Drilling Manual

A Guide to Using the Cable Tool Drilling Rig

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Safety Guidelines

1. **Gasoline is highly toxic and flammable.** Avoid inhaling gasoline fumes, and wipe up any spills immediately and completely. Do not store extra gasoline in direct sunlight or near heat sources or open flame.

2. **Keep clear of all moving parts.** Do not attempt to check the tension in any belts while the rig is running. Keep everyone except for drill rig operators away from the rig at all times.

3. **Always block the wheels.** Properly block the trailer wheels from rolling forwards or backwards. Use the leveling jacks to keep the trailer and rig as level as possible. **Do not** use the trailer jacks to lift the rig off the ground; they are not designed for this.

4. **Stay away from the drill bit and bailer.** The drill bit weighs over 700 lb. The bailer, when fully loaded, is also very heavy. When raising or lowering the bit or bailer, **never** place yourself underneath, and pay attention to them at all times. Remember, they are 15 to 16 ft long and can hurt you from that distance.

5. **Wear protection.** The drill rig is noisy and dangerous. Always wear ear and eye protection, and hard-toed boots and hard hats are recommended. Wear gloves when handling the wire rope.

6. **Move towards the front of the trailer in an emergency.** If the wire rope breaks, drill bit tips over, or any catastrophic failure occurs, move towards the front of the trailer (towards the tow vehicle). This is the safest place to be.

Checklist of Drill Rig Parts

Before embarking on any drilling endeavor, a full check and diagnostic of the rig must be completed. Below is a checklist of the rig parts which should be accounted for and inspected each time the drill rig is used. The following page contains a list of accessories which should also be carried at all times with the rig.

1. Trailer
2. Frame
3. Engine
4. Clutch
5. Pulleys, belts
6. Walking beam
7. Flywheel
8. Derrick
9. Derrick attachment points— vertical and horizontal
10. Engine throttle
11. Winch
12. Winch controls
13. Jacks
14. Brakes
15. Brake controls
16. Sheaves
17. Crown and damper
18. Cable
19. Bit(s)
20. Bailer
21. Swivel
22. Trailer hitch

Check List of Drill Rig Accessories

1. **Gloves**
   Gloves are important when handling wire rope to avoid burns on the hands. A sturdy pair of leather or equivalent synthetic material is recommended. Remember not to wear gloves around rotating machinery.
2. **Casing (two kinds)**
   Surface casing is needed to start the bore hole, and depending on the hardness of formation, additional casing may be necessary to keep the borehole walls from collapsing.
3. **Welder**
   A stick (SMAW) or MIG (GMAW) welder is recommended to dress the drill bit(s) and make any repairs to the drill rig. Welding rod or wire should be compatible with mild steel. Welding gloves and leathers, a wire brush, and wire cutters should always be kept with the welder.
4. **Pipe rack**
   In the case that the entire hole needs casing, you may need a pipe rack to prevent extra lengths of casing from rolling away and injuring someone.
5. **Tools**
   Make sure any tools necessary for each job are on board the trailer or tow vehicle. These include, but are not limited to wrenches for attaching the drill string and sections of casing, shovels, pick axes, a marsh funnel for checking mud, and sets of smaller wrenches and pliers for tightening or repairing parts.
6. **Drilling mud**
   Drilling mud consists of primarily water, with a thickening agent added to increase viscosity. In most cases, the thickening agent will be bentonite clay. Use a Marsh funnel to test and maintain the viscosity of the mud.
7. **Mud pit**
   A large reservoir is needed to maintain enough mud for the entire hole drilling process. Typically, the mud pit is a hand-dug hole several feet across and about 2 ft deep. The size of the mud pit depends on the size and depth of the hole being drilled. A tarp may be used to line the mud pit and prevent loss of drilling mud.

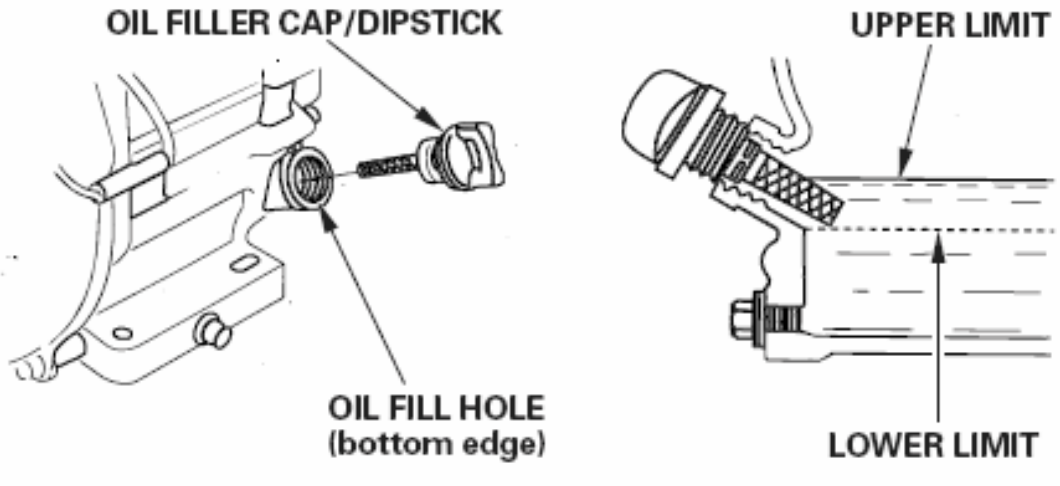
Rig Maintenance

Fuel

The Honda engine requires unleaded gasoline of octane rating 87 or higher. Avoid leaving extra gas in the tank for extended periods of time (more than a month). To clear the carburetor, turn the gas lever on the engine to the "OFF" position and let the engine run until it dies. This prevents extra gas from drying and gumming up the carburetor.

Oil and Lubrication Schedule

The Honda engine's crank case has a capacity of approximately 0.58 quarts (0.5 liters), and uses SAE 10W-30 weight oil. Make sure to use the same quality of oil (regular, synthetic mix, fully synthetic…) each time when changing the oil. Keep a logbook or schedule detailing the date of each oil change and total hours of operation. The oil should be changed after every 100 hours of operation.



The Frame

The frame and components are welded and bolted together. Vibrations caused by the rig's operation inevitably causes welded and bolted joints to weaken and/or loosen. Before beginning any hole, and at regular periods during disuse, check the welds for any cracks and the bolts and nuts for tightness. In the case of cracked welds, have a qualified welder grind away the broken weld and lay a new weld. The welding rod or wire must be compatible with mild steel. In the case of loose nuts and bolts, re-tighten using the proper tools. The torque created by one person using proper tools is adequate for tightening bolts and nuts.

Hitching and Un-Hitching the Trailer

When hitching the trailer, follow this checklist.

1. The towing vehicle is in park with the emergency brake engaged.
2. The hitch rests fully and snugly onto the ball (2 in or 51 mm) and the ball lock is fully engaged with the safety pin in place.
3. T he brake cable (circular multi-pin plug) is fully inserted into its receiver on the towing vehicle, and all brake lights and blinkers are operating properly.
4. The chains on the trailer are securely hooked on either side of the trailer hitch.
5. The emergency brake cable (thin metal cable with carabiner) is attached somewhere on the towing vehicle.
6. All leveling jacks are fully raised and not in position to drag on the ground.
7. All wheel chalks have been removed and the trailer is free of obstructions

To unhitch the trailer, do the opposite of the checklist, in reverse.

The Cable

A properly-maintained wire rope can last many years; make sure the rope is always properly greased and repair any fraying as soon as possible.

The Bit and Drill String

Drill bits can easily wear down. When the drill bit shows noticeable wear or performs poorly, rebuild the cutting face of the bit by laying down several beads of weldment. This is known as “dressing” the bit. It is helpful to have a welder available to dress the bit as drilling progresses. Having two bits on hand is a good idea, because drilling can still continue while one of the bits is being dressed.

Step-by-Step Guide to Drilling

Preparing the Drill Site

1. **Inspect the potential site for ease of drilling and likelihood of reaching water.** A very level site will work better than a steep hill. Consult a groundwater geologist or local surveying records, if possible, to determine the best formations for hitting water.

2. **Inspect the potential site for debris or obstructions.** Remove any objects or large plants that are in the way. Make sure that there are no power lines or trees close by that the mast will catch on. If necessary, determine the location of any underground pipes, power lines, or structures, and avoid them.

3. **Cordon off the area from children, livestock, etc.**

4. **Dig a hole and drive in the surface casing.** The surface casing provides guidance for the drill bit at the beginning of the drilling process. Surface casing must have an inner diameter that is larger than the diameter of the drill bit. The depth of the surface casing depends on the formation being drilled.

Running the Drilling Rig

1. **Park the towing vehicle and the trailer so that the chosen site is directly behind them.** The rig should be positioned so that the drill bit will hang in or directly over the surface casing. Turn off the towing vehicle's engine, and use the emergency brake.

2. **Level the trailer using the leveling jacks.** Trailer jacks are located at the front (2) and back (2) of the trailer. **Note:** Trailer jacks are not intended to lift the trailer off the ground.

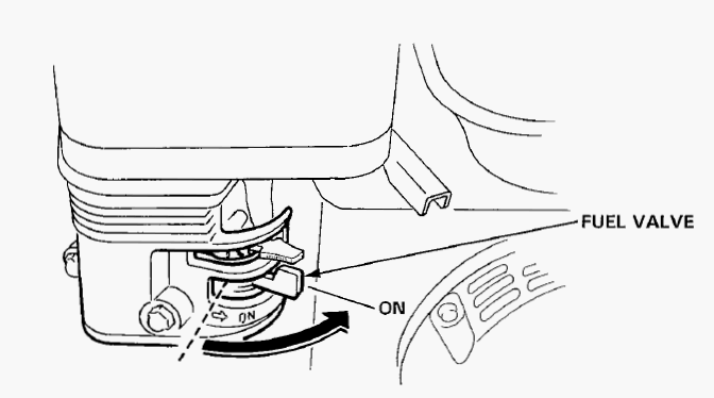
3. **Attach the drill string.** The drill bit or bailer attach to the cable via a swivel.

4. **Add drilling fluid to the hole.** Drilling fluid will be composed of water and bentonite clay. The resulting mud is designed to keep cuttings floating up from the bottom of the hole. As the hole is drilled and bailed, more mud must be added to maintain a constant level.

5. **Lower the bit into the hole, keeping the cable taut.** Only allow enough cable for the bit to barely touch the bottom of the hole. Cable feed is controlled by adjusting the brake control. When the brake is fully engaged, no cable is released from the cable spool. Be cautious not to ever let the brake fully disengage.

6. **Clear any drillers or remaining bystanders away from the hole.**

7. **Start the engine.** Before starting, **check that the oil level is correct and that there is gas in the tank.** The engine is a pull-start. Standing next to the engine, flip the red ignition switch to the "ON" position. Slide the lever labeled "GAS" into the on position. Slide the lever labeled "CHOKE" into the on position. When this is done, pull the starting rope quickly. When the engine starts running, quickly move the "CHOKE" lever into "OFF" position. After this is done, the engines speed can be manipulated by the throttle control at the rear of the rig.



8. **Monitor the hole.** Have an experienced operator holding the wire rope during the drilling process, monitoring the tension in the rope. Maintain adequate mud level in the hole by adding mud each time after bailing cuttings from the hole.

9. **Turn off the engine** in the case of excessive vibration, or failure of any parts. **Do not** attempt to turn on the engine if the rig looks to be catastrophically failing. **Get away from moving parts and towards the front of the drill rig**, as this is the safest place to be.

10. **Detach the drill string and attach the bailer.** Before detaching the drill bit, raise it out of the hole by de-tensioning the belt connecting the drive train to the walking beam. Next, tension the belts connecting the drive train to the cable spool. Increase the engine speed and decrease tension on the brake. The cable will begin winding cable onto itself. When the drill bit is completely raised out of the hole, fully engage the brake and move the bit away from the bore hole. Release the brake very slowly to lower the drill bit to the ground. Attach the bailer and complete this process in reverse. **Keep people away from the drill bit as it is raised from and lowered into the hole.**

11. **Lower the bailer into the hole.** With the bailer in the hole, put the drill rig into its regular operation. Make sure enough mud is in the hole to keep cuttings flowing into the bailer. The bailer may have to be raised and emptied several times before the hole is clear. Once again, **make sure to maintain the mud level down hole.**

12. **Detach the bailer and re-attach the drill string.** When raising and lowering the bailer, follow the same procedure for raising and lowering the drill bit. A full bailer will be very heavy, so keep bystanders away from the borehole area.