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Guidelines for Earthquake Bracing of Residential Water Heaters

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Introduction

During past earthquakes, water heaters have moved or tipped over if they were not securely anchored to adjacent walls or floors. This movement has resulted in gas line or water line leaks, and electrical wiring damage. Gas line leaks and damaged electrical wiring pose health and fire hazards, and water line leaks can cause significant and costly property damage.

California law (Health & Safety Code Sections 19210-19217) requires:

- Any new or replacement water heater sold in California on or after July 1, 1991 be braced, anchored or strapped when installed to resist falling or horizontal displacement due to earthquake forces.
- The seller of any real property containing a water heater to certify in writing to the purchaser that water heater bracing requirements have been met.

The Division of the State Architect (DSA) has prepared these guidelines, which illustrate several earthquake bracing systems for typical (30 to 75 gallon capacity) residential water heater installations. These guidelines meet the bracing requirements of California's building and plumbing codes, which require that a minimum of two sets of bracing straps be provided to secure the water heater against movement.

These guidelines were developed for water heaters with a capacity of 52 gallons or less, and may also be utilized for water heaters with a capacity of up to 75 gallons, provided an additional (third) set of bracing straps is provided at mid-height of the water heater. Earthquake bracing details for water heaters with a capacity greater than 75 gallons should be approved by the local building department prior to installation.

Limitations:

These guidelines do not replace any requirements adopted by local building departments. The installation of residential water heaters (including seismic bracing) is under the jurisdiction of local building departments.

These guidelines do not address water heater installation in an attic or other unusual location (such as a water heater not located adjacent to a wall).

These guidelines do not address other plumbing code requirements (such as protection from damage, venting, clearances from combustible materials, and combustion air). Clearances of water heaters from adjacent walls must meet minimum requirements specified by the manufacturer and the local building department.

Note:

DSA strongly recommends that code-compliant **flexible** connectors be provided between the water heater and any water, gas, and electrical lines.

Methods for Earthquake Bracing of Water Heaters for Residential Use

These guidelines specify two methods for bracing water heaters. One method utilizes plumbers tape (perforated metal strapping), while the other method utilizes round thin wall metal conduit (commonly known as EMT).

Plumber's Tape Bracing: This method utilizes 3/4" perforated 24 gauge steel strapping (plumber's tape) to brace the water heater at an adjacent wall.

- See illustration on page 4 to brace a water heater located adjacent to a room corner.
- See illustration on page 6 to brace a water heater located adjacent to a straight wall.

EMT Conduit Bracing: This method utilizes 1/2" diameter EMT conduit, in conjunction with 3/4" perforated 24 gauge steel plumber's tape, to brace the water heater to an adjacent wall.

- See illustration on page 8 to brace a water heater located adjacent to a room corner.
- See illustration on page 10 to brace a water heater located adjacent to a straight wall.

Helpful Hints:

- One method for locating studs behind the wall finish is to use a small drill bit to drill a series of holes through the drywall until a stud is located. Both sides of the stud should be located in order to place the pilot hole for the lag screws at the center of the stud. A stud finder (magnetic device that locates drywall screws/nails) can also be purchased from your local hardware store to locate studs.
- Lag screws must be installed into a pre-drilled pilot hole (and must be screwed in, not driven in with a hammer). A standard cut washer must be installed with the lag screw as shown.
- It is possible that a 10 foot length of plumber's tape will not be long enough for this installation. If this proves to be the case, the plumber's tape can be spliced using a 1/4" hex head bolt or 1/4" round head machine screw (RHMS) with washers and a nut.
- A vise is the simplest method for flattening the ends of the conduit. The conduit can also be flattened by placing it on a hard flat surface (i.e. garage floor) and striking it with a hammer.

Insulation Blankets

If the water heater has an Insulation blanket around the outside of the tank, it should be removed and reinstalled after the bracing system is completed.

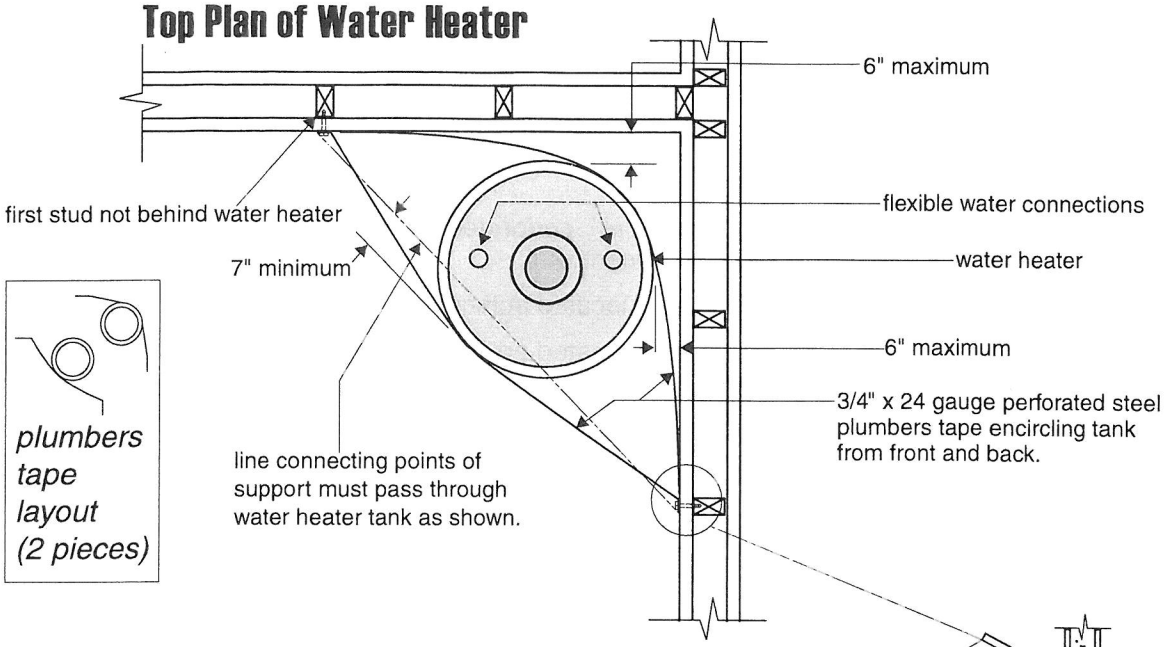
Water Heaters on a Raised Platform

The plumbing code requires that a gas water heater located in a garage must have the pilots, burners or heating elements, and switches located at least 18" above the floor level. Gas water heaters are generally placed on a platform to meet this code requirement. It is recommended that the water heater be secured to the platform, and that the platform be secured to the floor and/or adjacent walls.

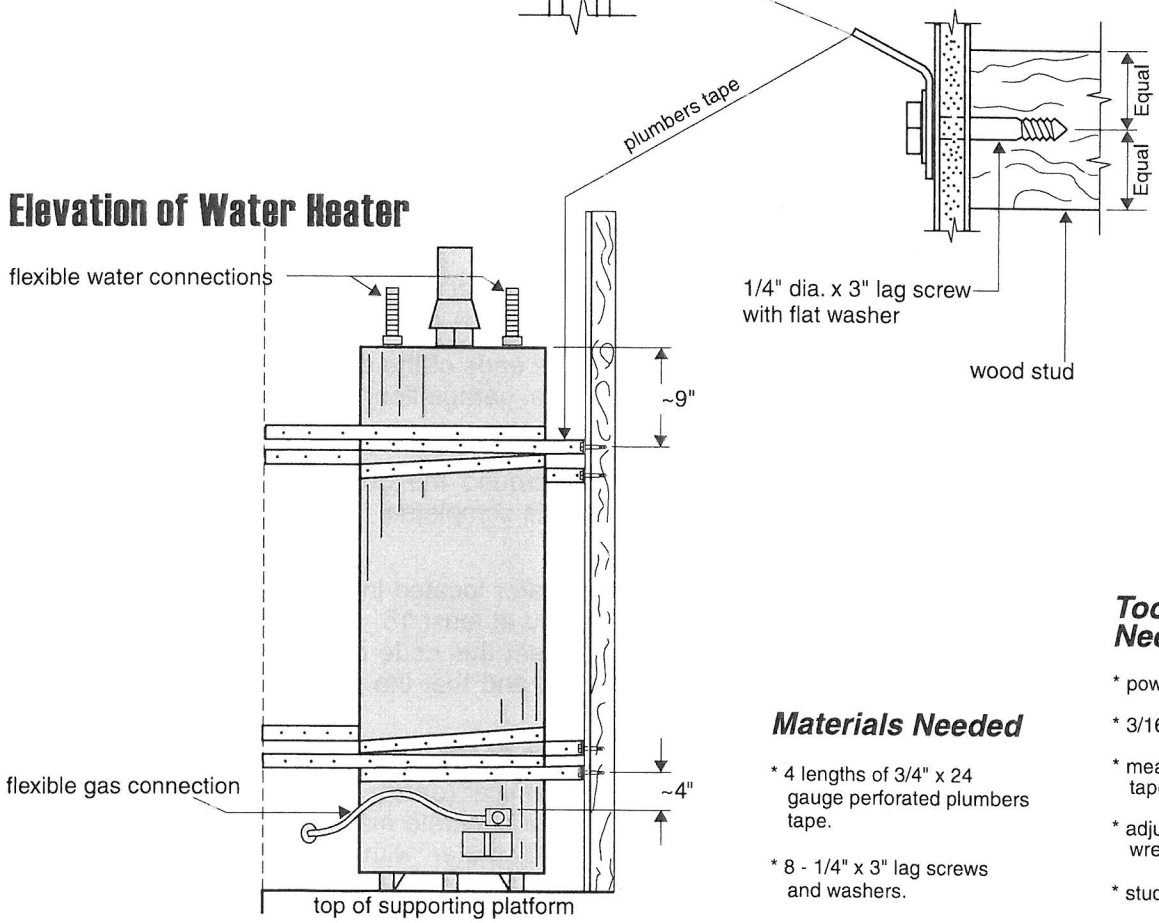
Water Heater Bracing Attachment to a Concrete or Concrete Masonry Wall

Mechanical (expansion-type) anchor bolts or chemical (epoxy adhesive) anchor bolts may be used to secure bracing or strapping to concrete or concrete masonry walls. The mechanical or chemical anchor bolt should be a minimum 3/8" diameter, with 2" minimum embedment at the concrete or masonry, and must be installed in accordance with the manufacturer's instructions. The concrete or concrete masonry (gray block) must be competent, without significant cracks (1/16" width or larger). Anchor bolts must not be installed at ungrouted (hollow) cells in concrete masonry walls.

Top Plan of Water Heater



Elevation of Water Heater



Materials Needed

* 4 lengths of 3/4" x 24 gauge perforated plumbers tape.
* 8 - 1/4" x 3" lag screws and washers.

Tools Needed

* power drill
* 3/16" Drill bit
* measuring tape
* adjustable wrench
* stud finder

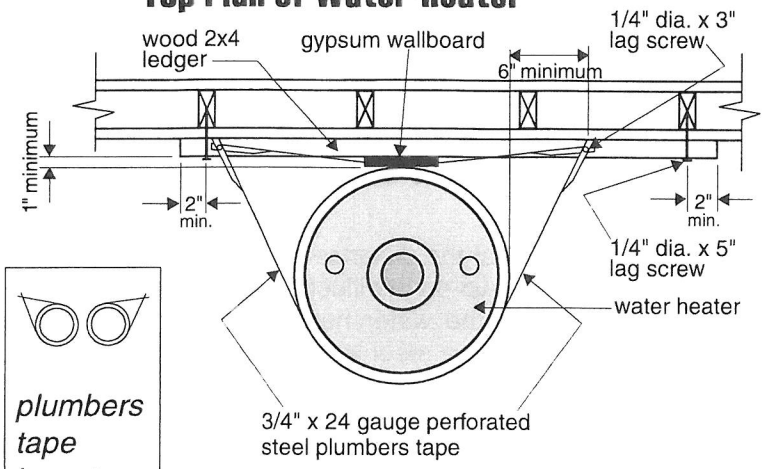
Refer to instructions on page 5.

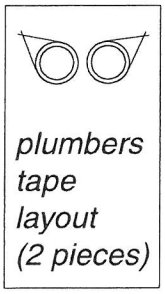
Plumber's Tape Bracing
Water Heater Located Adjacent to Room Corner

See Illustration on Page 4

1. Mark the water heater approximately 9 inches below the top for the upper strap location, and 4 inches above the top of the controls for the lower strap.
2. Using a stud finder or another appropriate method, locate the nearest wall stud not directly behind the water heater (see illustration on page 4).
3. Stretch a string between the two support studs and verify that the distance from the string to the face of the water heater is at least seven inches (as shown on the illustration). If it is not at least seven inches, it will be necessary to either move the water heater, or utilize the alternative support detailing shown on page 11, which utilizes a steel ledger angle (1-1/4" x 1-1/4" x 1/8") at the bracing attachments to the wall.
4. Transfer marks on the water heater horizontally onto the adjacent walls where the studs identified in step 2 are located.
5. Drill 3/16" diameter x 3" deep pilot holes into the support studs at each lag screw location.
6. Anchor one end of each length of plumber's tape (4 total) to a support stud with a 1/4" diameter x 3" lag screw, wrap the plumber's tape around the water heater, and pull the tape tightly against the support stud on the opposite wall.
7. Secure each length of plumber's tape (4 total) at the support stud at the opposite wall with a lag screw, and cut off any excess length of tape. It is important that the tape be taut. If the tape is not taut, remove one or both lag screws and reinstall in the another hole in the plumber's tape, and then reinstall the lag screw(s) into the support stud.

Top Plan of Water Heater



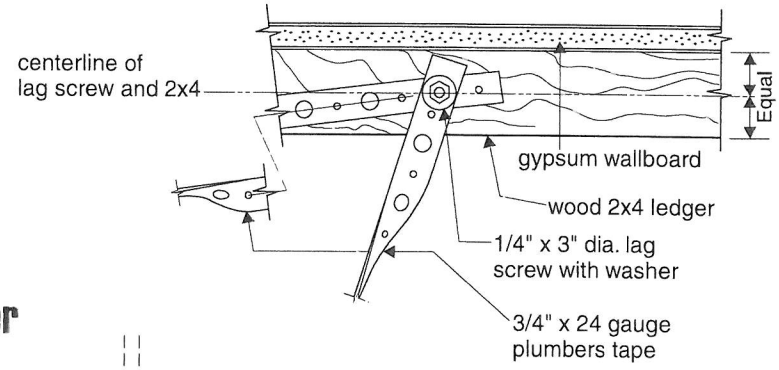


Materials Needed

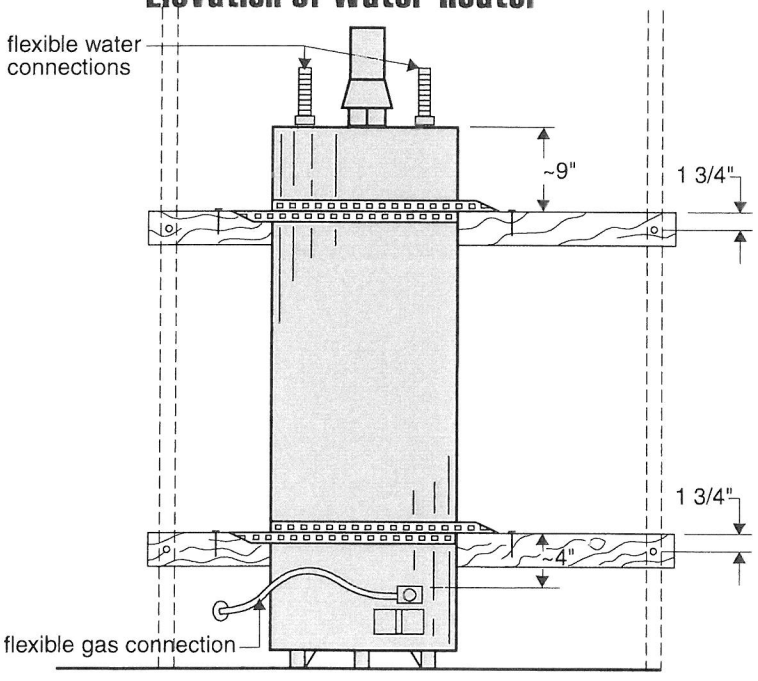
* gypsum wallboard (fire resistant drywall)
* 2 lengths of 2x4's
* 4 lengths of 3/4"x 24 gauge perforated plumbers tape
* 4- 1/4" x 5" lag screws
* 4- 1/4" x 3" lag screws

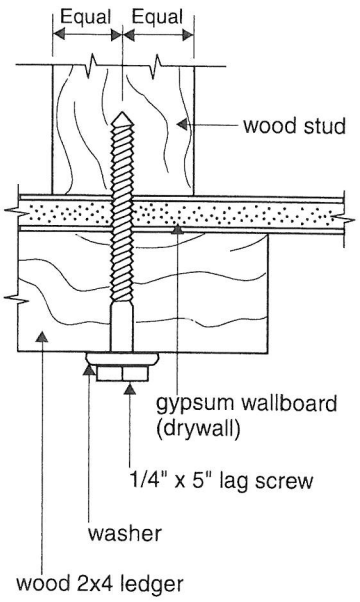
Tools Needed

* power drill
* 1/4" drill bit
* 3/16" drill bit
* stud finder
* measuring tape
* adjustable wrench



Elevation of Water Heater





Refer to instructions on page 7.

Plumber's Tape Bracing
Water Heater Located Adjacent to Straight Wall

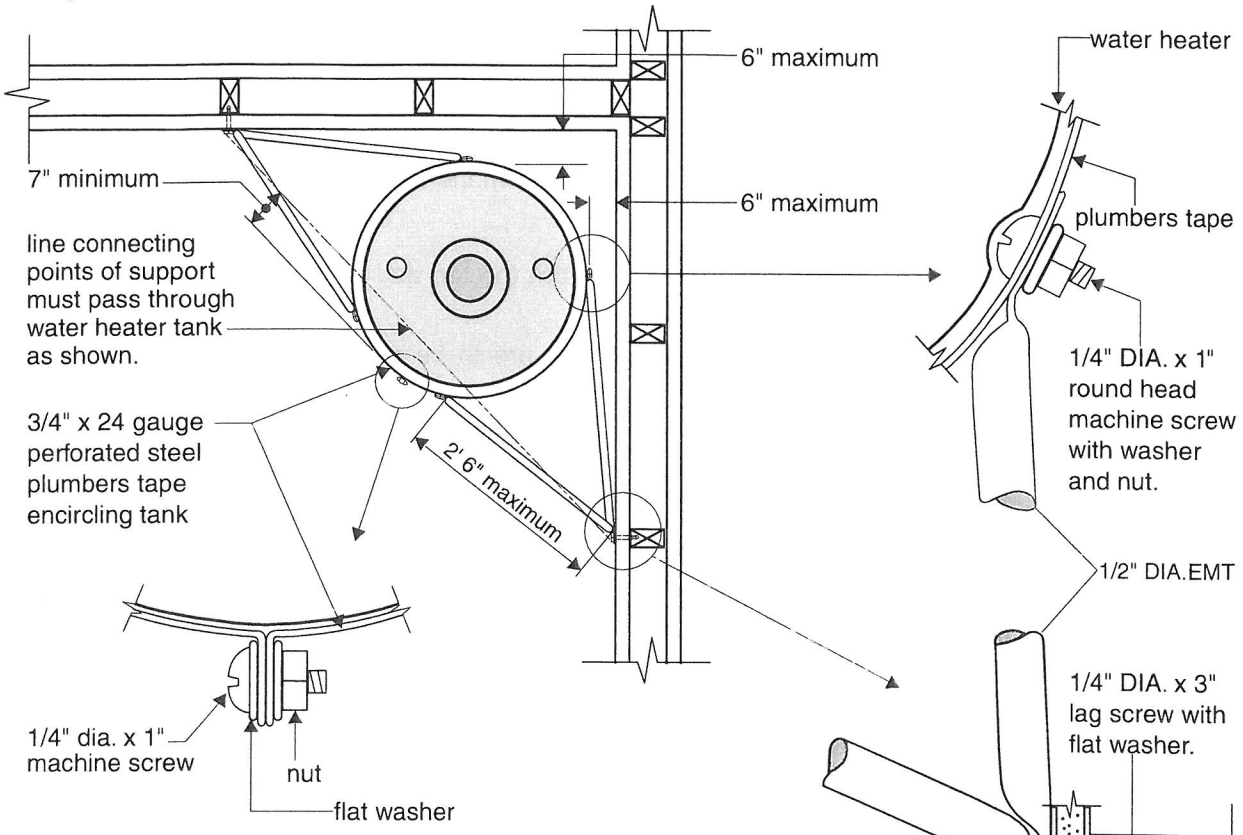
See Illustration on Page 6

This method requires that the water heater be at least 2-1/2" from the wall. It may be necessary to move the water heater to use this method.

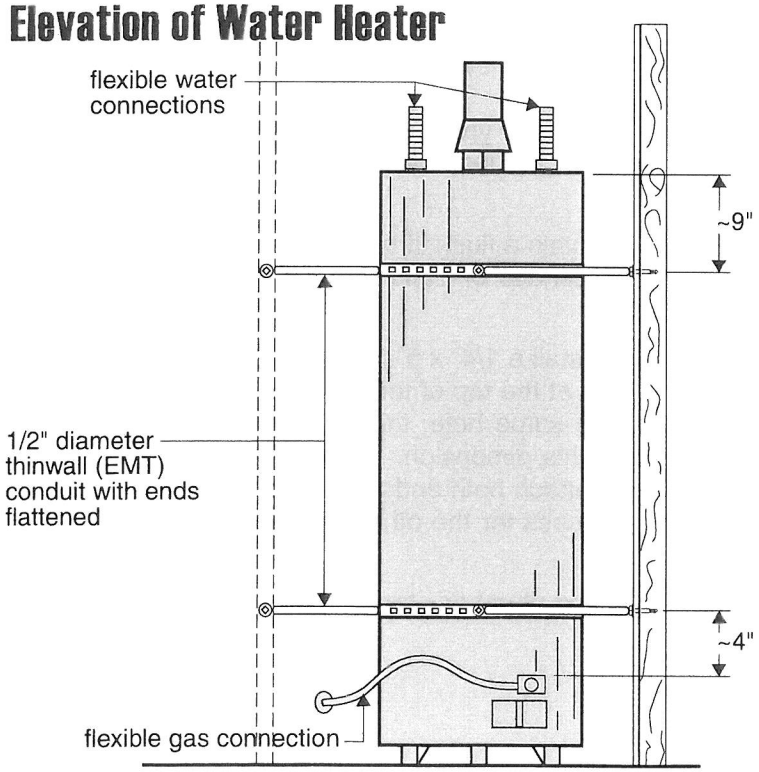
1. Mark the water heater approximately 9 inches down from the top and 4 inches up from the top of the controls. Transfer these marks to the walls.
2. Locate the studs to receive the wood 2x4 ledgers that are to be centered at the heights marked on the wall.
3. Measure the distance between the centerline of the studs that are to support the upper 2x4 ledger and add 4 inches. Cut both 2x4 ledgers to this length.
4. Drill a 1/4" diameter hole two inches from each end of each 2x4 ledger, located at the center of the 3-1/2" width of the 2x4 ledger.
5. Place the upper 2x4 ledger on the wall at the correct height (i.e. lining up the 1/4" hole over the center of the wall studs at the previously marked height). Through the 1/4" hole, mark the hole location on the stud and then remove the ledger. Drill a 3/16" diameter x 3" depth hole in the stud.
6. Place the upper 2x4 ledger on the wall and insert the 1/4" diameter x 5" lag screws through the holes in the ledger and the 3/16" holes in the wall stud. Tighten the screw only enough to hold the 2x4 in place as the 2x4 will have to be removed to drill holes in the top of the 2x4 for the plumber's tape connection (see step 7).
7. Mark the appropriate locations for connection of the plumber's tape and measure the distance from the face of the 2x4 to the face of the water heater. Remove the 2x4 from the wall. Drill the 3/16" diameter holes in the top of the 2x4. At the face of the 2x4 ledger, adjacent to the water heater, place two or more layers of Type X gypsum wallboard (secure with drywall screws or nails). The water heater must be flush at the drywall when the 2x4 ledger is in place against the wall.

   A 24" length of wood (1x4 or 2x4) may be used to obtain a flush fit between the water heater and the 2x4 ledger, provided at least a 1-inch thickness of Type X gypsum wallboard is installed adjacent to the water heater.
8. Place the 2x4 ledger behind the water heater and install a 1/4" x 5" lag screw at each end of the 2x4 ledger. Measure the distance from the hole at the top of the 2x4 ledger, around the circumference of the water heater and back to the same hole, then add 2 inches to that measurement. Cut a length of plumber's tape to this dimension. Place the cut length of plumber's tape tightly around the water heater and attach both ends of the tape to the top of the 2x4 with a 1/4" x 3" lag screw. Repeat the process for the other hole at the top of the 2x4 ledger.
9. Repeat Steps 5 through 8 for the lower 2x4 ledger and plumber's tape.

Top Plan of Water Heater



Elevation of Water Heater



Materials Needed

* 2 lengths of 3/4" x 24 gauge perforated plumbers tape
* 2 lengths of 1/2" dia. EMT conduit
* 10- 1/4" dia. x 1" round head machine screws
* 12- 1/4" washers
* 10- 1/4"nuts
* 4- 1/4" dia. x 3" lag screws

Tools Needed

* tape measure
* hammer
* hack saw
* center punch
* stud finder
* power drill
* 1/4 dia. drill bit
* 3/16" dia. drill bit
* adjustable wrench

Refer to instructions on page 9.

EMT Conduit Bracing
Water Heater Located Adjacent to Room Corner

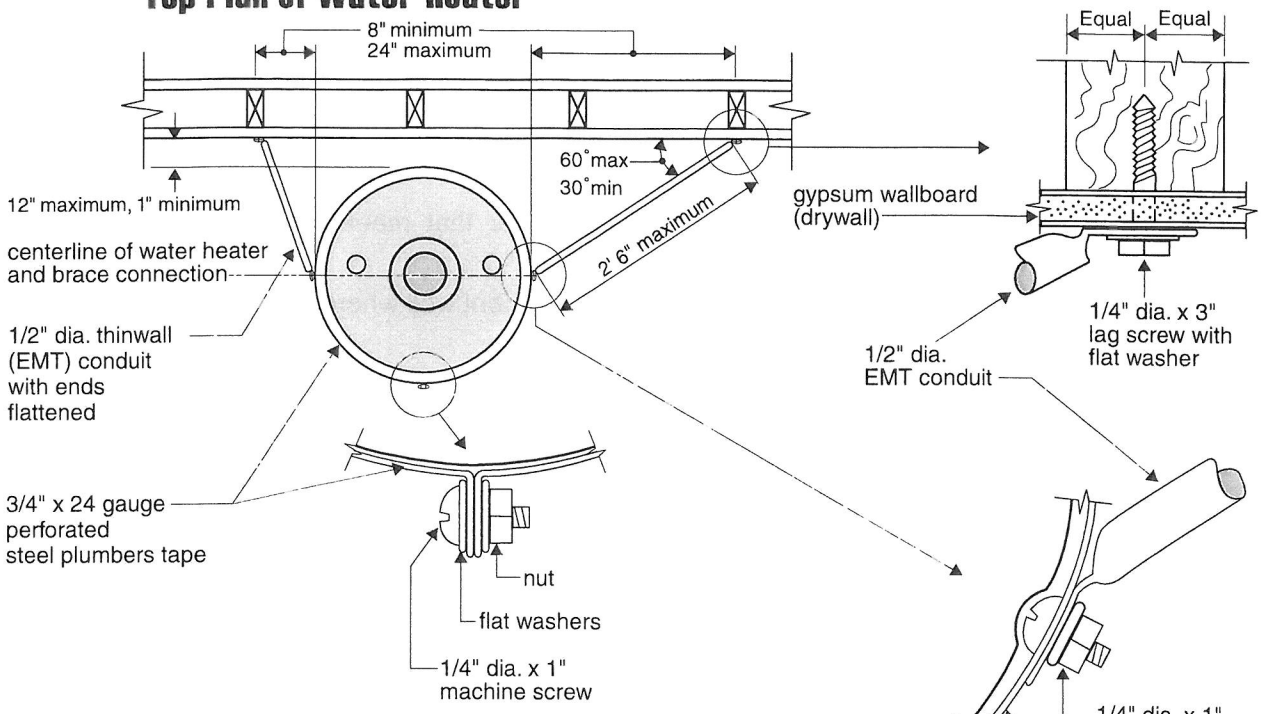
See Illustration on Page 8

1. Mark the water heater 9 inches down from the top and approximately 4 inches up from the top of the controls. Transfer these marks to the walls.
2. Locate the wall studs on both sides of the water heater that meet the minimum and maximum criteria shown on the illustration (page 8).
3. Transfer marks on the water heater horizontally to the adjacent wall where the studs located in Step 2 are located.
4. Drill a 3/16" diameter x 3" pilot hole at these four stud locations to receive a 1/4" diameter x 3" lag screw.
5. Measure the circumference of the water heater and add 2 inches to this measurement. Cut two pieces of plumbers tape to this length. Place a 1/4" x 1" round head machine screw (RHMS) with washer through the end hole of each end of these pieces. Bend the ends of the tape out 90 degrees as close to the edge of the washer as possible then remove the bolt. The tape can be broken at the smaller holes by holding the tape with pliers and bending several times.
6. Place the tape around the water heater and place a 1/4" x 1" RHMS through the bent ends of the tape. Install a washer and nut on the bolt and tighten. The tape should be tight around the water heater. If the tape is not tight, remove the bolt and place it through the next adjacent 1/4" diameter hole after bending the tape out 90 degrees at that point. Install a washer and nut on the bolt and tighten. Repeat this procedure for the other tape.
7. Measure the distance of a line formed by connecting a hole in the wall stud to a 1/4" hole on the plumber's tape nearest to where the line would tangent or almost tangent the water heater surface and add 1 inch to this dimension. Cut a piece of 1/2" diameter EMT conduit to this length. Repeat this procedure for the other locations.
8. Using a hammer or vice, flatten 1 inch at each end of the four pieces of EMT conduit. Be sure to flatten the ends of the conduit in the same plane.
9. Drill a 1/4" hole in one end of each conduit approximately 1/2" from the end and then bend up the flattened 1" section approximately 45 degrees.

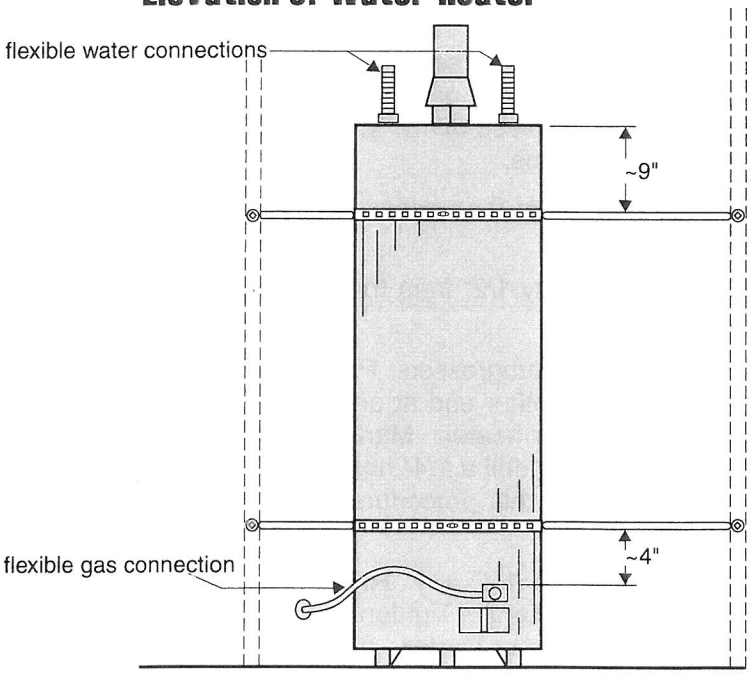
   This angle will have to be corrected slightly as the work progresses. Place the conduit hole over the 1/4" drilled hole in the wall stud and mark the other end at one of the holes in the plumber's tape nearest the tangential point on the water heater. Mark this location on the tape, conduit and water heater. Remove the conduit and drill a 1/4" hole at the mark for the bolt through the flattened end of the conduit. Repeat this procedure for the other three locations.

   Loosen the tape around the water heater and place a 1/4" x 1" RHMS from the inside through the tape and hole in the conduit at all four locations. Tighten the tape around the water heater so that the bolts are at the marks on the water heater. It may be easier to do one side of the water heater at a time as positioning may be difficult. Place the conduit on the bolt protruding from the tape and install a washer and nut then tighten. Position the opposite end of the conduit at the hole in the wall stud and install a 1/4" x 3" lag screw. Repeat this procedure for the other three conduits.

Top Plan of Water Heater



Elevation of Water Heater



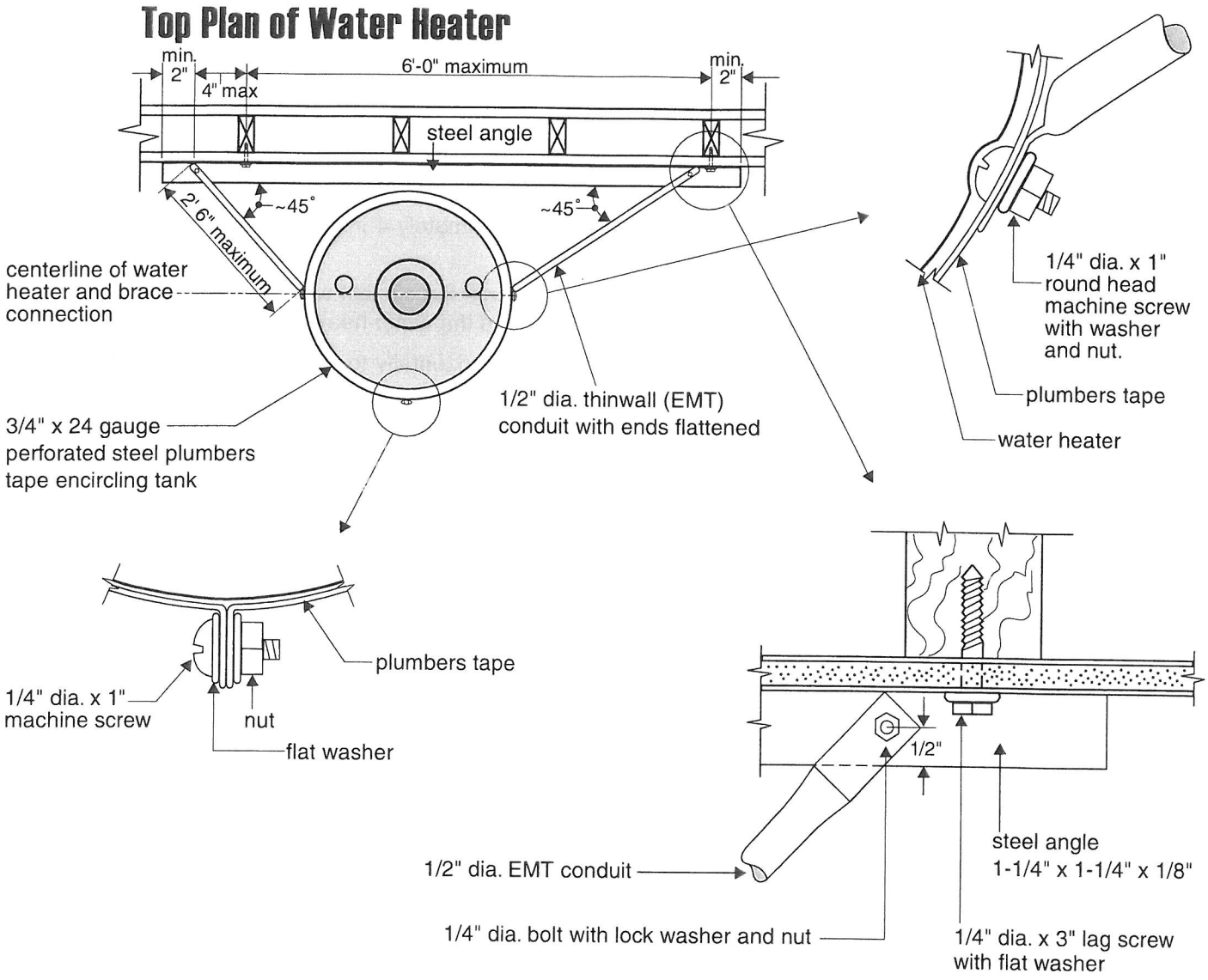
Materials Needed

* 2 lengths of 3/4" x 24 gauge perforated plumbers tape
* 4 lengths of 1/2" dia. EMT conduit.
* 6- 1/4" dia. x 1" round head machine screws
* 8- 1/4" washers
* 6- 1/4" nuts
* 4- 1/4" dia. x 3" lag screws

Tools Needed

* tape measure
* hammer
* hack saw
* center punch
* stud finder
* power drill
* 1/4" dia. drill bit
* 3/16" dia. drill bit
* *adjustable wrench

Refer to instructions on page 12.


Top Plan of Water Heater
min. 2"
4" max
6'-0" maximum
min. 2"
steel angle
~45°
~45°
2' 6" maximum
centerline of water heater and brace connection
3/4" x 24 gauge perforated steel plumbers tape encircling tank
1/2" dia. thinwall (EMT) conduit with ends flattened
1/4" dia. x 1" round head machine screw with washer and nut.
plumbers tape
water heater
plumbers tape
1/4" dia. x 1" machine screw
nut
flat washer
1/2"
1/2" dia. EMT conduit
1/4" dia. bolt with lock washer and nut
steel angle 1-1/4" x 1-1/4" x 1/8"
1/4" dia. x 3" lag screw with flat washer

EMT Conduit Bracing
Water Heater Located Adjacent to Straight Wall
See Illustration on Page 10

If the location of wall studs do not meet the limitations specified on the page 10 illustration, refer to the alternate support detailing on page 11, which provides a steel ledger angle for attachment of the braces at the wall.

1. Mark the water heater 9 inches from the top and approximately 4 inches up from the top of the controls. Transfer these marks to the wall.
2. Using a stud finder or another appropriate method, locate the closest wood studs in the wall on both sides of the water heater, but not directly behind the water heater (see illustration).
3. Transfer the marks on the water heater (See Step 1) horizontally to the center of the wood studs located in Step 2.
4. Drill a 3/16" diameter x 3" deep pilot hole (4 total) at the locations noted in Step 3 to receive 1/4" diameter x 3" lag screws.
5. Measure the water heater circumference and add 2 inches to that measurement. Cut two pieces of plumber's tape to this length. Place a 1/4" x 1" RHMS with washer through the end hole of each end of the plumber's tape and bend the tape out 90 degrees as close to the edge of the washer as possible. Remove the bolt and washer. Plumber's tape typically has 1/4" diameter holes 1" apart with 1/8" diameter holes between. The tape can be broken at the smaller holes by holding the tape with pliers and bending the tape several times.
6. Place the plumber's tape around the water heater at the top and bottom marks with the 90 degree bends meeting in front of the water heater. Install a 1/4" x 1" bolt with washer and nut through the holes in the 90 degree bends and tighten the nut. The tape should be tight around the water heater. If it is not tight, remove the bolt and place it through the next adjacent 1/4" diameter hole after bending the tape to 90 degrees at that point.
7. Measure the distance of a line formed by connecting a hole in the wall stud to a 1/4" hole on the plumber's tape nearest to where the line would tangent or almost tangent the tank surface, and 1 inch to this measurement. Cut a piece of 1/2" diameter conduit to this length. Repeat this procedure for the other three locations.
8. Using a hammer or vice, flatten 1 inch at each end of the four pieces of conduit. Be sure to flatten both ends of the conduit in the same plane.
9. Drill a 1/4" hole in one end of each conduit approximately 1/2" from the end. Measure 1 inch in from each end and bend the flattened conduit up approximately 45 degrees. This angle will have to be corrected slightly as the work progresses. Place the conduit over the hole in the wall stud and mark the other end at one of the holes in the plumbers tape. Be sure to mark the hole in the tape to be used and the corresponding point for the hole in the flattened conduit as well as the location of the connection on the water tank. Drill a 1/4" hole at the mark in the center of the flattened conduit end. Repeat this procedure for the other three conduit pieces.
10. Loosen the tape around the water heater and place a 1/4" x 1" RHMS from the inside through the holes marked on all the tapes. Tighten the tape around the water heater so that the bolts are at the marks on the water heater (See Step 9). It may be easier to do one side of the tank at a time, as positioning the tape can be difficult. Place the conduit on the bolt protruding from the top and place a washer and nut on the bolt and tighten. A 4d finish nail inserted in the slot in the bolt head will prevent the head from turning. Position the opposite end of the conduit at the hole in the wall stud and insert a lag screw with washer and tighten. Repeat this procedure for the other three conduit braces.