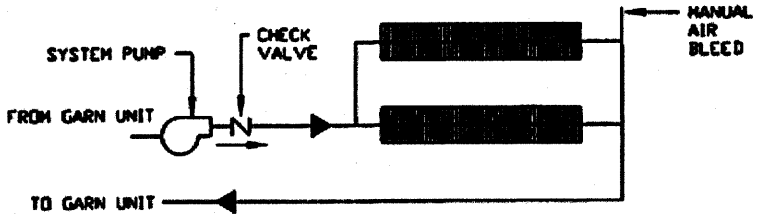
INSTALLATION MANUAL

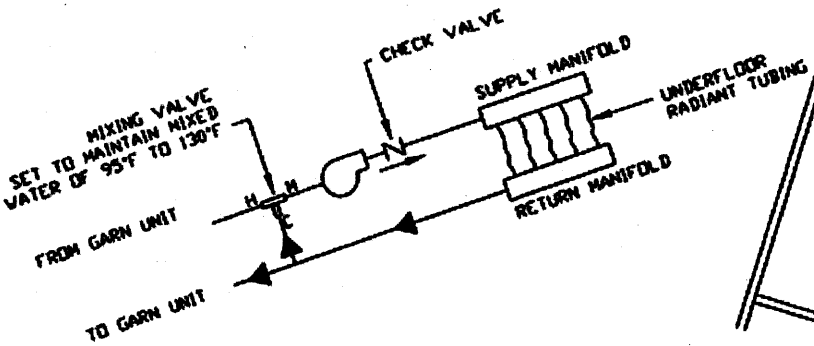
FOR

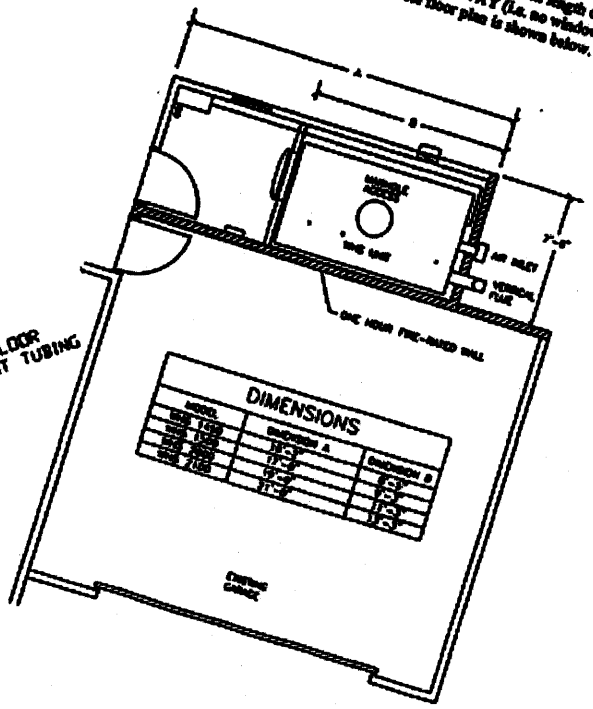
GARN® MODELS WHS 1350, 1450, 1500, 1900, 2000 & 3200



State and local codes, do not allow solid fuel appliances to be located in a garage. Gasoline fumes are heavier than air, thus settle on the floor of any garage and mix with the oxygen in the garage. One spark or hot ash from any wood unit could explosively ignite the fumes causing extensive property damage and personal injury or death.

Therefore, locate the GARN WHS unit outside the garage within 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 the garage. Firewall must extend from floor to ceiling and for the full length of the addition. There must be NO DIRECT CONNECTION OR PASSAGEWAY (i.e. no window or personnel door) between the garage and the "lean to." One possible floor plan is shown below.





GARN®

Innovators in affordable energy systems.

INTERTEK Warnock Hersey C US

INSTALLATION INSTRUCTIONS

GARN® MODELS WHS 1350, 1450, 1500, 1900, 2000 & 3200*

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 competent **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 listed**. Installer to supply and install all code required electrical over current and disconnect devices.

** See the WHS-3200 Addendum for specifics that apply only to the WHS-3200.*

TABLE OF CONTENTS

SAVE THIS MANUAL FOR FUTURE REFERENCE

DECTRA CORPORATION @ 3425 33rd Avenue Northeast, St Anthony, Minnesota 55418
Phone: 612-781-3585 Fax: 612-781-4236 Web Site: www.garn.com

A. CODES AND INSURANCE

The **GARN WHS** Wood Heat Storage 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 **CSA standard B366.1-M91** and **ETML 78-1.** It is to be installed according to this manual, the Unpacking and Assembly Manual, Federal, State and local codes, and your insurance underwriter's guidelines.

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.

Notice: 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 Fired Heat Storage Device** is unique and is covered by one or more of the following patents: United States Patents # 4,401,101 and # 4,549,526; Canadian Patents # 1,163,880 and # 1,220,686.

B. UNIT PLACEMENT

All **GARN WHS** equipment must be placed in a sheltered enclosed space; however, it is not necessary for it to be a heated space. When locating the **GARN WHS** unit, consider the following carefully:

- Clearance to all combustibles must be in compliance with the listing and labeling.
- A full 24" clearance is required between the **left side** of the door and nearest wall to the left of the unit, in order to allow the fuel-loading door to fully open.
- Traffic patterns past unit, i.e. service door, any overhead door, pump locations, etc.
- Source of electrical power and location of electrical panel.
- The routing and insulation of piping to the heating system.
- The vertical space requirements for access to the manway cover and anode rods on top of the unit.
- 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 within 10 feet (all models) of an 8-foot deep basement wall, this wall will need to be reinforced in order to prevent collapse of wall due to total weight of the GARN WHS unit plus water. Check with your local code official if you have any questions concerning proper placement of the unit. **Clearance to Combustibles**

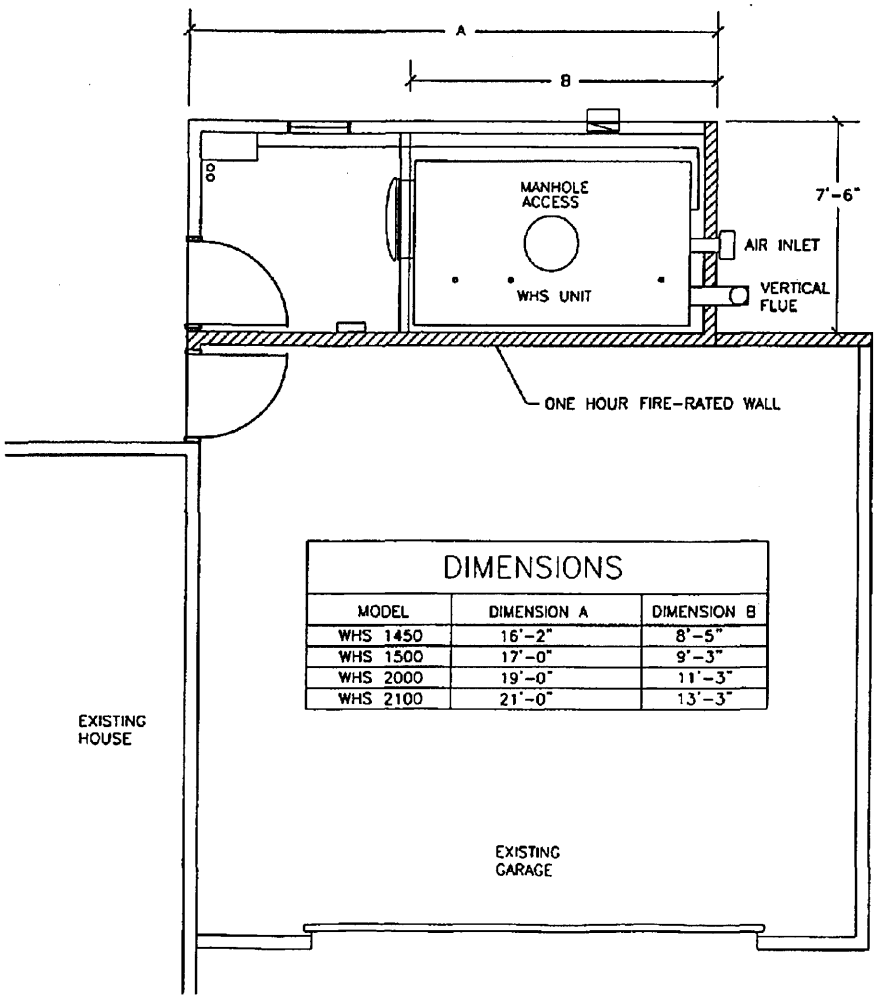
Unit must be placed on a non-combustible floor. Clearances to combustibles are listed below. The clearances shown are **minimum** clearances and must be adhered to during installation.

Rear	**2" (6" to 8" recommended for pipe clearance)**
Sides and top	**2"**
Draft inducer housing	**½"**
Front	**60" (allows for door swing and loading)**
Class A flue	**2"**

Garage Location

State and local codes, **do not allow propane, oil or solid fuel appliances to be located in a garage.** Propane and gasoline fumes are **heavier** than air, thus settle on the floor of any garage and mix with the oxygen in the garage. One spark from an electronic igniter or one hot ash from any wood unit could **explosively ignite** the fumes causing extensive property damage, personal injury or death.

Therefore, locate the **GARN WHS** unit **outside** the garage within 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 the garage. Firewall must extend from floor to ceiling and for the full length of the addition. There must be **NO DIRECT CONNECTION OR PASSAGEWAY** (i.e. no window or personnel door) between the garage and the "lean to." One possible floor plan is shown below.



DIMENSIONS

MODEL	DIMENSION A	DIMENSION B
WHS 1450	16'-2"	8'-5"
WHS 1500	17'-0"	9'-3"
WHS 2000	19'-0"	11'-3"
WHS 2100	21'-0"	13'-3"

Remote Building Location

Units may be installed in either heated or unheated buildings such as pole barns, sheds, or shops. The unit must be completely sheltered with enough room in front of it for fuel loading, periodic maintenance and clearance to combustibles.

Schematic plans for a stand alone, remote "**GARN BARN**" Energy Center have been included on the next two pages. The plans are **one suggestion** as to how to enclose your unit. The **GARN BARN** provides an attractive shelter that allows one to correctly store 4+ full cords of fuel wood under a protective roof facing south to allow solar drying of the wood fuel. It also allows the unit to be fueled without being exposed to bitterly cold winter weather and provides a safe location for pumps and controls.

Slab Recommendations

The **GARN WHS** unit must be set on a concrete slab on grade. The tables below provide data regarding skid pressures and standard allowable soil bearing capacities:

Skid pressure applied by each unit, by model:

WHS 1450	1710 psf
WHS 1500	1755 psf
WHS 2000	1810 psf
WHS 2100	1705 psf

Various soil types and their allowable bearing capacities:

Rock	8000 psf
Gravel	4000 psf
Sand	2000 psf
Loose sand, clay	1000 psf

- For most average soils with an allowable bearing capacity equal to or **greater than 2000 psf**, use a 4" thick 3000 psi concrete slab with 6 x 6 x 10/10 welded wire mesh reinforcement.
- For soils with an allowable bearing capacity **less than 2000 psf** use a 5 1/2"" thick 3000 psi concrete slab with 6 x 6 x 10/10 welded wire mesh reinforcement.
- The slab width and length should at least equal the **enclosure size** and have reinforced edges.
- Consider trenching for and location of pipes (depth, direction) and other underground utilities.

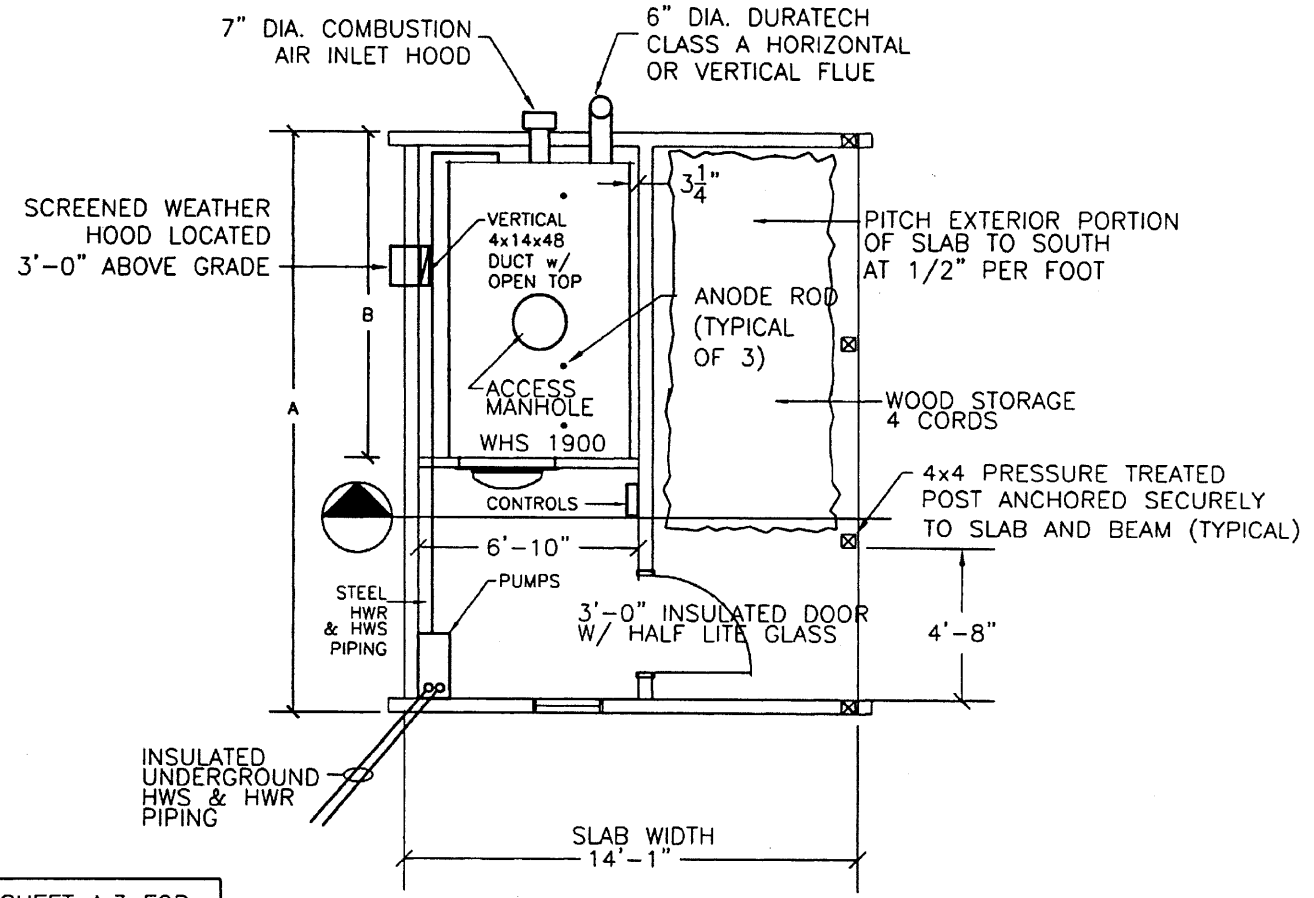
Setting of the Unit

Once the location is determined, set and center each skid on 1-1/2" thick x 16" wide blue, yellow, green or pink foam board (**extruded** polystyrene foam – minimum of 1.6 PCF density, per ASTM C 578-95 specification). **DO NOT USE WHITE BEAD BOARD.** The foam should be cut to the length of the skids plus 2". Lever each side of the tank off the ground and slide the foam under the skids. The compressive strength of this type of foam board is approximately 3,100 psf.

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.

THE GARN WHS MAY BE LOCATED WITHIN THE BUILDING TO BE HEATED OR WITHIN A SMALL REMOTE BUILDING AS DETAILED IN A.1, A.2 AND A.3

SUGGESTED DIMENSIONS		
MODEL	DIMENSION A	DIMENSION B
WHS 1450	16'-0"	8'-0"
WHS 1500	17'-0"	9'-0"
WHS 1900	18'-0"	10'-0"
WHS 2000	19'-0"	11'-0"

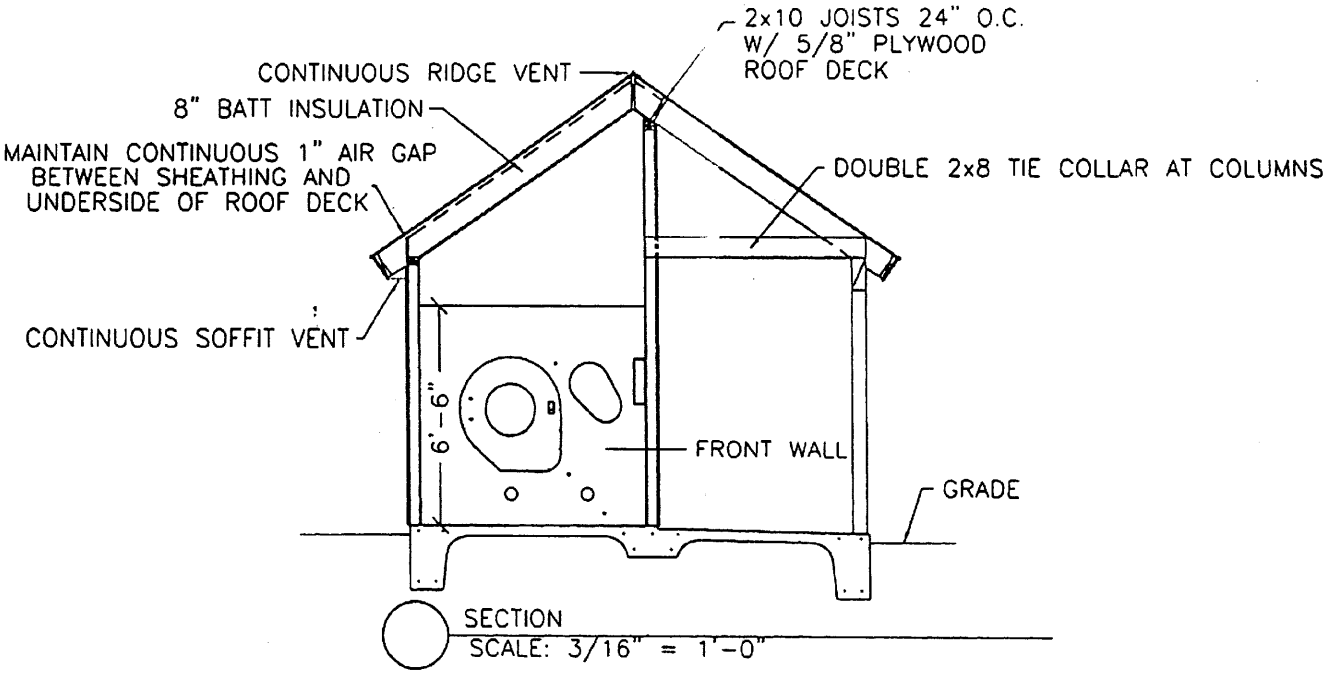


SEE SHEET A.3 FOR CONSTRUCTION NOTES

FLOOR PLAN
SCALE: 3/16" = 1'–0"

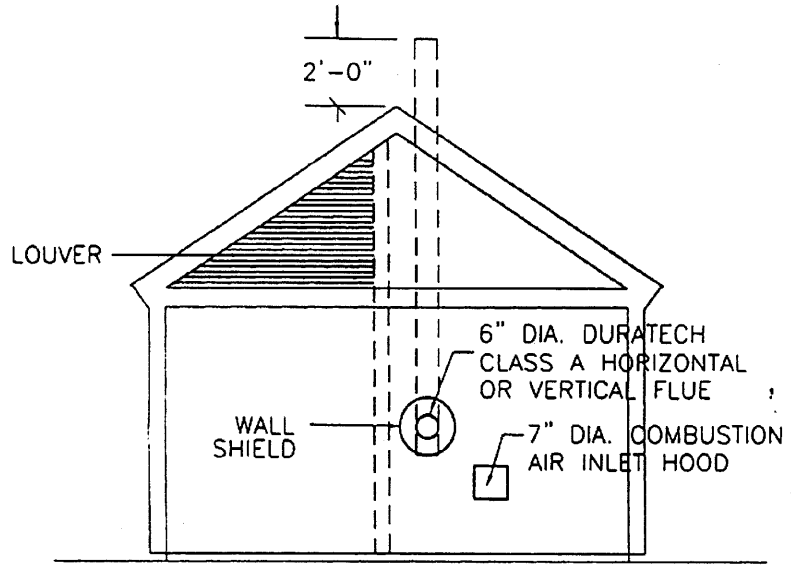
SOUTH

A.1	GARN® 1450/1900 WHS ENERGY CENTER			Dectra CORPORATION

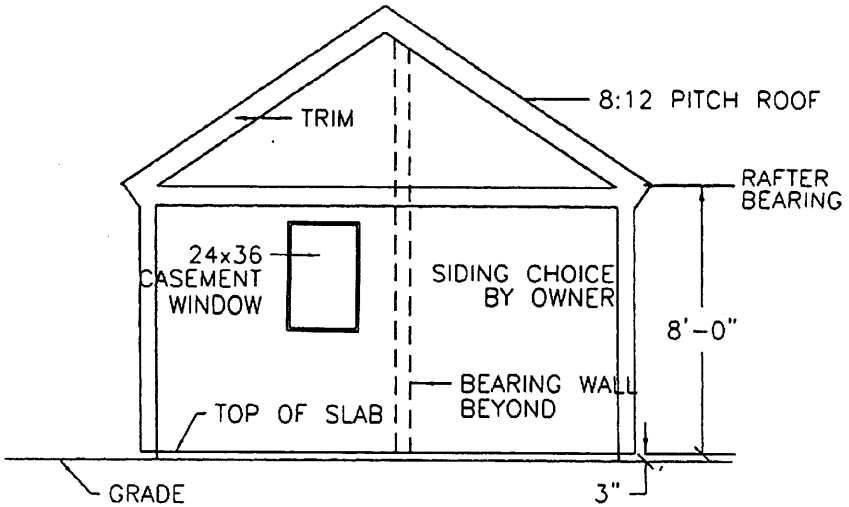


SECTION
SCALE: 3/16" = 1'-0"

SEE SHEET A.3 FOR CONSTRUCTION NOTES



EAST ELEVATION
SCALE: 3/16" = 1'0"



WEST ELEVATION
SCALE: 3/16" = 1'-0"

A.2	GARN® 1450/1900 WHS ENERGY CENTER		**Dectra** CORPORATION

CONSTRUCTION NOTES

Drawings A.1 and A.2 represent one of many design options for a **GARN Micro Energy Center** building. However, the design and construction of any such facility **must comply** with all local, state and national codes including wind uplift criteria (windier areas will require stronger fastening methods to keep the roof and framing from being lifted off the foundation by strong winds). It is the contractor's sole responsibility to ensure compliance with such codes.

All electrical wiring shall be in **strict compliance** with the National Electric Code (NEC).

Installation of the **GARN WHS** unit shall be in **strict compliance** with the manuals provided with the unit.

The **footing/foundation** may be constructed as a reinforced floating slab (schematically shown) or may utilize spread footings and a conventional slab. Assuming reasonable soils (bearing capacity of 2000 PSF or greater), a 4" thick concrete slab with 6x6x10/10 wire mesh is sufficient to carry the weight of **GARN** unit. In all cases, standard good engineering practice dictates pouring the slab upon 6" to 8" of well-compacted class 5 highway gravel. Final foundation and slab design is the sole responsibility of the local engineer or contractor.

The **exterior walls** are constructed as follows: siding, tar paper or Tyvek, ½" plywood or OSB sheathing, 2 x 4 wood studs @ 24" on center, 3.5" fiberglass insulation, 6 mil vapor barrier and ½" or 5/8" sheetrock. ¾" exterior plywood is recommended as the exterior siding in the wood storage area to resist abrasive wear. The 4 x 4 posts and the bottom plate of all walls must be pressure treated and anchored securely to the concrete slab.

The **roof** is constructed as follows: shingles, tarpaper, 5/8" plywood or OSB, 2 x 10 joists @ 24" on center and aligned with wall studs, a maximum of 8" fiberglass insulation where appropriate, 6 mil vapor barrier and 5/8" sheetrock. Maintain a 1" air space over the insulation and install proper soffit and ridge vents. The vaulted roof/ceiling allows access to the manway on the top of the **GARN** unit. The south facing portion of the roof may be sheathed with translucent fiberglass or tempered safety glass to enhance the drying of the firewood in the storage area.

The **front wall** at the **GARN WHS** unit is constructed as follows: 5/8" sheetrock over 16 gauge metal studs. **Do not** install sheetrock between the metal studs and the face of the **GARN** unit. **Do not** use wood studs for framing the front wall. The front wall is to be constructed to a height of 6' – 6" to allow access to the top of the **GARN** unit. Set the **GARN WHS** unit on foam board according to the manual.

Insulate the **GARN WHS** unit in **strict compliance** with the manuals provided with the unit.

Install **only** DuraTech brand class A flue components (this is a listing requirement) including a wall shield at the rear of the **GARN** unit or appropriate ceiling and roof shield on vertical installations. Install all flue components in strict compliance with manufacturer's manual.

Because the **GARN WHS** unit utilizes an induced draft combustion blower a vacuum relief duct is required. Thus a vertical 4" x 14" sheet metal duct is installed along the north wall (refer to drawing A.1) within the insulation. The outdoor portion consists of a screened weather hood positioned 36" above grade. The top of the duct is open-ended and terminates above the insulation that surrounds the **GARN** unit. The upper end may also be screened. No damper is required.

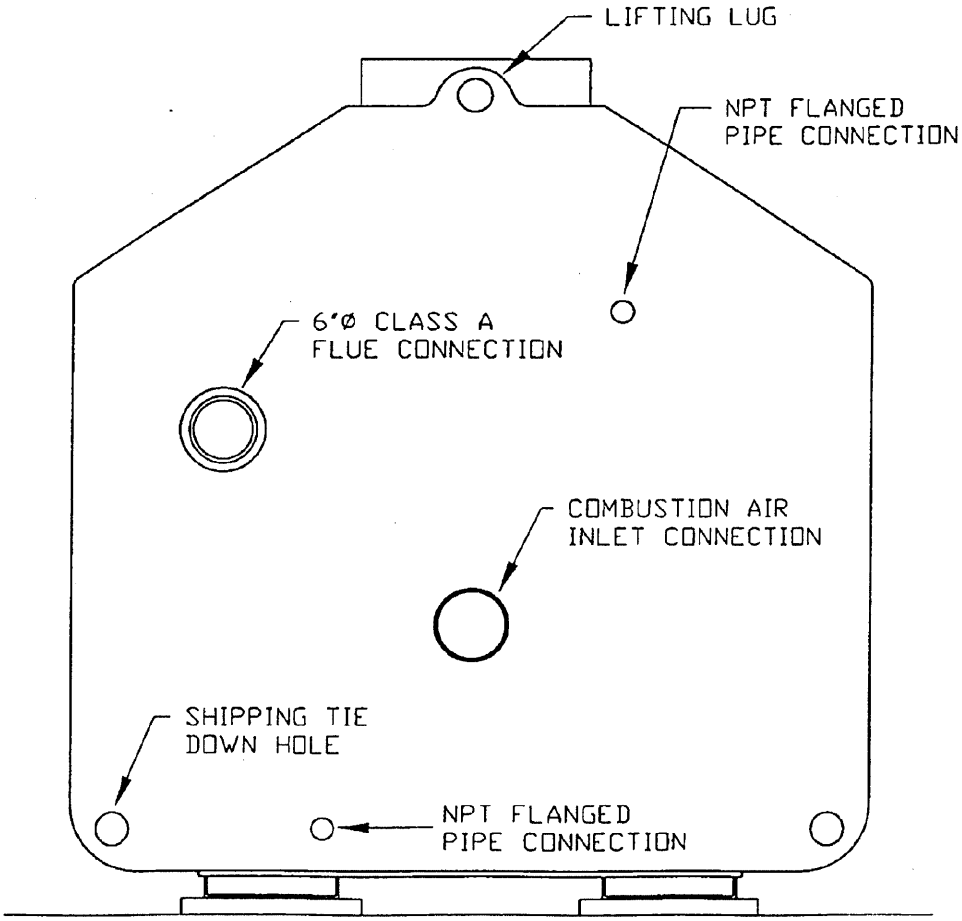
GARN WHS
ENERGY CENTER

A.3

C. COMBUSTION AIR INLET INSTALLATION

As a direct-vented appliance, the **GARN WHS** unit complies with NFPA 211 that states in section 6-6.1.1, "Direct vent appliances shall be listed and shall be installed in accordance with their listing and the manufacturer's instructions." Refer to NFPA sections 6-3.5 and 6-6.1.2. Venting recommendations are discussed in **section E.**

The drawing below shows the location of the various fittings on the rear head of the unit. Specifically, note the location of the combustion air inlet connection and the Class A flue connection as these will be discussed in the following paragraphs.

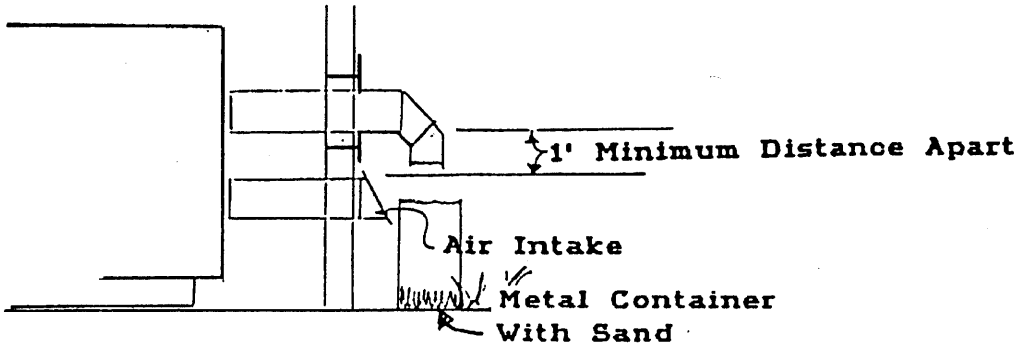


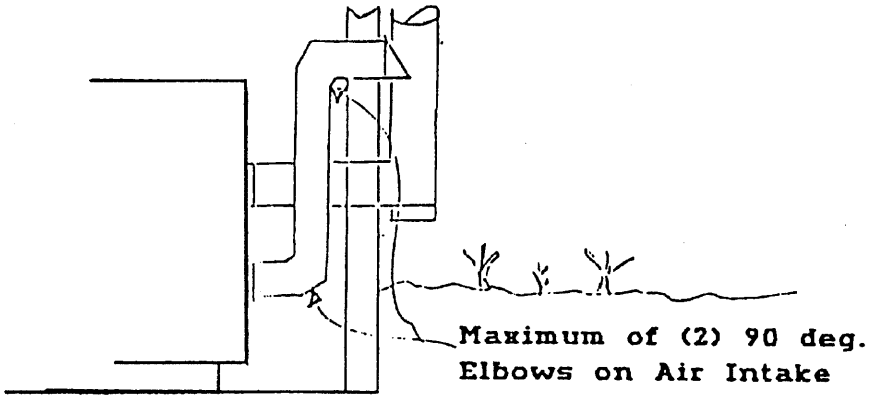
Air Inlet Installation – Models WHS 1350, 1450, 1500, 2000 AND 2100

Combustion air for the **GARN WHS** unit is brought in from the outdoors through a 7" diameter single walled duct. The unit is to be operated **ONLY** when 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 feet when using 7" diameter duct. It is connected to the lower 6" diameter pipe extending from the back of the **GARN WHS** unit with a 7" x 6" reducer fitting and a collar clamp. The combustion air inlet duct does not require a wall thimble. The air inlet should extend above any obstructions and possible snow drifts. The outdoor portion of the inlet duct **must** consist of a 7" diameter fresh air intake hood (similar to a dryer vent **without** a back draft damper) with a galvanized ¼ or ½ inch mesh screen. The hood is provided as part of your **GARN WHS** unit; the other items are available from your local hardware store or heating contractor.

The **total** air pressure drop through the air intake duct must not exceed 0.10 inches of water at 70 degrees air temperature at a flow rate of 300 CFM. Inlet screens must be checked for freeze over during cold weather.

NOTICE: The air intake should be at least 12 inches lower than the exhaust vent if both terminate on the same surface or 24 inches lower than the exhaust vent if exhaust is not terminated on the same surface.





Operating the GARN WHS unit without an inlet hood or without the specified inlet hood will significantly decrease airflow into the unit resulting in inefficiency and the creation of creosote.

D. EXHAUST FLUE SELECTION

DO NOT CONNECT THE GARN WHS PRESSURIZED FLUE TO A CHIMNEY FLUE THAT SERVES ANOTHER APPLIANCE.

The **GARN WHS** unit can be purchased with either a rear, horizontal flue connection, or a top, vertical, flue connection. Both come with a **DuraTech brand Class A** flue connector. DuraTech Class A 2100 F HT stainless steel flue sections are affixed to this connector to carry away the flue gases. **NO** other flue (brand, size or material) is to be connected to a **GARN WHS** unit. The flue gases coming from the Draft Inducer are pressurized. This means that **all joints,** both inside and outside of the building, must be caulked with silicone caulk and/or sealed with self-adhesive aluminum tape. The first section connected to the back of the **GARN WHS** unit **MUST BE SILICON SEALED TO THE CONNECTOR and TANK.** In addition, three #10 x ¾" long self drilling/self tapping SS screws are to be driven thru the flue flange into the tank mounted receiving flange to prevent separation of the flue.

Strictly follow DuraTech's installation instructions. A 2-inch clearance must be maintained between the Class A flue and any combustible material; however, **non-combustible** insulation may be in direct contact with the outside surface of the flue if passing through a non-combustible material. Once outside the building the flue may be terminated either horizontally or vertically (see below).

GARN WHS 1350, 1450, 1500, 1900 and 2000 models utilize a 6" diameter flue. Shown below is the "**Flue Warning**" label that is placed on every **GARN WHS** unit near the DuraTech brand Class A flue exhaust connection.

FLUE WARNING

Use only DuraTech brand Class A 2100 F HT flue and accessories. All other brands or types of flue will not safely connect to the GARN® unit, and will void the ITS/Warnock Hersey listing. Refer to the Installation Manual and flue manufacturer's instructions for flue installation details.

E. EXHAUST FLUE INSTALLATION

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, national and state codes. The following is a partial summary of those codes as they apply to **GARN WHS** equipment:

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

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

- Within 20 feet of a powered air inlet into any building or structure (except for the **GARN WHS** combustion air inlet).

- Within 20 feet 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 feet 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 18 inches from building siding when the discharge is aimed **away from** the building.
- When wood or vinyl is the siding 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.

In addition, flue gas shall **NOT** be discharged **vertically:**

- Less than 2 feet above any building component within a 10 feet radius of the flue. The vertical flue must extend at least 3 feet above the roof surface where it penetrates the roof.
- From a building with wood shingles (cedar shakes), etc. due to fire hazard.
- If chimney is under a large tree due to fire potential in fall (power exhaust with dried leaves).

CAUTION: Failure to follow the above installation directions will cause reduced unit performance and a possible hazardous condition may develop.

Horizontal Sidewall Flue

The flue extends horizontally through the wall using the DuraTech brand Wall Radiation Shield to maintain safe clearances to combustibles. The end of the flue should terminate no closer than 18" from building siding. A single wall, 6" diameter, adjustable stainless steel elbow is fitted onto the end of the flue. The elbow is screwed onto the class A flue and diverts the flue gases downward at an approximate angle of 45 – 90 degrees. Run a bead of Hi-Temp Silicon around the elbow where it contacts the Class A flue to prevent separation.

A ½" mesh screen is to be installed on the end of the elbow as a spark arrester and animal barrier. This exhaust screen is to be checked prior to start-up each season and for freeze over periodically during cold weather.

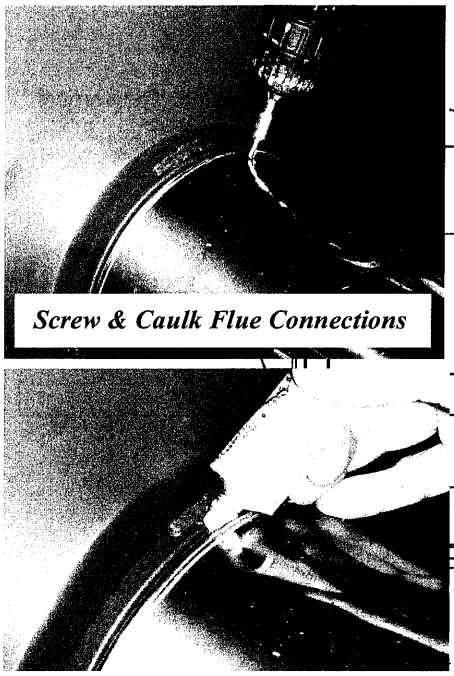
A **METAL CONTAINER** partially filled with sand should be placed below the angled stainless steel elbow to catch any fly ash or sparks that may exit the exhaust. The container should be at least 2 feet laterally from any combustible surface and 6 feet from any combustible surface above it. **DO NOT USE A PLASTIC CONTAINER.** Fasten a ½" to ¾" mesh wire screen over the top of the container to prevent the entrance of dry leaves, animals, birds, etc into the container. Delete the screen where the flue enters the container.

CAUTION: When the sidewall discharge is used, 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 and generally follow flue manufacturers recommendation.

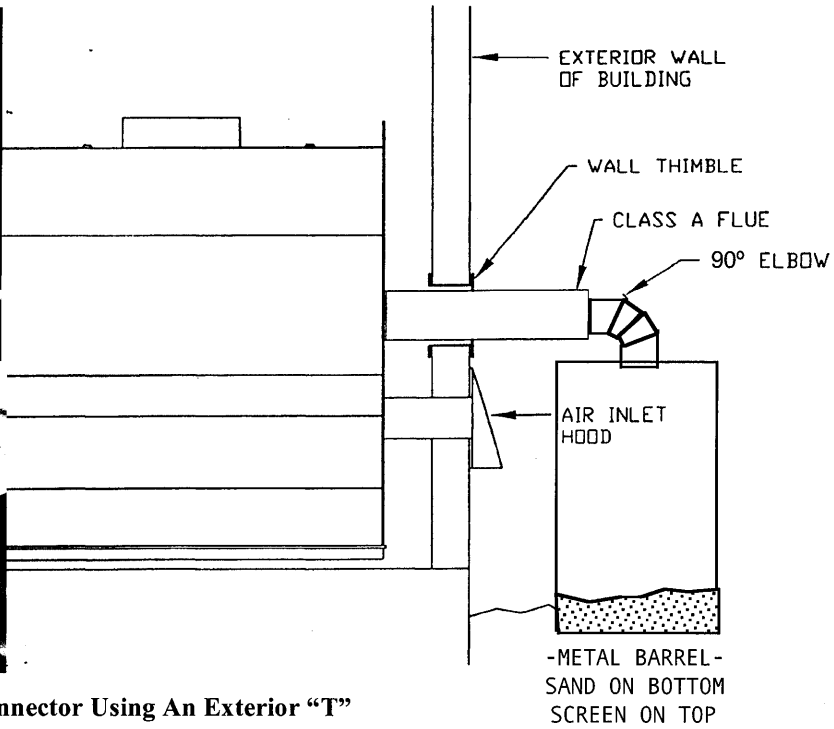
Depending on the fuel used and frequency of firing, the volume of initial smoke coming from a horizontal sidewall flue may be a nuisance. If windows or doors are in or near the smoke path, a vertical flue should be used. Likewise, if the horizontal sidewall flue discharges into a confined space between two buildings, a vertical flue must be used. Refer to the accompanying chart for **minimum** specified clearances to various architectural features (such as windows) or materials.

WARNING: Maintain a clean area free of any combustible debris such as leaves, trees, plants, grasses, paper, wood, tires, oil, etc for a distance approximated by a circle with a radius of at least 15' centered on the flue elbow discharge. This is especially important during dry weather in the Spring and Fall.

CAUTION: Depending on your firing rate and fuel type, the cool surfaces of the metal container may become lightly coated with ash and creosote. The accumulated ash and creosote should be removed periodically to minimize the potential of a creosote fire.



Screw & Caulk Flue Connections



Vertical Flue From A Horizontal Connector Using An Exterior "T"

If the GARN unit has a horizontal flue connection, and a vertical flue is required or desired, utilize only **DuraTech Class A 2100 F HT** flue components installed in strict accordance with DuraTech installation instructions. Mount the vertical flue on the exterior of the building. **DO NOT** install a vertical flue **within** a building unless approved by your local building inspector. Installation will require the use of the following additional DuraTech Class A 2100 F HT components:

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

Diagram Showing Vertical Flue Using An Exterior "T" From DuraTech

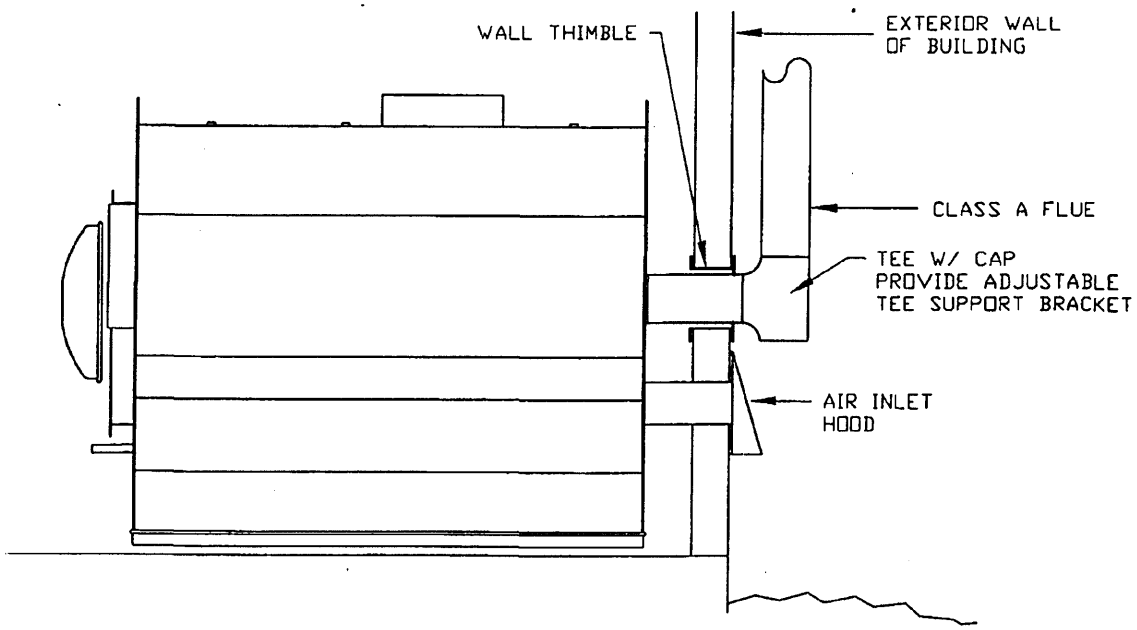
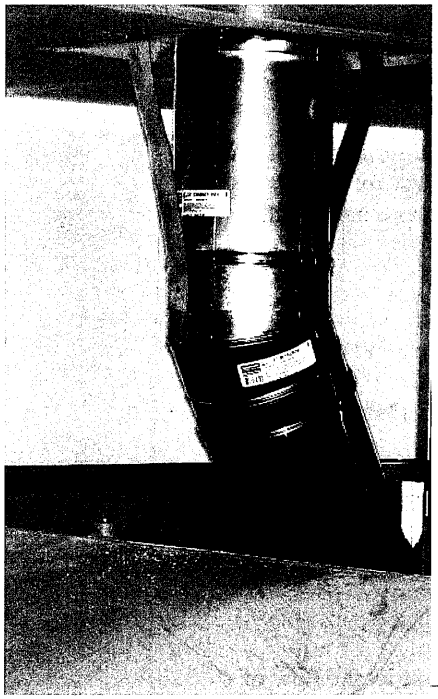
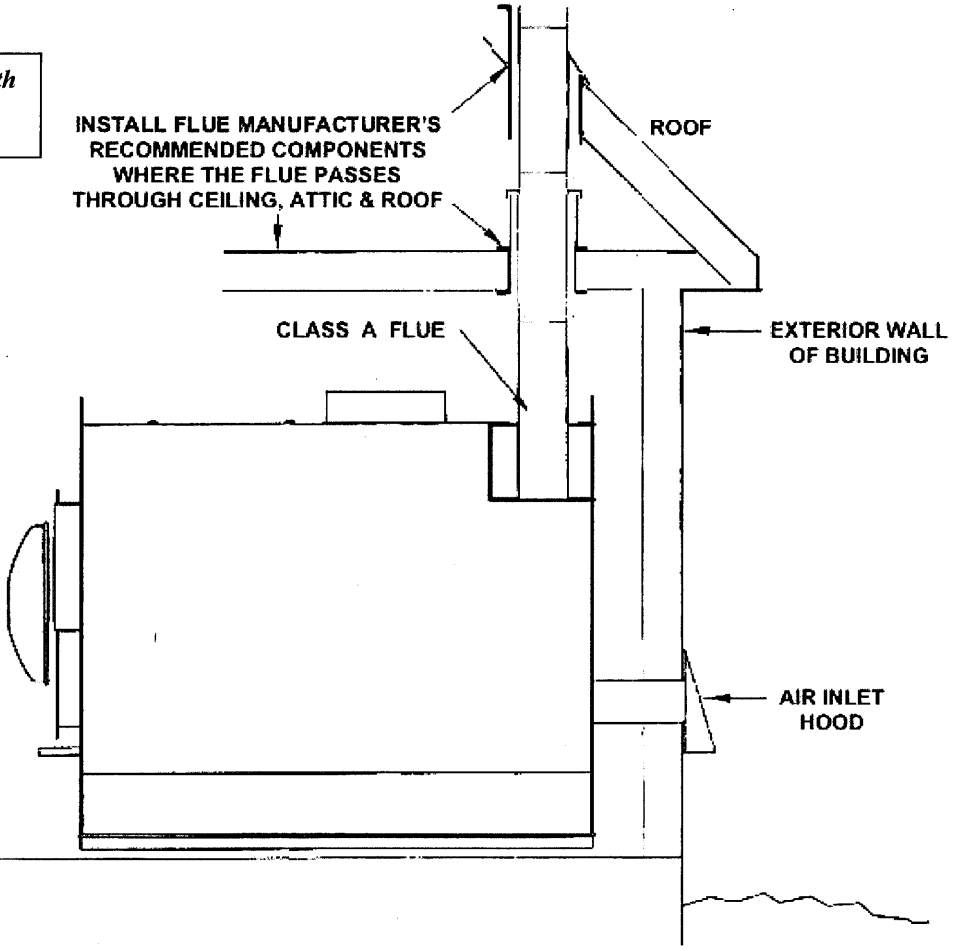
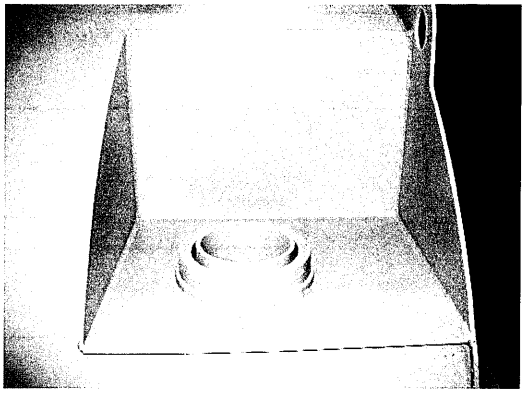


Diagram Showing The GARN Unit With The Factory Vertical Flue Connection





GARN's Vertical Flue Connection



The **GARN WHS** unit can also be purchased with a top vertical flue connection. Utilize only **DuraTech Class A 2100 F HT** flue components installed in strict accordance with DuraTech installation instructions. Installation will require the use of DuraTech Class A 2100 F HT components to pass through the ceiling, attic and roof.

Connect and seal the flue connections as indicated above.

Vertical Flue Height

The vertical flue must extend to a height not less than 2 feet above any building component within a 10 feet 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 feet 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; some States may have minimum flue height requirements.

NOTE: A vertical flue should not be used if the building has wood shingles or if the flue would have tree's branches above it.

Connection to a Masonry Chimney

Only under limited circumstances may a **GARN WHS** unit be connected to a masonry chimney. Masonry chimneys are designed for heating devices that burn continuously in cold weather. Because the **GARN WHS** unit 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 feet. The maximum total static pressure loss in the vertical portion of the existing flue must not exceed .10" of water column at a flow rate of 375 CFM.

ONLY STAINLESS STEEL LINER COMPONENTS ARE TO BE USED. The performance of the **GARN WHS** unit can be seriously hampered by an improper connection to a (or an improperly constructed) masonry chimney and a **DEADLY** condition may result.

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** unit is located within a recessed area such as a basement, a carbon monoxide detector mounted close to the floor is required.

CAUTION: In any flue configuration, failure to seal **ALL** flue joints inside a building **WILL** result in harmful levels of carbon monoxide and carbon dioxide being introduced into the space. If strong smell of wood smoke is noticed – **LEAVE THE ROOM AND VENTILATE THE SPACE IMMEDIATELY.**

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 flue manufacturer's recommendation.

F. FLUE CAPS

DO NOT INSTALL A FLUE CAP on a vertical chimney as the cap will unduly restrict the flow of exhaust gas due to increased back-pressure. Restricted exhaust gas flow will decrease overall efficiency and may create a creosote condition within the GARN unit.

G. ADDITIONAL COMMENTS

If burned correctly, wood is a wonderful **rural** fuel that unlike coal or fuel oil is "carbon neutral." Carbon neutral means that if wood is combusted properly, it produces the exact amount of carbon dioxide required to grow another tree equal to the tree that was either burned or allowed to rot on the forest floor. Wood is generally not recommended as a primary fuel for housing:

- In most suburban locations.
- In most city locations.
- To heat an outdoor swimming pool during the summer months.
- To heat domestic water. Solar heating is a better as a primary heat source.

Improperly combusted wood fuel produces emissions that are toxic to humans and animals. These emissions include, but are not limited to: finely atomized liquid oils (creosote), very fine particulates, aromatic hydrocarbons, polycyclic organic matter, carbon dioxide, carbon monoxide, etc. Most of these are easily drawn into one's lungs during normal breathing. However, complete combustion can reduce these by products significantly as most of these chemicals are fuels.

Population densities in suburban and urban locations create significant local air shed pollution issues that essentially and reasonably preclude the use of coal, wood and even some oil fuels even if combustion is mostly complete. Housing in such locations must do the following in order to help curb the concentration of unwanted emissions:

- Conserve energy by installing good insulation and caulking.
- Install only double glazed, argon filled energy efficient windows.
- Install insulated thermally efficient doors and storm doors, with good quality weather stripping.
- Install an air-to-air heat exchanger to provide ventilation. This uses the building's exhaust air to pre-heat the in-coming ventilation air.
- Insulate and caulk all rims joists.
- Insulate basements walls from floor to ceiling with methods that prevent the formation of mold and mildew.
- Utilize passive solar techniques whenever possible.
- Install water saving toilets, showers and faucets through out the residence.
- Utilize a high efficiency natural gas condensing furnace or boiler to provide space and domestic water heating.
- Install only high SEER air conditioning equipment with variable speed fans to effectively control indoor relative humidity.

The above items alone or as a group will reduce fuel usage and yearly fuel costs. At the same time they create a very comfortable healthy housing unit for the occupants as well as a healthier local air shed. And the above items will provide the user a reasonably quick return on his/her energy investment dollar. Not only because of the fuel savings, but also because of less expensive heating, ventilation and air conditioning systems due to reduce heating and cooling loads.

So what about swimming pool heating? This is best accomplished utilizing solar heating and/or an evaporation prevention blanket. Solar heating has proven cost effective, dependable and efficient for many years in many countries. Solar heating is not an "outside the mainstream" idea. In fact, it is efficient in almost every area of the US. Most people do not realize that a swimming pool requires a heater that may be several times the size and capacity of their residential space heater. However, during the spring, summer and fall the amount of energy required to heat a pool is easily provided by solar panels. All without emissions that exacerbate the local air shed pollution problem.

Remember this: Eliminating fuel usage is the same as burning fuel with absolutely **zero emissions** - impossible for any fuel even natural gas! A well-designed and constructed energy efficient building can reduce heating demand (thus fuel usage) by at least half, and sometimes by two-thirds when compared to a present day "code built house." This is critical in urban or suburban location.

H. INSULATION OF GARN WHS EQUIPMENT

CAUTION: Construction of the insulation enclosure around the GARN WHS unit shall utilize **ONLY NON-COMBUSTIBLE MATERIALS** such as sheetrock, galvanized metal studs and sheet metal for all wall surfaces. **DO NOT USE WOOD, PLYWOOD, PARTICLE BOARD, ORIENTED STRAND BOARD, ETC.**

Minimum clearances between any surface and the GARN WHS unit are:

Rear		**2" (8" recommended for pipe clearance)**
Sides and top		**2"**
Draft inducer housing	**½"**	
Front		**60" (allows for door swing and loading)**
Class A flue		**2"**

MAINTAIN A CLEAR AND CLEAN 60" MINIMUM DISTANCE THE FULL WIDTH OF THE GARN UNIT IN FRONT OF THE GARN UNIT.

DO NOT STORE COMBUSTIBLE MATERIALS INCLUDING MATCHES, PAPER, KINDLING, WOOD, OIL, GASOLINE, RAGS, CLOTHING, ETC WITHIN THIS AREA OR ABOVE THE GARN UNIT. DO NOT ALLOW THE ACCUMULATION OF BARK, SAWDUST, SHAVINGS, KINDLING, ETC WITHIN THIS AREA.

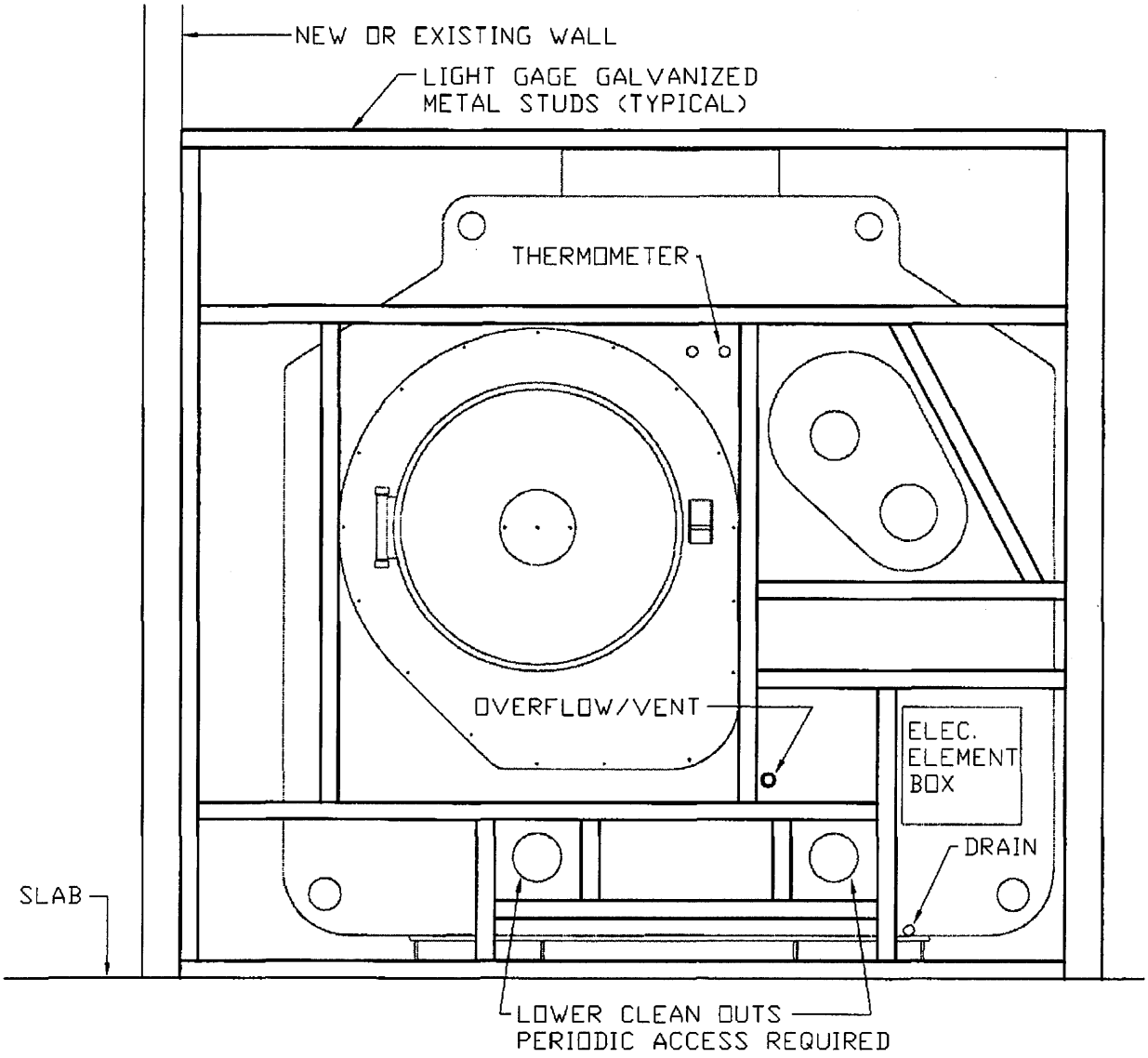
Construct the insulation enclosure around the **GARN WHS** unit utilizing 3" x 1 5/8" x 18 gauge galvanized steel studs and 5/8" sheetrock. Install per stud manufacturer's directions. Tape all joints after the sheetrock is securely fastened into final position.

1. Utilize 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, the sheetrock is to be cut around the air collar, draft inducer housing and electric element box. Maintain a dimension of 4" from the surface of the tank to the exposed (exterior) surface of the sheetrock. This will allow the sheetrock to slip behind the 2" steel flange that surrounds the air collar. Fasten the sheetrock to the flange utilizing 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 as necessary 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. (Review the drawing on the next page).

3. Provide access to the two lower cleanout covers as access for flue cleaning will be required on a routine basis. Simply 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** unit 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. Install and fasten in place according to the National Electrical Code. Wiring is to be only installed by a Licensed Electrician.

6. Properly ground the **GARN WHS** unit 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. It is essential that insulation completely surround the **GARN WHS** unit. Use **ONLY** the following types of NON-**COMBUSTIBLE INSULATION**:

   - Vermiculite
   - Dense pack blown in non-binder fiberglass or rock wool
   - Unfaced glass fiber batts
   - Unfaced rock wool batts

   Vermiculite insulation will naturally "flow" beneath the unit. However, if blown-in or batt insulation is used, be sure to slide unfaced batt insulation beneath the GARN unit, between the skids and within the skids.

CAUTION: **DO NOT USE FOAM BOARD OR FOAM BEADS AS BOTH WILL MELT AND ARE A FIRE HAZARD. DO NOT USE CELLULOSE INSULATION AS THE ACID TREATMENT OF THE CELLULOSE INSULATION WILL CORRODE THE STEEL TANK. DO NOT INSTALL INSULATION WITHIN THE ELECTRIC ELEMENT BOX.**

8. Fill the insulation enclosure to a level about 6" above the tank portion of the GARN WHS unit. Steel studs may be extended across the top of the tank to fasten opposite enclosure walls together. Prevent loose insulation from falling into the manway opening. The manway cover does not need to be insulated as the heat loss through it is minimal.

9. In an industrial setting, the **GARN WHS** unit 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.

CAUTION: **The GARN WHS unit is non-pressurized. As such, the manway cover should just rest on the manway opening. In a case of rapid boiling, the manway cover is designed to allow for the rapid escape of water vapor. Therefore, DO NOT FASTEN, BRACE OR ADD WEIGHT TO THE MANWAY COVER SO THAT IS UNABLE TO FUNCTION PROPERLY.**

I. WATER TREATMENT CHEMICALS

GARN® WHS WATER TREATMENT PROGRAM

CORROSION PROTECTION IS THE SOLE RESPONSIBILITY OF THE OWNER

GARN equipment has always been fabricated from quality materials, utilizing 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 nor the level or frequency of ongoing chemical testing and maintenance. Therefore, corrosion protection is the *sole responsibility* of the owner. To this end, it is strongly suggested that every owner become a "proactive participant" in the protection of their investment and fully use this program.

There is *no warrantee 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.

Dectra Corporation is recommending the program offered by PrecisionChem Water Treatment of Waupun, WI. They provide a comprehensive product line and individualized services for GARN® WHS/ETS customers. ***Initial chemicals will be shipped to the new owner from the chemical supplier after they have tested the fill water sample you have mailed in.*** The PrecisionChem Water Treatment products and services are fully compatible with previously Dectra Corporation approved products and services.

ONGOING WATER TREATMENT PROGRAM

Be sure use and maintain the supplied water filter when filling or adding water.

The GARN® WHS water will be professionally tested biannually by PrecisionChem Water Treatment to ensure proper and appropriate monitoring. Full participation is vital to the system's protection. Twice a year you will receive a card reminding you to send a water sample in with the sample bottle shipped with your last chemicals or test results. The sample bottle needs to be filled and returned per the instructions.~~a~~

PrecisionChem Water Treatment will complete a full analysis of the sample. Results and recommendations will be shipped to the owner. Large amounts of sludge or "dirty" water should be noted when the water samples are sent in.

Chemical level, corrosion potential, scale/sludge potential, and biological fouling (bacteria and fungus) are examples of things that will professionally monitored. Recommendations are to be followed, and necessary actions taken, to ensure positive results. This program supports only PrecisionChem Water Treatment products and services.

Periodic dosing of additional CLT-551 chemical is to be expected. It may also be required to add other chemicals to remedy specific conditions or problems (ex. Biocide to kill bacteria following a positive test result for presence of bacteria). These chemical additions will be based on viable testing and require appropriate and prudent action.

DO NOT add oxygen scavenging chemical compounds (i.e. sodium sulfite, sulfite, meta sulfite, bisulfite). These materials are inappropriate for GARN® WHS equipment and will result in corrosive conditions and early tank failure. GARN® WHS units are not an "open" system, such as a steam boiler, and should not be chemically treated as such.

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.

CORROSION and WATER QUALITY CONCERNS

BACTERIOLOGICAL CORROSION
Only about 9 % of GARN WHS and ETS owners have had a corrosion problem; it appears that most of those have been bacteriological in nature. Bacteriological corrosion is highly unpredictable; however, once active it can corrode through a tank in a few months. As indicated in the past, visual inspection, periodic testing and periodic cleaning coupled with ongoing chemical treatment is one of the most effective programs for corrosion prevention.

WATER POLLUTION
There exists a wide range of "normal" water available to GARN WHS and ETS owners. 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 20 years, national surveys have shown a significant increase in the number of polluted rural wells, thus compounding the already complex corrosion problem. As a result, it has become obvious that corrosion is a complicated issue requiring professional attention and ongoing owner maintenance.

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, but should be monitored on a regular basis to detect any changes.

Under deposit corrosion - occurs under any material that prevents water treatment chemicals from plating a bare steel surface. This will occur under sludge that may form on the floor of the tank or other horizontal surfaces. Note any corrosion (refer to Appearance section below) and wire brush or sand blast to bare steel. Recently manufactured equipment has an epoxy-coated floor to help minimize this problem.

Bacteriological corrosion - discussed in detail above. Refer to Appearance section below.

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 (refer to Appearance section below) and wire brush or sand blast to bare steel.

Crevice corrosion - essentially a form of under deposit corrosion. Occurs where two pieces of steel lie against each other (but are not welded together) effectively preventing water treatment chemicals from plating the adjacent bare steel surfaces. Does not occur in GARN equipment as all internal joints are seal welded. This condition cannot be visually inspected as the steel surfaces lie very close together.

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 equipment and/or an improperly grounded electrical service to a building. No known water treatment program 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. Sacrificial anode rods further help reduce the potential for this type of corrosion (refer to Appearance section below).

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 discontinuity or pipe fitting) is generally electrolysis.

WARNING

CONNECTING TO AN EXISTING OR GLYCOL TREATED DISTRIBUTION SYSTEM

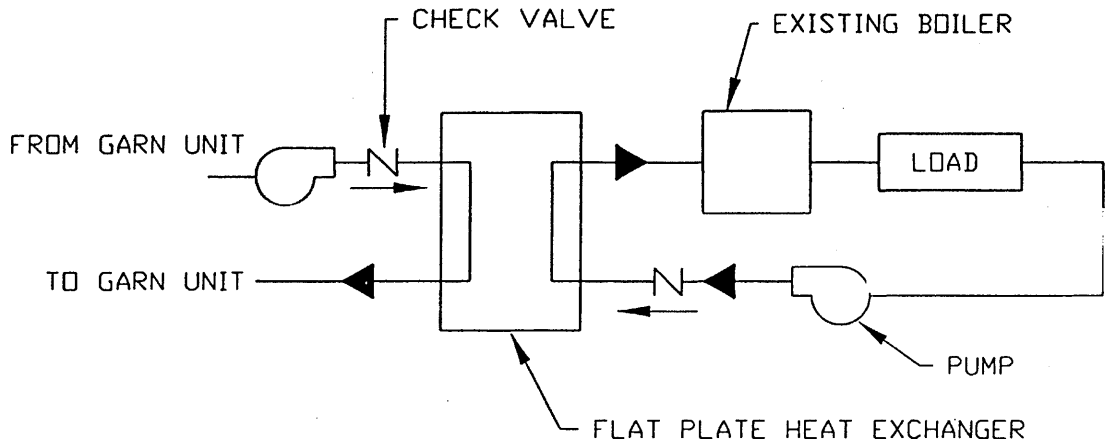
WARNING: Do **NOT** connect your GARN® WHS or ETS unit to an old, dirty or glycol treated existing hydronic system until the existing system has be thoroughly cleaned and flushed.

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.

WARNING: 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.

WARNING: Isolate GARN water from distribution system with a heat exchanger (see below). 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.

WARNING: 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. Sacrificial anode rods further help reduce the potential for this type of corrosion.
Carefully follow all procedures specified in the Installation and Operators manuals.



NEW BOILER SYSTEM FLUSHING AND RE-FILL WITH CHEMICAL

A GARN® WHS purchase includes the price of CLT-551 that is sized appropriately to provide the initial dose of chemical required for start-up. However, the system should always be filled, heated, flushed and re-filled prior to the CLT-551 being added. This will help remove any foreign materials within the GARN unit or piping system that result from the manufacturing, transportation and installation process.

Remove any internal accumulated dirt (from manufacturing, trucking, or on site construction) and thoroughly **flush wash** the entire inside of the tank as noted below:

PREFERRED CLEANING - Dectra encourages GARN owners to use a pre-wash to clean and prime the steel for the regular water treatment chemicals. This may be purchased with the GARN unit or directly from PrecisionChem after the unit is received. It is recommended for the flushing of new GARN® WHS installations. The PreCln-775 flush process can also be done at a time after initial start-up with the same excellent results. It is safe for all system components and should be circulated. The product is biodegradable and safe to add to a municipal waste sewer or drained onto an appropriate ground surface. **Do not** add to a septic system.

Using PreCln-775 will remove all manufacturing by-products (grease, mill scale, etc.) that may contribute to a dirty system and sludge formation. In addition, the mild steel interior surfaces are passivated or "*primed*" by the flushing chemical that enhances the CLT-551's ability to quickly establish a solid and uniform oxygen barrier at the metal surface. *This is equivalent to scraping, washing and PRIMING a surface before painting. You will use less paint and it will last longer. In this application, the surface preparation will ensure better protection and the need for less replacement chemical over time.*

This flushing procedure requires filling your system, adding required amount of PreCln-775 flushing compound, circulating your system (fired is best), and then completely draining the entire system followed by a short rinse of clean, fresh water. The system is then refilled and the CLT-551 product is added for ongoing corrosion and system treatment.

FILL WATER QUALITY - Much discussion could be made in regards to fill water quality, softened or unsoftened water, etc. The design of your GARN® WHS requires minimal make-up water if operated properly. This results in very low scale deposition potential (mineral deposits). Customers with very hard water of 14+ grains per gallon would see some benefit in softening the water supply Softened water does not mean proper treatment chemical can be excluded. In fact, softened water requires close attention to corrosion protection. **Chlorinated water should never be added** to any heating system. A water sample of the proposed fill water must be sent to PrecisionChem before they will ship the appropriate chemicals tailored to your system.

MONITORING - The chemical program will closely monitor the dissolved solid concentration that can have potential harmful effects to the GARN® WHS unit and system components. Dispersant additives or WHS draining may be necessary to keep the system clean, efficient, and corrosion free.

PrecisionChem Water Treatment • W7231 State Road 49 • Waupun, WI 53963 • Phone 1-920-382-6498

WATER FILTER INSTRUCTIONS

Connect the water filter to a standard garden hose with a brass fitting (MPT-- to hose thread). Use the filter and hose to fill the unit to a water depth of approximately 12". Add the water treatment chemicals, and then continue to add filtered, clean water until the GARN unit is full (water surface is 4" below the crown at the top of the tank). The above procedures are most easily accomplished through the manway on top of the tank.

Whenever additional water is added to the unit, utilize this filter so that sediment is **not** carried into the system. Replacement 5 micron filter elements are available from **DECTRA @ 1-612-781-3585**

INITIAL WATER TREATMENT INSTALLATION PROCEDURES

1. Upon delivery of a GARN WHS unit, cover the manway access to prevent the unwanted entrance of dirt, debris and water. Inspect the unit and notify the delivery driver and your GARN dealer of any problems.
2. Install the unit in full compliance with all federal, state and local codes and this Installation Manual. Do not insulate the unit until it has operated successfully for a few days.

PROPER CONNECTIONS AND GROUNDING

3. Properly ground the GARN WHS unit to help avoid electrolytic corrosion due to a "floating ground." DO NOT USE THE STEEL CONDUIT AS A GROUND CONDUCTOR. 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.
4. Do not install a copper, domestic water-heating coil within the tank as this may cause corrosion of the steel shell.
5. Attach only non-galvanized, black steel pipe to the GARN unit. If copper pipe is being used, please refer to item 6 below.
6. 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-flush is being done.

PROPER CLEANING AND FLUSHING - de-bug leaks with plain water.

7. Remove any internal accumulated dirt (from manufacturing, trucking, or on site construction) and thoroughly flush wash the entire inside of the tank with PreCln-775, and clean, filtered water. Drain all water and dirt. Visually inspect the interior of the tank (from the manway without climbing into the tank) to ascertain that the unit is OK to be filled with clean water.
8. NOTE: It is advisable to plumb the system so the entire distribution system can be isolated from the GARN unit. This will aid in testing for leaks and any replacement of components.

FILLING WITH PROPER WATER TREATMENT CHEMICALS

9. Initial chemicals will be shipped to the new owner direct from the chemical supplier after they have tested your water sample. Prior to filling the unit, carefully read and follow the instructions provided with the chemicals. Follow all safety procedures and retain the Material Safety Data Sheets. Store all unused material in a locked and safe location away from children and animals, but ALL the chemical should be added once the system becomes operational.
10. Fill the unit (using the water filter) to a water depth of 12". Add the initial quantity of treatment chemical according to the manufacturer's instructions and continue to add filtered, clean water until the unit is full (4" below the crown at the top of the tank). Check for and repair any pipe leaks.
11. 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 has dropped significantly.

PERIODIC TESTING IS A MUST

After one week of operation, obtain a treated water sample from the manway access. Forward it to the water treatment supplier for an initial chemical test. When drawing a sample, always fully rinse the container twice with the water being sampled before collecting the final sample to be submitted.

Every water treatment sample must be tested for at least the following: residual chemical concentration for each chemical additive; conductivity; pH; total dissolved solids; total iron; copper as Cu; and the concentration of bacteria (including both iron reducing and sulfur reducing strains) if bacteria tests positive in the sample. Upon receipt of the test results, adjust the chemical concentration as advised by the water treatment supplier.

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 WHS and ETS product is the manway access on the top of the tank. Its benefit is the ease with which GARN products 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, immediately take a 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. Once per year unscrew one of the magnesium anode rods, remove it and examine it for degradation (anode rods are also consumed while providing protection). If the rod is "in poor condition" contact DECTRA to order replacement rods. Install new magnesium anode rods without thread compound or Teflon thread tape. The rod thread must develop a good electrical contact with the tank fitting into which it is screwed. Do not install aluminum anode rods. Accelerated magnesium anode rod degradation may be a sign of electrolysis. Accelerated anode rod degradation may indicate the presence of a poor ground connection, a "floating ground condition" or stray voltage within the building wiring or electrical service to the building. Installation of a proper ground will help to minimize this condition. Contact a local electrician for additional grounding and stray voltage information.
6. Every three (3) to five (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); water recently treated with biocide (wait 4 to 6 months); 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 your water treatment company. Upon receipt of the test results, adjust the chemical concentration as advised during refilling. Depending upon the type of corrosion found, check the tank ground, building electrical ground and anode rods. Clean all corrosion spots thoroughly by wire brushing and flushing with clean water.
7. Refill the GARN unit in compliance with Initial Water Treatment Installation Procedures, above. Obtain a treated water sample from the manway access and forward it to the water treatment company for an initial chemical test. Use standard sampling procedures in obtaining the sample. Upon receipt of the test results, adjust the chemical concentration as advised.

J. RULES OF THUMB FOR AN INITIAL ESTIMATE OF EQUIPMENT SIZE

The following "rules of thumb" are just that – **approximate values** that may be used to estimate the size of the primary wood heating equipment. Once a project is given the "go ahead" an exact heat loss should be calculated according to ASHRAE methods to ensure the correct sizing of the various components. Over-sizing equipment leads to excessive first cost and inefficient operation. Under-sizing yields a system that may be excessively noisy and not maintain proper indoor temperatures during winter operation.

Residential Heat Loss excluding ventilation:

- Old houses or poorly insulated houses – 20 to 35 BTUH/sq. ft. of **above** grade floor area.
- Uninsulated, but heated basements – 18 to 30 BTUH/sq. ft. of **below** grade floor area.

- Newer houses – 13 to 22 BTUH/sq. ft. of **above** grade floor area.
- Insulated, heated basements – 10 to 20 BTUH/sq. ft. of **below** grade floor area.

- Energy efficient houses – 8 to 15 BTUH/sq. ft. of **above** grade floor area.
- Insulated, heated basements – 8 to 12 BTUH/sq. ft. of **below** grade floor area.

Residential Ventilation:

- In newer tighter energy efficient houses, mechanical ventilation is required at a generally accepted rate of 15 cfm per person. This calculates to about 6,800 BTUH if an energy recovery device is NOT used; and 3,000 BTUH if an energy recovery device is installed. This should be added to the heat loss figure for newer houses, but not added to the heat loss figures of older houses.

Residential Domestic Water Heating:

- For a normal family of 4 in a modest house generally 40,000 BTUH of heating will provide a reasonable recovery rate when used with a 50 to 75 gallon water heater.

- For a larger family in a larger house it is recommended that a recovery rate of 75,000 BTUH be used coupled with a larger 100 to 120 gallon water heater.

- Maximum delivered water temperature must be 120 F or less; thus an anti-scald valve is required by most codes on the discharge of the water heater. Maintain the water heater at 140 F or higher to kill bacteria and virus.

Hot Tub Heating:

- Small (7' to 10' square x 4' deep) insulated outdoor hot tubes with an insulated cover generally require only 2,000 to 2,500 BTUH maintain temperature when the tub is covered at OD temperatures of –20F. It is assumed that the hot tub is used for brief periods (say 1 to 2 hours per day) during which time the evaporative cooling of the waters surface is the primary heat loss and may equal 6,000 to 9,000 BTUH. Hence, any heat exchanger used to heat a hot tub should be sized for this larger value.

Radiant Floor Heating:

- Maximum flow for ½" PEX tubing is 5/8 gpm, maximum length of individual tube is 300' and maximum number of tubes per mini manifold is 8 (assumes 100% water).

- Maximum flow for 5/8" PEX tubing is 1 gpm, maximum length of individual tube is 450' and maximum number of tubes per standard manifold is 12 (assumes 100% water).

- Normal temperature drop is 10F to 20F per tube length and try not to exceed a floor surface temperature of 85F (comfort and finish materials limitations).

- **Always insulate** beneath a radiant floor system whether on or above grade.

Forced Air Heating:

- Size a coil that increases the air-side pressure drop by only .25" to .33" WC. Increase blower RPM to offset this increased static pressure and maintain CFM. Also, select a coil that will provide a supply air temperature of 110F or slightly greater. Code limit is 140F.

- Pipe all coils in a **counter flow** pattern. The "normal" range of water temperature drop through a coil is 8 F to 20F.

- In almost all cases the coil will be physically larger than the existing supply air plenum: thus the plenum size will have to be increased.

- Unless specifically **approved by the furnace manufacturer**, do not mount a hot water coil on the return side of the furnace as warm air will be flowing over the blower motor and may not provide sufficient motor cooling.

Hot Water Baseboard Heating:

- HWBB output ratings are based upon a 1 gpm to 4 gpm flow rate and a 215F entering water temperature (EWT) for most ¾" and 1" standard sizes. The following correction factors are to be applied to the 215F ratings when a lower EWT is utilized:

EWT:	180F	160F	140F	120F
FACTOR:	.69	.53	.38	.25

- Normal temperature drop is 10F to 20F per HWBB run. Many **non-wood** systems today are based upon an EWT of 140F and a RWT of 120F to take advantage of condensing boilers.

- Combining a radiant floor manifold and PEX tubing with HWBB, can yield individual room control with wall mounted, night set back thermostats.

- Modern European flat panel wall mounted steel radiators (such as Runtal, etc) are similar in flow requirements as HWBB.

K. PIPING and PUMPS TO DISTRIBUTE THE HEAT

The **GARN WHS** unit is non-pressurized. As such, the gasketed manway cover is simply set upon the top surface of the manway access ring. **DO NOT FASTEN OR OTHERWISE ADHERE** the cover to the tank or access ring; likewise, do not add weight to the cover after the cover is in its final position.

An internal overflow/vent will prevent the development of internal pressure that could result from the gentle expansion and contraction associated with the varying temperature of water storage. In cases when accidental over firing results in rapid boiling, the manway cover is designed to rise slightly to relieve internal pressure and vent water vapor.

Correctly sized piping and pumps are necessary for the efficient and safe transport of heated water from the **GARN WHS** unit to the building heating system.

All piping, pumps, wiring and controls, etc must be sized and installed by a qualified and licensed professional. All items are to be installed in full compliance with all national, state and local codes.

For installations not covered in this manual contact your local GARN dealer or DECTRA CORPORATION for design assistance.

General Piping Guidelines

Size all **above grade and underground piping** per standard industry guidelines:

1. Maximum head loss of 4' to 6' per 100' of pipe for energy conservation.
2. Maximum velocity of 8' per second to minimize surface erosion potential in most pipes.
3. Maximum velocity of 6' per second to limit noise.

Incorrect pipe sizing will adversely affect the heating system performance, efficiency and cost of operation. Undersized piping may cost less to install; however, the pump size must be increased, adding significantly to the pump cost and the cost of operation. Head loss data for a specific pipe or tubing, and for various fittings is tabulated in manufacturer literature, plumbing manuals, state plumbing codes and local building codes. A representative sample of the head loss associated with various fittings for **copper or steel** is listed below. Recommended flow rates for various pipe materials are tabulated on the next two pages.

EQUIVALENT FEET OF PIPE FOR FITTINGS AND VALVES

Nominal pipe size, inches	1/2	3/4	1.0	1 1/4	1 1/2	2.0
45 Degree Elbow	0.8	0.9	1.3	1.7	2.2	2.5
90 Degree Elbow Long	1.0	1.4	1.7	2.3	2.7	3.5
Gate Vale. Open 0.7	0.7	0.9	1.0	1.5	1.8	2.3
Full port ball valve	0.3	0.4	0.5	0.7	0.8	1.0
Tee-Side Flow	3.0	4.0	5.0	7.0	9.0	12.0
Swing Check Valve	6.0	8.0	10.0	14.0	16.0	20.0

Flow and heat capacity @ 4' of head loss per 100' of pipe length

SIZE	INSIDE DIA.	FLOW, gpm	BTU/HR 10F delta T	BTU/HR 20F delta T	BTU/HR 30F delta T
Oxygen Barriered PEX Tubing					
3/4"	.678"	3	15,000	30,000	45,000
1"	.875"	5.5	27,500	55,000	82,500
1 1/4"	1.28"	15	75,000	150,000	225,000
1 1/2"	1.60"	27	135,000	270,000	405,000
2"	2.03"	52	260,000	520,000	780,000
Type L Rigid Copper Tube - max. vel = 6'/sec for noise; max. vel = 10'/sec for erosion					
3/4"	.785"	3.5	17,500	35,000	52,000
1"	1.025"	6.5	32,500	65,000	97,000
1 1/4"	1.265"	12	60,000	120,000	180,000
1 1/2"	1.505"	18	90,000	180,000	270,000
2"	1.985"	39	195,000	390,000	585,000
Schedule 40 Black Steel Pipe					
3/4"	.824"	4.2	21,000	42,000	63,000
1"	1.049"	8	40,000	80,000	120,000
1 1/4"	1.380"	17	85,000	170,000	255,000
1 1/2"	1.610"	25	125,000	250,000	375,000
2"	2.067"	48	240,000	480,000	720,000

Remember:

- Die-electric couplings **must** be installed between any metallic pipe and the **GARN WHS** unit. If using copper pipe see the next paragraph.
- When installing copper distribution pipe use **ONLY:** long sweep elbows; 95-5 solder or brazing; and die-electric couplings where copper pipe joins steel pipe. **DO NOT CONNECT** copper pipe directly to the **GARN WHS** unit as electrolytic corrosion will occur. Install 4' to 6' of black steel pipe between the copper pipe and the **GARN WHS** unit.
- If installing steel pipe, use **ONLY** black steel pipe. **DO NOT USE** galvanized pipe.
- **DO NOT** install polybutylene or PVC plastic pipe.
- Provide pipe support according to plumbing code guidelines.
- After installation, flush all piping to remove, threading oil, solder flux, debris, etc.
- All check valves and ball valves shall match pipe size. Ball valves shall be full port, if possible.
- **DO NOT** install piping to produce a bull-headed tee condition.
- Install accessible shut-off valves on the supply and return pipes near the **GARN WHS** unit.

Flow and heat capacity @ 6' of head loss per 100' of pipe length

SIZE	INSIDE DIA.	FLOW, gpm	BTU/HR @ 20F delta T	BTU/HR @30F delta T
Oxygen Barriered PEX Tubing				
3/4"	.678"	4.5	45,000	67,500
1"	.875"	6.5	65,000	97,500
1 1/4"	1.28"	19	190,000	285,000
1 1/2"	1.60"	34	340,000	510,000
2"	2.03"	64	640,000	960,000
Type L Rigid Copper Tube - max. vel = 6'/sec for noise; max. vel = 10'/sec for erosion				
3/4"	.785"	4.2	42,000	63,000
1"	1.025"	8.5	85,000	127,000
1 1/4"	1.265"	15	120,000	180,000
1 1/2"	1.505"	23	230,000	345,000
2"	1.985"	48	480,000	720,000
Schedule 40 Black Steel Pipe				
3/4"	.824"	5.5	55,000	82,000
1"	1.049"	9.5	95,000	142,000
1 1/4"	1.380"	19	190,000	285,000
1 1/2"	1.610"	30	300,000	450,000
2"	2.067"	60	600,000	900,000

- Install a separate boiler drain at the designated fitting on the front head of the unit.
- Install drain valves where appropriate and required to allow future maintenance and equipment repair/replacement.
- **DO NOT** Install automatic air bleeds in a non-pressurized system. Install only manual air bleeds at all system high points.
- In new installations a floor drain should be provided to accommodate the over flow pipe and drain valve.
- Install a domestic water sill cock for adding water near the **GARN WHS** unit. A filter housing and filter is provided and should be mounted in series with, and adjacent to, the sill cock. Use a hose to fill the unit through the manway opening. **DO NOT** permanently connect the **GARN WHS** unit to a domestic water source.
- Insulate all above grade piping with ¼" to ½" wall polyolefin pipe or fiberglass insulation rated to 212 degrees (Thermocel, Imcolock, Imcoshield are preferred brands).
- Retrofitting a **GARN WHS** unit to an existing pressurized heating system will require the installation of a pressure rated flat plate heat exchanger. Contact your local **GARN** dealer or **DECTRA CORPORATION** for sizing, availability and pricing.

Calculation of Net Positive Suction Head For Pumps

All GARN® WHS wood heating units are zero pressure closed systems as opposed to:

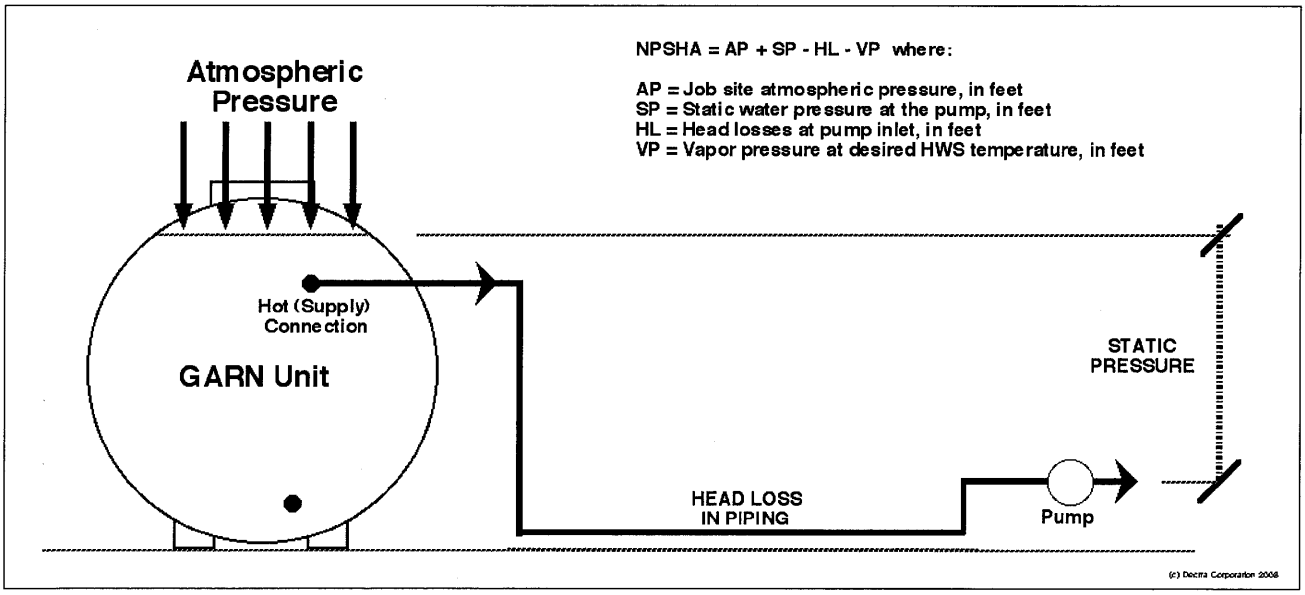
- Open system – replaces the vast majority of its contained water daily. A good example of this is a domestic water heater.

- Pressurized closed system – replaces little if any of its contained water on a yearly basis and operates with an internal pressure of 15 to 30 PSIG. A good example is a standard hot water boiler that is used for space heating.

A zero pressure closed system does **not** develop internal pressure due to its unique open vent system. Such systems do replace a minor volume of contained water on a yearly basis. The designer **must** take into account net positive suction head (NPSH) when selecting pumps for such systems. Proper selection will prevent cavitation and suction boiling that can: destroy the pump; prevent the system from attaining its rated heating capacity; or air lock the hydronic system totally.

Graphs of pump performance and net positive suction head requirements are available from pump manufacturers. In all cases, the NPSHA available must be ***greater than*** the required NPSH for a specific pump. Generally, lower RPM pumps have lower NPSH requirements.

Calculation of Net Positive Suction Head For Pumps



The NPSHA (net positive suction head ***available***) is calculated thus:

NPSHA = AP + SP – HL - VP where:

AP = Job site atmospheric pressure, in feet
SP = Static water pressure at the pump, in feet
HL = Head loss between GARN and pump inlet, in feet
VP = Vapor pressure at desired HWS temperature, in feet

NPSHA must always be greater than the NPSH ***required*** for the pump at design GPM, or cavitation and suction boiling will occur.

HL is the summation of pipe, fitting and valve pressure losses between the GARN unit and the inlet of the pump. All losses are to be calculated at maximum system design flow (GPM). Such losses are normally expressed in feet of head.

The shown tables list atmospheric pressure (AP) at various elevations and vapor pressure (VP) at various HWS temperatures.

TABLE 1

Elevation, ft	Atmospheric Pressure, ft	Boiling Point of Water, Deg F
Sea level, 0'	33.9'	212° F
1000'	32.8'	210° F
2000'	31.5'	208° F
3000'	30.4'	206° F
4000'	29.2'	204° F
5000'	28.2'	202° F
6000'	27.2'	200° F
7000'	26.2'	198° F

The above numbers are rounded to the nearest tenth.

TABLE 2

System Type	HWS temperature, F	Vapor Pressure, ft
Radiant floor heat	90° F	1.68'
Radiant floor heat	104° F	2.47'
Radiant floor heat	113° F	3.50'
Radiant floor heat	125° F	4.56'
Air coil	125° F	4.56'
European wall radiator	140° F	6.65'
Hot water baseboard	150° F	9.02'

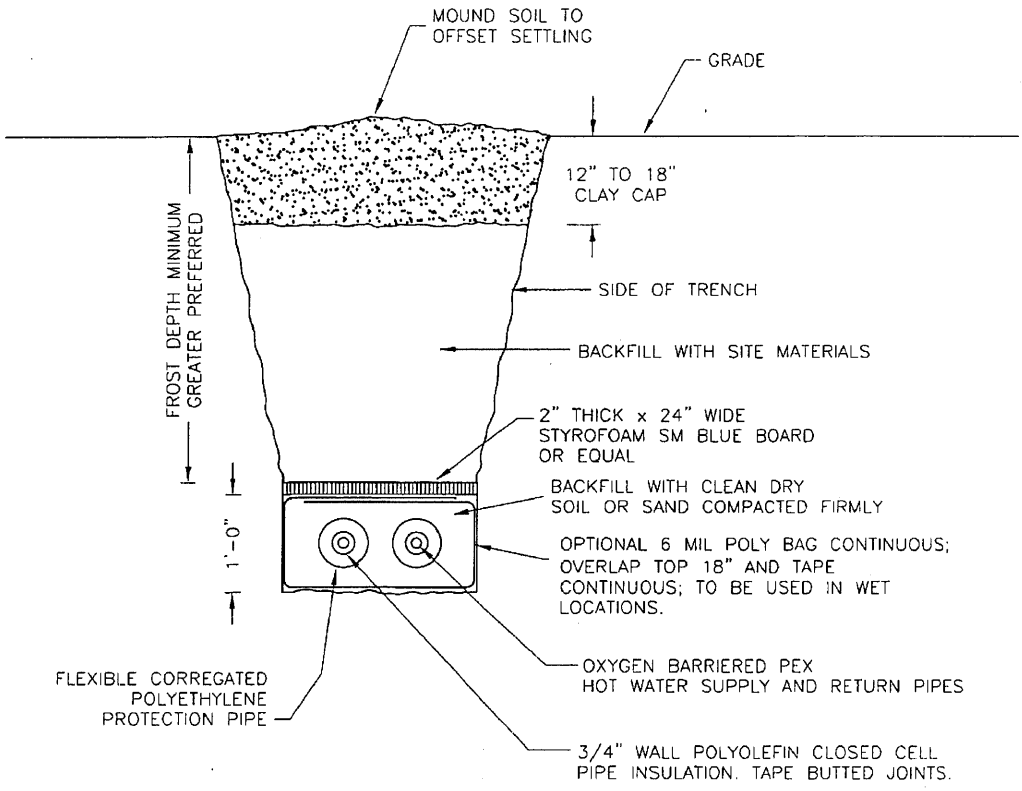
Hot water baseboard can be sized to utilize 140° F HWS

Underground Piping

Use only **oxygen barriered,** cross linked, high density polyethylene for underground installation. HeatLink, Wirsbo and pre-insulated Ecoflex are the preferred brands. Underground piping must be designed to allow for expansion and installed in strict compliance with the manufacturer's specific instructions. In addition:

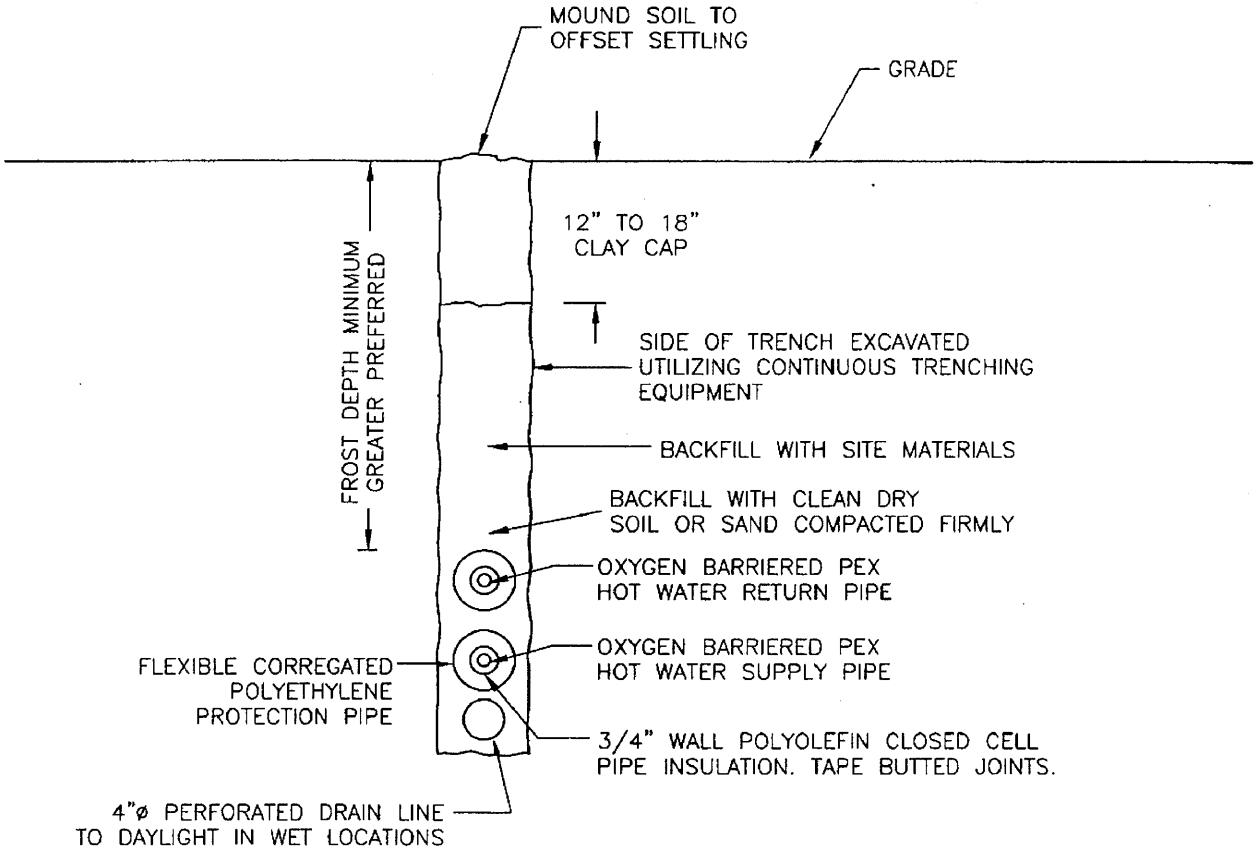
- **DO NOT** install copper, steel, polybutylene or PVC pipe underground.
- **DO NOT** join pipe underground unless absolutely necessary. If required use **ONLY** materials provided by the pipe manufacturer and installed according to their specific directions.
- Insulate all underground pipe with at least ½" wall polyolefin pipe insulation rated to 212 degrees. Thermocel, Imcolock, Imcoshield are the preferred brands. **DO NOT USE** rubber based insulation (such as Rubatex) as it will absorb water and destroy the insulation value.
- Encase the pipe/insulation within flexible, black corrugated seamless **non-perforated** polyethylene drainage tubing. This is low cost and locally available in 4" to 8" diameters. This provides protection against ground water, inquisitive small animals and abrasion. Extend the encasement pipe to a point about 6" above grade to prevent the intrusion of unwanted surface water.
- In very cold climates place a sheet of 2" thick x 24" wide foam insulation (blue, pink, yellow or green) board immediately above the pipe, centered on the pipe before back filling the trench. Trench depth in cold climates should be 4 feet (grade to top of pipe) if possible.
- Deeper burial and additional insulation is required when below grade piping extends beneath a parking lot or roadway (frost will normally penetrate the soil to a greater depth in such areas).
- Pressure test for water leaks before back filling the trench.
- If the piping can only be positioned above frost depth, provide a pump timer to circulate water for ten minutes every hour.

On the following page is a drawing of a typical underground pipe installation with pertinent details. Note that the "poly bag wrap" is required only in location of **continuously wet soils.** However, it is always best to avoid such soil conditions if at all possible.



NOTE:

MICROFLEX PRE-INSULATED PEX PIPE MAY BE SUBSTITUTED FOR THE HOT WATER PIPES, INSULATION AND PROTECTION PIPE.



Pump Selection and Installation Guidelines

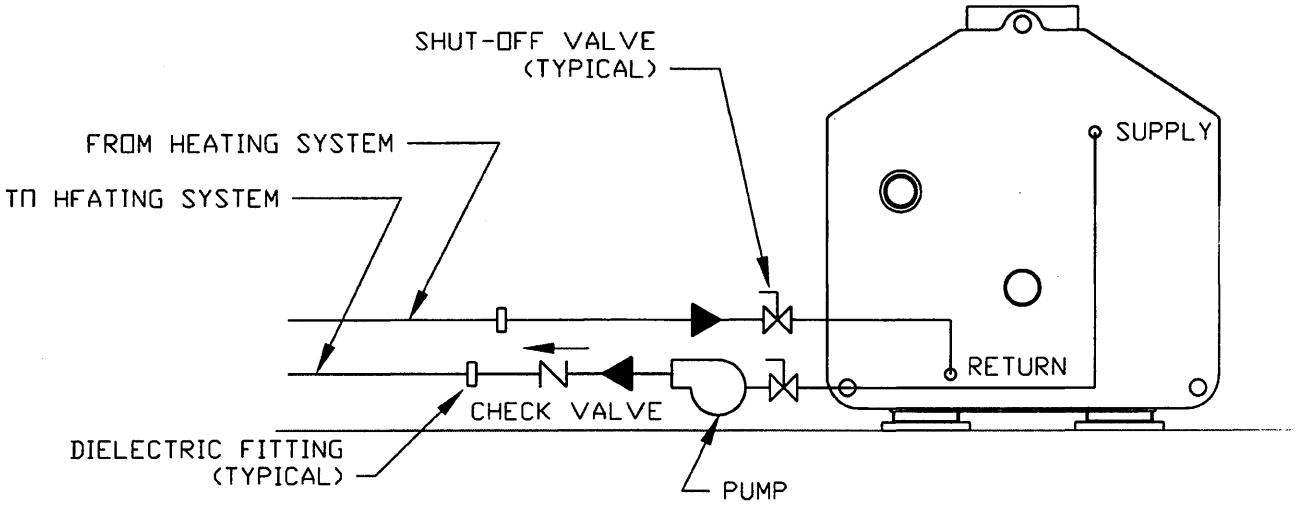
All pumps must be selected based on a **calculated total** static and frictional head loss of the piping connected to the pump as well as the calculated required system flow.

Preferred pump brands include: Wilo, Taco, Bell & Gossett, and Grundfos.

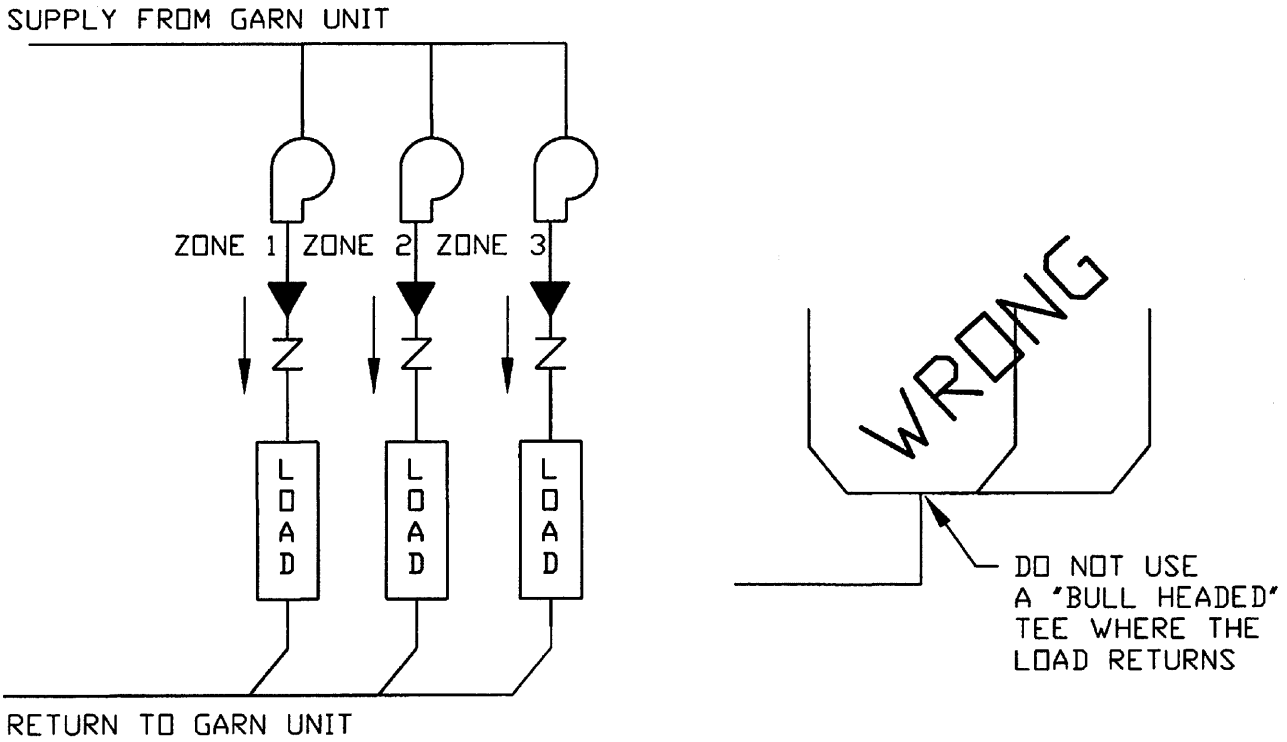
- Select a pump that delivers a flow rate that does not violate the above listed General Piping Guideline for head loss and fluid velocity. **Size the pump based upon a calculated system head loss and system flow requirement – do NOT guess.**
- All pumps shall be installed in strict compliance with manufacturers instructions, with particular attention to shaft orientation and the length of straight run of inlet and discharge pipe required to produce stated performance. In most cases, install pumps to discharge **vertically up or horizontally.**
- Provide isolation full port ball valves and flanges on the inlet and discharge of the pump.
- Pumps should be located adjacent to the **GARN WHS** unit if at all possible. Mount pumps at least 3' below the surface of the **GARN WHS** water level in order to prevent suction boiling at the pump inlet at higher water temperatures. *(See previous section - Calculation of Net Positive Suction Head For Pumps)*
- A heating system may use several zones within a building. Likewise, one **GARN WHS** unit may supply heat to several buildings. Use individual pumps with check values for each zone (or building) and develop a common supply manifold to feed the pumps. Likewise, provide a common return manifold. **DO NOT** install manifold piping to produce a bull-headed tee condition.
- In a remote location, zone pumps may be mounted adjacent to the heating system **PROVIDED:** the total head loss (static and frictional) of the supply pipe is equal to or less than 3 feet; and the pump is mounted at least 6' **below** the surface of the **GARN WHS** water level. Again this is necessary to prevent suction boiling at the pump inlet. *(See previous section - Calculation of Net Positive Suction Head For Pumps)*
- **Do not** select a pump to operate near the top of its pump curve as "cycling flow" may occur with resultant damage to the pump and substandard system heating performance.
- In an existing system, the pump size must be confirmed as adequate for the modified system.
- Under-sizing a pump will significantly reduce the performance of the heating system and may allow system piping to freeze.

Refer to the drawings on the next page for **general** schematics associated with a single **GARN WHS** unit heating a single building containing either a single zone system or a multiple zone system.

Typical Single Zone System:



Typical Multiple Zone System:



Another pump/piping strategy that can allow for a better control, smaller pumps and fewer design calculations is as follows (refer to the drawing on the following page). This drawing details a single GARN WHS unit providing heat to two separate buildings, a home and a shop. This type of system is termed a "primary secondary piping system." Note the following:

- Pumps P1 and P3 circulate water from the **GARN WHS** unit to a pair of closely spaced tees within each building and then back to the **GARN WHS** unit. The two pumps are sized based upon the head loss of the underground piping and the manifolds at the **GARN WHS** unit. The head loss for the piping **within** either building is **NOT** taken into account. This makes for simpler piping head loss calculations when interfacing with an existing system.

  The underground piping and the GARN manifold are considered the **"primary piping loop."**

- Pumps P2 and P4 simply circulate warm water (a mixture of cool system return water and hot **GARN WHS** water) to the heat delivery system within the building. The two pumps are sized based upon the piping and equipment head losses within the building **without** taking into account the head loss of the underground piping or the manifold at the **GARN WHS** unit. This allows a good match between pumps P2 and P4 and the heat delivery equipment (air coil, hot water baseboard, radiant floor, or any combination thereof). In fact multiple small pumps may be used to split the building into independently controlled heating zones. Again, this makes for simpler piping head loss calculations when interfacing with an existing system because the existing pump generally does not have to be replaced as it experiences no net change in its resistance to flow.

  This piping within the building is considered the **"secondary piping loop."**

One could further increase the energy efficiency of this system by utilizing variable speed pumps for P1 and P3. The speed of the pumps would be controlled by an optional temperature sensor or even an indoor-outdoor reset temperature controller. Thus whenever the **GARN WHS** unit was hot (say 195F) P1 and P2 would run very slowly as only a small volume of hot **GARN WHS** water would be required to warm the water within the secondary piping loop. When the **GARN WHS** unit was cool (say 125F) the pumps would provide a greater flow to warm the water within the secondary piping loop.

Some specifics about the closely spaced tees:

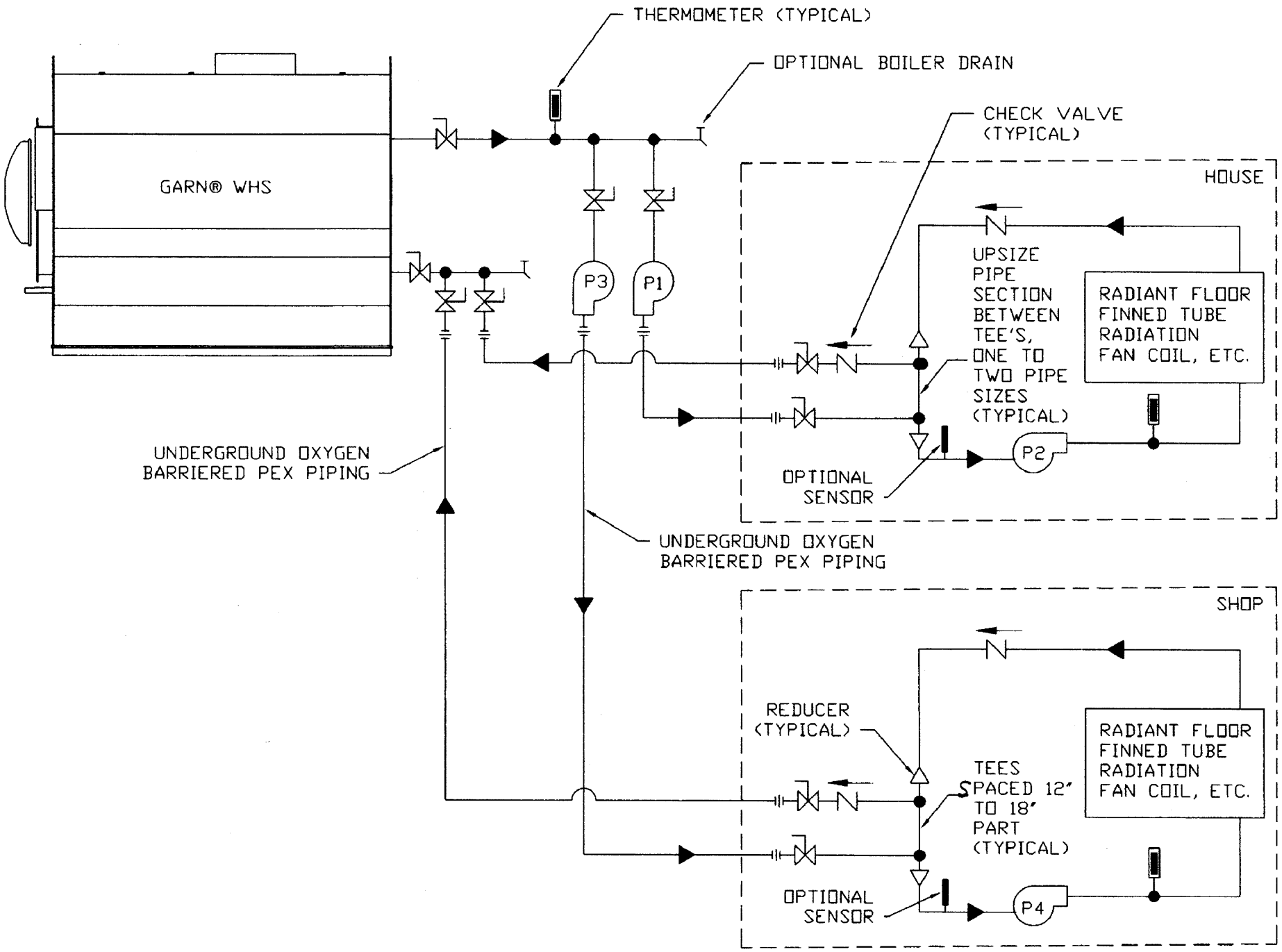
- The tees should be **no more than 12" apart** and the pipe section between the two tees should be fabricated from pipe one to two sizes larger than the secondary system pipe.

- The tees should be located on the return side of any hot water heating system.

- Flow between the tees may reverse direction when the secondary system pumps (P2 and P4) are activated.

- The piping reducers are beyond the 12" of pipe and the two tees.

- Activation of P1 and P3 may be interlocked with P2 and P4 except when there is a possibility of the underground piping freezing.


THERMOMETER (TYPICAL)
OPTIONAL BOILER DRAIN
CHECK VALVE (TYPICAL)
GARN® WHS
HOUSE
P3
P1
UPSIZE PIPE SECTION BETWEEN TEE'S, ONE TO TWO PIPE SIZES (TYPICAL)
RADIANT FLOOR FINNED TUBE RADIATION FAN COIL, ETC.
P2
OPTIONAL SENSOR
UNDERGROUND OXYGEN BARRIERED PEX PIPING
UNDERGROUND OXYGEN BARRIERED PEX PIPING
SHOP
REDUCER (TYPICAL)
TEES SPACED 12" TO 18" PART (TYPICAL)
RADIANT FLOOR FINNED TUBE RADIATION FAN COIL, ETC.
OPTIONAL SENSOR
P4

L. BUILDING HEAT DISTRIBUTION SYSTEMS

All piping, pumps, wiring and controls, etc must be sized and installed by a qualified and licensed professional. All items are to be installed in full compliance with all national, state and local codes, as well as the manufacturer's manuals and specific instructions. For installations not covered in this manual contact your local GARN dealer or DECTRA CORPORATION for design assistance.

CONNECTION TO FORCED AIR FURNACE

Water/Air Coil

A water/air coil may be added to any forced air furnace or blower cabinet to serve as the primary source of heat. When the room thermostat demands heat, water from the **GARN WHS** unit is circulated through the coil and the blower moves air through the coil. In a two-fuel installation, the thermostat will activate the auxiliary heating unit if there is insufficient heat from storage.

When adding a water/air coil to any forced air furnace please note:

- **DO NOT** relocate, modify or rest any of the safety controls in the original furnace installation.
- Blower pulleys and motor pulleys may be changed, but the electrical current flowing through the motor is to be maintained within the nameplate rating. Under some circumstances a larger motor may have to be installed.
- Any water/air coil added to the system must be installed in accordance with the instructions of the manufacturer and in a manner acceptable to the regulatory authority by mechanics experienced in such services.

Coil Selection

- Check the nameplate on existing heating system for BTU/HR output, blower CFM and allowable external static pressure. Measure the external static pressure with a clean filter in position.
- Choose coil based upon desired BTU/HR output and LOWEST entering water temperature (usually 110—130 degree STORAGE water temperature).
- Choose circulating pump based upon required water flow and total system pressure drop,
- Determine if EXISTING furnace blower is adequate. If NOT adequate, and furnace is in GOOD condition, replace blower assembly or blower motor and outlays to yield proper flows. It NOT adequate and furnace is in POOR condition, replace the furnace with a new furnace of proper blower capacity. Or replace the furnace with a package fan-coil unit. If the furnace is adequate and in good condition, install the coil.
- **DO NOT INSTALL A COIL IN A SYSTEM THAT UTILIZES A HIGH EFFICIENCY OR CONDENSING FURNACE.**
- Call your local GARN® dealer or DECTRA CORPORATION if you do not have a source for coils.

High Limit Switch

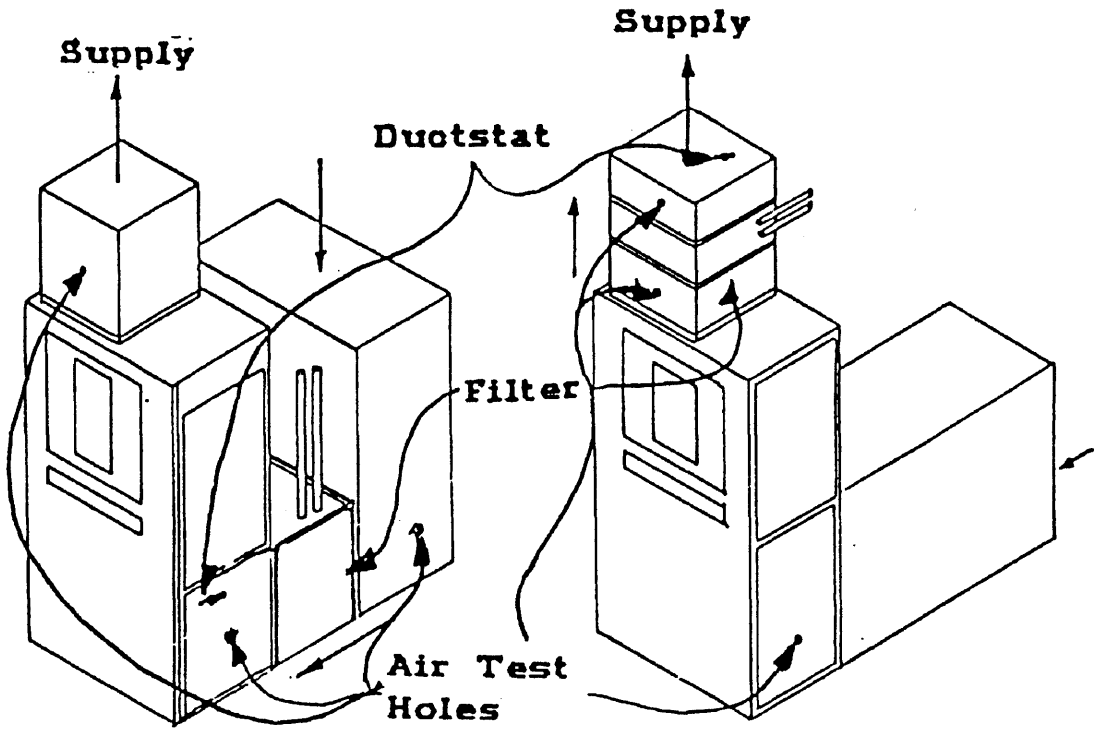
If the coil is placed on the return airside, a high limit switch, located on the downstream side of the coil, provides overheating protection for the blower motor. If the temperature of air discharged from the coil reaches l20F degrees, the switch stops the fluid flow through the coil. No additional heat will be available from the coil and the blower motor will not be subjected to excessive air temperature.

If the coil is placed on the supply airside, the high limit switch, located on the downstream side of the coil, provides overheating protection for the space being heated. If the temperature of air discharged from the coil reaches 140 degrees, the switch stops the fluid flow through the coil.

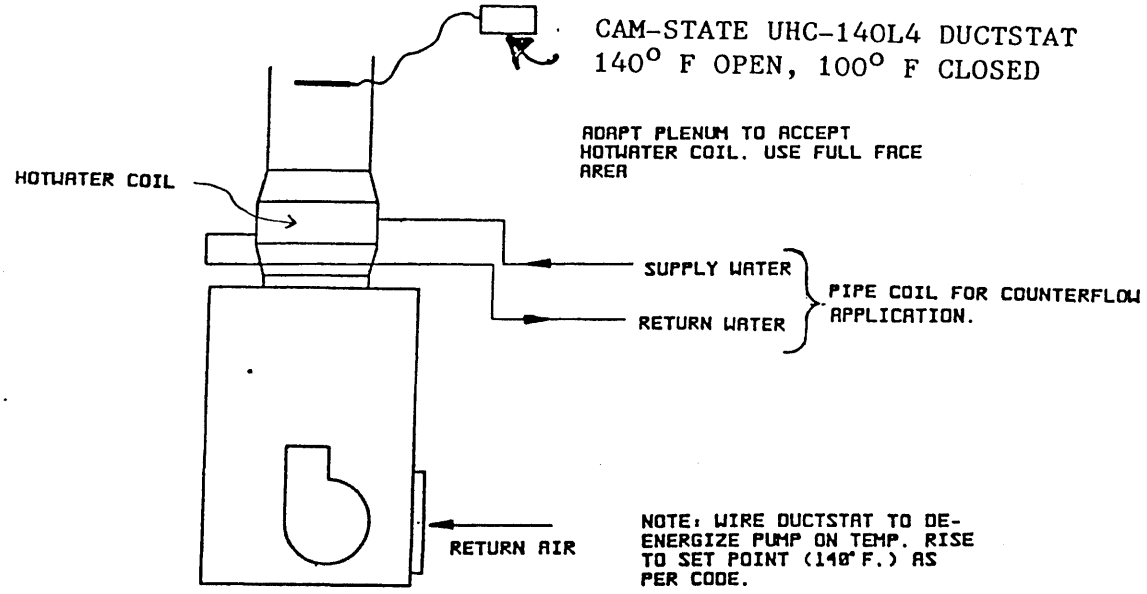
Blower Adjustment

It is very important that the proper air volume is supplied to the heated space, across the furnace's heat exchanger, and across the coil. These air volumes are to be determined by design specifications. A draft gauge reading of pressure drop across the furnace is taken before the coil is installed. This yields the initial system air volume. After the coil is installed, a pressure drop across the coil should be taken to indicate the new system air volume. This new system air volume must be adjusted to supply (1) the minimum air volume across the furnace's heat exchanger as specified in the manufacturer's engineering data, (2) the proper air volume across the coil to yield the required output, (3) the proper air volume to heat the space.

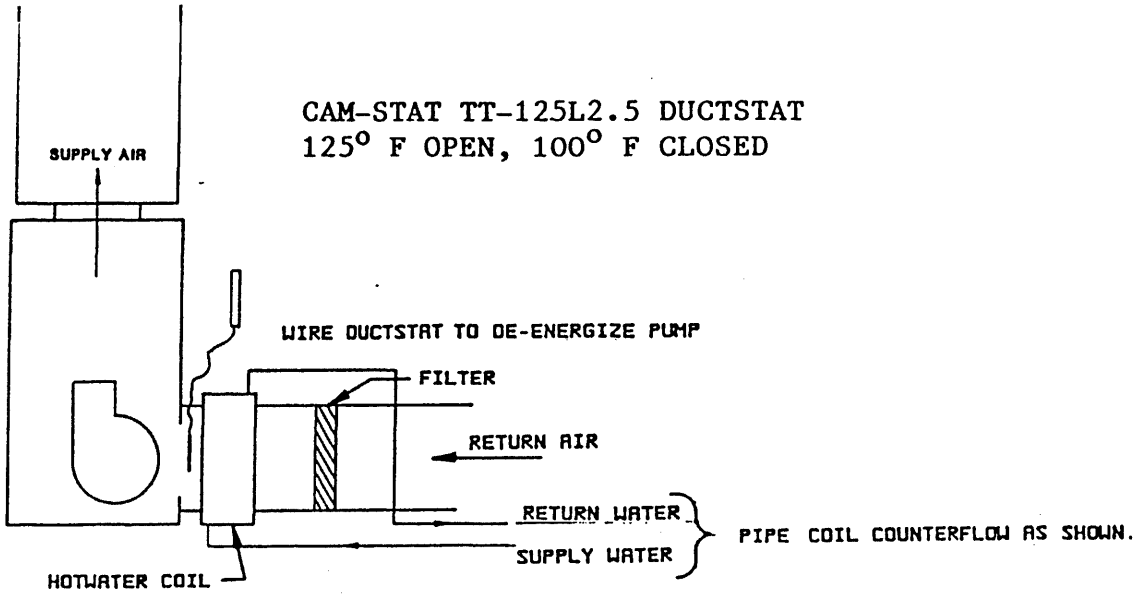
- A minimum of three 1/4" air test holes must be drilled. One in the ductwork on both sides of the furnace and one on both sides of the coil. Refer to following three (3) diagrams.
- Connect draft gauge. The zero end of the draft gauge scale connects to the air entering side. Insert the hoses so about. 1/4' extends inside the plenum. Seal around holes with permagum.
- Start furnace blower motor by placing thermostat fan switch in continuous position with no heating or cooling demand. Turn on power.
- Refer to the manufacturer's literature for the list of air volumes and equivalent draft gauge readings. Observe draft gauge reading, if reading is below required air volume, increase blower speed, however, if reading is above required air volume, decrease blower speed. Refer to furnace wiring diagram for changing direct drive blower speed.
- On belt drive blowers, check amperage draw on motor by connecting an ammeter to one leg of the motor supply line and comparing this reading with the full load amps listed on the motor nameplate. The motor pulley must be adjusted **not to exceed** the motor nameplate full load amps for motor installed.
- After required draft gauge readings are obtained, remove draft lines and insert snap hole plugs in air test holes.



Coil on return side of furnace **Coil on the discharge side of the furnace**



Forced air furnace – coil on discharge side of furnace



Forced air furnace – coil on return side of furnace

CONNECTION TO HOT WATER BASEBOARD SYSTEM

Hot water baseboard guidelines

Install good quality (even commercial grade) hot water baseboard. Sterling® is a preferred brand. Cheaper grades produce few BTU'S per linear foot of baseboard; thus require significantly more footage for a given heat loss. Look for copper tube/aluminum finned elements, full back plates and die formed hangers with nylon or roller slides to eliminate noise. In addition:

- Size the baseboard for 140 F supply water temperature and a 20 F temperature drop.
- Circuit baseboards in a parallel configuration so that all elements receive the same 140 F supply water.
- Utilize either copper or **oxygen barriered,** cross-linked, high-density polyethylene for supply and return piping.
- **DO NOT** mount the baseboard closer than 4" above the floor.
- Size the pump to provide 1 to 1.5 gpm of flow at a maximum velocity of 4' per second through each baseboard.
- Individual room-by-room control is best. If this is not possible, try to zone the system so that rooms with similar heat loss characteristics are on the same circuit.
- Whenever a zone thermostat calls for heat, the pump serving that zone is to be activated.

New construction

Determine the lineal footage of wall that is available for the placement of the hot water. Divide the BTU/HR heat loss of the building by the available footage. Select the baseboard units that can supply the BTU's per foot required to meet the building's heat loss. Select the baseboard based on a supply water temperature of 140 F. Adding more baseboard, selecting a more efficient baseboard, or selecting a larger GARN unit maybe required it the available liner wall footage is not sufficient.

Converting an existing baseboard system

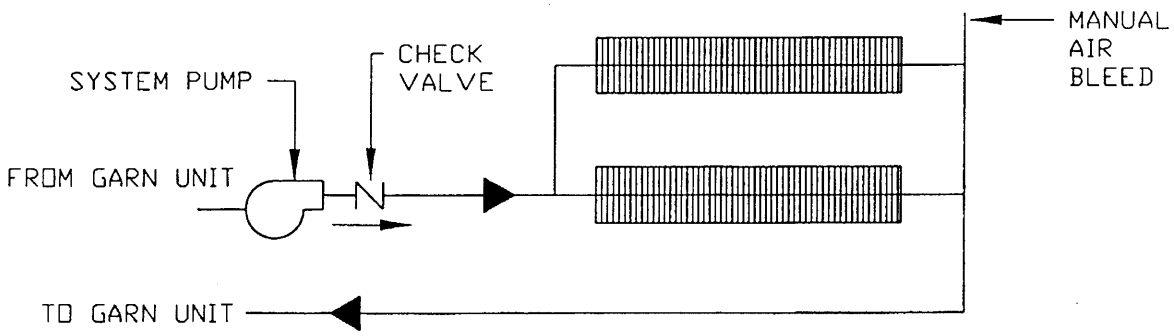
Most installers select a GARN system that will supply 130 to 140 degree F water to a baseboard system. If the existing system was supplying water at a higher temperature, say 180 degrees, an analysis must be done to determine whether a lower supply water temperature will meet the needs of the building. The following table can be used for this purpose.

Water Temperature Correction Factors, based on an entering air temperature of 65 F

	Average supply water temperature in degrees F.												
	100	110	120	130	140	150	160	170	180	190	200	210	215
Correction factor	.13	.19	.25	.31	.38	.45	.53	.61	.69	.78	.86	.95	1.0

The above table can be used to determine the difference between the BTU/HR delivered by the existing system vs. the BTU/HR that can be delivered by the GARN system at a lower supply water temperature. A standard of 215 degrees is used in the industry as the basis for rating. If a baseboard is rated at 1000 BTU's/linear foot at 215 degrees (contact manufacturer for output ratings), the table indicates that at 180 degrees the existing baseboard can deliver 69% of the rated BTU's or 690 BTU's/linear ft. A GARN system sized to use 140 degree water will yield 38% of the rated BTU's or 380 BTU's/linear ft. If the old system was sized twice as large as the actual heat loss (a common occurrence), then the sizing of the GARN system for 140-degree water is correct. If more heat is required, a larger storage system or more baseboard footage will be required.

The **drawing below** shows a simple, multiple zone hot water baseboard system.



CONNECTION TO HYDRONIC RADIANT FLOOR SYSTEM

Radiant floor guidelines

Use only **oxygen barriered,** cross-linked, high-density polyethylene for radiant floor installation. HeatLink, Wirsbo, Kitec and Roth are the preferred brands. Any radiant floor system shall be installed in strict compliance with manufacturers specific instructions. In addition:

- **DO NOT USE** steel, copper, rubber based hose (such as Heatway tubing), low-density polyethylene, polybutylene or PVC plastic pipe as radiant floor tubing. All of these involve significant and complex corrosion and durability issues for the tubing, pumps and controls, as well as GARN equipment.

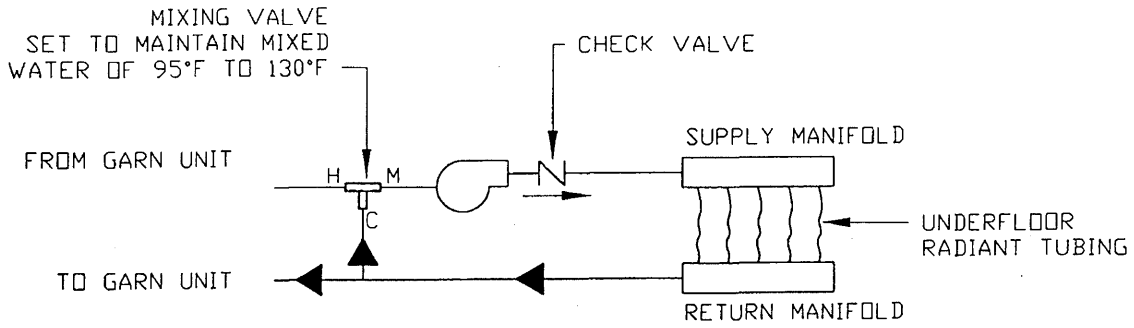
- The installation of rubber based hose (such as Heatway tubing), low-density polyethylene, polybutylene or PVC plastic pipe in a radiant floor system connected to a GARN unit **will void the GARN warrantee.**

- In new construction, install 2" of blue, yellow, green or pink foam board (**extruded** polystyrene foam – minimum of 1.6 PCF density, per ASTM C 578-95 specification) under the **entire** slab that is to be radiantly heated. The foam should be placed immediately below the bottom of the slab, upon 6" of well compacted granular fill. This construction provides a proper structural bed (compacted gravel) yet minimizes downward heat loss.

- When radiant heating is utilized with above grade floors, the underside of the floor **MUST** be insulated to prevent significant downward heat loss and overheating of the rooms below. A minimum insulation valve of R =13 is recommended.

- The radiant floor manifolds supplied by the manufacturers listed, provide for room-by-room control while using a single pump and mixing valve. Therefore, multiple pumps/valves are generally not required.

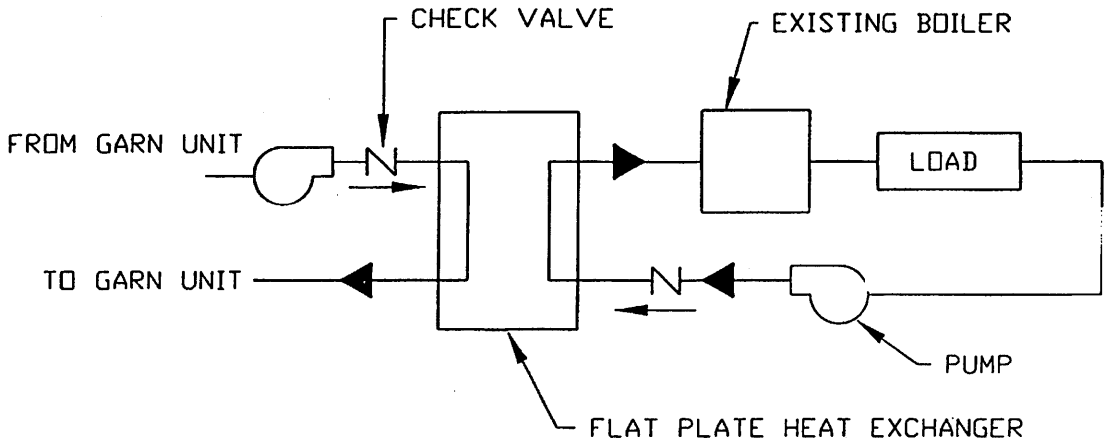
- Install a 3 way mixing valve to bend cooler radiant floor return water with hot supply water from the GARN unit in order to maintain the moderate supply water temperatures (between 95 F and 130 F) required for radiant floor heating. Mixing valve brands are Paxton ESBE, Honeywell Sparco and Watts. Install mixing valve between the GARN unit and pump so that the pump draws through the valve from the GARN. Note the position of the pump in the **drawing below:**



CONNECTION TO AN EXISTING PRESSURIZED SYSTEM

In some instances, the backup system will be an existing pressurized boiler. Retrofitting a **GARN WHS** unit to an existing pressurized heating system will require the installation of a pressure rated flat plate heat exchanger. Contact your local **GARN** dealer or **DECTRA CORPORATION** for sizing, availability and pricing of FlatPlate heat exchangers. Note the following and review the drawing below:

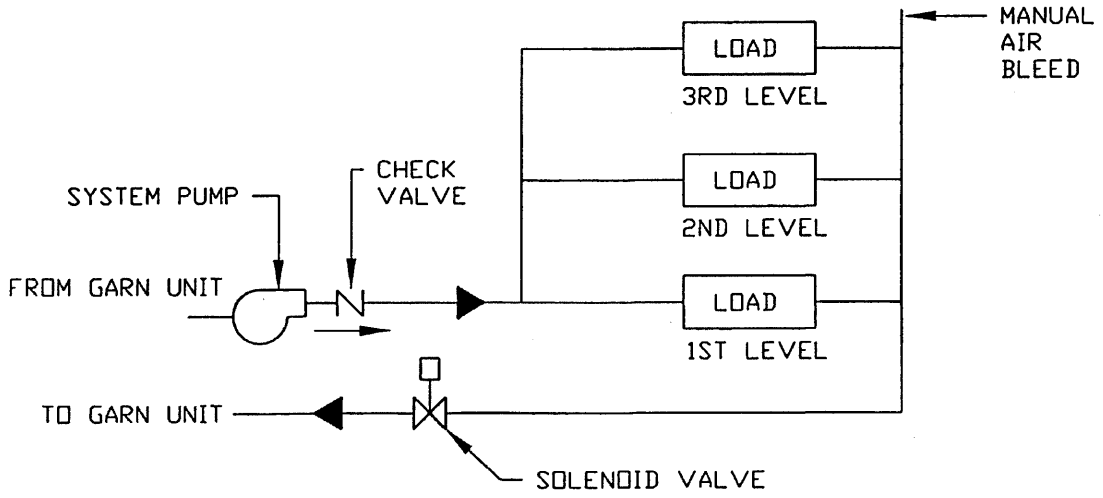
- **DO NOT** connect any GARN unit to a steam boiler or steam heating system.
- The water-to-water heat exchanger must have a pressure rating that is equal to or greater than the pressure rating of the existing boiler.
- The heat exchanger shall be positioned on the return side of the existing boiler.
- The **GARN WHS** unit and the heat exchanger shall **NOT** be installed so as to interfere with the normal delivery of heated water from the existing boiler.
- The **GARN WHS** unit and the heat exchanger **SHALL BE** installed without changing the function of the controls or rewiring the existing boiler. A control wiring connection is permitted only if required to obtain proper operation. For instance, when a thermostat calls for heat, both the GARN pump and the existing pump are to be powered.
- The electrical system of the existing boiler and GARN unit shall be powered from a single branch circuit, without exception.
- The **drawing on the next page** is a schematic representation of connection to an existing pressurized system.



CONNECTION TO AN ELEVATED SYSTEM

Even though the **GARN WHS** unit is non-pressurized, it is adaptable to heating systems that are elevated up to 24' above the level of the slab on which the GARN unit sets. If the vertical distance is greater than this, a flat plate water-to-water heat exchanger must be installed (refer to "Connection to an Existing Pressure System). Note the following and **review the drawing below:**

- This type of system is found mostly in warehouses with high ceilings and in multiple floor residences or small commercial facilities.
- All piping and flanges **MUST** be airtight or this type of installation will not function properly. Air leaks will constantly bleed air into the system (negatively affecting both system performance and corrosion).
- **DO NOT** use automatic air bleeds in the heat delivery system. Install only manual air bleeds.
- Select pump to overcome total head, i.e., pipe friction and vertical elevation. Pump sizing is very critical in this application.
- Install a solenoid valve that is energized to open when the pump is powered. This valve is to close whenever the pump is not powered. The valve locks the water in vertical loop when the pump is not operating.
- Install a reliable full port spring check valve down stream of the pump.



DOMESTIC HOT WATER CONNECTION

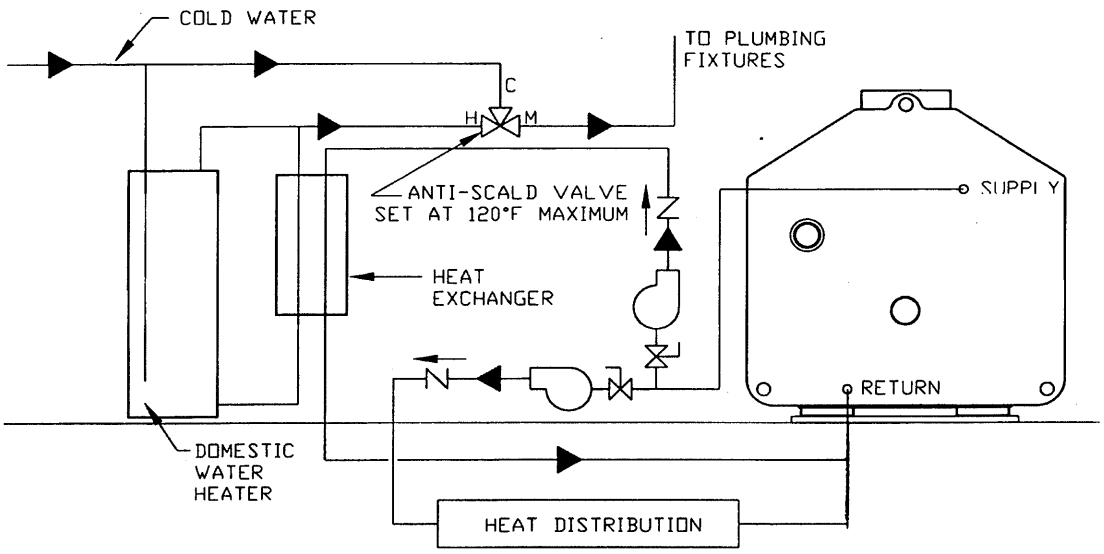
The preheating or heating of domestic water is easily accomplished with GARN equipment. However, in-tank copper water heating coils are **NOT** provided within the GARN tank for several reasons:

- A copper coil within any steel boiler induces electrolytic corrosion, leading to early tank failures.
- With a coil inside a remote boiler, two additional below grade insulated domestic water lines are required (a supply and return line that connects the coil to the water heater). This adds significant cost to the project.
- Because of non-turbulent flow conditions, the tank-mounted heat exchanger is significantly larger (more expensive) that a heat exchanger mounted close to the water heater.

The two methods of preheating domestic water include: an external "saddle mounted" heat exchanger; and a stand alone "indirect fired" tank heat exchanger. A double walled, leak detected tube within a tube all copper water-to-water heat exchanger is the recommended "saddle type" heat exchanger. This heat exchanger is to be mounted external of, close to and slightly below the level of the top of the existing water heater. Saddle heat exchangers can be installed to thermo-siphon or use a pump on the domestic waterside.

Indirect fired tank heat exchangers generally include a stainless steel internal coil within an insulated stainless steel tank. This unit is then connected in series upstream of the existing water heater. Contact your local **GARN** dealer or **DECTRA CORPORATION** for sizing, availability and pricing of either preheat unit. Please carefully review the following as it applies to **ANY** domestic water heating system:

- All domestic water piping, valves, fittings, pumps, controls and the overall installation must meet all national and state plumbing, sanitation and health codes.
- After installation is complete, the entire domestic waterside of the system must be pressure tested, flushed, and then sanitized according to local health department requirements.
- In all cases, a NSF or Board Certified **anti-scald mixing valve** is required by national and state codes when preheating or heating domestic water with equipment other than a conventional water heater. The valve shall be set to deliver hot water at a temperature of 120 F maximum.
- Install a differential thermostat to control the small (1/25 hp) system pump. The domestic water within the water heater should be heated to 145 F in order to kill water borne Legionelle bacteria. The "hot sensor" of the control should measure the GARN water temperature; the "cold sensor" should measure the domestic water temperature at the inlet of the heat exchanger. The sensors may be "strapped" to the pipe and covered with insulation in order to provide accurate temperature readings to the differential controller.



SOLAR INTERFACE

All **GARN WHS** equipment is factory ready to connect to solar collectors. The collector with the simplest interface is the drain-back solar collector. Water is pumped from the GARN unit to the collector, is circulated through the collector, then drained back into GARN unit via gravity. An NPT flanged fitting on the left side of the manway collar is the drain back fitting where the return line from the collectors is to be connected.

Some solar collector designs utilize a collector non-water based medium in lieu of water. Such collectors require a heat exchanger to interface with the GARN unit.

Refer to manufacturers' manuals and data provided with the solar collectors regarding proper installation.

BACKUP HEATING

If the GARN unit is being added to an existing building, the existing heating system will normally be used as a backup system. However, off peak electric heating is available to serve as a backup to the wood heating. Some utility companies offer discounted electric rates to installations using electric heat with heat storage equipment. Contact your local utility about various programs. Then contact your GARN dealer or **DECTRA CORPORATION** for electric backup heating options.

M. CHECK OUT AND START UP PROCEDURES

REVIEW

Before filling the **GARN** unit with water and chemicals, review the following check list:

- Has the unit been assembled in strict compliance with the **Unpacking & Assembly** section of this manual?
- Has the unit been installed in strict compliance with the **Installation** section of this manual as well as state and local codes?
- Is all piping connected correctly? Are shut off valves in place, in correct open/closed position and operable?
- Have all wiring and controls been installed by a Licensed Electrician and inspected by local code authorities?
- Has the unit been properly grounded electrically?
- Are all unused electric element holes plugged inside of the element box?
- Have you thoroughly reviewed the **Water Treatment Chemical** and **Suggested Water Treatment Procedures** sections?

As stated in the **Insulation** section, the unit and related piping does **not** have to be insulated prior to check out and start up. It is much easier to located and correct pipe leaks, etc without insulation in place. If everything checks OK, then fill the unit with clean water according to the **Suggested Water Treatment Procedures** section.

Any combustion process produces water, in the form of water vapor. One-year-old dry firewood stabilizes at approximate 20% moisture content. When such wood is burned, 1 to 3 gallons of water will condense (within the unit) as the temperature of the water in the **GARN** unit increases from approximately 50 F to 90 F. The bulk of this water vapor is blown out the flue with the other products of combustion; however, some can puddle in the flue tubes and blower housing. Although not dangerous, it can be messy.

Therefore, if the unit is filled with cold well water or water that is less than 80 F, it may be best to warm the **GARN** water to 80 F before executing an initial fire. This can be accomplished by the following methods:

- If the average daily outdoor temperature is **above 70 F**, simply let the unit sit for a few days and the air will warm the water. This warming will be accelerated by activating the induced draft blower (**without** a fire).
- If the unit is outfitted with optional electric heating elements, simple set the electric controls to bring the water up to 80 F.

If neither of the above water warming techniques is workable, start up will have to be accomplished with a wood fire. Do this in compliance with the procedures set forth in the next sections; however, use **only one year old dry cord wood, 3" to 10" in diameter** and build a full size fire. Do **not** down size the fire in hopes of preventing condensation, as a small fire will produce significant hazardous **creosote,** as well as condensation.

LEAK CHECK

1. Start at the unit and check for any obvious signs of water leakage – particularly at the elements and sensor locations.
2. Check supply and return pipes. Make sure all threaded steel joints are doped and tight.
3. Check dielectric fittings where steel pipe joins copper pipe; check valves, pumps, gate and ball valves, etc.
4. Energize pumps, circulate water, and bleed air from all lines.
5. Check water level after line bleed.

GARN UNIT CHECK

If no leakage is evident and all items are installed and piped correctly, make the following inspections before start-up operations.

1. Check door gasket and door latch adjustment. Latch should be snug fitting. If you need to force handle to get door closed, adjust the door by rotating the inner disc until the latch closes snugly without excessive force.
2. Is the ceramic reaction chamber with its end gasket in proper position? Carefully slide it into the metal tube at the back of the combustion chamber. Small chips in the liner are normal and will not affect the performance of the unit.
3. Do not insulate unit until after start-up procedure.

START UP OPERATION

READ THE ENTIRE OPERATOR'S MANUAL BEFORE STARTING THE FIRST FIRE!

Confirm that the water temperature is above 80 F before proceeding with the following steps.

1. Open the fuel-loading door.
2. Place small kindling or a small amount of newspaper near front of combustion chamber. Securely tuck the newspaper and/or kindling under the first few log. Paper can be sucked into the flues when the door is closed if not anchored down.

   This step is eliminated when reloading the unit. In some cases a few remaining coals and the hot bricks provide sufficient heat to ignite a fire even after sitting idle overnight.
3. Place 50 to 85 lbs of **one-year dry cordwood, 24" to 32" long and 3" to 10" in diameter, into the combustion chamber. Wood 10" in diameter and larger should be split once or twice.** Place the fuel toward the rear of the combustion chamber. **Load all wood carefully** or damage to the reaction chamber may occur.
4. **DO NOT OVERLOAD THE FIREBOX. The wood fuel should not extend above the half way line of the loading opening**. Sufficient heat release volume must be maintained **above the wood fuel** for proper combustion.
5. Turn **WHS Timer** on to confirm that the draft inducer is operative. Shut Timer off.
6. Light the paper and watch it for a few seconds to a minute to confirm that the paper has ignited.
7. Turn the **WHS TIMER** past the 3-hour setting to activate the draft inducer.
8. Close door.
9. After 15 minutes, open door, check fire, add more wood if necessary, close door.

10. Note the water temperature. What is the rise in temperature from the start in (1) above? It should be in the range described in the Operator's Manual.

11. If you have experienced any problems up to this point, turn the power off, **LEAVE THE DOOR CLOSED** and call your dealer. Discuss the problem before proceeding further.

12. If there are no problems, allow the unit to burn for an hour or more.

13. The water should be approximately 120 F at this point. If no problems have developed, add additional fuel wood and shut the door. Again do not load past the 1/2 full mark in order to allow for sufficient "heat release volume" above the woodpile.

14. Ten minutes after loading open the door and observe if combustion is proceeding.

15. During this first burn, check for leaks and pump operation. When the thermostat calls for heat, the pump should operate.

16. Check supply/return water pipes at various locations to verify heating conditions.

17. If air vents are installed and there is not heat being delivered, bleed air from system.

18. Note water temperature after completed second burn. Did you get a similar (but slightly less) rise in water temperature?

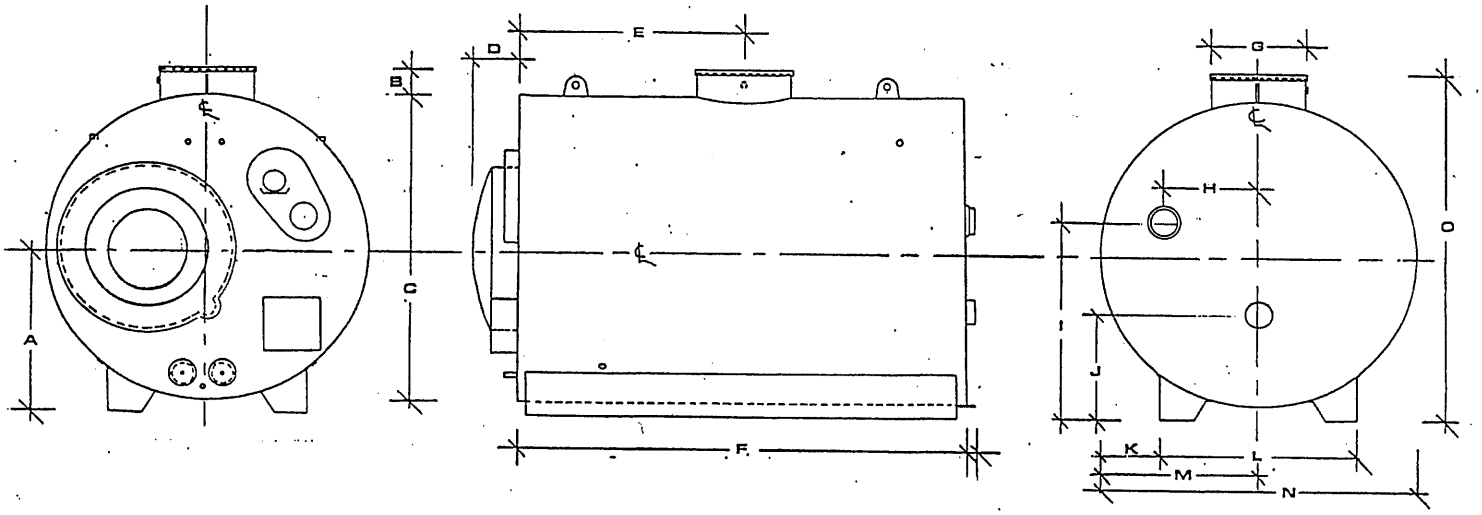
19. If all is well, continue to burn until the water temperature is 190 to 200 degrees. At this condition, water level in manhole should be slightly below the overflow pipe. If too much water was put in initially, heat will cause it to expand and drain out the overflow.

CAUTION: Take care when checking the water level at this temperature as the water vapor could cause burns.

20. Check water level again after tank has cooled down to 100 degrees. It should be a couple of inches below the overflow pipe.

During the first week or two, the owner should check the water level at high and low water temperature levels. Instruct the owner on this procedure. It would be preferable for the dealer to make these checks.

M. SPECIFICATIONS

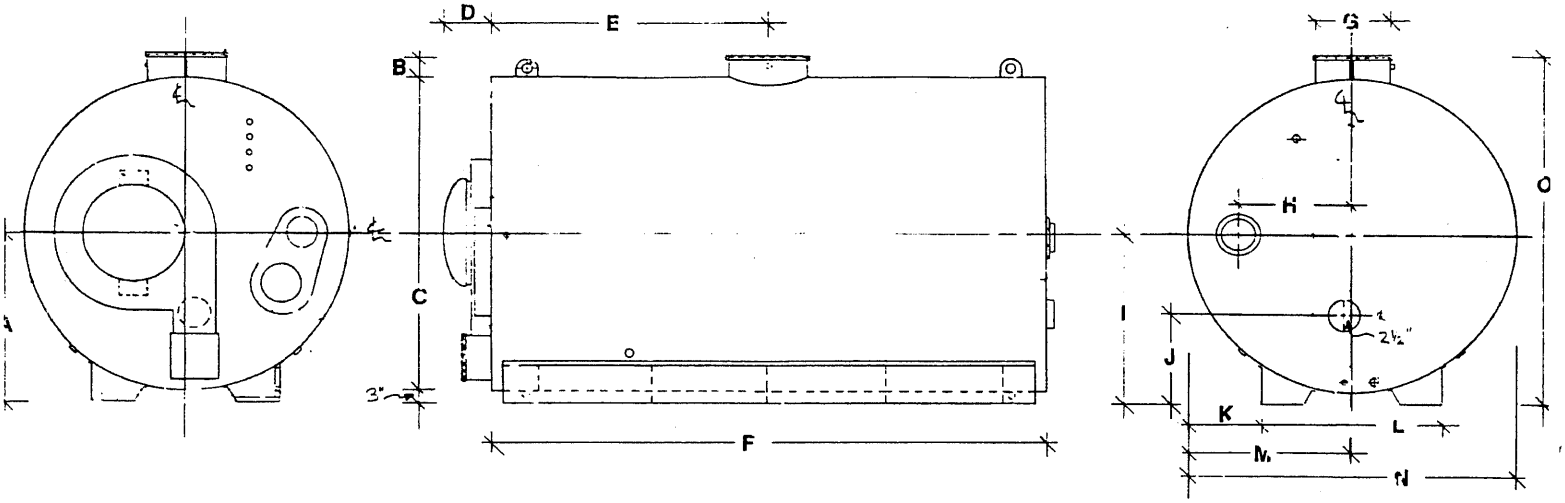


DIMENSION	WHS-1500	WHS-2000
A	37"	37"
B	5"	5"
C	69 1/2"	69 1/2"
D	12"	12"
E	48"	48"
F	96"	120"
G	20"	20"
H	22"	22"
I	44" w/o foam	44" w/o foam
J	24" w/o foam	24" w/o foam
K	13 3/4"	13 3/4"
L	42"	42"
M	34 3/4"	34 3/4"
N	69 1/2"	69 1/2"
O	78"	78"
Fuel opening diameter	18"	18"
Overall Length	110"	134"

WHS SPECIFICATIONS		
	WHS - 1500 (Round)	**WHS-2000 (Round)**
Diameter	69 1/2 "	69 1/2 "
Height	78 "	78 "
Tank Length	96 "	120"
Overall Length	110"	134"
Recommended wood length	24" to 32"	24" to 32"
Recommended wood diameter	3" to 10"	3" to 10"
Weight - empty	3,000 lbs.	3,900 lbs.
Weight - filled	15,500 lbs.	20,600 lbs.
Nominal gallons of storage	1,496 gallons	1,870 gallons
NPT Supply and return flanges	1 1/2" or 2"	1 1/2" or 2"
Draft inducer motor	1/2 HP	3/4 HP
Electrical requirements	115 VAC, 9 amps	115 VAC, 11 amps
Flue collar and flue	6" dia. DuraTech Class A, 2100F HT	6" dia. DuraTech Class A, 2100F HT
Air intake fitting	7" dia. screened hood	7" dia. screened hood
Combustion chamber length	42"	42"
Nominal Combustion chamber diameter	25" firebrick lined	25" firebrick lined
Height to chamber opening	39"	39"
Average BTH/HR into storage	350,000 (fuel dependent*)	425,000 (fuel dependent*)
Approx. BTU's/degree of water temperature change	12,476	15,270
MATERIAL SPECIFICATIONS		
Tank shell - mild steel (MS)	7 GA	7 GA
Front and back heads - MS	3/16"	3/16"
Combustion chamber shell - MS	3/16"	3/16"
Blower housing components - MS	3/16"	3/16"
Door spinnings		
Outer - MS	12 GA	12 GA
Middle - Galvanized Steel	16 GA	16 GA
Inner-304 Stainless Steel	16 GA	16 GA
Element box - MS	3/16"	3/16"
Skids - MS	10 GA	10 GA
Heat exchanger tubing	Welded Steel Boiler Tube	Welded Steel Boiler Tube

NOTE: All welding conforms to AWS specs. All seams, joints, etc., exposed to water are welded to prevent crevice corrosion.

**Figures based on split, 24" oak with 17% moisture and reloading once/hour.*



DIMENSION	WHS-3200
A	46"
B	5"
C	86"
D	15"
E	72"
F	146" +/-
G	20"
H	30"
I	46" w/o foam
J	25" w/o foam
K	19"
L	48"
M	43"
N	86"
O	94"
Fuel opening diameter	25.5"
Overall Length	162" +/-

WHS SPECIFICATIONS	
	WHS - 3200 (Round)
Diameter	86"
Height	93"
Tank Length	146"
Overall Length	162"+/-
Recommended wood length	24" to 32"
Recommended wood diameter	4" to 10"
Weight - empty	6,500 lbs.
Weight - filled	34,000 lbs.
Nominal gallons of storage	3,200 gallons
NPT Supply and return flanges	2"
Draft inducer motor	3/4 HP
Electrical requirements	115 VAC, 12 amps
Flue collar and flue	10" dia. DuraTech Class A
Air intake fitting	8" dia. screened hood
Combustion chamber length	49" - firebrick bottom
Nominal Combustion chamber diameter	40"
Height to chamber opening	32.5"
Average BTH/HR into storage	950,000 (fuel dependent*)
Approx. BTU's/degree of water temperature change	26,700
	*Figures based on split, 24" oak with 15% moisture and reloading once/hour.
MATERIAL SPECIFICATIONS	
Tank shell - mild steel (MS)	Minimum 3/16"
Front and back heads - MS	1/4"
Combustion chamber shell - MS	1/4"
Blower housing components - MS	3/16"
Door spinnings	
Outer - MS	12 GA
Middle - Galvanized Steel	16 GA
Inner - 304 Stainless Steel	16 GA
Element box - MS	3/16"
Skids - MS	3/16"
Heat exchanger tubing	Welded Steel Boiler Tube
All welding conforms to AWS specifications. All seams, joints, etc., exposed to water are welded to prevent crevice corrosion.	

GARN® PACKING LIST FOR MODEL WHS 1500/2000

ORDER NUMBER_____ **SHIP DATE** _____

SERIAL NUMBER ___**CPW-**_____ **LISTING NUMBER**_____

SHIP TO: _____

STREET ADDRESS _____

CITY, STATE, ZIP _____

PACKAGED IN COMBUSTION CHAMBER

GARN® Unpacking Manual w/shipping list	1	_____
GARN® Installation Manual	1	_____
GARN® Operation & Maintenance Manual	1	_____
GARN® WHS/ETS Controller	1	_____
Water temperature thermometer, 50°F to 300°F	1	_____
Exhaust temperature thermometer, 100°F to 800°F	1	_____
GARN® WHS Standard Sensor stem (float switch only) with plastic fitting and nut	1	_____
GARN® W/ETS Upgrade Sensor stem (float switch and stats) with plastic fitting and nut	1	_____
Motor mounting plate with gasket & upper cleanout plate with gasket	1 pkg	_____
Manhole cover with black, self adhesive 1/4" x 1" gasket (*mounted in middle of door)*	1	_____

AIR INTAKE & EXHAUST FLUE ITEMS

Galvanized combustion air inlet hood	1	_____
Air intake reducer	1	_____
6" Class A flue (36" long)	1	_____
Class A wall shield	1	_____
Adjustable SS elbow	1	_____

WATER TREATMENT ITEMS

Water filter housing w/replaceable 5 micron sediment cartridge	1	_____
Water treatment chemicals	1	_____

BLOWER ASSEMBLY

1/2 HP face mounted motor with cord in box (4) socket head cap screws & allen wrench (8) motor mount plate & upper cleanout nuts (1) Motor mount spacer ring	1 box	_____
Radial blade blower wheel, 9 3/16" X 3 1/4"	1	_____
3/4 HP face mounted motor with cord in box (4) socket head cap screws & allen wrench (8) motor mount plate & upper cleanout nuts (1) Motor mount spacer ring	1 box	_____
Radial blade blower wheel, 9 15/16" X 3 1/4"	1	_____

FACTORY INSTALLED ITEMS

Secondary combustion chamber sections & end gasket	Installed	_____
Lower cleanout plates with gaskets & left shield	Installed	_____
Door latch, bolt, nut and lock washer	Installed	_____
Magnesium anode rod(s)	Installed	_____
Combustion Chamber Refractory	Installed	_____
Secondary combustion chamber end plate	Installed	_____
Firebrick - (10) #2 fireplace splits - 4 1/2" x 2" x 9"	Installed	_____
(18)#1 fireplace splits - 4 1/2" x 1 1/4" x 9"	Installed	_____
(3) 550K firebrick pad, 1/4" x 10" x 40.5"	Installed	_____
Steel heat shield for lower nozzle with 1/4" insulation	Installed	_____
VERTICAL EXHAUST-rear cleanout cover, insulation & shield	Installed	_____

OPTIONAL ITEMS (as per Order)

ELECTRIC HEAT STORAGE ITEMS

• Electric Tank Fittings	9	_____
• Electric element box and cover	1	_____
• Electric element box gasket	1	_____
• Electric element box labels	2	_____
• 240 vac single phase 5.5 KW immersion elements with O rings	9 maximum	_____

FLUE COMPONENTS

- 6" Class A flue (6" long) _____
- 6" Class A flue (12" long) _____
- 6" Class A flue (18" long) _____
- 6" Class A flue (24" long) _____
- 6" Class A flue (36" long) _____
- Clamp rings _____
- Class A insulated Tee with bottom cap _____
- Wall support for Tee _____
- Roof flashing and storm collar _____
- Roof support _____
- 30 degree elbow _____
- Class A flue install manual _____

ADDITIONAL ITEMS

- 4" flue cleaning brush _____
- 5" flue cleaning brush _____
- 36" long fiberglass cleaning rods _____
- Spare set of four (4) flat gaskets _____

WARNING:
Non-combustible steel supports must be provided to support the weight of the flue and tee for any horizontal flue that utilizes a tee.

P. COPY OF LISTING LABEL (located below the motor on the blower housing)

GARN® WHS/ETS MODELS 1350, 1450, 1500, 1900 and 2000
NON-PRESSURIZED WOOD FIRED HYDRONIC HEATER

TESTED TO ANSI/UL-391, UL 726 and CSA B366.1 – M91-CAN/CSA.
REPORT No. 632-600901 - April 17, 1986

Electrical rating: 120 VAC; 15 Amps; 60 Hertz; 1 phase

INSTALLATION - Use only a solid fuel Class A chimney. **DO NOT** connect this unit to a chimney flue serving another appliance. Place only on a non-combustible floor and maintain the following minimum clearance to combustibles:

Sides, top and rear = 2 in. Front = 60 in. Class A flue = 2"

This equipment may only be installed by qualified personnel. This appliance may be connected to an existing boiler system by utilizing a water-to-water heat exchanger. Refer to the **Installation Manual** for additional specific information.

REQUIRED CONTROL - Use only with **GARN® WHS/ETS CONTROLLER** and **GARN®** sensor stems or float switch.

OPTIONAL CONTROLS - If supplemental electric heating is desired, use only **GARN® ETS** components and controls, or **UL listed** components and controls. Refer to the **GARN® ETS** Manual for sizing, installation, operation, etc.

OPERATION - Refer to and review the Controller label, and the **Operator's Manual** supplied with this appliance. **Burn only wood, densified wood briquettes or corn-on-the-cob. DO NOT LOAD** fuel above the mid-point of the fuel loading door. Load fuel carefully or damage may result.

DANGER - DO NOT OPEN THE LOADING DOOR in the event of a power failure. **Hot surfaces. Keep children away. Do not touch during operation.**

C US

O WHS 1350 O WHS 1900
O WHS 1450 O WHS 2000
O WHS 1500 O ETS Package

W/N 0488 **SERIAL NUMBER: XXXXXX**

This non-pressurized wood fired hydronic heater is covered by one or more of the following United States and Foreign Patents:

United States Patent # 4,401,101 and # 4,549,526
Canadian Patent # 1,163,880 and # 1,220,686
Other patents pending in the United States and Canada

GARN® is a registered trademark of DECTRA CORPORATION.

DECTRA CORPORATION @ 3425 33rd Avenue Northeast, Saint Anthony, Minnesota 55418. Phone 612-781-3585. Fax: 612-781-4236. Web Site: www.garn.com.

WARRANTY

WARRANTY ON GARN® PRODUCTS: 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 with a copy of results forwarded to DECTRA CORPORATION. **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.

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Important GARN® Installation Guidelines

Congratulations on your purchase of a GARN hydronic wood heating unit. While the design and operation of the unit is very simple, it contains several innovative and novel design elements that will impact how your system is designed.

SPECIAL DESIGN CONSIDERATIONS:

Before you finalize the design of your system, be sure to read this manual and pay specific attention to the following items:

- ☐ NON-PRESSURIZED WATER STORAGE - This is a non-pressurized water storage system and as such requires careful attention to:
  - how pumps are sized
  - where pumps are located in relation to the storage tank
  - where pumps are located within the distribution system
  - how pumps are controlled
  - connection to an existing system (Warning: Do not directly connect to a system with glycol in it)

- ☐ PRESSURIZED EXHAUST FLUE - The GARN unit uses a blower to provide efficient combustion and heat exchange. This requires all flue connections to be sealed to prevent exhaust gases from entering an interior space.

- ☐ STORED HEAT - The temperature of the water in the storage tank will vary depending on frequency of burning and the rate heat is removed from storage. Your system should be sized for the LOWEST expected system water temperature. The lower the system water temperature, the more effective your storage becomes. Many conventional heating components are marketed based on 180 F water temperatures. Make sure your components are selected based on their performance with lower water temperatures.

- ☐ METHOD OF HEAT DISTRIBUTION - Water-based heat storage systems work well with all heat distribution options. However, the specific need for heat will suggest one type of distribution over another. Properly sized radiant floor heating works exceptionally well with water-based storage systems, however, the requirement for air filtration or conditioning may dictate the use of hot water coils in an air circulating system (NOTE: Heating coils should NOT be added to forced air systems that use a high efficiency furnace with *plastic flue pipe*). Other design considerations may point to some form of radiator that uses the hot water directly. Several different methods can be combined, but care must be taken so they all work equally well with the temperature of water available.

- ☐ METHOD OF CONTROLS - There are certain control designs that work best with a water-based heat storage system. Carefully read the entire manual for options that will work best for your application.

GOOD ENGINEERING PRACTICES:

Any heating system that circulates heated water from a heating device to its point of use can benefit from incorporating the following good design practices:

- ☐ PROPER SIZING OF DISTRIBUTION PIPING - Many times a smaller size pipe is chosen to save on installation cost; however, undersized piping can dramatically reduce how efficiently the heat is distributed. Often, the required heat cannot be delivered regardless of the selection and sizing of other systems components. This is an error that can only be corrected by replacing the undersized pipe.... a very expensive option.

- ☐ PROPER SIZING OF PUMPS - Many people do not understand how to select a pump that matches the requirements of the system. Use the charts in this manual and those supplied by pump manufacturers to insure the selection of the proper size and model of pump. Consideration must be given to both the head loss and gallons per minute required at the lowest expected temperature.

- ☐ PROPER SIZING OF HEAT EXCHANGE EQUIPMENT - Equipment should always be selected based on the system water temperature available and other components in the system. Be careful of "rules of thumb" that appear too good to be true.