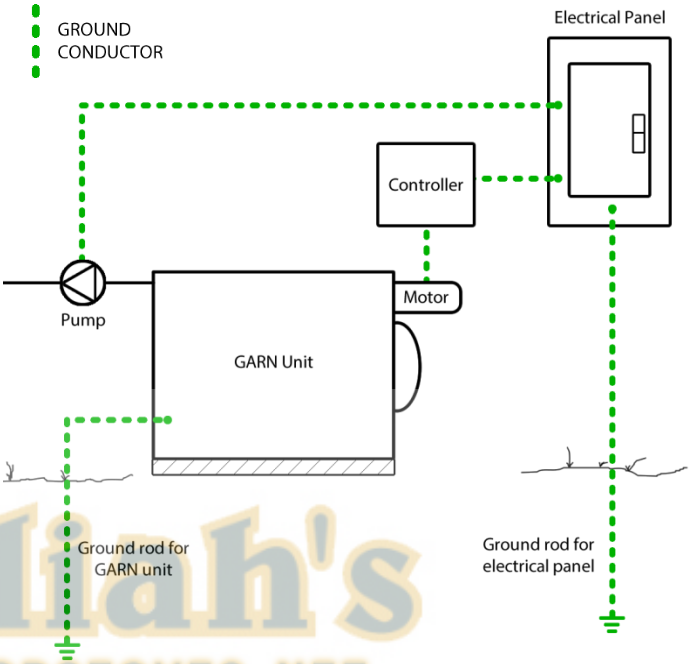
- Assess the overall condition of the GARN tank. Remove any rod debris from previous anode rods, sludge, and/or sluff build-up on the bottom of the tank. If there is build-up that cannot be easily removed while the tank is filled (in service), now is a good time to drain the unit, clean it, and refill it with fresh water and chemical.
- Electrically isolate the tank following the steps outlined in the following sections.

FOR NEW CUSTOMERS:

- Anode rods will no longer be supplied with a GARN unit. Electric isolation is required as part of installation. Follow the steps in the following sections.

ELECTRIC ISOLATION:

The following diagram shows a typical GARN installation with no electrical isolation and two separate ground paths: one through the electrical panel, and one through the independent ground rod of the GARN unit (typical setup for customers prior to fall 2015). In the following instructions, we will build off of this diagram for explanation and illustration.



All electrical work must be completed by a licensed electrician in compliance with all Federal, State, and local codes.

IF ELECTRIC HEATING ELEMENTS ARE INSTALLED:

When electric heating elements are installed, single point grounding must be used, but specific grounding procedures must be followed. Skip to the appropriate section.

LOW VOLTAGE SENSORS:

Low voltage sensors do not need isolation accommodations as these sensors are almost universally ground isolated due to their inherent signal sensitivity.

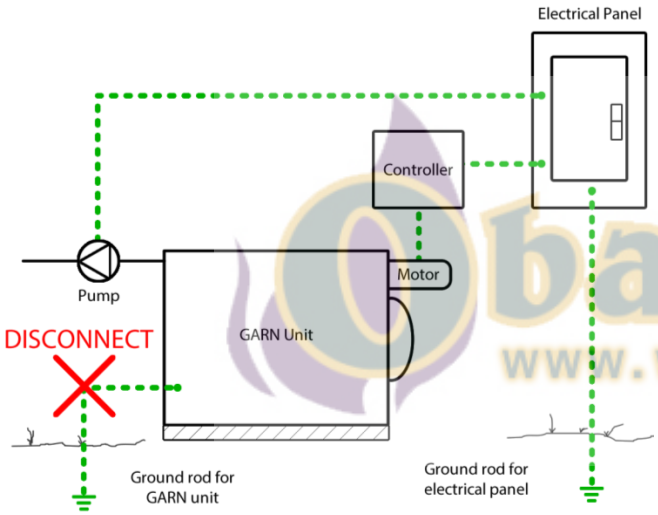
AIR INTAKE DAMPER:

The combustion air intake damper uses a brushless 24VAC motor. It is also a 2-wire motor with no ground wire. Because of these two items, the motor and casing is effectively isolated from the controller and GARN unit.

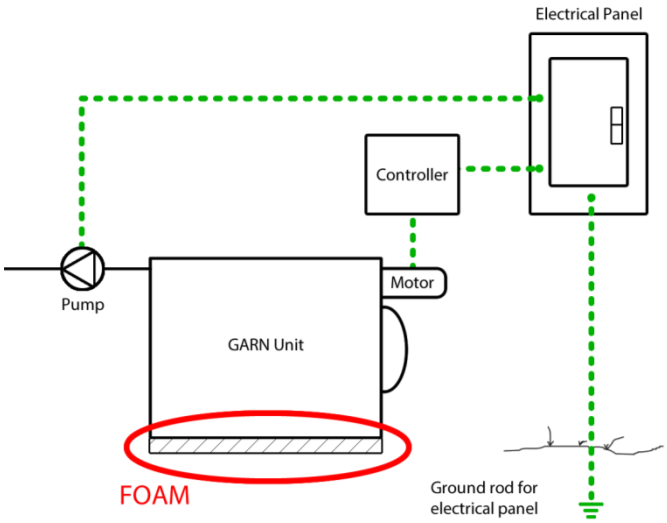
UNITS WITHOUT ELECTRIC HEATING ELEMENTS:

FULL ISOLATION (OPTION 1)

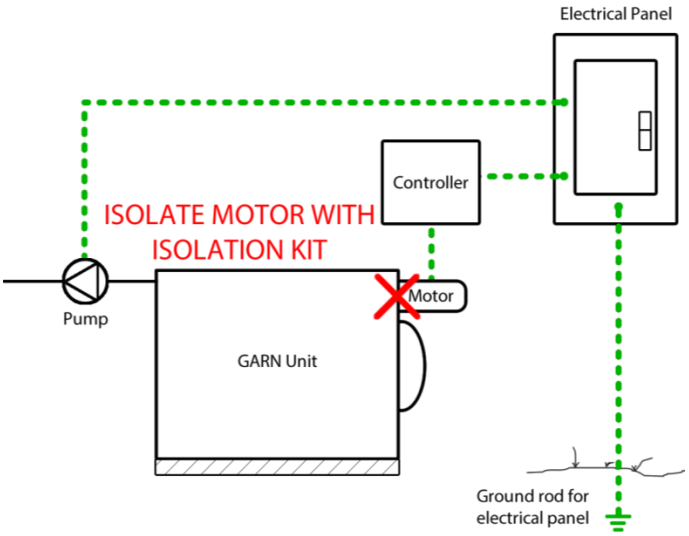
1. DO NOT connect an independent ground rod to the GARN unit:



2. Check to ensure that the unit is set on foam:



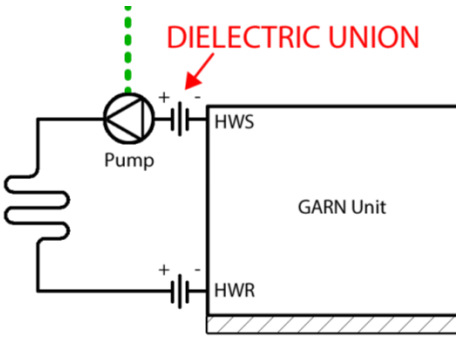
3. Isolate the blower motor with a blower motor isolation kit: (Part #: P-0125 on www.garnparts.com). Installation instructions for the isolation kit can be found on _____.



4. Dielectrically isolate any pumps directly connected to the GARN unit:

A pump is dielectrically isolated if there is a means that breaks the metal-to-metal contact between the pump housing itself and the GARN unit. Examples of di-electric isolation include: dielectric unions, any length of PEX, or isolation valve flanges attached directly to the pump (such as Grundfos dielectric isolation valves).

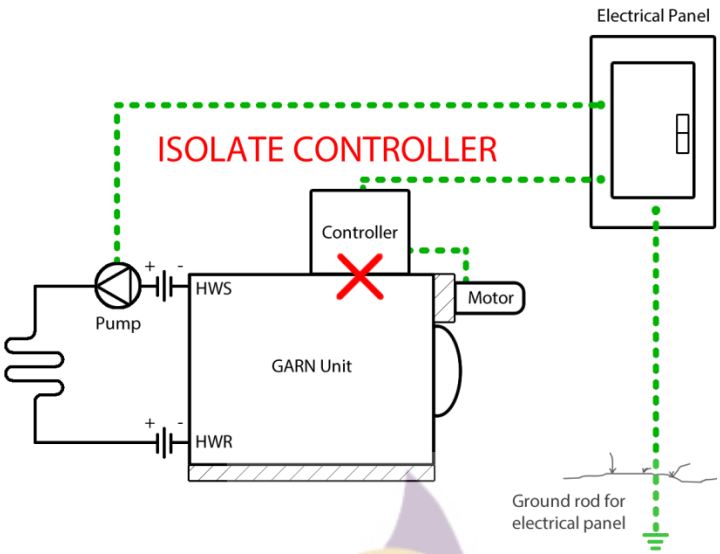
The following picture shows a pump that is dielectrically isolated from the GARN unit:



By installing dieletric unions (or equivalent) on or near the Hot Water Supply (HWS) and Hot Water Return (HWR) connections of the GARN unit, electric isolation is achieved for any and all components connected downstream.

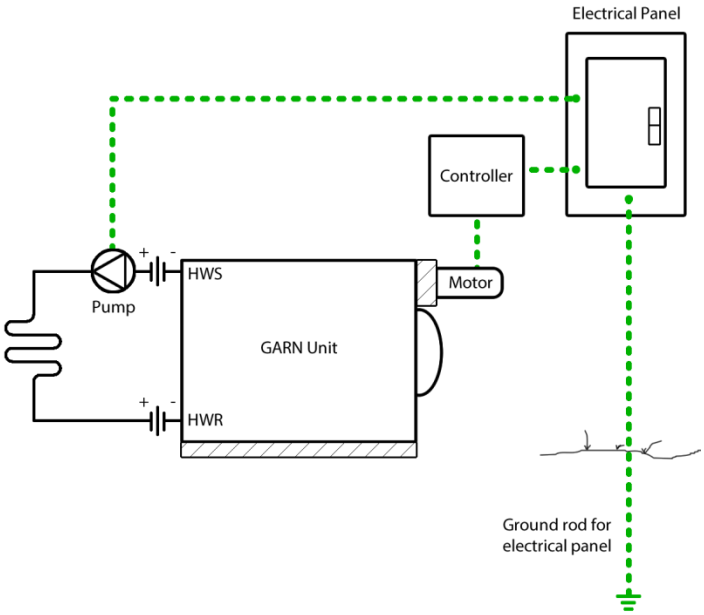
5. Isolate the controller:

In some installations, the controller may be directly screwed into steel studs. The steel studs may then be in direct contact with the GARN unit. In such a situation, the housing of the controller is effectively a ground path to the tank.



A simple solution to isolate the controller is to remove the controller from its steel stud mounting, screw a piece of plywood into the steel studs, then mount the controller to the plywood. Make sure the controller mounting screws are not in contact with the steel studs. Plywood is an effective electric isolator.

6. Isolation is now complete, and the schematic of how the installation should look is:

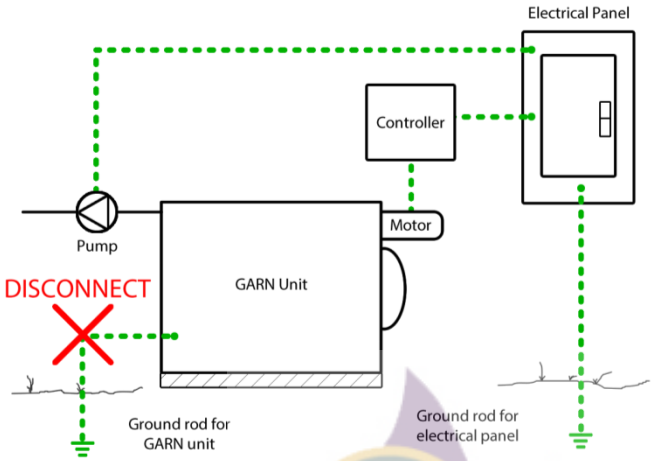


The GARN unit is now fully electrically isolated. Anode rods are not needed. If the installation changes over time and other electrical devices are installed on or near the GARN unit that are wired to ground, keep these concepts in mind and isolate appropriately.

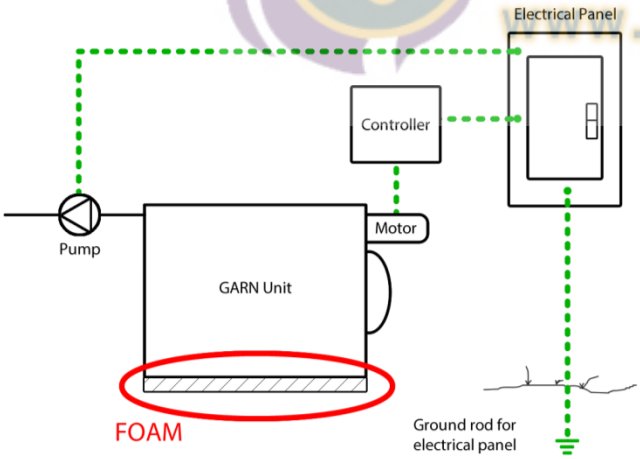
UNITS WITHOUT ELECTRIC HEATING ELEMENTS:

SINGLE POINT GROUNDING (OPTION 2):

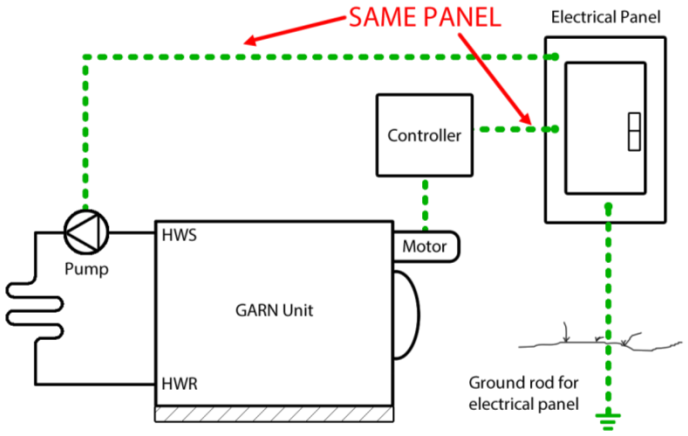
1. DO NOT connect an independent ground rod to the GARN unit:



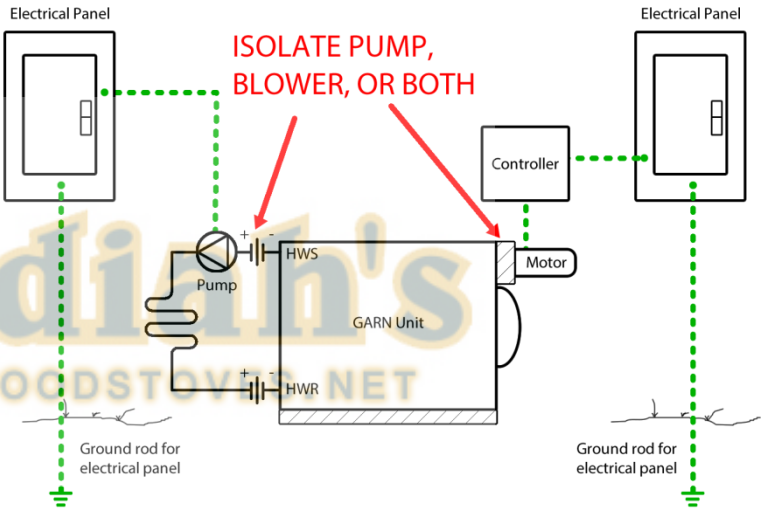
2. Check to ensure that the unit is set on foam:



3. Check to ensure that the blower motor and **ANY** pump that **IS NOT** dielectrically isolated from the GARN unit is wired to the same electrical panel:



4. If a pump connected directly to the GARN unit is wired to a different panel, then the pump **OR** blower motor **or both** must be electrically isolated:



Isolate the blower motor with a blower motor isolation kit: (Part #: P-0125 on www.garnparts.com). Installation instructions for the isolation kit can be found on _____.

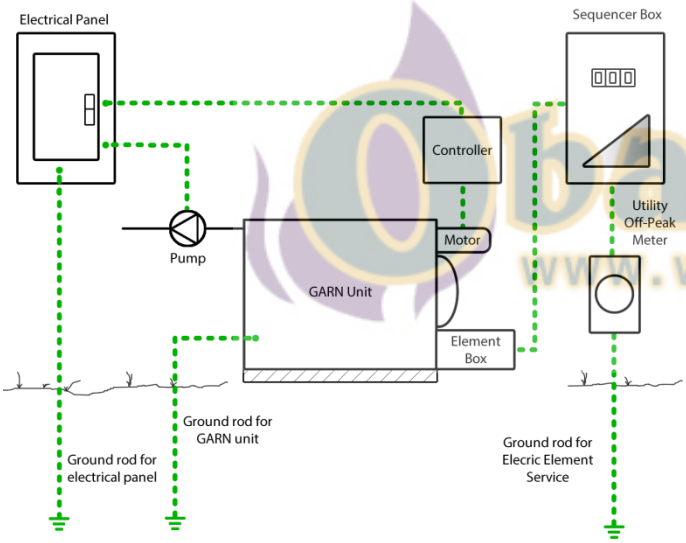
A pump is dielectrically isolated if there is a means that breaks the metal-to-metal contact between the pump housing itself and the GARN unit. Examples of di-electric isolation include: dielectric unions, any length of PEX, or isolation valve flanges attached directly to the pump (such as Grundfos dielectric isolation valves).

5. Single point grounding is now complete. All ground pathways in contact with the GARN unit should now be wired to the same panel, and, ultimately, the same ground.

UNITS WITH ELECTRIC HEATING ELEMENTS:

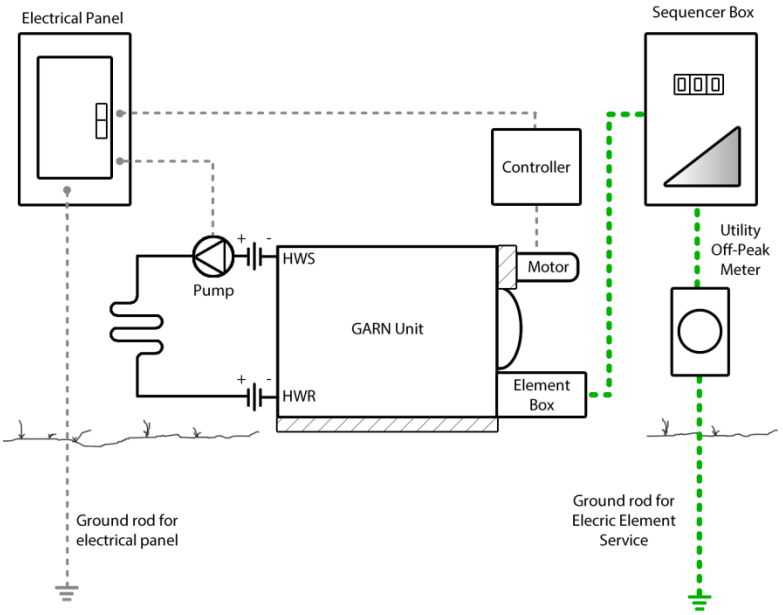
Units with electric elements CANNOT be fully electrically isolated (per the National Electric Code). The solution is then to ground to a single point. But the single point ground must run through the panel providing power for the electric elements.

The following diagram shows a typical GARN installation with electric heating elements, no electrical isolation and potentially three separate ground paths: one through the electrical panel feeding the pump and controller, one through the independent ground rod of the GARN unit, and one through the electric element sequencer.

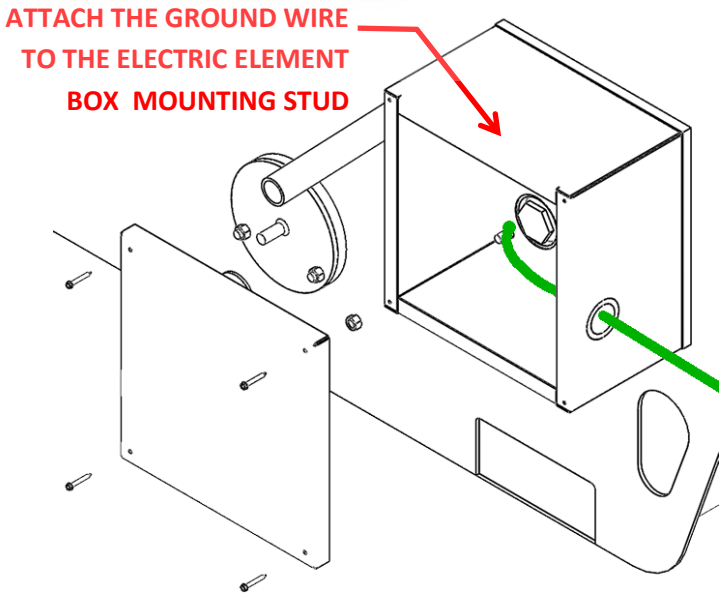


The goal is to build to a single-ground point through the element box, the sequencer box, and ultimately the ground rod associated with the electric heating element service. To do this:

1. Follow the steps in the FULL ISOLATION (OPTION 1) section.
2. After completing the full isolation steps, the installation should now look like the following figure. The only ground connection should be through the sequencer box.

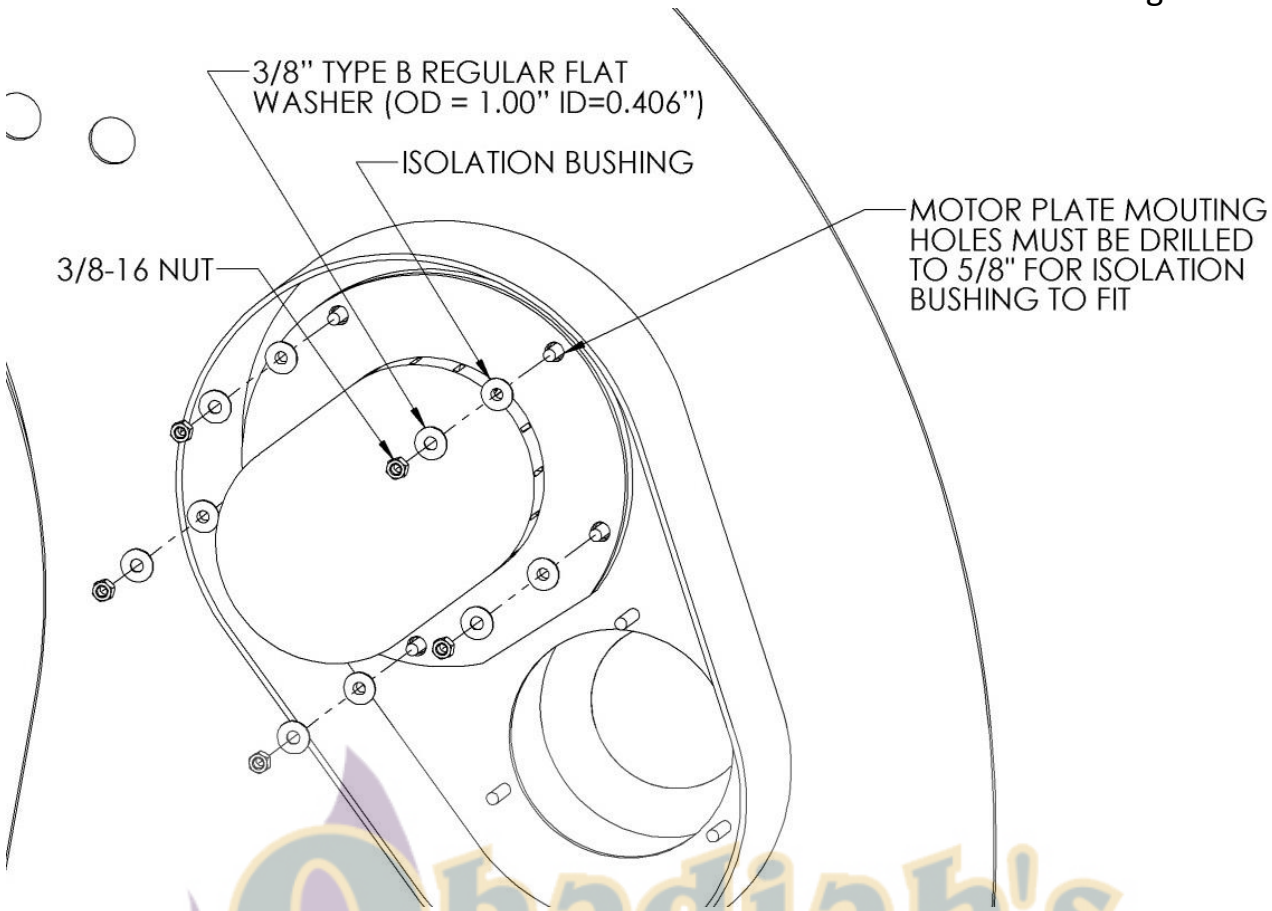


3. Ensure that the unit is grounded through the element box by attaching the ground wire to one of the studs in the electric element box. The ground wire must ultimately run back to ground of the meter/panel supplying power to the electric elements.



4. Single-point grounding with electric heating elements is now complete.

GARN® WHS: Installation Instructions for Blower Motor Electric Isolation Bushings



MOTOR ISOLATION BUSHINGS INSTALLATION:

The isolation bushings are designed to prevent undirected current from reaching the storage tank.

The blower motor's housing is electrically grounded through the motor power cord, and the motor's housing is also directly connected to the steel tank through the mounting studs. Electric current has the potential to find its way from the building's electrical panel through the motor housing and into the tank. As a result, undirected current is possible. Undirected current can increase the effect of galvanic corrosion or directly cause corrosion. Using the isolation bushings will eliminate the motor as a undirected current source and may help to extend the life of the steel tank. The isolation bushings are made from an electrically none-conductive, high-temperature Nylon plastic.

Install the isolation bushings as shown above:

1. Remove the motor and blower assembly.
2. Drill out all of the motor plate mounting holes with a 5/8" drill bit.
3. Test fit all of the isolation bushing into the newly drilled holes. Ensure that they all fit. They will be loose, which is fine. The loose fit helps compensate for any dimensional tolerance in the stud spacing.
4. Test fit the plate with the bushings onto the studs (if the plate was removed in Step 1 or 2). If the assembly is hard to fit on the studs, evaluate and drill any problem holes out with the next larger drill bit.
5. Reinstall the motor assembly onto the studs.
6. Install the flat washers and nuts.

F. OPERATION

STARTING A FIRE

1) CHECK CONDITION OF THE UNIT

A single full load of hardwood will raise the thermal storage temperature approximately 20°F to 40°F (assuming no heat draw). If the unit is at 170° F or less, then you may proceed as follows. Judge your fuel loads so that you do not boil the unit as this wastes fuel, degrades your chemical water treatment and can exacerbate corrosion.

- Turn the On/Off Power Switch to the "On" position to power up the controller.
- Place the Wood Electric Selector Switch in the "Wood" position. Electric backup heat will be locked out with the switch in this position.
- Hold the "START" button for 5 seconds to ensure blower is working. If working normally, turn the Controller to OFF/ON to reset it.

2) IF THERE ARE NO COALS, ADD NEWSPAPER AND KINDLING

Place 3 to 8 sheets of crumbled newspaper on the firebrick slightly towards the rear of the combustion chamber.

- Confirm that the newspaper is tucked firmly under the fuel load. Paper can be sucked into the reaction chamber and flue when the door is closed if not secured. In some cases a few remaining coals provide sufficient heat to ignite a fire.
- Place 1 to 3 lbs of dry kindling (small branches, ¼" to 1" in diameter) on top of the newspaper.

3) LOAD SEASONED FIREWOOD

Use one-year dry cordwood (18 to 28% moisture content), 16" to 32" long and 3" to 7" in diameter. Wood 8"to 12" in diameter should be split once, larger than 12" split twice.

- Load 145 to 160 lbs of hardwood centered in the combustion chamber front to back, max length of 32". If using 16" material place end to end, but do not exceed 32" (this allows approximately 4" clearance to the front and back of the combustion chamber). The chamber can be almost packed full.
- If using softwood, the total weight of wood will be less due to the lower density of the softwood and reloading after 1.5 hours may be required.
- Load all wood carefully or damage to the reaction chamber may occur.

4) LIGHT FIRE AND START BLOWER

- Light the paper with a match and watch for a few seconds to confirm that the paper has ignited.
- Push and hold the "Start" button for 5 seconds, then close the door. This activates and locks the combustion blower on for 10 minutes. This time lock is a preset factory setting.
- The Controller will turn the draft inducer off once the wood has been consumed

5) MONITOR COMBUSTION AND RELOAD

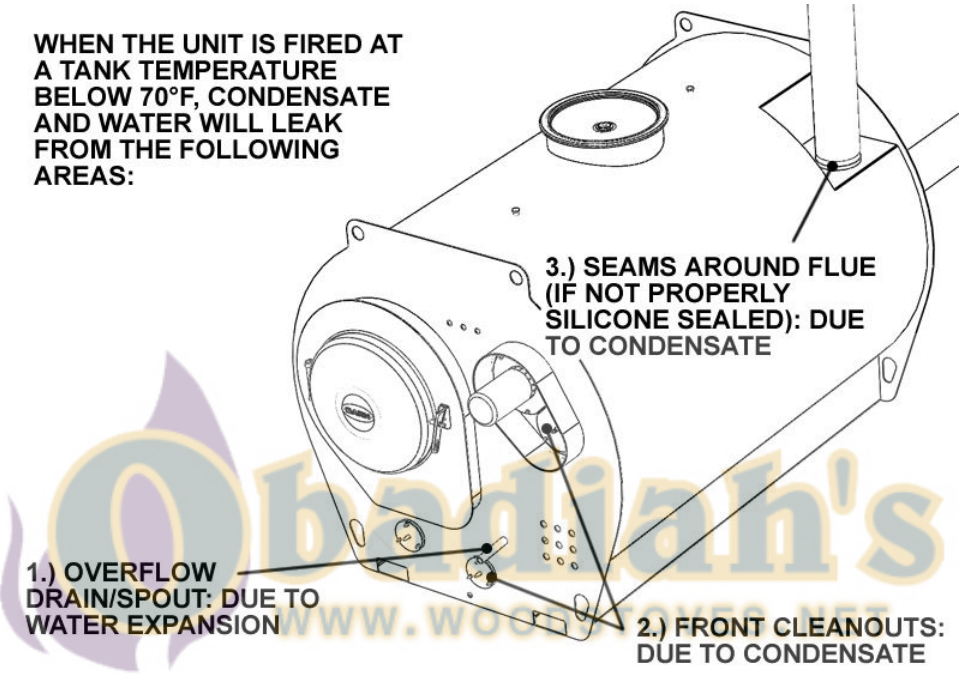
- Open the door to adjust the fuel pile for complete combustion….OR
- Open the door to reload if the storage temperature has not reached 185°F. A full load of dry cordwood burns completely in about 3 hours. You can load additional fuel before the fire is out and continue to burn. Watch the tank temperature, being careful not to continue adding wood if the temperature approaches 185°F. Never exceed 200°F or boiling.
- The above procedure should take about 5 minutes. The GARN® WHS equipment is not to be used with any automatic fuel-loading device.

Managing your firing temperature to match your required heating load and outdoor temperature will significantly improve your wood consumption. With experience you will determine the lowest water temperature required to satisfy your needs during cold weather and establish that as your target "high" temperature. During the much longer shoulder season you will be able to lower your target high temperature resulting in fuel savings.

⚠ CAUTION **THE EXTERIOR DOOR AND AIR COLLAR SURFACES MAY BECOME HOT ENOUGH TO CAUSE BURNS.** The hot surfaces inside of the door and combustion chamber WILL cause burns.

CONDENSATION LEAK POINTS DURING COLD FIRING

NOTICE When firing your GARN® with a tank temperature below 70°F, condensate water may leak out of the upper cleanout and/or flue. Water may also leak from the overflow pipe due to thermal expansion. Both are normal. It is STRONGLY suggested to perform the first two cold firings before the unit is insulated or enclosed. Otherwise, build in accommodations for dealing with condensation when performing a cold firing. Damage or staining of sheetrock may occur otherwise.



OVERVIEW OF THE DIGITAL CONTROLLER

BUTTONS AND SWITCHES:

CONTROL	FUNCTION
"On/off" power switch	Turns controller on or off
"Wood or Wood/ Electric" selector switch	Select between wood only operation or wood with electric backup
"Start" button	Activates the combustion blower
"View" button	Switch between the various sensor temperatures on digital readout
"Back Light" slide switch	Illuminates the digital readout for better visibility in low light

LED INDICATOR LIGHTS:

LIGHT	MEANING	SOLUTION
"Red"	Low water level. Neither combustion blower or electric backup will activate	Fill unit until water level is higher than low water cut-off switch.
"Green"	Controller is on and water level is ok	

DIGITAL READOUT:

TOP LINE: displays one of five temperatures. The "View" button cycles through the different temperatures.

TOP LINE DISPLAY TEXT	TEMPERATURE RANGE
Tank Temperature (TST)	35°F to 212°F
Flue Gas Temperature (FGT)	80°F to 1800°F
Hot Water Supply Temperature (HWS)	35°F to 210°F
Hot Water Return Temperature (HWR)	35°F to 210°F
Outdoor Temperature (OT)	Minus 35°F to 210°F

LOWER LINE: displays operational mode, alarms, and burn time.

<table>
<tr><th>LOWER LINE DISPLAY TEXT</th><th colspan="2">MEANING</th></tr>
<tr><td>"DAMPR OPENING"</td><td colspan="2">This will display only if you have the motorized air intake damper installed. When it displays, a countdown will start at 60 seconds. The damper will begin to open. When the damper finishes opening and contacts its end switch, the message will disappear and the blower motor will start.</td></tr>
<tr><td>"SENSOR"</td><td colspan="2">A sensor reading is an indication that a sensor is not wired properly, has a bad connection at the terminal block, has a broken wire, or a sensor itself is bad.

Cycle through the different sensors using the "View" button. Pause at each one of the sensor readings. The failed sensor's reading will flash and indicate a default code from the table below:
<table>
<tr><th>SENSOR</th><th>DEFAULT CODE</th></tr>
<tr><td>OUTDOOR</td><td>-40 °F</td></tr>
<tr><td>TANK</td><td>00 °F</td></tr>
<tr><td>W. SUPPLY</td><td>00 °F</td></tr>
<tr><td>W. RTURN</td><td>00 °F</td></tr>
<tr><td>FLUE</td><td>0000 °F</td></tr>
</table></td></tr>
</table>

OPERATIONAL SAFETY GUIDE

NOTICE **DO NOT OVERFIRE**. If steam discharges from the overflow pipe or manway cover – you are over firing. Higher temperatures significantly increase water loss and can exacerbate corrosion.

⚠ CAUTION **DO NOT OPEN THE LOADING DOOR IF THE BLOWER STOPS OPERATING DURING A BURN.** Opening the loading door allows smoke to enter the room. Ventilate the space immediately if the smell of wood smoke is strong.

⚠ DANGER **RISK OF FIRE OR EXPLOSION: DO NOT BURN GARBAGE, GASOLINE, OIL IN ANY FORM OR OTHER FLAMMABLE LIQUID.**

⚠ CAUTION **DO NOT BURN TRASH, PLASTICS, HOUSEHOLD GARBAGE, MATERIAL TREATED WITH PETROLEUM PRODUCTS (PRESSURE TREATED WOOD, RAILROAD TIES, PARTICLE BOARD, ETC), LEAVES, PAPER PRODUCTS, CARDBOARD.**

⚠ WARNING **DO NOT USE LIGHTER FLUIDS, GASOLINE, NAPTHA, OIL, OR ANY OTHER LIQUID FUEL TO START A FIRE.** DO NOT OPERATE with the fuel loading door open. DO NOT OPEN the fuel-loading door if a flammable gas is present.

APPROVED FUELS

Seasoned Cord Wood: Firewood that has been cut, split and dried for one year is best. Wood cut 24" to 32" long x 6" diameter is considered best. Longer lengths should be cut and larger diameter logs should be split. Load the woodpile toward the rear of the combustion chamber to allow airflow. Any type of stick woods; i.e. oak, birch, poplar, pine, etc. is very acceptable. Dry wood at 15 to 20% moisture content contains 6880 BTU's per pound.

Briquettes: Briquettes consist of wood scrap that has been highly densified (without adhesives) into small 3" diameter "logs" that are 3" to 8" long. Because of the high cost to set up a facility, briquettes are usually the by-product of a large wood products company (furniture, door and window trim, etc). They are usually sold in 70 lb paper bags, like dog food. Load the bag and contents into the combustion chamber, ignite the bag and shut the door.

Clean Scrap Wood: This may be waste from construction sites, truss-manufacturing facilities, pallet recycling facilities, etc. This fuel is usually very dry and bark free. Cut it to 24" to 32" lengths and stack it neatly in the combustion chamber. Because scrap wood fuel has a high surface to volume ratio and is dry, puffing may occur. Stack the wood tight (to reduce exposed surface area) and use a primary air control brick.

⚠ WARNING **DO NOT BURN PAINTED OR PRESSURE TREATED WOOD.**

OPERATION AT HIGHER ALTITUDES

When heating equipment is installed at higher altitudes, its rated output will decrease due to a decrease in the density of air at the higher altitude.

For each 1000 ft of elevation above sea level, the output of the GARN® WHS unit will decrease 4% from its published value. For instance, the GARN® WHS 1500 with a rating of 250,000 BTUH installed at 5000 ft above sea level with only output 200,000 BTUH (20% less than the published value). In addition, the maximum allowable storage temperature will be lower:

Elevation (feet)	Maximum Storage Temp (°F)	Boiling Point (°F)
0	200	212
1000	198	210
2000	196	208
3000	194	206
4000	192	204
5000	190	202
6000	188	200
7000	186	198

G. MAINTENANCE

Periodic inspection and maintenance is required on all mechanical and electrical equipment in order to keep machinery operating safely and efficiently. For instance, cars require periodic: oil changes; replacement brake pads, radiator flushes; tire replacements; spark plug replacements; etc. The same is true for GARN® WHS equipment. This section describes the periodic maintenance that is required to keep your unit in top shape, operating safely and efficiently.

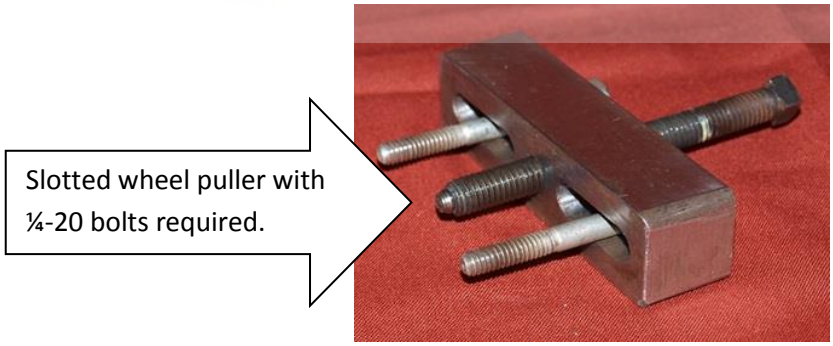
Blower Wheel Gasket/Wheel Replacement & Removal (as necessary):

The blower wheel must be removed in order to:

- Replace a damaged wheel
- Replace a non-operable or damaged motor
- Replace a worn or damaged motor mount gasket
- Clean an out-of-balance wheel

Tools required:

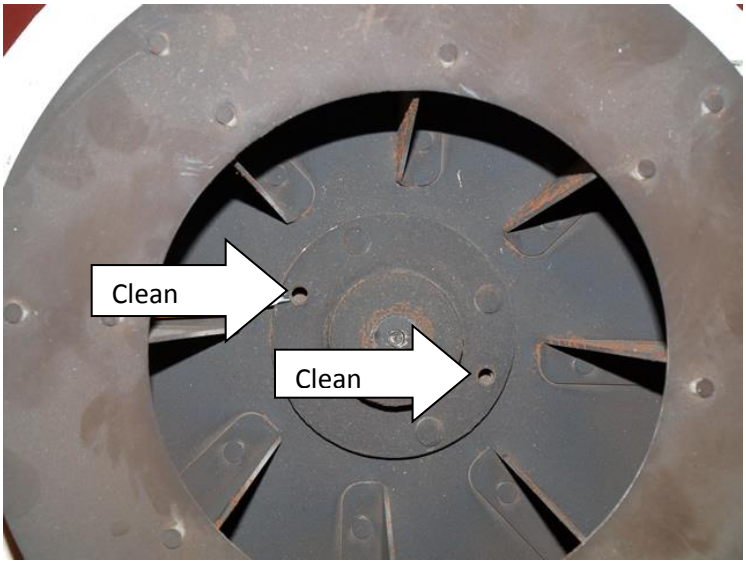
- Slotted wheel/hub/gear puller
- 3/8" drive socket with 5/32" Allen
- Penetrating lubricant (WD-40)
- Crescent/Adjustable wrench
- ¼-20 tap and t-handle tap wrench.
- Hi temperature anti-seize lubricant (Nickel-Graphite is typical)



A properly sized wheel puller MUST be used to remove the blower wheel. DO NOT attempt to remove the blower wheel by prying on the wheel rim or hub as damage will result. The GARN® blower wheels are dynamically balanced for 3450 RPM and distortion of the rim will cause significant vibration resulting in early blower motor bearing failure.

1. Unplug the motor and remove the motor/blower assembly.
2. Set the assembly "wheel up" on a flat surface; stabilize it to prevent tip over.
3. Apply penetrating oil to the 2 set screws located in the hub and to the end of the motor shaft.

4. Loosen the two set screws with an Allen wrench.
5. Using the ¼-20 tap *carefully* clean the two threaded holes in the hub.



6. Blow out the loose material from the holes.
7. Align the wheel puller over the hub and screw the two ¼-20 hex bolts into the two threaded holes. Be sure the bolts extend into the hub *at least* ¼".
8. Snug the center bolt tight.

9. Gently holding the wheel, tighten the center screw. The wheel should slide off the motor shaft. Be careful not to drop the wheel as it disengages from the shaft. Also do not lose the square steel key. The wheel and hub can now be cleaned using a degreaser. Rinse and set the wheel aside.
10. Remove the motor gasket and clean the mounting plate. Replace the gasket and/or the motor, as required.
11. Clean the motor shaft and apply a hi-temp anti seize compound to the shaft and internal bore of the hub.

12. Reinstall the blower assembly according to the "Induced Draft Face Mounted Blower Assembly" section of this manual.

Ash Removal: (frequently)

Remove excess ash from the combustion chamber as needed. Ash should never be allowed to cover the primary air inlet nozzle located at the lower front of the combustion chamber under the loading door. Nor should the ash slope up to the level of the bottom edge of the reaction chamber.

You can expect to remove approximately 2 to 3 cubic feet of ash per full cord (4' x 4' x 8') of hardwood burned. Remove ash using a small shovel through the loading door of the unit. DO NOT rake ashes forward into the lower nozzle!

Ashes should be placed in a metal container with a tight fitting lid. Place the ash container on non-combustible surfaces only, safely away from all combustible items such as wood, cardboard boxes, paper, walls, vehicles, paints, chemicals, etc. until the ashes and container have thoroughly cooled.

Heat Exchanger/Flue Tube Cleaning: (1 per year or as necessary)

CAUTION **ALWAYS WEAR A DUST MASK AND EYE PROTECTION WHEN CLEANING THE HEAT EXCHANGER TUBES**

Periodically inspect all flue tubes. Look for accumulated ash and debris. If one year dry, seasoned wood (15% to 20% moisture content) is burned the flue tubes and chimney may only have to be inspected every 12 to 24 months. Flue tubes will require more frequent cleaning if wet wood is burned.

If inspection indicates that cleaning is required, use a stiff round wire brush coupled to standard flexible rod extenders. Correctly sized wire brushes (4" and 5" diameter) and flexible rod extenders are available from DECTRA. The flue tubes are accessed through the secondary reaction chamber, the lower two cleanout ports, the upper cleanout port, and the blower housing. On vertical flue units, the rear cleanout should also be cleaned. Cleaning of the small sections of tubing that are hard to reach is generally not necessary.

Replace all damaged gaskets and install missing gaskets with new gaskets manufactured specifically for GARN® WHS equipment obtained from your GARN® dealer or online at www.garn.com.

WARNING **DO NOT INSTALL CLEANOUT COVERS WITHOUT GASKETS OR WITH DAMAGED GASKETS.** Omitted or damaged gaskets may result in carbon monoxide release and/or fire hazards.

Chimney Cleaning: (1 per year or as necessary)

GARN® units may be installed with either a short horizontal flue or a more traditional a vertical flue. Both require periodic inspection and cleaning. Use a correctly sized wire brush coupled to flexible rod extenders. Be careful not to damage the inside surface of the flue.

An insulated, double-wall UL-103 HT (US) or ULC-S629 (Canada) Class a 2100°F stainless steel tee is required at the base of an external vertical chimney. This tee is supported by a tee bracket hung from the exterior wall of a building. The chimney tee may be cleaned by removing the insulated bottom access cover that is supplied with the tee. Be sure to reinstall the cover before firing the unit.

⚠ WARNING **CALL A LICENSED CHIMNEY SWEEP IF CLEANING FROM THE TOP OF A VERTICAL CHIMNEY IS REQUIRED.** Cleaning from the top of a chimney can be extremely dangerous.

Cleanout Cover Gaskets: (as necessary)

⚠ CAUTION **USE ONLY REPLACEMENT GASKETS PROVIDED BY DECTRA FOR GARN® WHS UNITS.** Use of another type of gasket material could cause damage to the unit or blower motor, and may result in carbon monoxide release or a fire hazard.

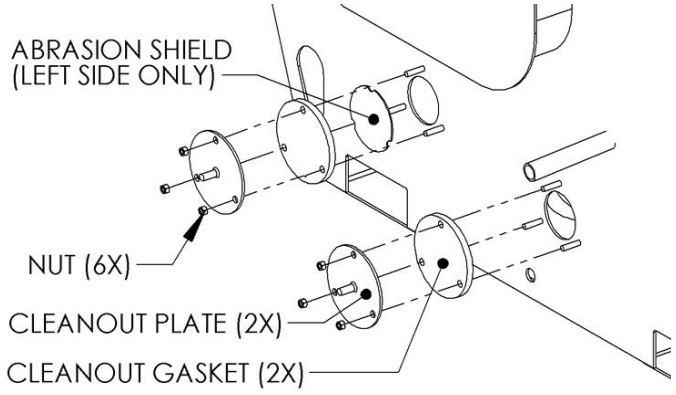
High heat resistant, insulating semi-rigid ½" thick gaskets are used at the following locations on the GARN® WHS: induced draft blower assembly; upper cleanout port; two lower cleanout ports and (on vertical flue models) a rear cleanout. Replacement gaskets can be ordered from your GARN® dealer or at www.garn.com. The gaskets serve two very important functions:

1. To create a seal and prevent unwanted particulates and gases from entering the building.
2. To provide thermal insulation so that the high temperature exhaust gases do not create a fire hazard or destroy the induced draft motor's bearings or windings.

The gaskets are sandwiched between a steel cover plate and the tank or blower housing. Gaskets require periodic inspection as they may wear over time or fail. Two primary modes of failure exist:

Erosion Damage

This is caused by the impact abrasion of high velocity fine ash particles carried with the exhaust gases. The lower cleanout cover gaskets and the gasket for the draft inducer motor may occasionally experience this condition. To minimize this abrasion at the lower left cleanout, a thin disk of sheet metal is installed as a shield between the gasket and the tank wall.



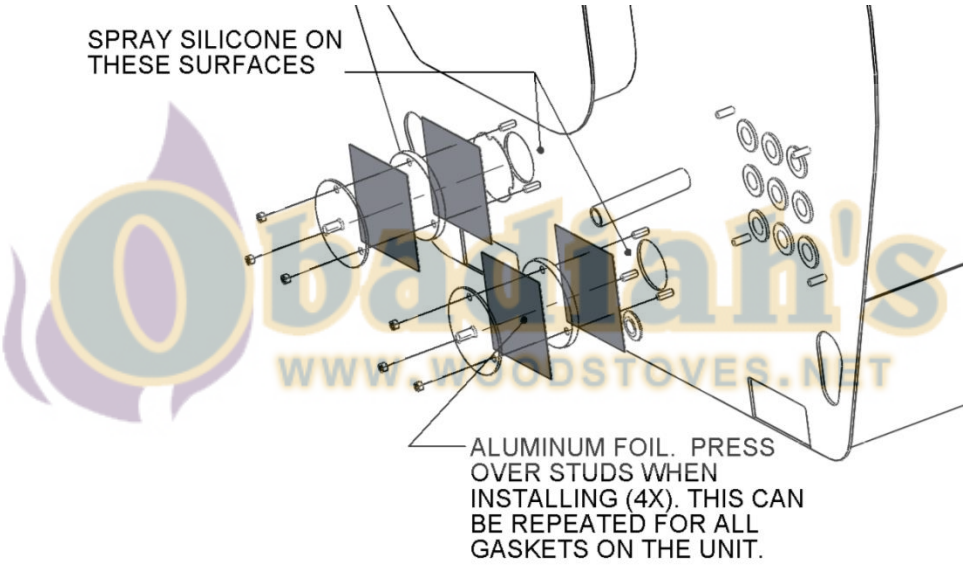
The disk resists abrasion while the perimeter provides a seal. To install the shield: center it on the insulation gasket and tape it with masking tape; place the gasket over the studs and the plate over the gasket; finally, install the nuts on the studs and snug so that the gasket makes a good seal with the tank.

Physical Damage

This may occur during the removal of the gasket in order to clean the heat exchanger tubes. If the clean out cover has not been removed for an extended period of time, the gasket will stick to both the tank and cover and tear.

PREVENTING THE CLEANOUT GASKETS FROM STICKING

The cleanout gaskets may stick depending on a number of factors. To help prevent sticking, install a sheet of aluminum foil between the gasket and the tank as well as between the gasket and the cover plate. In addition, spray the surface of the tank where the gasket mates with a high-temp silicone spray. In most cases, this will extend the life of the gaskets significantly.



GARN now offers an official Gasket Saver product. The gasket savers are installed in the same way as the aluminum foil. They are made out of high-quality, 316 stainless steel and are thin to allow sealing to the tank surface. They can be purchased at www.garnparts.com (Part #: P-0126):

Review the material safety data sheet (MSDS) regarding the safe handling of the gasket material. Use the specified 3M or equivalent air purifying respirator while handling the gasket material.

Clean Blower Motor: (2 per year)

At least twice per year (preferably during the heating season) use compressed air and a high velocity nozzle to remove accumulated dust from the windings of the draft inducer motor. Excessive dust accumulation will block airflow around motor windings creating hot spots that may terminate motor operation via a thermal safety switch. Hot spots may start a fire. Hot windings shorten motor life. The motor bearings do not require periodic lubrication.

Combustion Air Intake Hood: (frequently)

Periodically inspect the combustion air intake hood and screen located at the rear of the GARN® unit on the outside wall of the building in which the GARN® unit is located. Remove all leaves, paper, etc – anything that may reduce or prevent the intake of combustion air to the unit. During winter months periodically remove snow from the area near the hood and ice from the hood screen.

A restricted air intake means inefficient, smoky combustion. This allows creosote to condense on the inside surfaces of flue tubes creating a fire hazard. A restricted air intake can also amplify or create "puffing" during combustion.

Fuel Loading Door Gasket: (every 5 years)

Periodically examine the fuel loading door tadpole gasket for tears, permanent compression set, burn outs, or other degradation. Replace the entire gasket when damage is found. Replacement gaskets are available from your GARN® dealer or www.garn.com.

⚠ CAUTION **USE ONLY TADPOLE DOOR GASKET THAT IS MANUFACTURED SPECIFICALLY FOR GARN® WHS EQUIPMENT.**

If the fuel loading door does not tightly seal against the front face of the air collar, open the door and rotate the inner door assembly counter clockwise one half turn to increase the seal pressure. Shut and latch the door to check. Repeat this process until the seal is snug. Only adjust the door when it is cool. The door will seal tighter when hot due to thermal expansion.

REPLACING THE DOOR GASKET

1) When the insulated disk (inner door) is cool, grasp the inner stainless door assembly and rotate it counterclockwise until the assembly is free of the unit (approximately 3 to 10 full revolutions)
2) Find some way to support the inner door while you disassemble it. A medium sized round trash can or barrel works well. Brace it well or have someone hold it while putting pressure on the screws.
3) Unscrew the sheet metal screws holding the two sides together. Set screws aside for reuse later.
4) Put on a dust mask.
5) Carefully pry the domed sheet metal up. Lift slowly. Disrupt the insulation as little as possible
6) Remove old gasket.
7) Using gloves, make sure the flat surface is free from insulation or any other material.
8) Mark the position of one of the bottom screw holes so it can be seen after the door is re-assembled.
9) Place the circular, tadpole gasket around the flat surface.
10) Set the door skin on the gasket and center.
11) Using a long, narrow screw; pull the round portion of the gasket from under the door skin. Move around the entire gasket until the skin sits on the tadpole with the round portion totally clear of the skin.
12) Using the point of your screw, put it in a screw hole nearest to your mark of the bottom screw hole. Rotate skin until holes align.
13) Put point of screw through both holes to keep door skins aligned. Repeat with the screw holes directly opposite the first hole.
14) Using the original sheet metal screws you removed, place a screw in an empty screw hole. Using a variable speed power drill or socket wrench, rotate the screw several times COUNTERCLOCKWISE to separate the gasket fibers.
15) Then turn the screw clockwise until tight. Repeat in the hole opposite the first. Go around door skin until all screws are in and tight.
16) Reinstall the inner door assembly by threading it (rotating clockwise) back onto the large bolt that protrudes from the center, inside face of the outer door skin.

Manway Cover Gasket: (1 per year or as necessary)

1) Occasionally the manway cover gasket may require replacement.
2) Fully remove the old gasket. Use a solvent such a lacquer thinner to remove all traces of the old adhesive. Follow all safety precautions when using any solvent; dispose of cleaning materials such as rags so as not to create a fire hazard.

3) Remove 2” of the paper backing from one end of the new gasket.
4) Align the end of the new gasket and firmly press it into position on the flat of the manway cover.

5) Carefully install the remainder of the gasket around the flat (avoid the rounded cover edges) while simultaneously removing the backing.
6) The replacement gasket is slightly longer than required, cut the free end so you have about 2” more gasket than needed. Leave the paper backing on the remaining 2” of gasket and overlap onto the beginning end of the gasket.

7) Use a razor knife or scissors to cut diagonally through both layers of the overlapping gasket.

8) Peel the diagonal scrap off the metal flange.
9) Remove the paper backing from the loose end, and butt tightly against the beginning end. Be sure that both ends of the gasket meet without a gap (a gap will leak moisture and air, which will significantly increasing evaporation).

Firebrick Replacement: (as necessary)

CAUTION **DO NOT ATTEMPT TO REPLACE THE BRICKS OR PADS WITH A BED OF HOT COALS OR WHEN THE BRICKS ARE TOO HOT TO HANDLE.**

Firebrick may occasionally require replacement. Firebrick breakage will occur as it is normal for brick to become more fragile with age and continued high temperature use. When significant breakage has occurred, it is necessary to replace the old firebrick and pads with new material (contact your GARN® dealer or DECTRA for replacement brick and pad).

When replacing firebrick in your GARN® WHS unit it is imperative that:

- The firebrick be placed over a ¼" brick pad
- Only Hi-duty or better firebrick be used; DO NOT use intermediate duty brick

The brick pad is used for three reasons:

- To cushion the brick and help absorb the impact of logs during fuel loading
- Provide insulation to maintain higher fire bed temperatures.
- Provide a "slip interface" to allow the firebrick to expand without inducing excessive stress.

Firebrick is available in numerous sizes and ratings. Some brick is "fired" (oven cured) and other brick is not. In order to achieve high efficiency and lower emissions, it is necessary to maintain high fire bed temperatures. Use only ASTM rated Hi-duty or better fired brick for replacement. Hi-duty brick has a minimum temperature rating of 2,700 °F. Common or intermediate duty fire brick has a rating of 2,200 F. Never use unfired or patio type brick. Two sizes of firebrick are used in the GARN® WHS:

- #1 splits, each brick measuring 4 ½" x 9" x 1 ¼" thick
- #2 splits, each brick measuring 4 ½" x 9" x 2" thick

The thicker bricks (#2 splits) are positioned on the flat bottom of the chamber. The thinner (#2 splits) are positioned on both inclined sides of the chamber. Three ¼" thick, flexible high temperature pads are placed between the steel combustion chamber and the firebrick.

Remove old brick and pad:

1) Properly remove and dispose of existing materials.
2) Clean the combustion chamber underneath where the brick and pad are set. Some of the pad may stick to the steel of the chamber.

Install new brick and pad:

1) Inspect the heat shield and its insulation mat around the primary air nozzle. If needed, order a replacement from DECTRA or your GARN® dealer and install before installing any brick. If the shield and pad are in good shape, reuse them.

2) Place the new or existing mat and heat shield around primary air nozzle. Feel around the air nozzle to insure the mat and shield are properly centered on the opening.
3) Lay a replacement ¼" mat on the bottom and along each side of the combustion chamber.
4) Beginning at the front of the combustion chamber, position the first #2 split on the bottom. Push it tight to the heat shield and center between the two sides.
5) Place two #1 splits on each side of the bottom brick. Center the #2 split so that the #1 splits are symmetric.
6) Continue by adding another bottom brick and side bricks. Repeat until all brick is installed. Small gaps are not critical.

After installation of the firebrick, any exposed pad can be trimmed flush with the brick using a sharp knife.

Secondary Reaction Chamber (SRC): (every 5 to 10 years)

CAUTION **USE ONLY REACTION CHAMBERS THAT ARE MANUFACTURED SPECIFICALLY FOR GARN® WHS EQUIPMENT.** By substituting a material damage to the unit could result.

WARNING **REVIEW THE MATERIAL SAFETY DATA SHEET (MSDS) REGARDING THE SAFE HANDLING OF THE SECONDARY REACTION CHAMBER AND MISCELLANEOUS GASKET MATERIALS.** Use the specified 3M or equivalent air purifying respirator when handling any of this material.

The SRC will last many years, but during the course of normal use it may be accidentally damaged. When the front 2" to 3" of the SRC is significantly damaged the front section should be replaced. Contact your GARN® dealer or DECTRA for a replacement.

The Secondary Reaction Chamber (SRC) is manufactured from a fibrous material (not asbestos) with approximate dimensions of: 10" OD; 8" ID; and overall length of 24". The SRC performs the following functions:

- Insulates the unburned hot flue gasses from the cool temperature of the water storage.
- Induces proper turbulent mixing of the unburned hot flue gasses with secondary air so that secondary combustion can occur.
- Provides significant retention time for the unburned hot flue gasses and secondary air to burn, consuming smoke and releasing additional energy.

CAUTION **WITHOUT THE SRC (OR WITH A SEVERELY DAMAGED SRC), OVERALL EFFICIENCY WILL DROP, AND THE WHS UNIT WILL SMOKE AND PRODUCE CREOSOTE LEADING TO A HAZARDOUS FIRE CONDITION.**

INSPECTION AND REPLACEMENT OF THE SECONDARY REACTION CHAMBER

Some field "trimming and fitting" may be required in order to have the cylinders slide into the steel tube. Trimming of the OD is easily accomplished with a rough file or a SUR-FORM® file. If the OD is such that the ceramic cylinders slide into place easily, then no trimming is required.

The tools that may be required are:

- 3M or equivalent face mask
- SUR-FORM® file
- Utility knife
- Sand paper or file

Replacement procedure:

1) Remove all ash from the combustion chamber in strict compliance with the *Ash Removal* section of this manual.
2) Remove the damaged sections of the reaction chamber by sliding them forward into the combustion chamber.
3) Properly dispose of the damaged pieces.
4) Use a brush or a shop vacuum to clean the steel tube in which the ceramic chamber rests.
5) Insert the new chamber by sliding the sections into the steel tube. The SRC section with the attached end plate should be slide into the steel tube first, followed by the other section.

WARNING **DO NOT INSTALL REACTION CHAMBERS THAT ARE INCORRECTLY SIZED, DAMAGED OR ADAPTED FROM OTHER HEATING PRODUCTS BECAUSE OF POSSIBLE CREOSOTE FORMATION AND FIRE HAZARDS.**

WARNING **DO NOT OPERATE THE GARN® UNIT WITHOUT A REACTION CHAMBER BECAUSE OF CREOSOTE FORMATION AND FIRE HAZARDS.**

WARNING **DO NOT INSTALL A REPLACEMENT REACTION CHAMBER WITHOUT AN END PIECE AS CREOSOTE MAY FORM AND A HAZARDOUS CONDITION MAY RESULT.**

Spring Shutdown/Wet Layup: (end of heating season)

At the end of the heating season, it is advisable to fill the GARN® unit until water begins to leak out of the overflow. This will ensure that the inside of the entire steel tank is in full contact with water. Doing so will minimize the potential for corrosion on the inside-top of the tank and prolong the life of your GARN®. If you are refilling from a rural well, you may have to add a biocide to kill any bacteria brought in by the well water. Follow the direction of PrecisionChem Water Treatment.

The first time the unit is fired the following winter, water will leak out of the overflow as the as it heats up and expands. Dispose of the water properly and follow the "Starting a Fire" section of this manual.

Maintenance Schedule:

GARN 1000/1500/2000 Maintanence Schedule	Maintenance Type	Frequently	Monthly	Yearly	Start of the Heating Season	End of the Heating Season	Every 5 Years	Task Duration
Check Air Intake Hood for Freezing/Obstructions	Ch	X			X			1 min
Motor Housing - Blow out w/Compressed Air	Cl				X			15 min
Cleanout Gaskets	RAN			X				1 hr
Flue Tubes	CAN				X			3 hr
Anode Rod(s)	RAN				X	X		1 hr
Ash Removal	Cl	X						10 min
Chimney Inspection and Cleaning	CAN				X			-
Fuel Loading Door Gasket	RAN						X	3 hr
Manway Cover Gasket	RAN				X			1 hr
Firebrick and Pad *	RAN						X	3 hr
Secondary Reaction Chamber	RAN				X			30 min
Water Chemistry Test	T				X	X		30 min
Spring Shutdown/Wet Layup†						X		3 hr
Left Cleanout Heat Shield	RAN			X				20 min
Primary Air Heat Shield and Pad	RAN			X				5 min
Door Handle/Latch Bolt	RAN		X					1 min
Flow Straightener	CAN			X				5 min
Low Water Cutoff	Ch/T			X				20 min

* Cracked brick is ok. Broken or missing pieces must be replaced

† Fill the unit until water leaks out the overflow

Maintenance Type	
Ch	Check
Cl	Clean
RAN	check for wear and Replace As Necessary
CAN	check and Clean As Necessary
T	Test/Sample

H. TROUBLE SHOOTING

Digital Controller

Refer to the OVERVIEW OF THE DIGITAL CONTROLLER on page 82.

Lack of Heat in Building

1) Check and confirm thermostat function.
2) Check and confirm power supply and circuit breaker.
3) Check and confirm pump operation.
4) Check and confirm supply water flow by determining if the pipes are hot when the pump activated. Check the pipes in the house, not at the GARN® unit. If pipes are not hot and the pump is activated, the pipes may be "air bound', a manual valve is set in the shut position or a solenoid valve is inoperable. Call your dealer and shut off your thermostat.
5) Check and confirm the supply water temperature. The minimum supply water temperature: for forced air systems should be 125°F; for radiant floor systems approximately 90°F - 125°F; for baseboard radiation or radiator systems 130°F -145°F. If the supply water temperature is inadequate, heat will not be delivered even though supply water flow is adequate.
6) If all of the above checks out and heat is still not getting to the building, call your dealer.

Draft Inducer Fails to Operate

1) If the draft inducer motor does not activate, check and confirm:
   - Status of the power supply, circuit breaker, etc of the circuit feeding the **GARN®** controls.
   - That the electrical plug for the motor is pushed all the way into the electrical socket.
2) If the motor stills does not activate pull the electrical plug and insert another electric device in the same outlet and activate the controller. If this device operates properly, then the motor is defective. If this device does not operate, then there is a problem with the digital controller. Call your dealer or DECTRA.
3) If everything above checks out, then visually check the water level in the **GARN®** unit. If the water level appears low and adding water corrects the condition (motor operates), then Low Water Indicator light is burned out. If the water is not low, or if adding water does not correct the condition, then the float switch is defective. Call your dealer.

Noisy Blower Wheel

If the draft inducer operates noisily, check and confirm that all of the mounting bolts are not loose and that the gasket is in good condition. If the bolts are loose tighten until snug (**do not** over tighten). If this does not solve the problem, the noise may be the result of:

1) Blow out the motor housing with compressed air. The noise could be a result of dirty windings or bearings in the blower.
2) Ash, wood debris or paper kindling that has been pulled through the heater exchanger and is stuck in the blades of the blower wheel creating an imbalance. Ash will normally disintegrate, debris and paper will not. Disconnect the motor from the GARN® controls and remove the draft inducer assembly from its housing. Clean the motor, blower wheel, etc, install a new full-face gasket and reassemble.
3) A defective bearing, generally due to overheating as a result of using a "donut gasket" in lieu of a GARN® full face gasket. Disconnect the motor from the GARN® controls and remove the draft inducer assembly from its housing. Replace the motor, reinstall the blower wheel with anti-seize compound, install a new full-face gasket and reassemble.

Puffing During Operation

Puffing or pulsing during operation is a condition that you will surely notice when it occurs. It is the result of an **incorrect** fuel air mixture. This condition occasionally develops in all wood equipment. Excessive or long term puffing could damage the unit and may create hazardous conditions. Reasons for puffing are:

1) **Excessively dry wood fuel** such as: wood that is more than 2 years dry; construction or furniture scrap; wood without bark; wood that has been stored for an extended period of time indoors, etc. Fuel with a moisture content of 15 % to 20% (one year dry) is best for a GARN® unit.
2) **"Punky wood"**: wood that has been drying for so long that it is beginning to decompose internally (usually very light to handle). Fuel with a moisture content of 15% to 20% (one year dry) is best for a GARN® unit.
3) **Wood fuel that has an excessively large surface area in relationship to its volume** (i.e. small sticks, leaves, small wood scraps, etc). Because all wood burners are surface burners, the surface to volume ratio of the fuel is critical for any burner. For the GARN® unit wood cut 24" to 32" long x 6" diameter is considered best. Longer lengths should be cut and larger diameter logs should be split.
4) **Lack of sufficient combustion air**: normally caused by a partially blocked air inlet hood or flue tubes. Sometimes cause by the installation of an improper air inlet hood (too small) or no inlet air hood. Generally easily corrected by clearing blocked passages or installing the correct hood.
5) **Wood fuel positioned too close to the primary air nozzle**. A hot fire in this position excessively preheats the primary combustion air, yielding a flash then no-flash combustion condition. To reduce this sensation, push the fire further back into the combustion chamber with a hoe or rake. This also allows the combustion air to disperse more widely at a lower velocity over the woodpile.
6) **Starting the fire with an overabundance of kindling**.

GARN® WHS: Installation Instructions for Blower Motor Electric Isolation Bushings

PLACEMENT OF OPTIONAL PRIMARY AIR CONTROL FIREBRICK

GARN® units are not shipped with a control firebrick. Most seasoned cord wood will not require the use of a primary air control firebrick. It is intended to be used when burning fuels that are very dry or have a large amount of surface area. The position of the control firebrick reduces the amount of primary air reaching the fire.

The control brick will minimize “flash burning” which can cause the GARN® to puff. The following figures show a 2” firebrick laid flat, for a moderate deflection of the primary air, or stood on end for maximum deflection. Position the brick approximately 3” to 5” from the primary nozzle. In lieu of a firebrick use a small log.

NOTICE **DO NOT PLACE THE CONTROL BRICK TOO CLOSE TO THE NOZZLE**. This will greatly decrease the performance of the GARN®. **NEVER CLOSE-OFF** the primary air nozzle as this will cause warping and minor cracking of the air collar.

In Case of Electrical Power Failure

If during operation the electrical power to the GARN® WHS unit fails, **DO NOT OPEN THE DOOR and DO NOT ATTEMPT TO RELOAD THE UNIT.** Fire in the combustion chamber will safely snuff itself out within a few minutes. When power returns, turn on the controller and start the blower. Allow the blower to purge the unit for 5 minutes before opening the door.

Formation of Smoke or Creosote

If you observe excessive smoke from the chimney or the accumulation of creosote within the combustion chamber and cleanout ports, it is generally the result of: insufficient combustion air; excessively wet wood fuel; too much fuel; or the burning of trash and plastic. Under normal operation, smoke and creosote are consumed by the high fire temperature in the Secondary Reaction Chamber. Smoke and creosote should almost be non-existent after 10 to 20 minutes of initial operation.

1) Reduce the volume of wood fuel loaded into the combustion chamber. Do not burn trash, plastic, pressure treated wood, etc.
2) Check and confirm that all of the flue passages and the chimney are not blocked.
3) Check and confirm that the air inlet hood is not blocked.
4) Check and confirm that the primary and secondary air nozzles are clear.
5) Check and confirm that the induced draft blower is operating properly.
6) Check and confirm that the loading door seals tight to the air collar face.
7) If all of the above check as OK, call your dealer.

Smell of Smoke

Immediately ventilate and exit the area. A strong smoke smell is usually caused by the following. Investigate and repair as required.

1) Flue joints not sealed with silicone and aluminum tape.
2) Flue connection ring not silicone sealed to tank.
3) Defective or worn cleanout cover gaskets.
4) Defective or worn loading door gasket.
5) Incorrectly adjusted loading door (door does not seal tight to the air collar face).
6) Defective induced draft blower motor or wheel.
7) Blocked chimney.
8) Excessive depressurization of the building in which the GARN® unit is located. This may be due to high levels of exhaust as a result of operating equipment not related to the GARN® unit. The solution is to provide make up air in a volume that is equal to the exhaust air volume. Contact a consulting Mechanical Engineer to help solve this condition.

Excessive Water Consumption

Excessive water consumption is caused by the following. Investigate and correct or repair:

1) High evaporation rates due to consistent over-firing.
2) Leak in a supply or return pipe (generally underground because leaks within a building are usually readily noticed).
3) Leak around the manway gasket seal

Corrosion of the Storage Tank

Corrosion is almost universally caused by not following a defined water treatment and maintenance program. Please refer to the Water Treatment section of this manual. The water in a GARN® unit must be tested at least twice per year.

Excessive Wood Use

Excessive wood use is generally caused by the following:

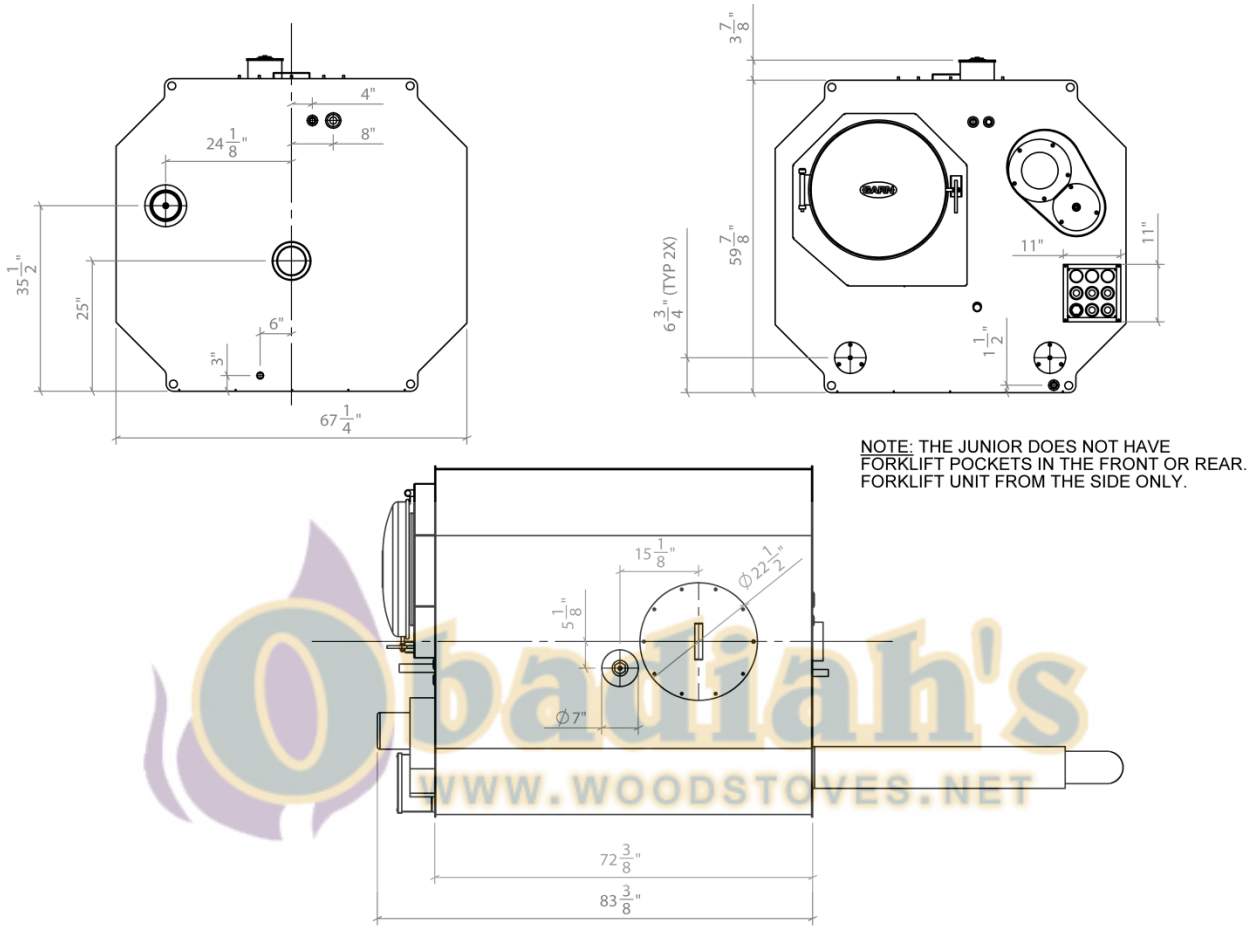
1) Consistent over-firing to water temperatures above 205°F.
2) Wood fuel moisture content too high (15% to 20% moisture content is best and most efficient). Burning green or very wet wood will significantly decrease the efficiency of the GARN® unit.

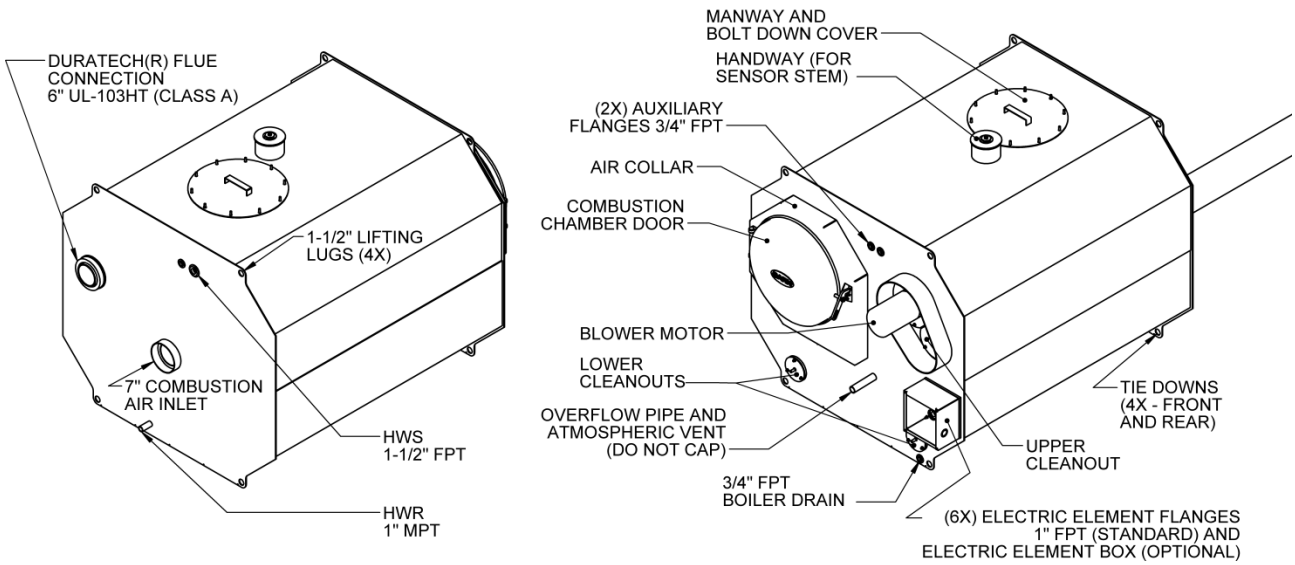
If you have additional questions please contact your GARN® dealer or DECTRA

www.GARN.com

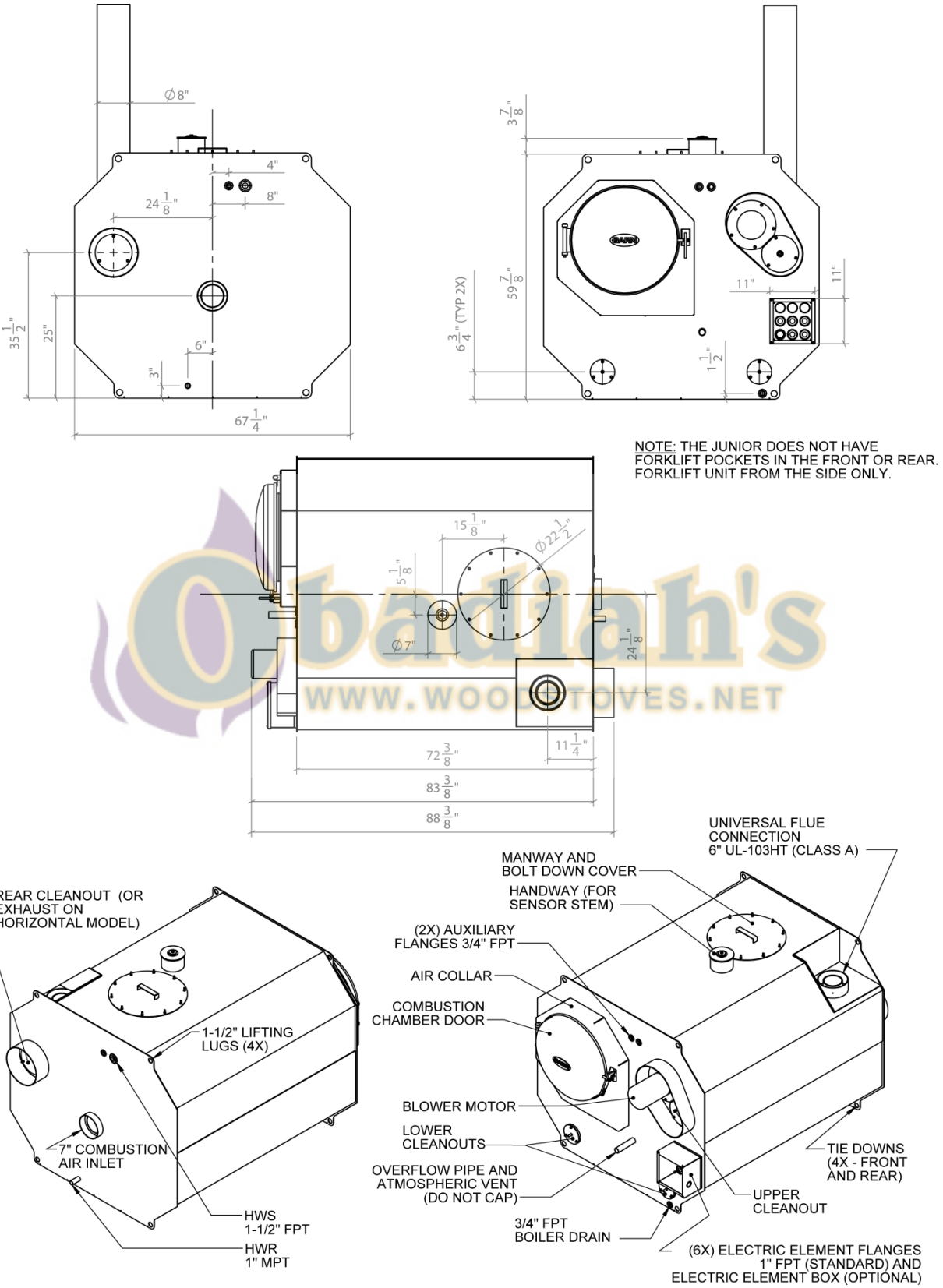
I. GARN® WHS DIMENSIONS

GARN® WHS-1000H (GARN® JR) Overall Dimensions

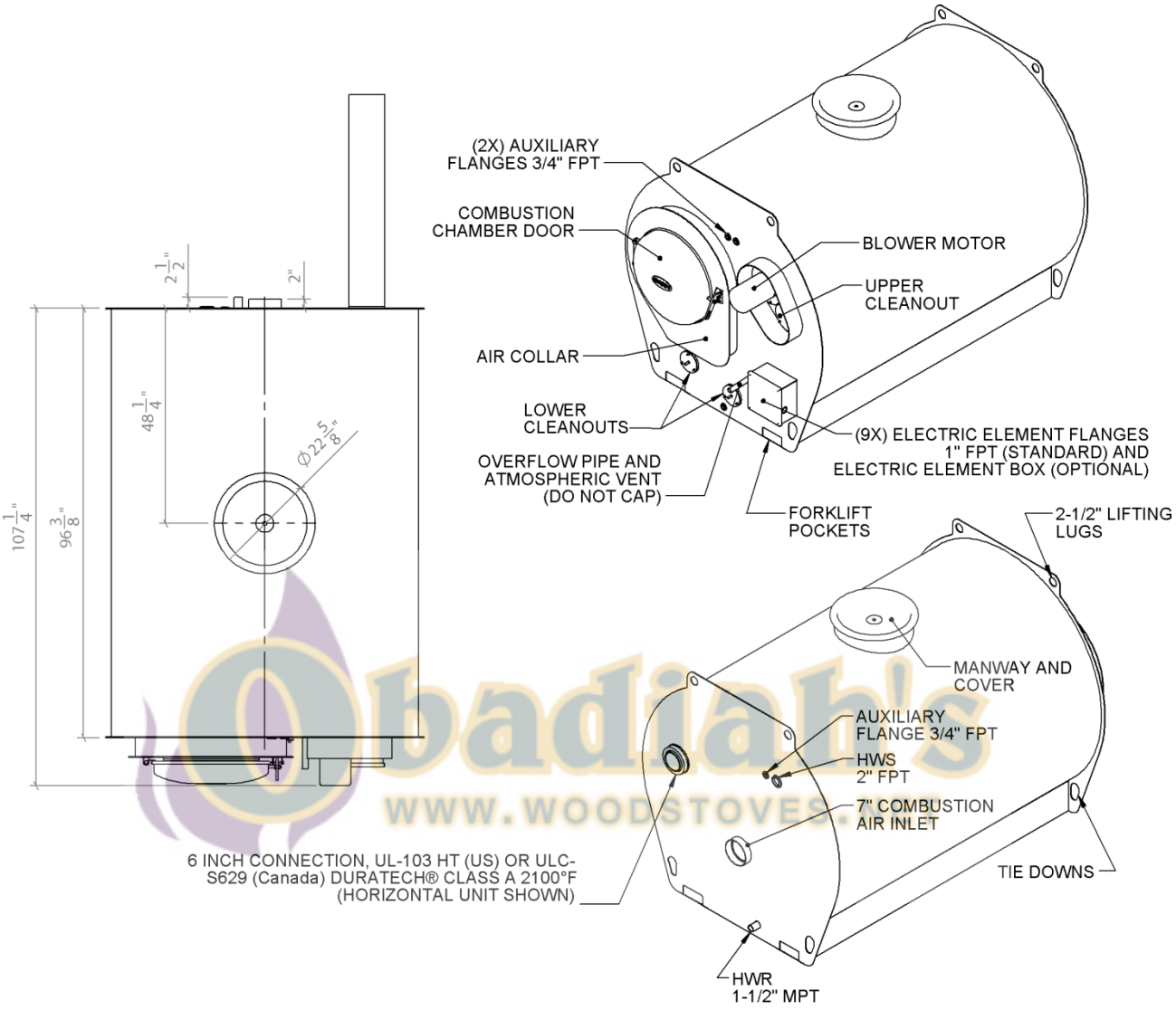


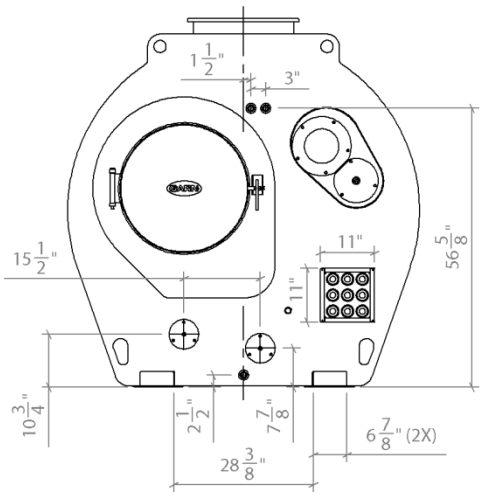


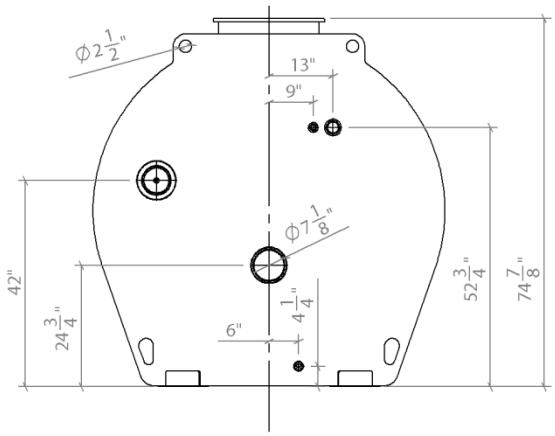
GARN® WHS-1000V (GARN® JR) Overall Dimensions



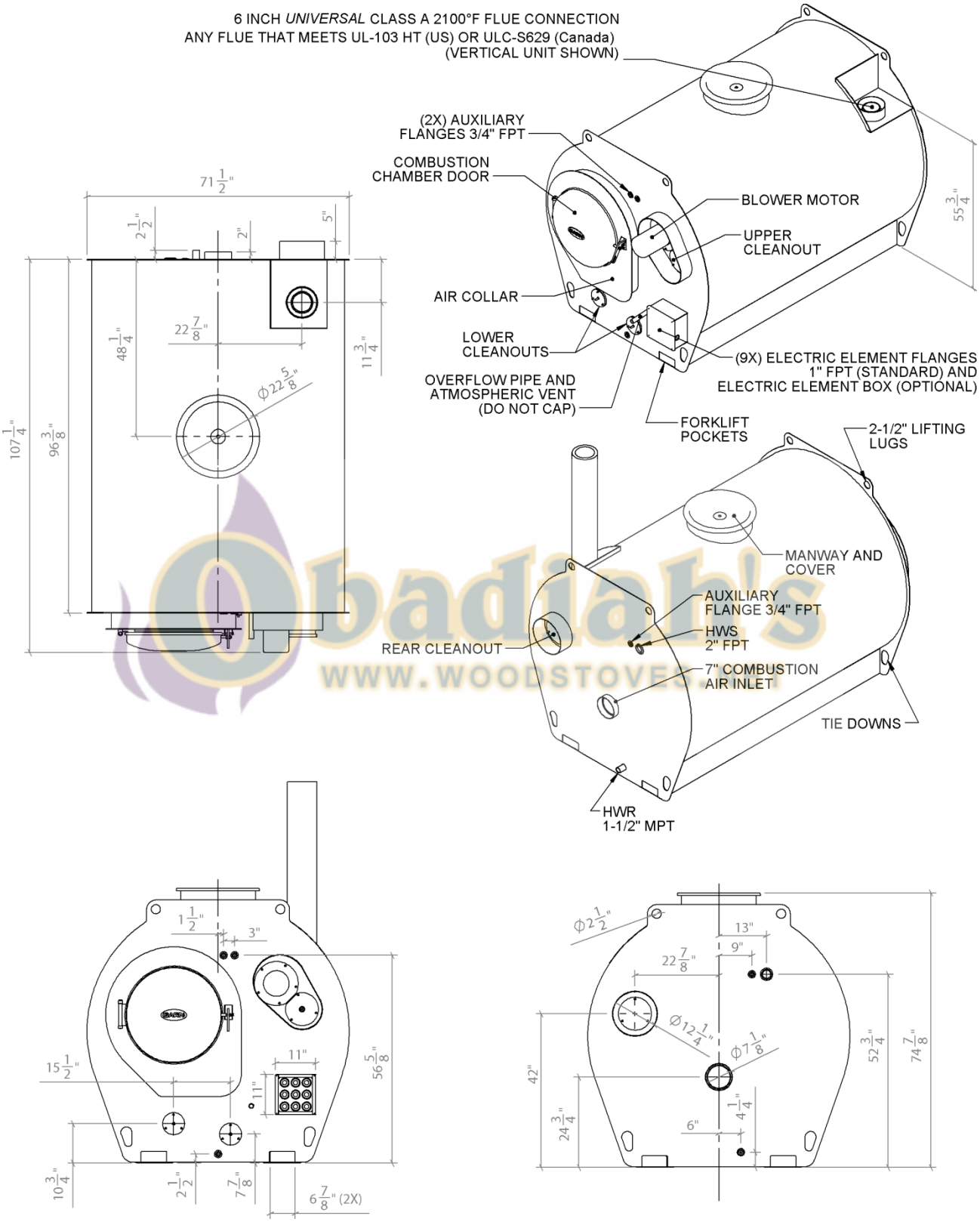
GARN® 1500H Overall Dimensions



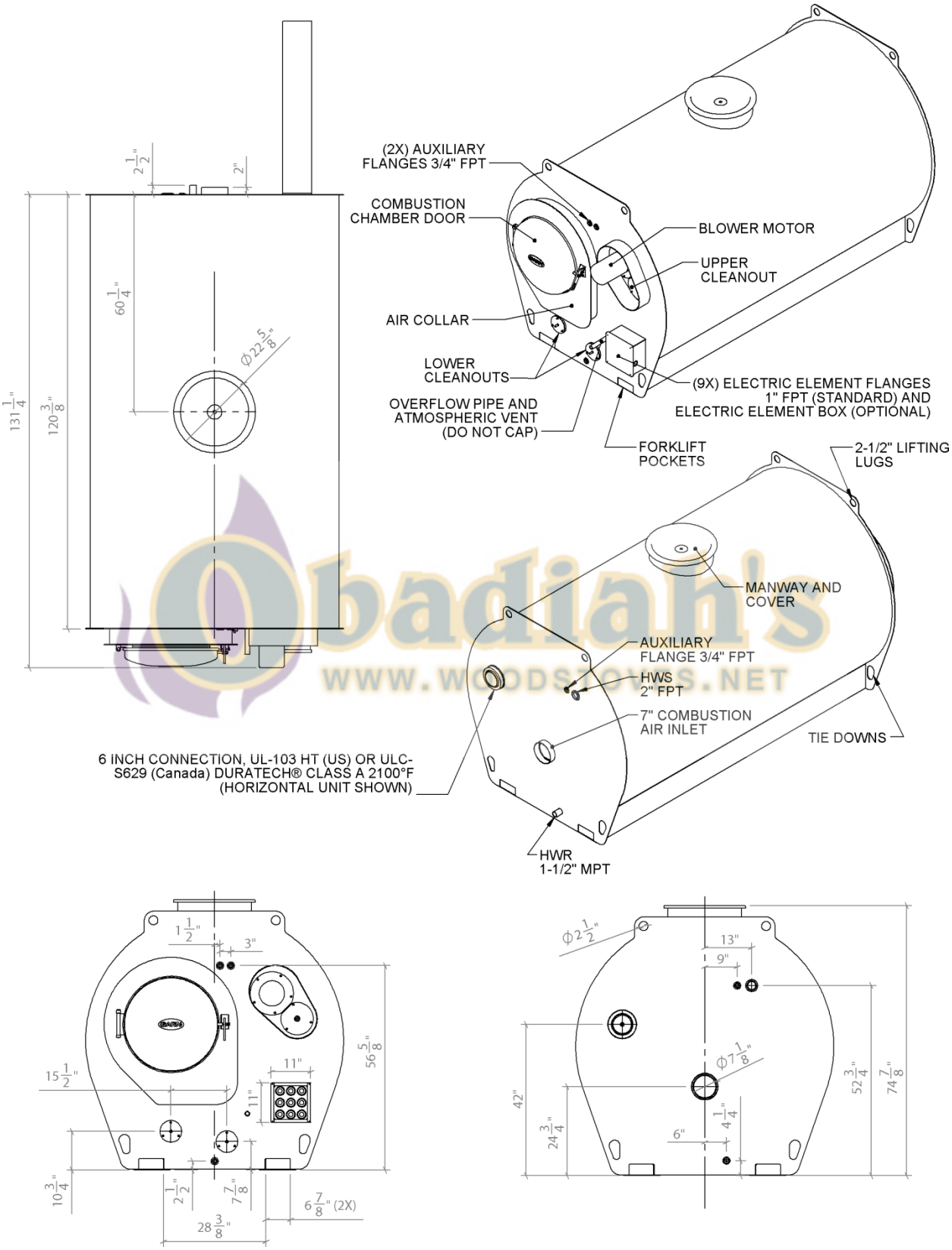




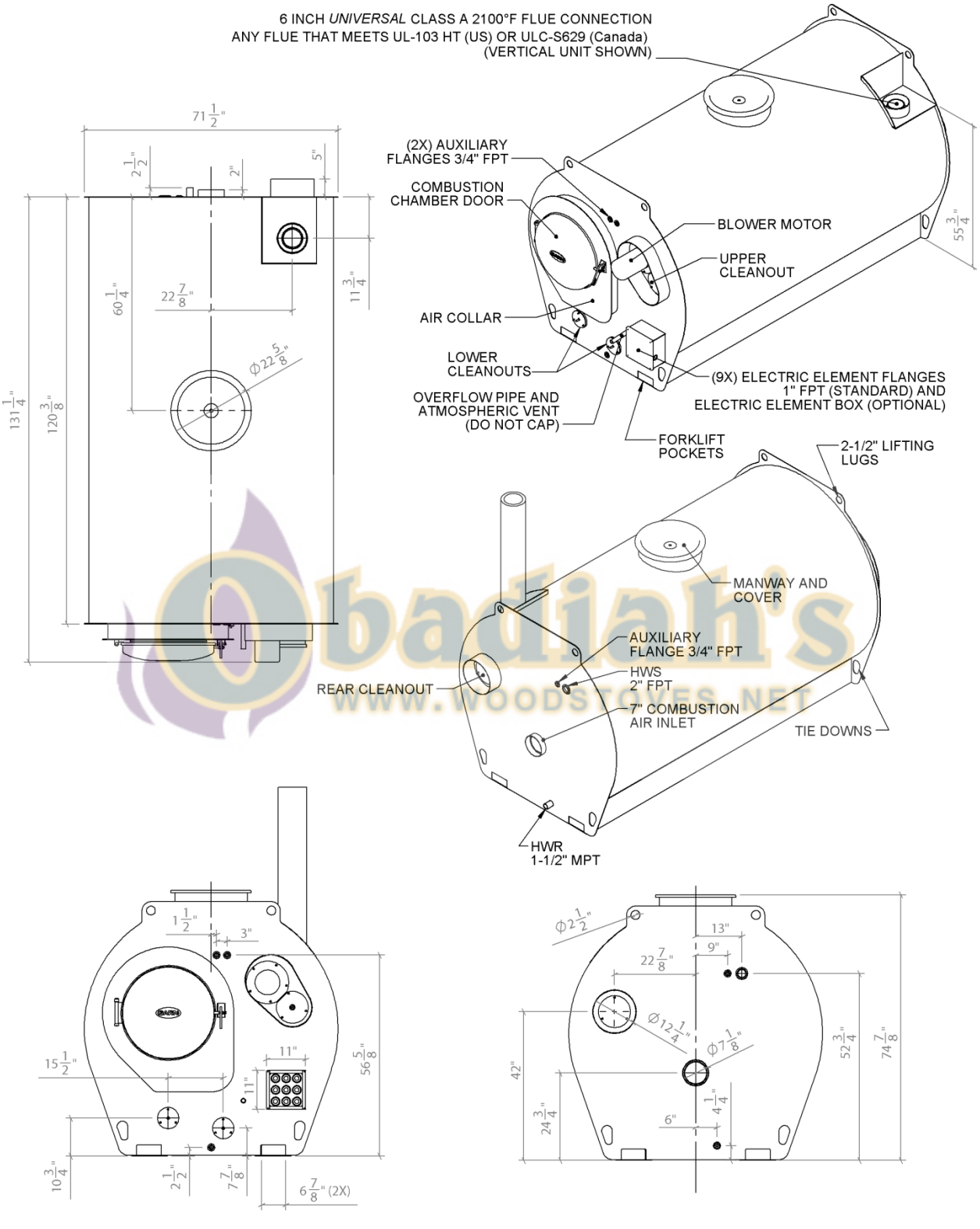
GARN® 1500V Overall Dimensions



GARN® 2000H Overall Dimensions



GARN® 2000V Overall Dimensions



J. EMISSIONS CERTIFICATION AND COMPLIANCE INFORMATION

This section of the manual is provided in order to comply with the requirements of the United States Environmental Protection Agency's (EPA) NSPS 40 CFR Part 60. As of March 15, 2015 Federal Regulations regarding wood heating equipment were passed that require all wood heating manufacturers to pass specific minimum standards for wood emissions. The Federal Regulations go into effect May 15th, 2015, and by January 1st, 2016, NO wood heating equipment will be allowed to be sold in the United States that doesn't meet the Federal Regulations. Read the NSPS regulation here: http://www.regulations.gov/contentStreamer?objectId=0900006481a45ee1&disposition=attachment&contentType=pdf. The regulation of emissions limits will be rolled out in 2 steps:

- Step 1: By May 15th, 2015 all wood heating equipment must have maximum emission of 0.32 lbm/mmBtu output.
- Step 2: By May 15th, 2020 all wood heating equipment must have maximum emissions of 0.15 lbm/mmBtu output.

How this affects GARN equipment: GARN currently produces 4 wood heating models (WHS-1000, WHS-1500, WHS-2000, and WHS-3200). The WHS-1500 and WHS-2000 are FULLY compliant with all appropriate US regulations and testing standards and out-performs the Step 2 NSPS emissions limits. The WHS-3200 is not considered a residential wood heater and, therefore, does not have to comply with the NSPS emission limits. The WHS-1000 (Junior) will be tested in June 2015, but currently does NOT comply with the federal emissions regulations.

Model and Compliance Status:

The following table shows compliance status for the various GARN Wood Heating models. The following heaters models meet the 2020 U.S. Environmental Protection Agency's crib wood and cord wood emission limits for wood heaters sold after May 15th, 2015. All models are tested with cordwood using the appropriate cordwood testing standard. The methods/standards listed under the "Compliance Status" column are what the GARN model has been tested to and passed.

Model	Federally Compliant?	Compliance Details	Fuel Used for Compliance
GARN WHS-1000	No	Not Tested	Not Tested
GARN WHS-1500	Yes	EPA Phase II, EPA M28HH, ASTM E2618-13, CSA B415.1-2010, NSPS 40 CFR Part 60 (Step 1 – 2015 standard, and Step 2 – 2020 standard)	Cordwood
GARN WHS-2000	Yes	EPA Phase II, EPA M28HH, ASTM E2618-13, CSA B415.1-2010, NSPS 40 CFR Part 60 (Step 1 – 2015 standard, and Step 2 – 2020 standard)	Cordwood
GARN WHS-3200	Yes	N/A – Does NOT need to be compliant as it is not a "residential heater"	Not Tested

Heat Output Ranges:

This manual describes the installation and operation of the GARN Models: WHS-1000H, WHS-1000V, WHS-1500H, WHS-1500V, WHS-2000H and WHS-2000V wood heaters. Under specific test conditions these heaters have been shown to deliver heat at rates in the following ranges:

Model	Minimum Heat Rate (BTUH)	Maximum Heat Rate (BTUH)*
GARN WHS-1000	0	119,000
GARN WHS-1500	0	177,000
GARN WHS-2000	0	200,000
GARN WHS-3200	0	450,000

* Maximum reloading once every 4 hours with 24 inch long split white oak, with 23% moisture content

Efficiency:

Efficiency was determined using ASTM E2618-13. There are 2 different heating values: Lower Heating Value (LHV) and Higher Heating Value (HHV). The HHV efficiency must be used when comparing to efficiencies of non-solid fuel heating equipment (i.e. propane, natural gas, fuel oil). The LHV efficiency must be used when comparing to other solid fuel heating equipment (i.e. wood, coal, pellets).

Model	8-Hour Average Efficiency		Annual Efficiency Rating*	
	LHV	HHV	LHV	HHV
GARN WHS-1000	73	64	69	60
GARN WHS-1500	73	68	65	70
GARN WHS-2000	76	82	74	79
GARN WHS-3200	Not Tested	Not Tested	Not Tested	Not Tested

* Annual Efficiency Rating is equivalent to the Annual Fuel Usage Efficiency (AFUE).

Using properly seasoned wood versus high moisture fuels will ensure optimum efficiency and prevent creosote build-up in the heat exchanger and flue. Efficiencies for GARN equipment were tested with wood having an average moisture content of 23%. For every increase in 5% of the moisture content of the fuel, the efficiency of the heater will be reduced by 2%:

Moisture Content	Adjustment to Listed Efficiency
23%	N/A – As tested
+5% (28%)	- 2 %
+10% (33%)	- 4 %
+15% (38%)	- 6 %
+20% (43%)	- 8%

Tamper Warnings:

This wood heater has a manufacturer-set minimum low burn rate that must not be altered. It is against federal regulations to alter this setting or otherwise operate this wood heater in a manner inconsistent with operating instructions in this manual.

Fuel Selection:

This heater is designed to burn natural wood only. Higher efficiencies and lower emissions generally result when burning air dried seasoned hardwoods, as compared to softwoods or to green or freshly cut hardwoods.

WARNING **DO NOT BURN:** (1) Garbage; (2) Lawn clippings or yard waste; (3) Materials containing rubber, including tires; (4) Materials containing plastic; (5) Waste petroleum products, paints or paint thinners, or asphalt products; (6) Materials containing asbestos; (7) Construction or demolition debris; (8) Railroad ties or pressure-treated wood; (9) Manure or animal remains; (10) Salt water driftwood or other previously salt water saturated materials; (11) Unseasoned wood; or (12) Paper products, cardboard, plywood, or particleboard. The prohibition against burning these materials does not prohibit the use of fire starters made from paper, cardboard, saw dust, wax and similar substances for the purpose of starting a fire in an affected wood heater. Burning these materials may result in release of toxic fumes or render the heater ineffective and cause smoke

WARNING **WARRANTIES ARE VOID IF THE UNIT IS USED TO BURN MATERIALS FOR WHICH THE UNIT IS NOT CERTIFIED BY THE EPA AND VOID IF NOT OPERATED ACCORDING TO THE OWNER'S MANUAL.**

Further Resources:

Read more about the issues discussed in this section by visiting the EPA's Burn Wise website: http://www.epa.gov/burnwise/

The website includes information about:

- Types of wood heating appliances
- Choosing the right appliance
- Best burn practices
- Health effects of wood emissions
- Importance of energy efficiency
- The benefits of burning properly seasoned wood
- Approved residential wood heaters
- Differences between the test methods

K. Maintenance Schedule

GARN 1000/1500/2000 Maintanence Schedule	Maintenance Type	Frequently	Monthly	Yearly	Start of the Heating Season	End of the Heating Season	Every 5 Years	Task Duration
Check Air Intake Hood for Freezing/Obstructions	Ch	X			X			1 min
Motor Housing - Blow out w/Compressed Air	Cl				X			15 min
Cleanout Gaskets	RAN			X				1 hr
Flue Tubes	CAN				X			3 hr
Anode Rod(s)	RAN				X	X		1 hr
Ash Removal	Cl	X						10 min
Chimney Inspection and Cleaning	CAN				X			-
Fuel Loading Door Gasket	RAN						X	3 hr
Manway Cover Gasket	RAN				X			1 hr
Firebrick and Pad *	RAN						X	3 hr
Secondary Reaction Chamber	RAN				X			30 min
Water Chemistry Test	T				X	X		30 min
Spring Shutdown/Wet Layup†						X		3 hr
Left Cleanout Heat Shield	RAN			X				20 min
Primary Air Heat Shield and Pad	RAN			X				5 min
Door Handle/Latch Bolt	RAN		X					1 min
Flow Straightener	CAN			X				5 min
Low Water Cutoff	Ch/T			X				20 min

* Cracked brick is ok. Broken or missing pieces must be replaced

† Fill the unit until water leaks out the overflow

Maintenance Type	
Ch	Check
Cl	Clean
RAN	check for wear and Replace As Necessary
CAN	check and Clean As Necessary
T	Test/Sample

L. Specifications

GARN® WHS SPECIFICATIONS	WHS 1000 (JR)	WHS 1500	WHS 2000
APPLICATION	RESIDENTIAL	SIDENTIAL/LIGHT COMMERCI	BUSINESS/COMMERCIAL
Maximum Heat Output †	180,000 btuh	250,000 btuh	325,000 btuh
Tested Efficiency (LHV)*	80.0%	80.0%	88.4%
Particulate Emissions output - PM2.5	0.190 lbms/mmbtu	0.131 lbs/mmbtu	0.088 lbs/mmbtu
Particulate Emissions rate - PM2.5	2.31 gr/hr	2.87 gr/hr	1.65 gr/hr
Nominal gallons of storage	980 gallons	1,420 gallons	1,830 gallons
Weight - Empty	2,200 lbs.	3,140 lbs.	3,570 lbs.
Weight - Filled	10,370 lbs.	15,000 lbs.	18,830 lbs.
Recommended wood length	16" to 20"	24" to 32"	24" to 32"
Recommended wood diameter	3" to 10"	3" to 10"	3" to 10"
Combustion chamber length	36"	40"	40"
Combustion chamber diameter	24"	25"	25"
Combustion chamber volume	110 gallons	130 gallons	130 gallons
NPT supply flange	1-1/2" (22 gpm MAX)	2"	2"
MPT return pipe	1"	1.5"	1.5"
Draft inducer motor	1/2 HP	1/2 HP	3/4 HP
Electrical requirements	115 VAC 15 amp	115 VAC 15 amp	115 VAC 15 amp
Flue	6" DuraTech Class A, 2100°F	6" DuraTech Class A, 2100°F	6" DuraTech Class A, 2100°F
Air intake	7" with screened hood	7" with screened hood	7" with screened hood

*Tested to ASTM E2618

† Reloading once every 3 hours with 24 inch long split white oak, 20% moisture content.

MATERIAL SPECIFICATIONS	WHS 1000 (JR)	WHS 1500	WHS 2000
Tank shell - mild steel	3/16"	3/16"	3/16"
Front and back heads - mild steel	3/16"	1/4"	1/4"
Combustion chamber - mild steel	3/16"	3/16" and 1/4"	3/16" and 1/4"
Blower housing components - mild steel	3/16"	3/16"	3/16"
Door spinnings			
Outer - mild steel - yellow zinc electroplated	12 GA	12 GA	12 GA
Middle - mild steel - yellow zinc electroplated	16 GA	16 GA	16 GA
Inner - 304 stainless steel	16 GA	16 GA	16 GA
Skids - mild steel	N/A - No Skids	10 GA	10 GA
Heat exchanger tubing	Sch. 40 A53 Grade B ERW	Sch. 40 A53 Grade B ERW	Sch. 40 A53 Grade B ERW

M. Warranty

GARN® products are warranted by the manufacturer to be free of defects in material and workmanship as follows, with the below-enumerated exclusions:

- With respect to the blower motor, controls and miscellaneous parts furnished as part of the basic unit, a one-year warranty shall apply.
- With respect to the storage tank, combustion chamber, flue tube heat exchanger, outer door, middle door and blower housing, a five-year warranty shall apply with regard to materials and workmanship.
- With respect to wear items such as gaskets, firebrick, reaction chambers, door latch and latch pin, door hinge and hinge pin, etc., a one-year warranty shall apply regarding materials and workmanship excluding normal wear and tear. Proper use and periodic maintenance will extend the life of these items. No warranty with regard to either anode rods or chemicals.
- NO WARRANTY SHALL APPLY WITH REGARD TO EPOXY COATINGS, PAINT, CORROSION OR CORROSION INDUCED FAILURES OF ANY COMPONENT OF THE UNIT OR COMPONENTS ATTACHED TO THE UNIT. It is the sole responsibility of the owner to install, maintain and test water treatment chemicals in order to minimize corrosion potential and damage. Testing of the GARN® water is required once every year. A record of this compliance is required or warranty is VOID.
- DECTRA shall not be liable for injury, loss, damage or any expense directly or indirectly arising from the use of the products it offers for sale or from any other cause.
- This warranty does not cover any parts replacement due to shortage or damage in shipment, exposure to weather, improper installation, operating the unit under abnormal conditions, or other claims not agreed to in writing by DECTRA. Replacement parts purchased from DECTRA are warranted for ninety (90) days from the date of installation.
- No warranty is given in connection with second-hand products and equipment, or products and equipment altered or rebuilt without DECTRA's knowledge or written approval.
- No warranty is given regarding the predicted or actual performance of any product manufactured or supplied by DECTRA.
- THIS WARRANTY IS EXPRESSLY MADE IN LIEU OF ANY & ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR PURPOSE SHALL APPLY. NO WARRANTY OF LOCAL CODE ACCEPTANCE OR OF INSURANCE CARRIER ACCEPTANCE SHALL APPLY. NO WARRANTY FOR INSTALLATION OR FOR HEATING SYSTEM PARTS OR PERFORMANCE SHALL APPLY.

The foregoing warranty periods shall each commence on the date of shipment to user of the products or parts and the obligation of DECTRA with respect to such products or parts shall be limited to replacement or repair FOB point of origin, and in no event shall DECTRA be liable for consequential or special damages, or for transportation, installation, adjustment, or other expenses which may arise in connection with such products or parts. Determination of what is a defective part, assembly or product is the sole responsibility of DECTRA CORPORATION personnel. The obligation of DECTRA hereunder with respect to any products or parts shall be to replace, or at its option, to repair parts determined to be defective in materials or workmanship. Correction of any such defects by repair or replacement shall constitute fulfillment of all obligations of DECTRA to the Purchaser hereunder.

DECTRA assumes no liability for labor or any other expenses incurred by anyone without DECTRA's express written consent.

No person, agent or representative is authorized to give any additional warranty on behalf of DECTRA or assume for DECTRA any other liability in connection with any GARN® products.