Replacing a Water Heater

By making a few simple upgrades, you can triple a basic water heater's life expectancy

by Peter Hemp

Not many folks give water heaters a second thought. But eventually the moment comes to take a soothing bath or a quick shower, and there's no hot water. Suddenly, a water heater becomes an important topic.

In his articles on water heaters, Rex Cauldwell explained the differences between gas and electric heaters, from the basic to the new high-tech models *(FHB* #82, pp. 54-59; *FHB* #89, pp. 80-85). This article, on the other hand, is primarily about the dirty work of replacing one, along with some advice on new installations (if you can replace a water heater, you won't have any trouble putting in a new one). I'll concentrate on typical low-budget heaters on these pages. They are called "holding tank" water heaters, and you'll find one in just about every house in America. Their tanks are made of thin steel (12 ga. at most), and they are typically guaranteed to last five years.

The easy way to get it out of the box. With the box vertical, use a sharp utility knife to sever the top and the bottom of the box. Then make a cut down the side, and peel the box away.

How big, and where should it go?—Most of the residential water heaters that I replace are either 80-gal., 40-gal. or 50-gal. models. Since I'm replacing one, I need to know if the defunct heater was large enough to get the job done. If not, I go to the next size up. For a new installation, a good rule of thumb is that a 50-gal. heater will serve a typical family of four.

In parts of the country where it doesn't freeze, I think the best place to put a water heater is in a shed attached to the side of the house. If it leaks there, the damage will be minimal. In colder parts of the country, put the water heater in the basement or in a closet. If you choose a closet location, try to put the water heater close to the bathrooms to minimize piping runs. And put a drip pan (also called a Smitty pan) under the heater, with a drain line to the outside.

In a closed room such as a closet, you need to provide a steady supply of combustion air to a gas water heater with vents at both the top and the bottom of the enclosure. The rule of thumb is 1 sq. in. of vent area per 1,000 Btus of input. Inspectors can have differing opinions on this, so be sure to check with your local authority.

I urge you not to put a gas water heater in a garage. Even if it is raised the required 18 in. above the floor, a water heater with an open flame can be a dangerous ignition source in a garage, where gasoline fumes are common.

Electric heaters are easier to install than gas heaters. Electric water heaters don't need a chimney to exhaust combustion gases, and they don't present a fire hazard in a location that might have combustible materials. Electric water heaters are also more efficient at converting energy to hot water. But they are a lot more expensive to run than gas water heaters, and they are slower. Most of my clients choose gas.

Get one in a perfect box—When you buy a water heater, look at the box. If it has any holes or tears, ask for another one. During my 30-year plumbing career, I've seen what can happen to merchandise during shipping and handling.

Ideally, you should carry the water heater to the job site standing up to keep the anode rod from bouncing around and potentially chipping

the ceramic glazing inside the tank. If you must lay the heater down, nest the carton so that it doesn't slide around, and avoid bumpy roads. Make sure that a gas-fired heater's thermostatic control is pointing up during transport. Same goes for the access panel on an electric heater. A hand truck is the best tool for getting the heater from the truck to the installation site.

To remove the heater from its box, stand it up, then cut around the top of the box about 4 in. down. Do the same at the base of the carton, then cut down one side from top to bottom and peel away the bulk of the cardboard (photo facing page).

Now is the perfect time to make a couple of modifications to extend the life of the water heater. Everything is accessible, and none of the fittings are bonded by corrosion to the tank. First, I change the dip tube.

Dip tubes direct incoming water—The dip tube is a ¾-in. dia. pipe that extends from the top of the tank to within a foot of the bottom. The tube deposits incoming cold water near the bottom of the tank so that it won't dilute hotter water near the top. Without the tube, incoming cold water would rush to the hot discharge port and exit the heater without being heated. Many a water heater is junked because this $10 part has broken off or split.

Sediment buildup in gas-fired water heaters wastes tremendous amounts of energy because sediment acts as insulation. Rust particles from steel pipes, for example, drift in with the supply water and settle to the bottom of the tank. In areas with highly silted water, a 6-in. deep layer can accumulate in less than a year. The standard straight dip tube can do nothing to alleviate this problem. But an improved dip tube can be a big help (photo right).

Resembling a hockey stick, the improved tube is longer and is curved at the tip. With the curved tip near the bottom of the tank, incoming cold water stirs up the sediment. While in suspension, the sediment then exits the tank with the hot water. The improved dip tube adds about $20 to $30 to the cost of a new water heater. You can also purchase just the dip tube (Gull Industries; 800-748-6286).

To install the curved dip tube, I first remove the factory-installed cold-inlet nipple. Sometimes this nipple is a combination nipple and dip tube, fused together. If it's a combo, by unthreading the nipple and lifting upward, you are removing both. If this dip tube is curved and if it is in good shape, I reinstall it. If it is a straight tube, I discard it for a curved one.

If the nipple doesn't have the dip tube attached to it, the dip tube is usually a straight one, with a flared end holding it in place. I use one handle of a 10-in. sliding-jaw pliers to ex-

Pull out the stock dip tube. The handle of a 10-in. sliding-jaw pliers makes a good tool for wiggling a straight dip tube out of its hole.

Dip-tube registration mark. Put a pencil mark on the top of the dip tube to show which direction the curved tip is pointing.

A curved dip tube improves heater efficiency. The author replaced the straight dip tube on the right with the one on the left. Its curved tip helps to prevent sediment from building up on the tank bottom.

tract the dip tube (top inset photo, p. 91). Run the handle down its throat, then wiggle it up and out. Incidentally, I learned this truck in an excellent book called *The Water-Heater Workbook* (Elemental Enterprises, P.O. Box 928, Monterey, CA 93942; 40S-394-7077; $20).

The new dip tube has a nipple on its end. I mark the nipple's white plastic liner with a pencil to show when the curved end is concentric with the bottom of the tank (bottom inset photo, p. 91). Then I put four or five wraps of Teflon tape on the male threads of this nipple, and I apply pipe-joint compound to the heater's female threads. As I tighten the fitting, I stop when the fit is snug and the pencil mark is in alignment. By the way, I use this same combination of pipe-joint compound and Teflon tape on all threaded fittings for water pipe.

You can't drain the tank without a good drain valve—The curved dip tube helps, but the way to make certain you have a clean tank is to flush it out systematically. You can't do this effectively, however, with the plastic drain valve that comes with the heater because its passageway is easily clogged. So I replace the stock valve with a full-port ¾-in. ball valve (top photo), which is big enough to pass a marble. I use my basin wrench in conjunction with an adjustable wrench to pull a plastic valve (bottom photo).

Incidentally, I wear the latex gloves you see in these photos to keep my hands clean, and to avoid contact with pipe-joint compound. I sometimes go through 20 pairs of gloves in a day.

If you've got well water with sediment in it, you should flush the tank every three to six months. If, on the other hand, you've got reservoir water such as we have, you can probably get by flushing the tank once a year. Simply hook up the drain hose, run it to a safe place, and open the valve for 3 to 5 minutes.

Anodes extend the life of the tank—Even though a steel tank has been coated with a ceramic glaze to protect it, microscopic cracks in the glaze will give rust a place to start. That's where the anode rod comes in. Anode rods are designed to dissolve slowly in water (bottom left photo, facing page). As they do so, their molecules are attracted to the tank's steel wherever there is a little crack in the glaze. When they hit the steel, the molecules come out of solution to form a thin plating of metal that protects the steel tank from rust, much the way zinc protects galvanized steel from rusting.

Anode rods are made either of aluminum or magnesium. Your local water quality determines which kind of anode rod was shipped with your water heater. Magnesium anodes are the most common. In areas of especially aggressive water, which is rich in sodium, aluminum rods are a better choice because they last longer. The anode rod usually lasts long enough to get the tank past the warranty period. Then it wears out, and if it isn't replaced, the tank will start to rust. You could keep your present water heater operating for decades if you replaced the anode in time and flushed the tank with regularity.

This valve makes it possible to flush the tank. Hemp replaces the standard gate valve at the bottom of the tank with a hill-port ball valve. The nipple on its end accepts a garden hose. The cap is insurance against leaks.

Standard drain valve clogs too easily. A basin wrench turned with a crescent wrench gets a good purchase on the skinny neck of this plastic drain valve.

You have to solve two problems to replace anode rods. First, the rods are reluctant to come out. I use a wrench called a torque multiplier for this task (top photo, facing page). This is an expensive, specialized tool. If you don't need to own one, you can sometimes find these wrenches at rental yards. Lacking this wrench, you can use a breaker bar with a long handle to loosen the anode rod.

You also can install a combination anode/outlet instead of replacing the original anode rod. Leave the old anode in place, unscrew the outlet (which is a lot easier to loosen than the anode) and then insert the combo anode/outlet.

The second common problem is lack of space above the water heater. It's tough to thread a 4-ft. long anode rod into the top of a tank with only 3 ft. of clearance. The solution is to use an articulated anode rod, which is segmented so that it can be bent a little bit for to make installation easier.

Temperature-and-pressure relief valve—I have a film from the 1940s that shows a group of research scientists studying overheated water heaters. Dressed in lab coats and pith helmets, the scientists hunker down in a concrete pillbox in a big field while a nearby cottage explodes. It illustrates the power of steam and is a sobering reminder to make sure the T&P valve on your water heater is in good shape.

The T&P valve (photo bottom right, facing page) protects your heater from two dangerous forces: too-high temperatures and too much water pressure. Inside the valve is a coiled spring that keeps the valve closed until it is overcome either by excessive pressure or temperature. Then the valve opens, and water (or steam) escapes, protecting the tank from rupture.

You might ask, "What goes wrong to allow such a buildup of temperature or pressure?" Gas-fired heaters have a thermostatic control valve that is designed to shut off the gas if the water exceeds a preset temperature. If this valve fails, the burner won't shut down, and the tank overheats. Electric water heaters have a thermostat that regulates the heating element. If this thermostat fails, the same over-temperature condition can result.

Matter of fact, electric heaters overheat more often than gas heaters. This is because electric heaters use a thermostat that is not immersed in the water (like gas models) and instead samples the tank's temperature. Corrosion from leaks can build up between the thermostat and the steel tank, resulting in inaccurate readings.

Opening an electric heater's access panel can also cause overheating problems. If someone pulls away the insulation under the panel—to adjust the temperature settings, for example—they must replace the insulation before replacing the panel cover. Without the insulation, the thermostat can be fooled by the lower temperature of ambient air.

Some heaters come with the T&P valve already installed; others will need one installed on site. The valve's outlet is threaded to accept a ¾-in. fitting. A drain pipe made of copper or galvanized steel connects to this outlet (don't use plastic—it can fail at high temperatures). The pipe should be run, always at a downward slope, to a safe place 6 in. to 24 in. above the

ground with the end of the pipe pointing straight down. At the valve end of the drain line, install a union or a flexible coupling with female nuts on each end so that the line can be easily disconnected from the T&P valve.

Typically, heaters have two valve locations: on the top and on the side. I prefer to use the top because it allows me the most choices in running the drain line. Some water heaters have only one outlet for the T&P valve. The gas water heater I installed on the job shown here, for example, had a side outlet only, requiring a more circuitous drain-line route (photo right, p. 95).

During the life span of the heater, you can plan on replacing the T&P valve. They eventually get paralyzed by mineral deposits. To test the installed valve, simply lift the lever on top of the valve and let the heater dump some water and pressure. Then release the lever. If no water exits or if the valve fails to close, replace it.

Taking out the old heater—Corrosion typically bonds the old heater to the pipes, and it's full of hundreds of pounds of water. You begin its removal by shutting off the gas or the electricity. A gas heater should have a valve on the gas line where it comes through the wall.

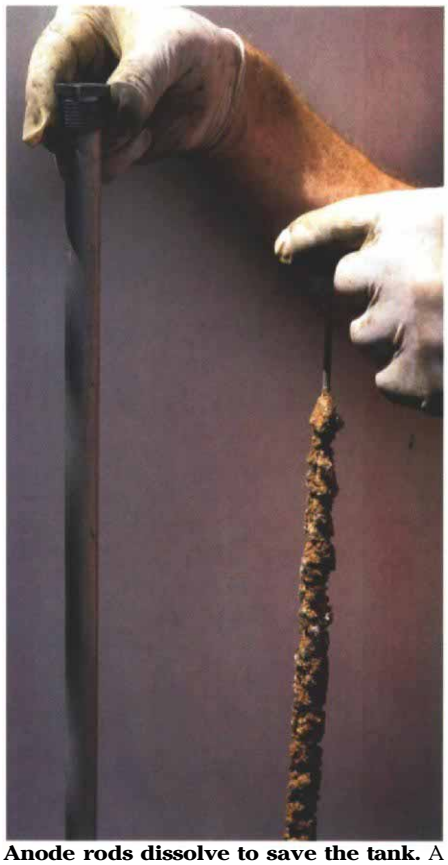
Modem electric codes require a shutoff switch within sight of an electric water heater. If the heater was installed prior to this code revision, go to the breaker panel and locate the breaker that controls the electric water heater. At this point, I like to check the heater's contacts to see if they have power (bottom photo, p. 94). Then I shut off the switch or the breaker and retest to make sure the power is off.

Next, shut off the water supply, hook up a hose to the heater's drain valve and empty the tank. The heater pictured here had a classic problem (photo left, p. 94). The drain valve was clogged, allowing a mere trickle to get through. So I loosened the old valve with a pipe wrench. Then, wearing thick, insulated rubber gloves, I slowly backed it out by hand. When the valve came out, along with a gush of hot water, I quickly inserted a ball valve into the opening. Then I hooked up the hose and drained the tank.

I cut the pipes to the old heater with a hacksaw, even if they have unions on them. The unions are often corroded shut, and a sharp hacksaw blade makes quick work of the job (photo top center, p. 94). A word of caution here: Don't use a reciprocating saw to cut the pipes. The intense vibration can break adjacent threaded connections in old pipes, creating a whole new job that you don't want. When the heater is empty and disconnected, lift it out.

Seismic restraints—A lot of the water heaters that I replace here in the San Francisco Bay area were installed before we had to anchor them to

Removing an old anode rod. Years of corrosion make threaded connections difficult to break. This torque-multiplier wrench applies tremendous torque with a minimum of effort.

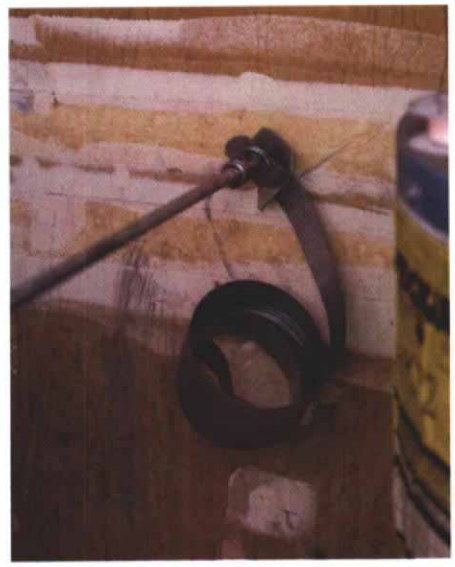


Anode rods dissolve to save the tank. A magnesium rod with a steel core hangs in the tank. As it dissolves, its molecules are deposited on exposed steel, preventing rust.

This spring-loaded valve can save your life. The temperature-and-pressure relief valve is a safety valve that releases water if it gets too hot.

Drain the old heater. The original valve was clogged and had to be replaced with a ball valve before the tank could be drained. Note the useless positioning of the T&P valve atop the tank's outlet, where it can't accurately gauge temperature or pressure.

Cut the old pipes. A sharp hacksaw makes quick work of the old pipes. A reciprocating saw, on the other hand, would likely break connections down the line.

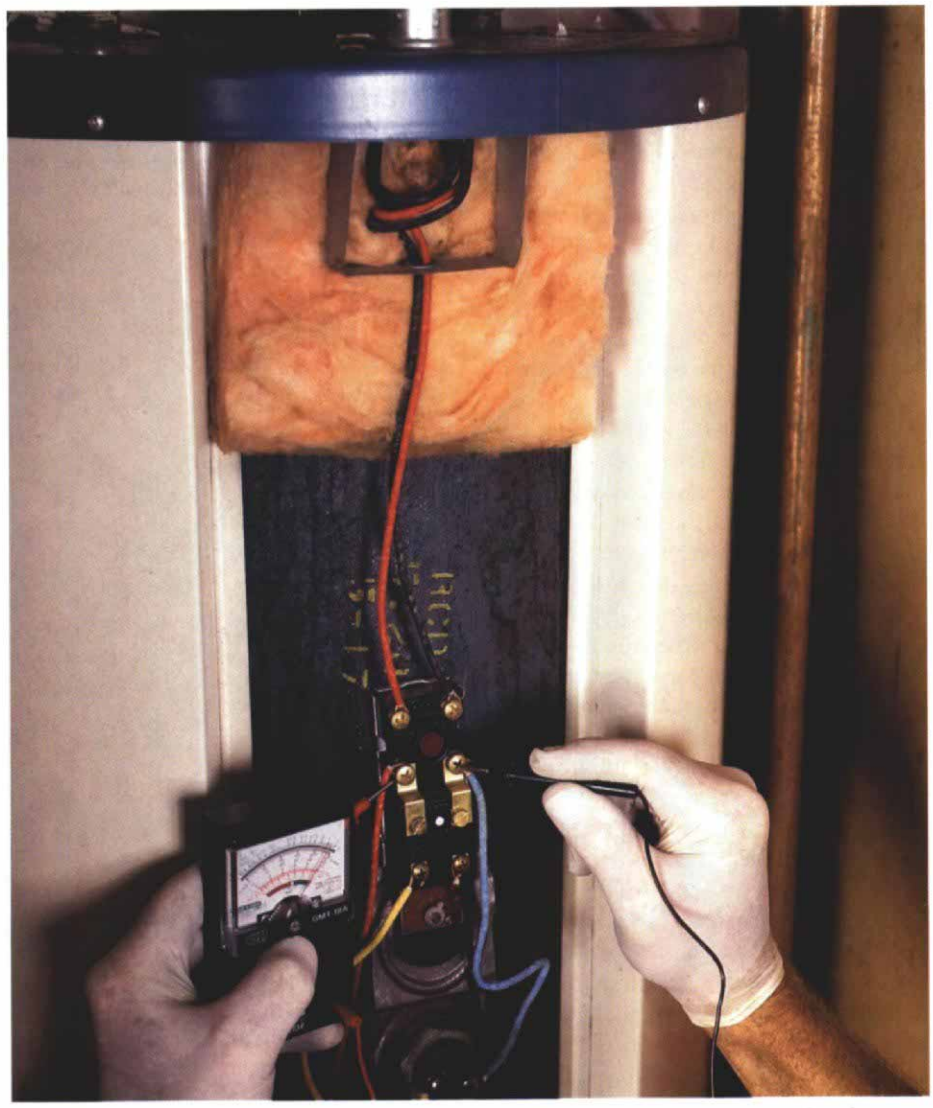


Seismic anchors holt to the framing. A ratchet wrench with a long extension helps to drive home the ⅜-in. lag bolts that secure the straps to the wall behind the heater.

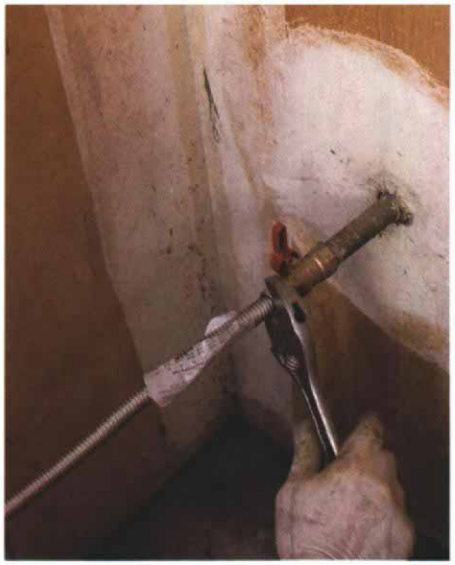
resist tipping in earthquakes. Modern building codes and common sense require that steel strapping be wrapped around the heater at the top and the bottom in any seismic zone. I use a commercially available kit made just for this purpose (The Quick-Strap 50, made by the Hold-Rite Co., 800-321-0316). The straps are bolted to the framing behind the heater, so they must be installed before the new heater is put in its place (photo top right).

Water and gas supply—The outlet side of your gas shutoff valve should have a ½-in. male flare nipple. It connects to a stainless-steel flex connector with captive female nuts on both ends (photo top left, facing page). The old valve, in this case, didn't fit that description, so I shut off the gas at the meter and replaced it with a new ½-in. ball valve. For threaded gas fittings, I use only pipe-joint compound. Teflon tape isn't allowed. The concern is that tiny pieces of Teflon might break free and clog the gas works.

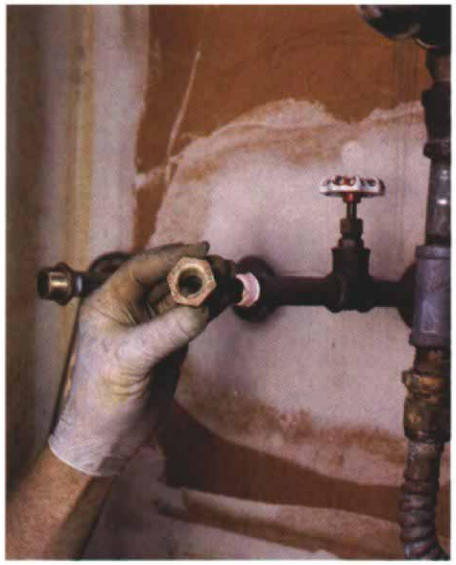
Most plumbing and building codes limit the length of the gas flex to 3 ft. If it has to be



Use a voltmeter to check for power. Before shutting off the power to an electric water heater, the author takes a reading on opposing contacts on the heater's overload. It reads 240v. Now he can shut off the breaker labeled water heater, and retest to see if the label is accurate.

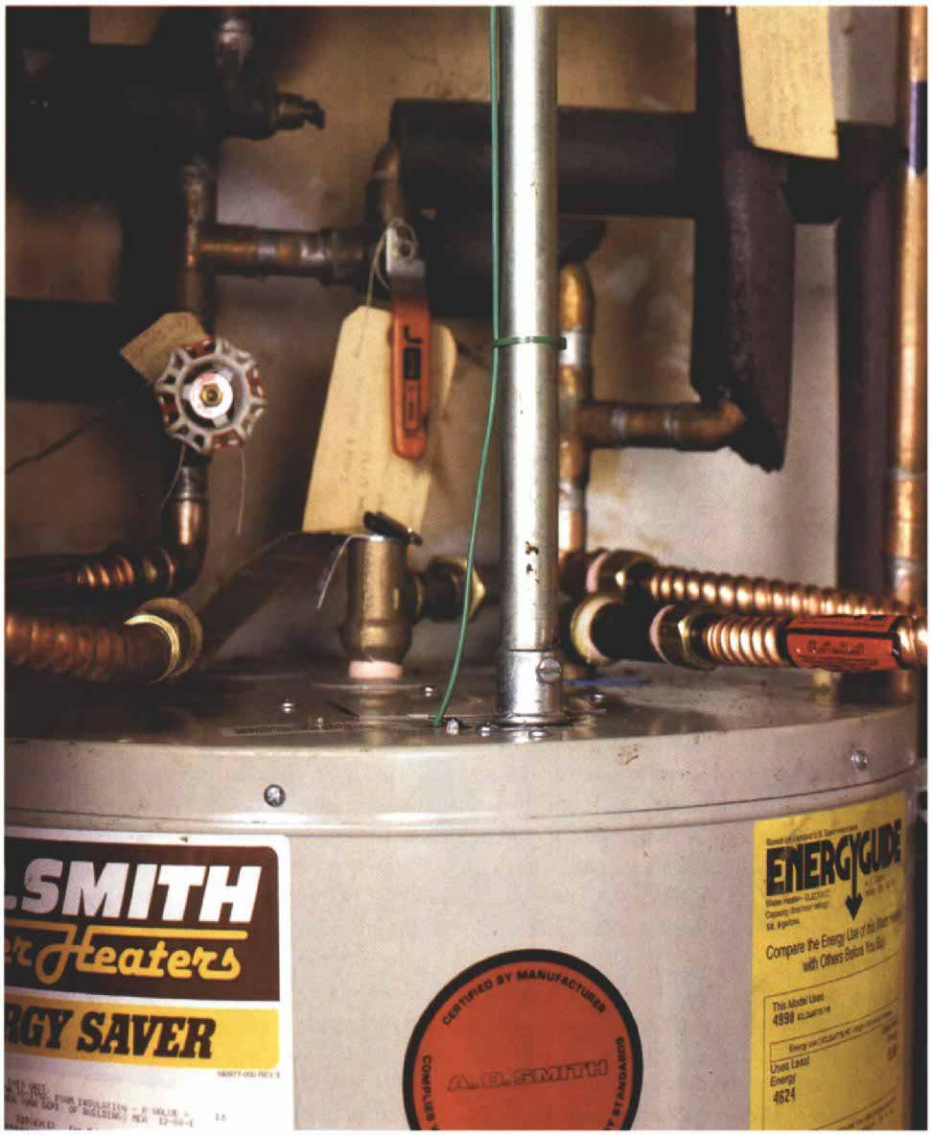


Gas supplies need shutoff valves. A ball valve on the end of the rigid gas pipe connects with a flexible stainless-steel coupling.



Bushings step up the pipe diameter. A ½-in. by ¾-in. brass bushing joins the old supply lines with the new heater.

A flex coupling can also be a drain. The side-mounted T&P valve presented a challenge because the drain was on the opposite side of the heater. A ¾-in. copper flex pipe made the hookup easy.



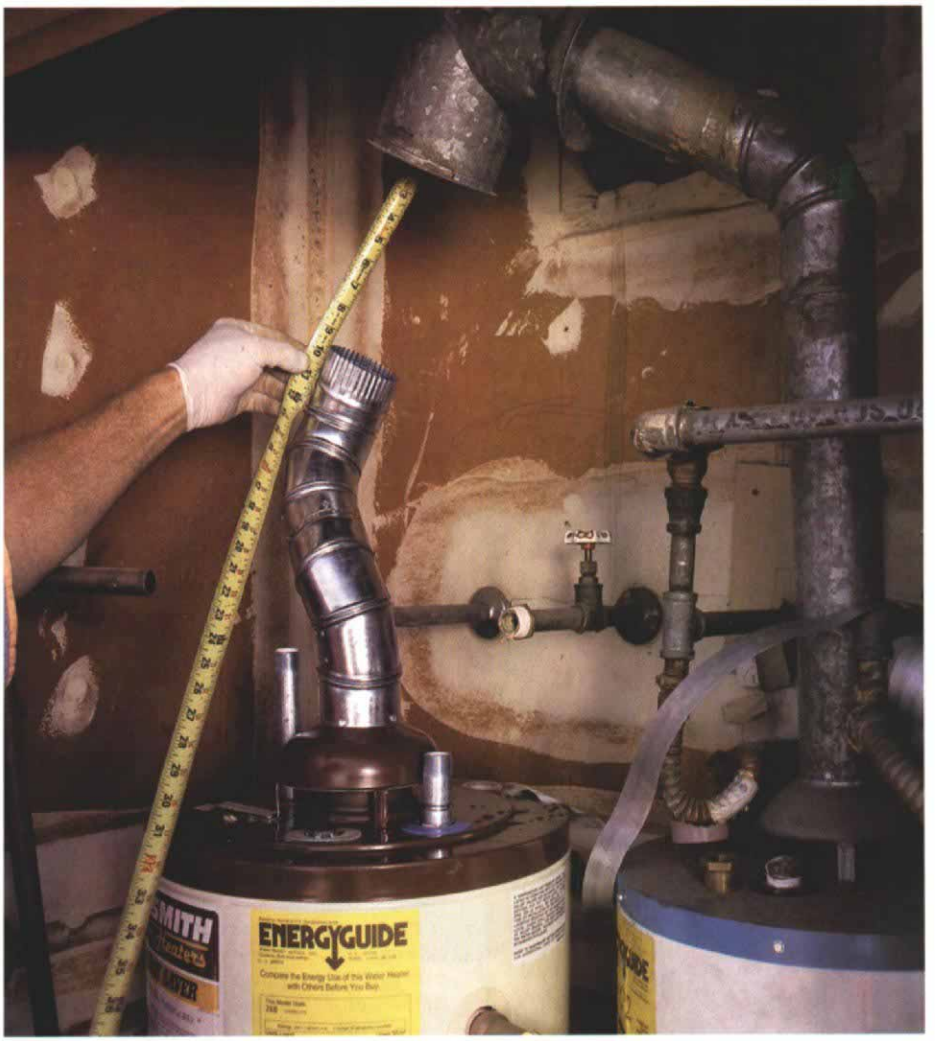
Electricity enters at the top. Rigid conduit containing the 240v power supply enters the top of the heater through a collar. The connections are made in the junction box behind the collar.

longer, you need to extend the supply line with rigid pipe.

The old water-supply pipes on this job were ½-in. dia., while the inlet and outlet nipples on the top of the new water heater were ¾-in. dia. To modify the situation, I threaded ½-in. by ¾-in. brass bushings onto the old nipples (photo top center). I used brass fittings because they are less likely to corrode than steel ones. Now I'm ready for installation.

Hooking up the new water heater—I bear-hug the new heater into place, positioning it for access to the gas valve, water supplies and the T&P valve. If the new heater is shorter than the old one, you can get it closer to the hookups by placing it atop a couple of concrete blocks. At this stage, the tank has no water in it, so it's easy to budge. Once you fill it, you can't budge it.

If it's a gas heater, I hook up the vent connector between the draft hood and the vent (photo left, p. 96). The vent fittings and pipes should be attached with three sheet-metal screws at each joint and wrapped with high-temperature alu-



Getting rid of combustion gases. The draft hood atop the heater collects combustion gases and feeds them to the flue. Here, Hemp measures for the connector between the adjustable couplings and the flue opening.

Crimping tool for custom parts. When a site-cut piece of sheet-metal ducting has to fit inside another piece, use this tool to reduce the diameter of the pipe.

minum tape. Don't use duct tape—it won't last. The pipes and fittings should extend at least 1½ in. into each other. I use a crimping tool to taper the small end of the pipe (photo right).

Although the flue is double-wall pipe, I typically make the connector out of galvanized single-wall pipe because clients don't want to pay the extra money for double-wall material. Galvanized draft-hood connectors will eventually start to rust, and then bits of rusty pipe will fall onto the burner. This is a dangerous situation, which can lead to clogged burners or even flames wrapping up the outside of the tank. You should replace any rusty flue pipes or connectors immediately, and check the burner to see if it needs cleaning (turn off the gas, of course).

Water hookups come next. I prefer flexible 24-in. stainless-steel supply lines (bottom photo, facing page). They can be bent into tight radiuses without kinking, and they loop more easily than the copper equivalent. And being all stainless, including the female-union ends, they are resistant to dielectnc corrosion with carbon-steel nipples. I also prefer them because they have female nuts on both ends, which makes it a lot easier to replace than a supply tube with a soldered fitting if it springs a leak.

Most water heaters have inlets and outlets on their tops. They don't typically come with nipples, so you need to supply them. I avoid galvanized steel, preferring instead to use 6-in. brass or plastic-lined steel nipples, which qualify as corrosion-resistant dielectric unions. In either case, I use nipples that are long enough to extend above a gas heater's draft hood. Otherwise, the connections on the flexible supply lines are subject to overheating.

I bend the flexible supply lines into big loops, allowing the heater to jiggle in an earthquake without breaking a pipe. The loops also help to keep a resting water heater's hot water from migrating out of the tank into the connecting pipes.

The nuts on the supply lines loosen over time, allowing water to escape. If I'm installing an electric heater, I route supply lines so that they don't pass over the control panels for the supply hookup, the thermostat or the heating elements. Otherwise, this water can drip onto the heater's electrical connections and corrode them.

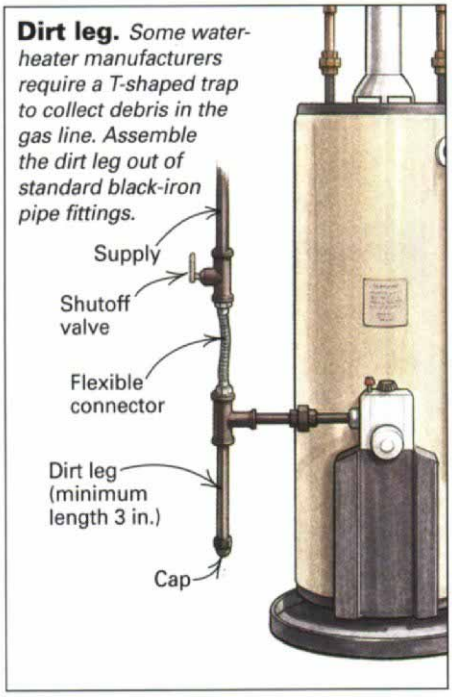
Hooking up the gas connection—The gas-control valve is at the bottom of the heater. You'll find a plastic plug inserted in the threaded female opening in the control valve's side. Take out the dust plug, and insert a ½-in. MIP (male iron pipe) x male flare adapter. Now you can hook up the flexible coupling from the gas pipe (top photo, facing page). The flex should have at least several inches of slack. I prefer to do a complete loop when possible.

When snugging up these connections, always back up your tightening wrench (on the flex pipe) with another wrench on the nipple coming out of the control valve. You want tight connections here, without damaging the valve.

Hookups complete, open the cold-water valve to fill the tank. Then turn on the gas and apply thinned liquid soap to the fittings to check for leaks. If you get a bubble, keep tightening.

By the way, some manufacturers want a debris trap, or dirt leg, installed on the gas-supply piping (drawing facing page). Without the dirt leg, the warranty will be void. In my experience, LPG heaters have required dirt legs far more than natural-gas heaters. Check your warranty to see if this is the case with your heater.

Before you light the burner, make sure the tank is full of water by lifting the lever on the T&P valve. When it's full, water will gush out the drain line. Now follow the manufacturer's light-



Dirt leg. *Some water-heater manufacturers require a T-shaped trap to collect debris in the gas line. Assemble the dirt leg out of standard black-iron pipe fittings.*

ing instructions. Be patient. There will be air in the lines for a while.

Hooking up an electric heater—Electric water heaters are 240v appliances, and as such they are hooked up to electric cable with two conductors in it. Make sure the heater you're installing has the same energy requirements as the one being removed. If you're upgrading, the old wiring might be inadequate. Water heaters rated at 3,500w and less need at least 12-ga. wire fused at 20 amps. Water heaters rated from 4,500w to 5,500w require 10-ga. wire fused at 30 amps.

The electrical connections typically hook up on top of an electric water heater (bottom photo, p. 95). A conduit collar enters the heater's top through a circular knockout. Behind the knockout is a removable plate for the junction box. You'll find two or three wires in the box: a black one, a red one and a green or bare copper one. The black and the red are the hot wires; the green or bare wire is a ground wire. These three wires are going to be matched up with the three wires in your supply cable. Before any of this connecting, double-check to make sure you've shut off the power to the heater supply.

Use the appropriate wire nuts to make the connections between supply and appliance wires. These connections might also need taping with an acceptable vinyl electrical tape.

This heater had a terminal next to the conduit collar for a ground wire. The conduit collar can also be considered a ground connection, provided the conduit extends to the electric panel.

The heater has one or two heating elements. Carefully remove their covers, separate the insulation, and check the temperature-setting screw for desired temperature. I usually set them at 120°F. Carefully put back the insulation.

Now fill the tank, but don't turn the electricity on until you're sure the tank is full. To do so would dry-fire the elements and burn them out.

Do the T&P test to check for a full tank, or open the highest hot-water valve in the house. When water runs out in a steady stream, the tank is full. Now you can turn on the power.

Straps go outside the blanket—Once I'm satisfied that the tank doesn't have leaks and that the heater is working, I wrap it with an insulation blanket. I minimize heat loss at the top of the tank by taping the edges of the blanket to the heater's top. Now I can cut the seismic straps to length and tighten them to finish the job. □

Peter Hemp is a plumber living in Albany, California. He is the author of Plumbing a House *(The Taunton Press, 1996). Photos by Charles Miller.*

Gas enters at the bottom. The gas supply hooks up to the control valve at the base of the tank. Use a pair of wrenches to avoid damaging the valve.

Wrap it up. If the heater gets an insulation blanket, put it on before tightening the seismic straps. Note the tape that seals the vent duct and the insulation to the top of the tank. Stainless-steel flexes connect the house piping to the tank.

Drawing: Bob La Pointe