PUMP INSTALLATION EXAMINATION TUTORIAL

Presented by

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Water Well Standards

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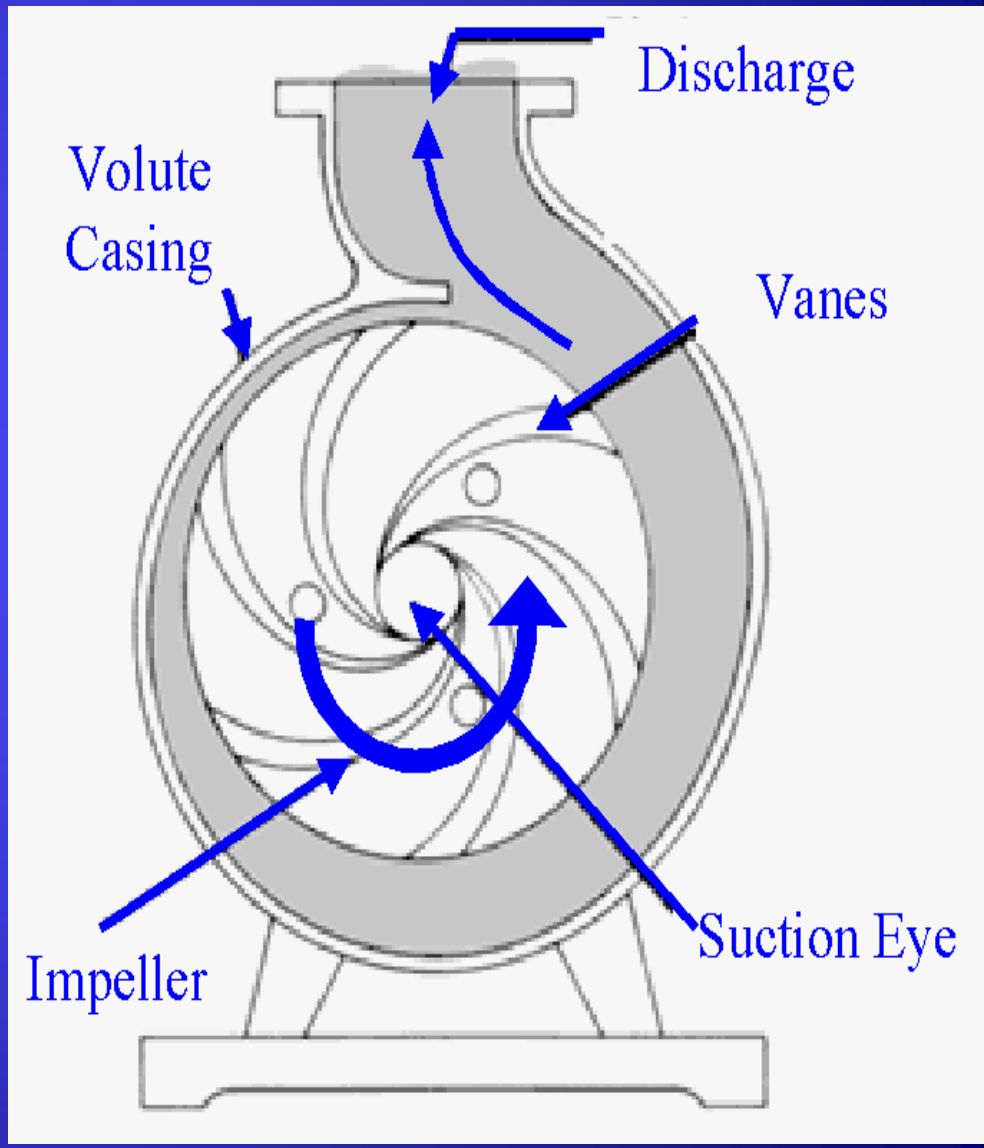
DHHS
NEBRASKA

Pumps

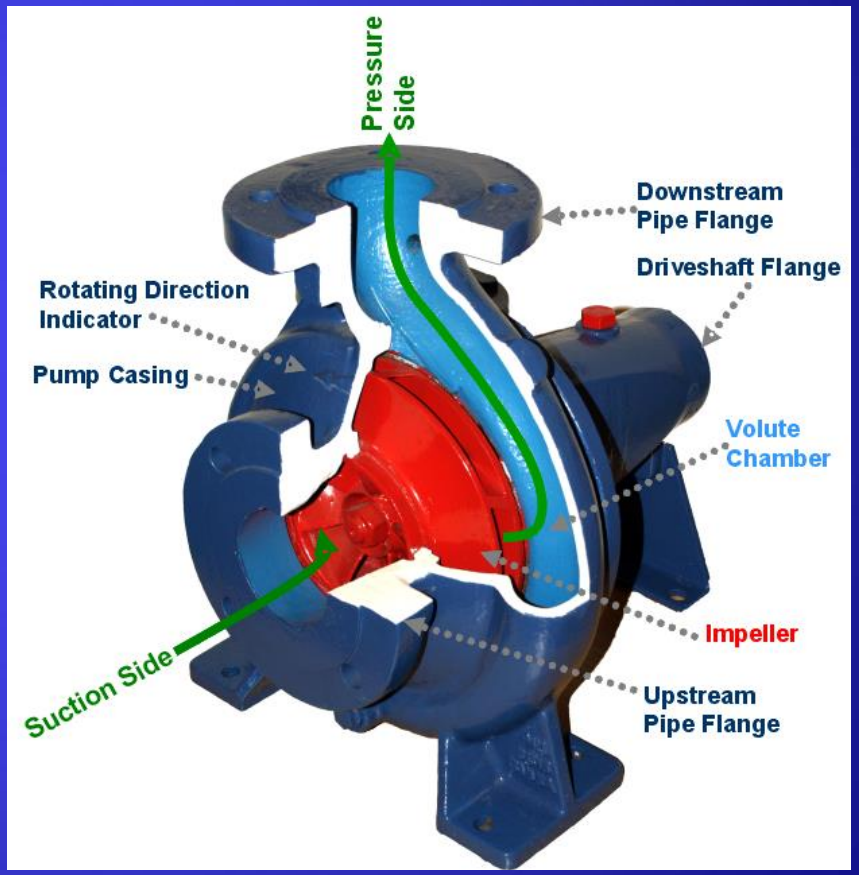
Most are Centrifugal Pump

- A centrifugal pump is one of the simplest pieces of equipment in any process plant. Its purpose is to convert energy of a prime mover (a electric motor or turbine) first into velocity or kinetic energy and the into pressure energy of a fluid that is being pumped
- The energy changes occur by virtue of two main parts of the pump, the impeller and the volute or diffuser.
- The impeller is the rotating part that converts driver energy into the kinetic energy
- The volute or diffuser is the stationary part that converts the kinetic energy into pressure energy.



Centrifugal pump

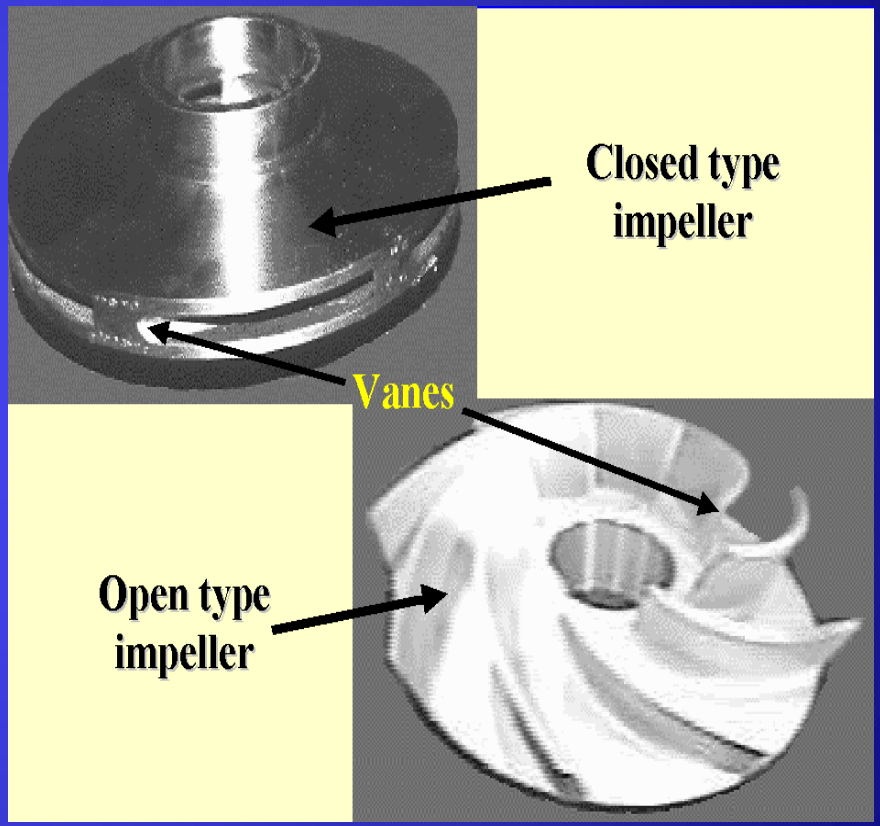
The process liquid enters the suction nozzle and then into eye (center) of a revolving device known as an impeller. When the impeller rotates, it spins the liquid sitting in the cavities between the vanes outward and provides centrifugal acceleration. As liquid leaves the eye of the impeller a low-pressure area is created causing more liquid to flow toward the inlet. Because the impeller blades are curved, the fluid is pushed in a tangential and radial direction by the centrifugal force. This force acting inside the pump is the same one that keeps water inside a bucket that is rotating at the end of a string.



Impellers

- Closed impellers require wear rings and these wear rings present another maintenance problem.
- Open and semi-open impellers are less likely to clog, but need manual adjustment to the volute or back-plate to get the proper impeller setting and prevent internal re-circulation.

  To increase head pressure add impellers .
- Wear rings: Wear ring provides an easily and economically renewable leakage joint between the impeller and the casing. Disassemble the pump to check the wear ring clearance and replace the rings



Impellers

- The number of impellers determines the number of stages of the pump:

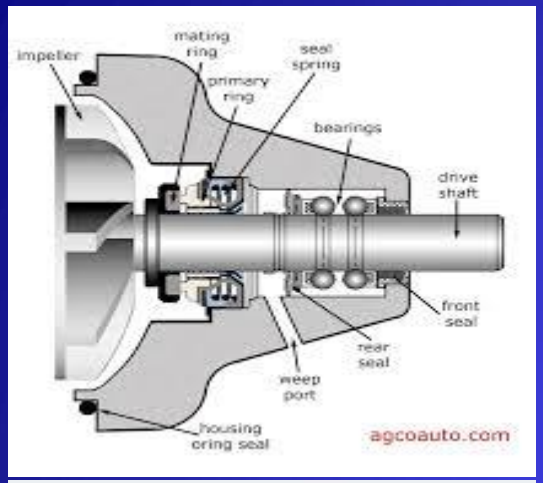
- A single stage pump has one impeller only and is best for low head service.

- A two-stage pump has two impellers in series for medium head service.

- A multi-stage pump has three or more impellers in series for high head

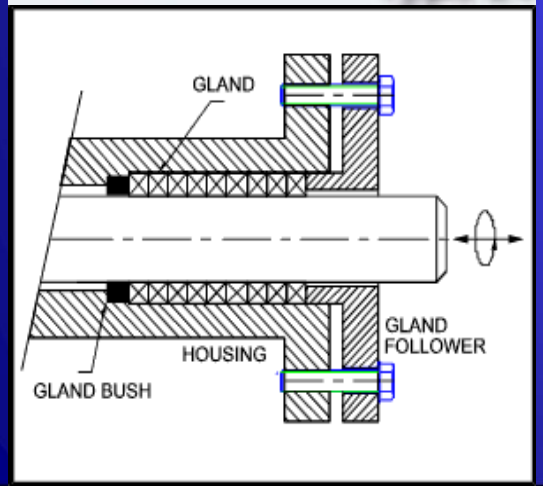
- As speed of the impeller increases the capacity increases and the HP requirements increases.

SEALS



A common application of sealing devices is to seal the rotating shaft of a centrifugal pump. To best understand how such a seal functions a quick review of pump fundamentals is in order. In a centrifugal pump, the liquid enters the suction of the pump at the center (eye) of the rotating impeller

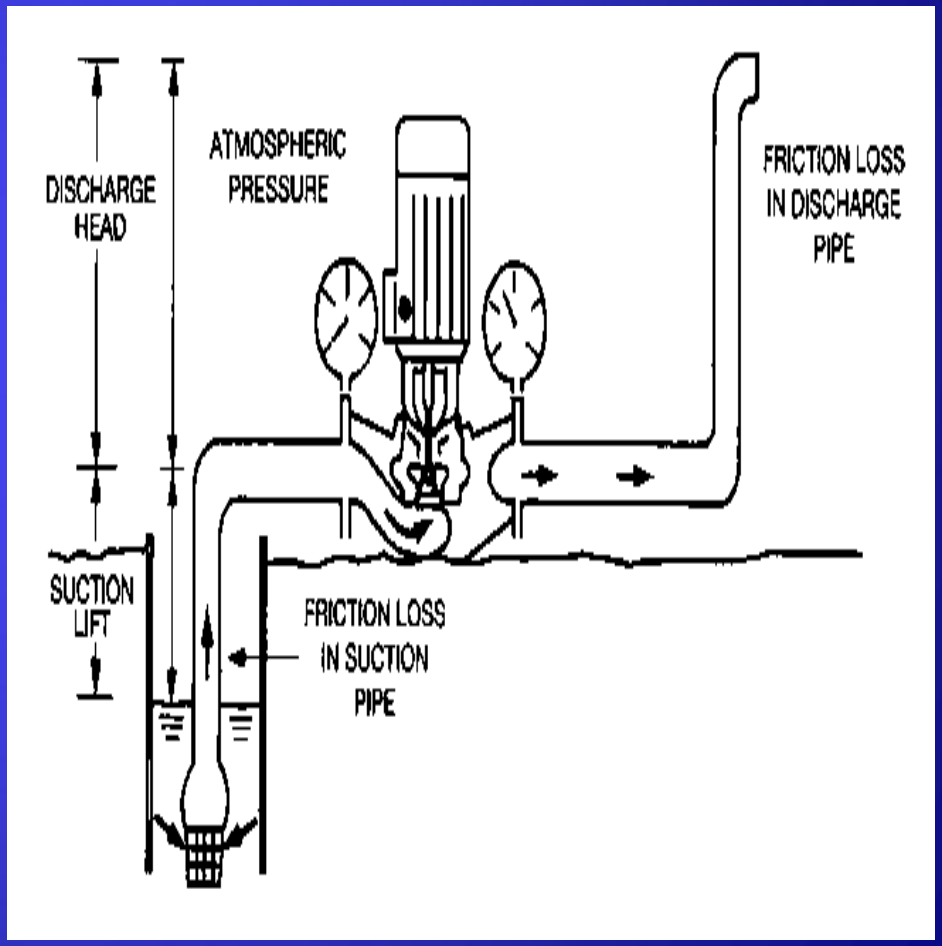
A mechanical seal is a sealing device which forms a running seal between rotating and stationary parts



The function of packing is to control leakage and not to eliminate it completely. The packing must be lubricated, and a flow from 40 to 60 drops per minute out of the stuffing box must be maintained for proper lubrication Packed glands should preferably be used in conjunction with shaft sleeves in order to prevent damage to the shaft

NET POSITIVE SUCTION HEAD (NPSH)

- When discussing centrifugal pumps, the two most important head terms are NPSHr and NPSHa.
- Net Positive Suction Hear required (NPSHr) is the total head in feet of fluid that must be present at the pump suction to prevent "cavatation"
- Cavation is formation and collapse of vapor-filled cavities in the pumped fluid and occurs when pump suction pressure is near vapor pressure of the pumped fluid.
- The Net Positive Suction Head available (NPSHa) must always be greater than the NPSH required for the pump to operate properly. It is normal practice to have at least 2 to 3 feet of extra NPSH available at the suction flange to avoid any problems at the duty point.
- The NPSH required varies with speed and capacity within any particular pump



POWER & EFFICIENCY

- Brake Horse Power (BHP)
- The work performed by a pump is a function of the total head and the weight of the liquid pumped in a given time period.
- *Pump input or brake horsepower (BHP) is the actual horsepower delivered to the pump* shaft.
- *Pump output or hydraulic or water horsepower (WHP) is the liquid horsepower delivered* by the pump. These two terms are defined by the following formulas.

$$BHP = \frac{Q \times H_T \times Sp.Gr.}{3960 \times Eff.}$$

where

- Q = Capacity in gallons per minute (GPM).
- H_T = Total Differential Head ,ft
- $Sp.Gr.$ = Specific Gravity of the liquid
- $Eff.$ = Pump efficiency , %

$$WHP = \frac{Q \times H_T \times Sp.Gr.}{3960}$$

where

- Q = Capacity in gallons per minute (GPM).
- H_T = Total Differential Head ,ft
- $Sp.Gr.$ = Specific Gravity of the liquid

Pump Efficiency

The constant 3960 is obtained by dividing the number or foot-pounds for one horsepower(33,000) by the weight of one gallon of water (8.33 pounds).

BHP can also be read from the pump curves at any flow rate. Pump curves are based **on** a specific gravity of 1.0. Other liquids' specific gravity must be considered.

The brake horsepower or input to a pump is greater than the hydraulic horsepower or output due to the mechanical and hydraulic losses incurred in the pump.

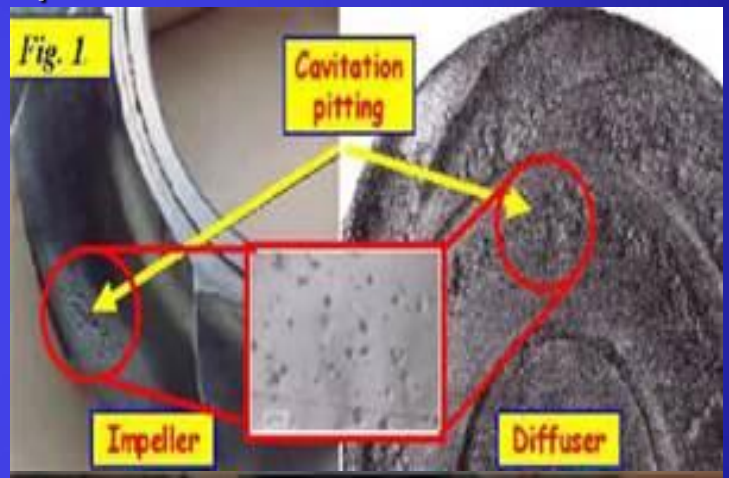
Therefore the pump efficiency is the ratio of these two values.

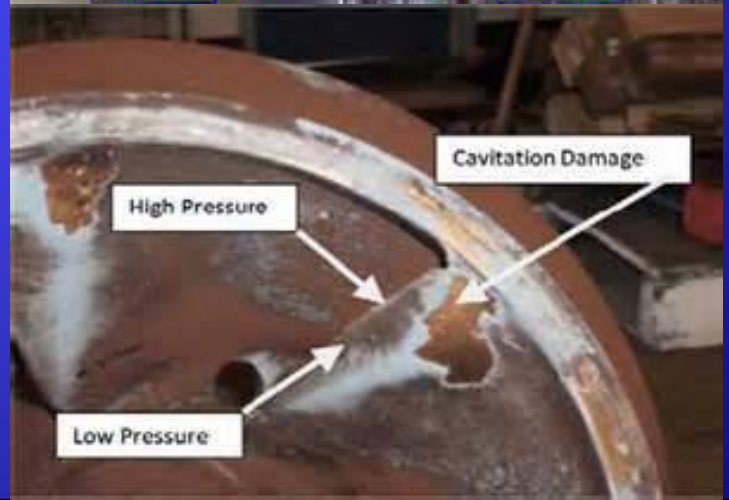
$$\text{Pump Efficiency (Eff.)} = \frac{WHP}{BHP}$$

Trouble-Free Operation of Centrifugal Pumps

- The **first** requirement is that no cavitation of the pump occurs throughout the broad operating range and the **second** requirement is that a certain minimum continuous flow is always maintained during operation. Here are some symptoms & causes:

- Cases of heavy leakages from the casing, seal, and stuffing box
- Deflection and shearing of shafts
- Seizure of pump internals
- Close tolerances erosion
- Separation cavitation
- Product quality degradation
- Excessive hydraulic thrust
- Premature bearing failures
- Well Rehabilitation



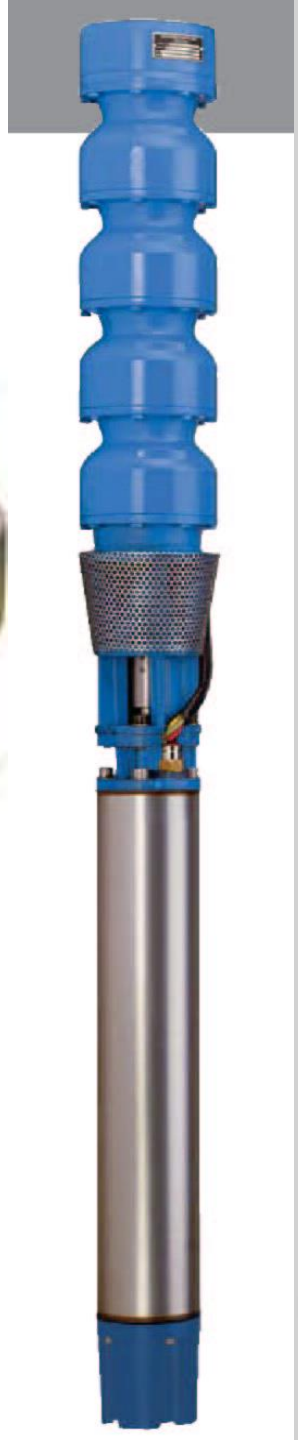


Drives

Vertical Hollow Shaft Turbine

Submersible Turbine Pump

Vertical Booster Pump



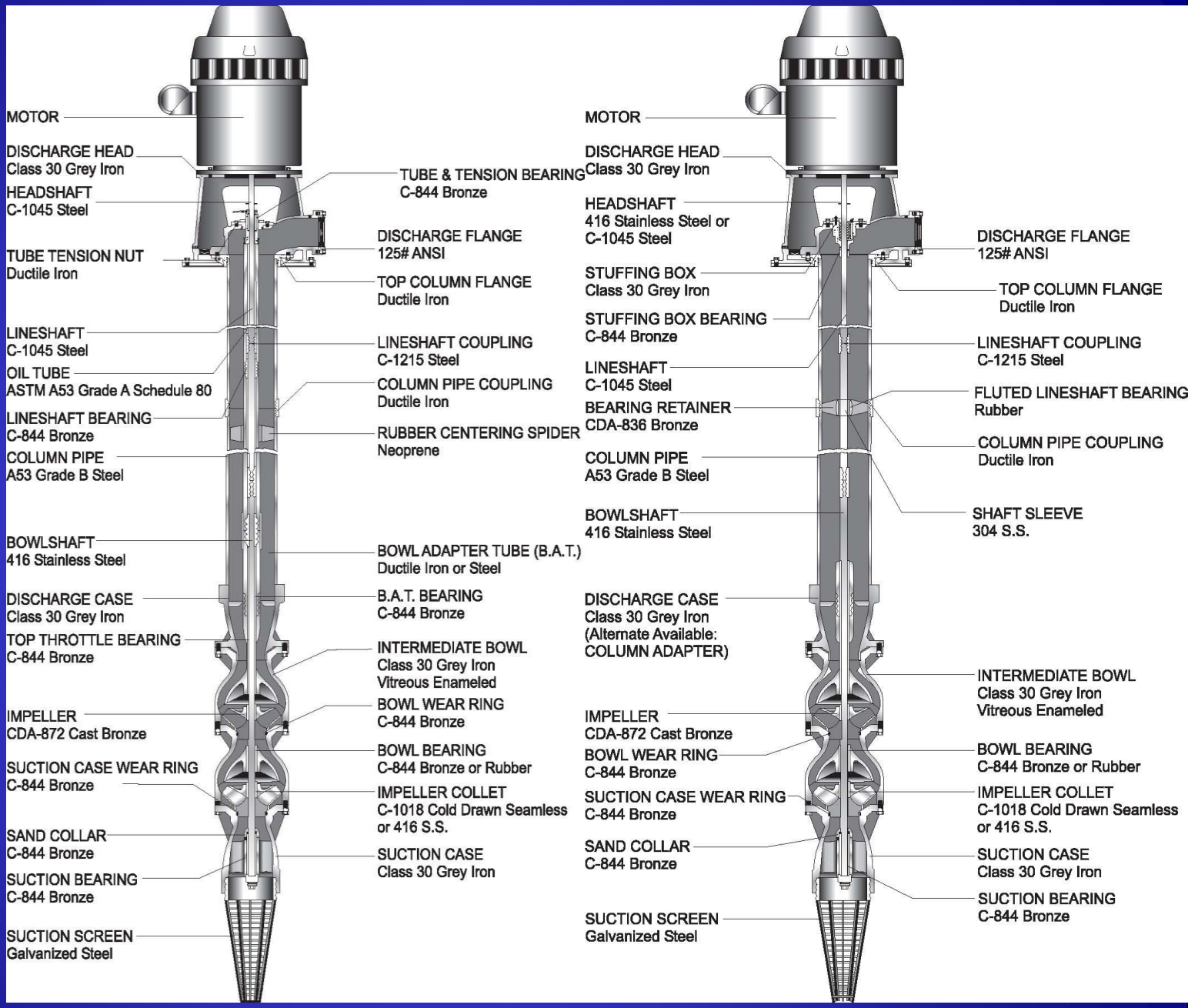
Drives

Belt Drive Gear Head

Right Angle Drive Gear Head

Deep Well Vertical Turbines

- Lubrication
  - Oil
  - Water
- Spiders
- Protective Collar
  - (sand)

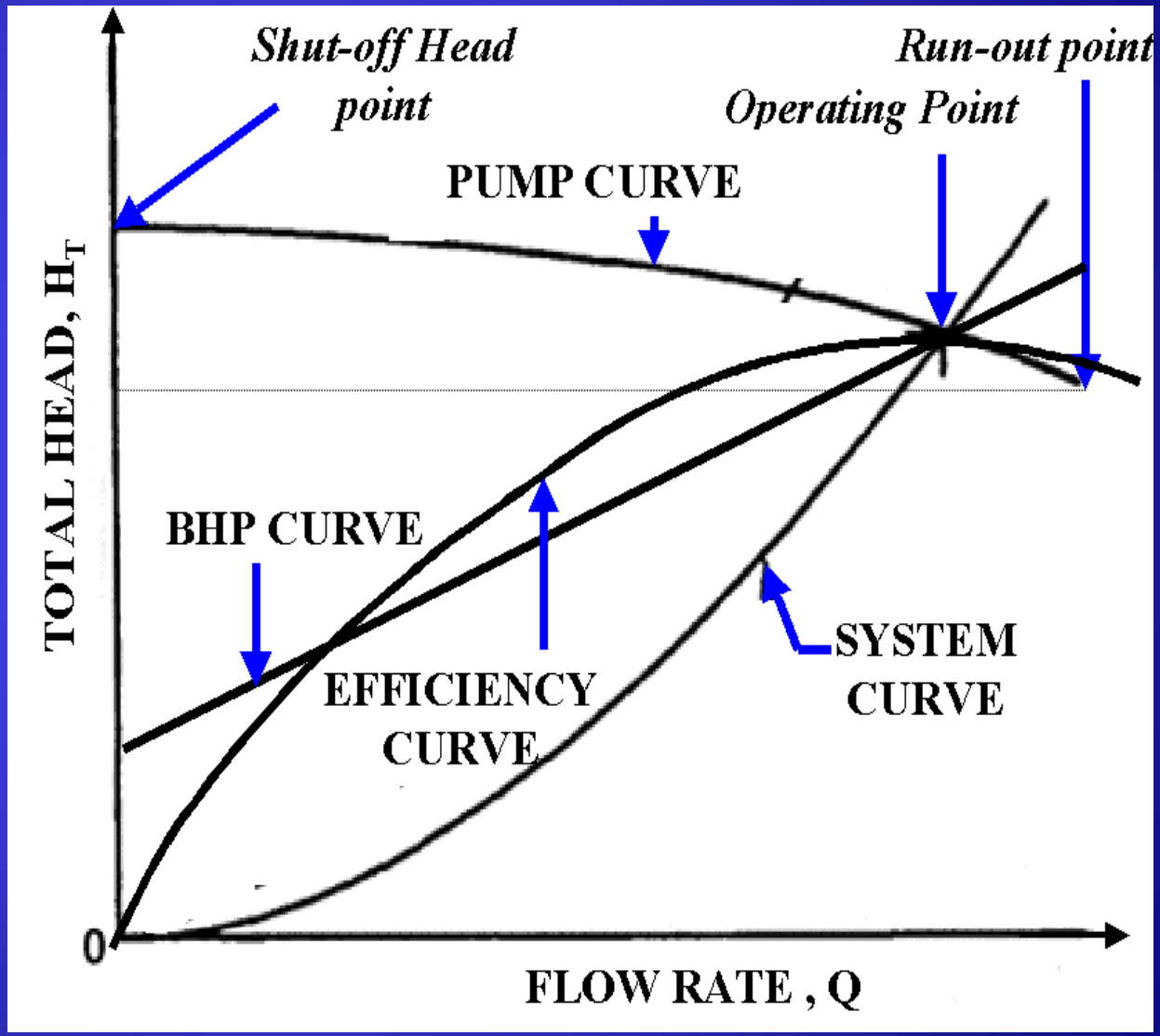


Oil-lube Turbine Pump

Water-lube Turbine Pump

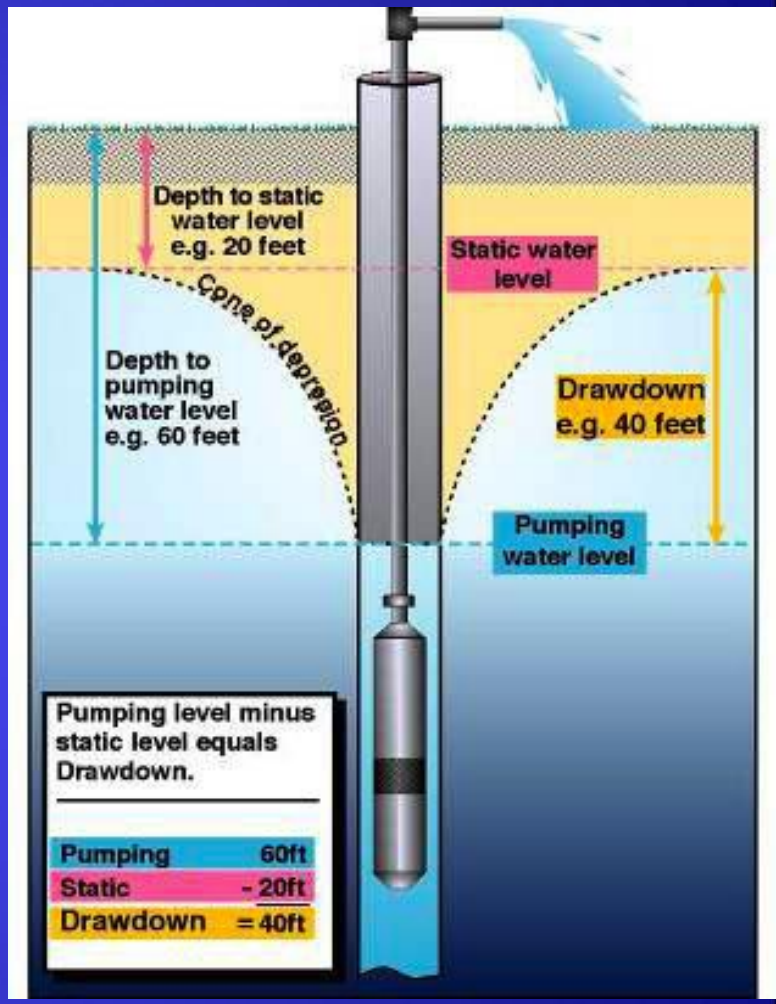
Pump Curve

- Pump Curve
- Head Changes
- Discharge vs. HP
- Discharge vs. Efficiency
- Brake Horsepower
- Efficiency



What is Specific Capacity

- The Specific Capacity of a well is simply the pumping rate (yield) divided by the drawdown.
- It is a very valuable number that can be used to provide the design pumping rate or maximum yield for the well.(Figure 1).
- It can be used to identify potential well, pump, or aquifer problems, and accordingly to develop a proper well maintenance schedule.
- It can also be used to estimate the transmissivity of the aquifer(s) tapped by the well's perforations.
- Transmissivity is the rate water is transmitted through an aquifer under a unit width and a unit hydraulic gradient.
- It equals the aquifer's hydraulic conductivity (permeability) times the aquifer thickness. The higher the transmissivity, the more prolific the aquifer and the less drawdown observed in the well.
- Typically, a well should run continuously for at least 24 hours at a constant yield before recording the drawdown.
- The formula is drawdown divided by yield equals gallon per foot of drawdown



Flow Measurement Methods

Weirs, Flumes and Flow Meters:

Over time, flow rates can change due to many factors including water table fluctuations and normal wear and tear. As a result, flow rates listed on original well registrations may not be accurate. Thus, it is beneficial to monitor flow rates throughout the pump's life.

Flume

V-notch Weir

Ultrasonic Flow Meter

Circular Orifice Weir

Jet Pumps

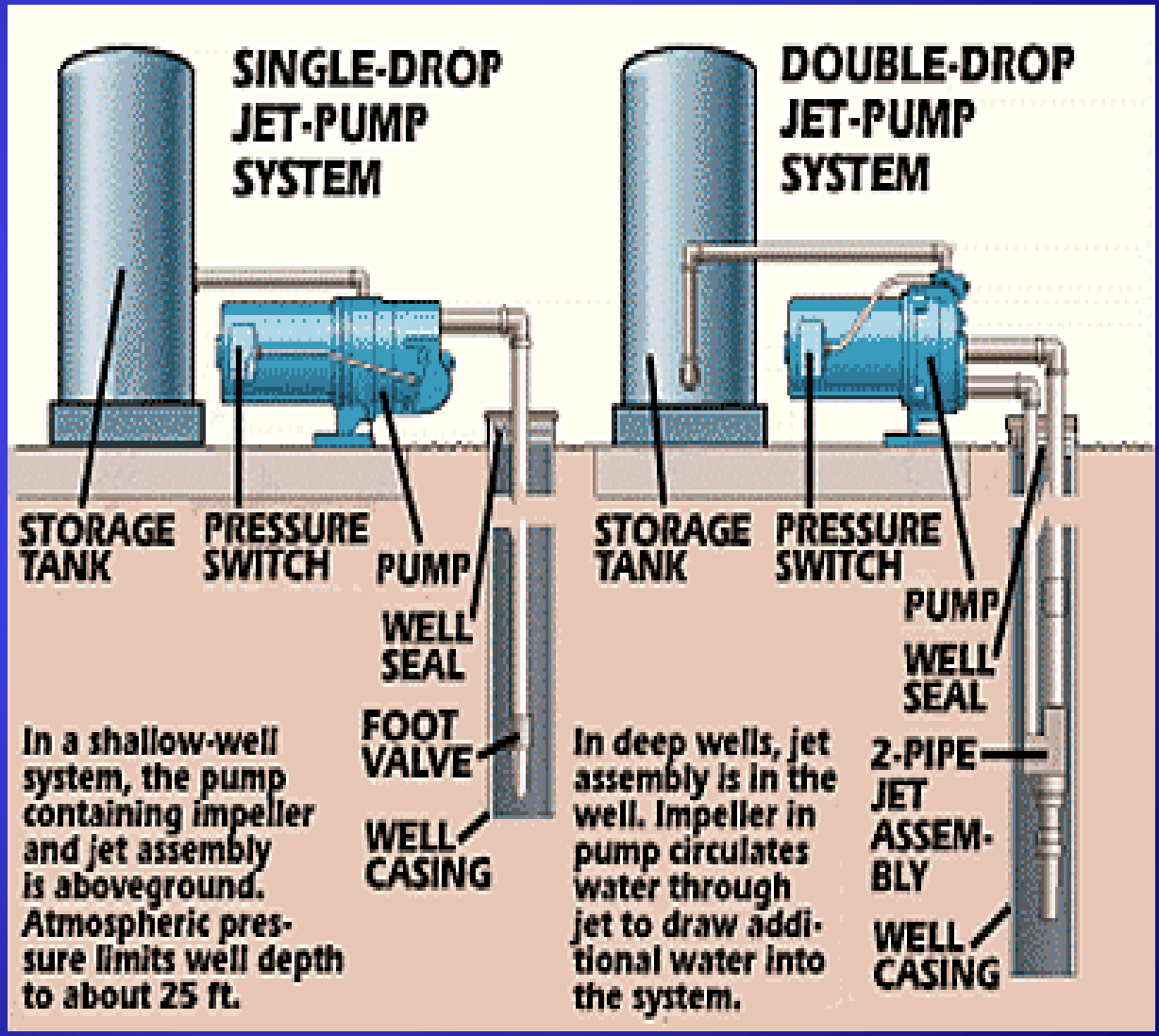
14.7 PSI

Suction lift capability of any pump based on atmospheric pressure

2 Types

- Deep Well
- double-pipe

- Shallow Well
- Single pipe



Shallow Well Jets

- Also single pipe jet
- Less than 21 feet
- Sandpoint or cased well
  - Check valve or Foot valve
- Primed
  - Chlorinated water
- NPSHA >= NPSHR
- Cavation & pump damage
- Service
- Low vacuum indicates a leak
- High vacuum indicates a plugged pipe or stuck check or foot valve

New Shallow Well, Driven Point Installation (Figure 4)

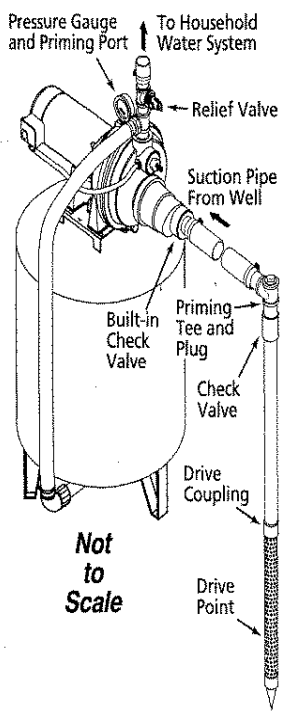


Figure 4 – Driven Point Installation

Cased Well Installation, 2" or Larger Casing (Figure 5)

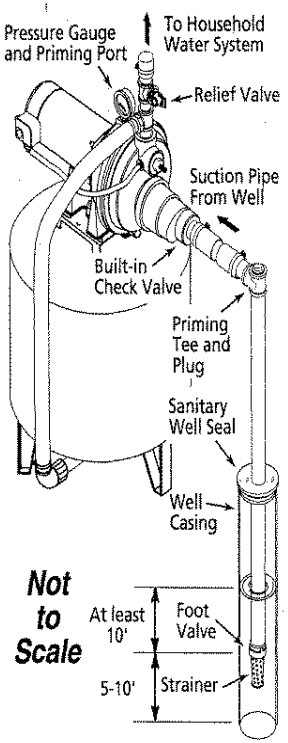


Figure 5 – Cased Well Installation

Single Phase Subs

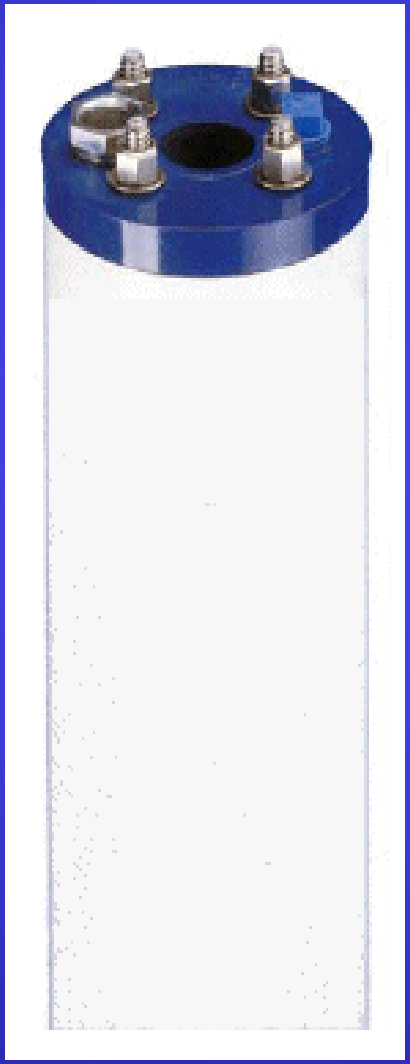
- 2 wire Components
  built-in
- 3 wire Control box
  Start Capacitor-Start the motor
  Run Capacitor-Smooth motor run
  Relay- switches from start-run
  Contactor-relieve surge on starting components
  Location-heat adds tripping-cold reduces starting torque
- Water for cooling and lubrication
- Any Position- Shroud in lakes and large diameter casing

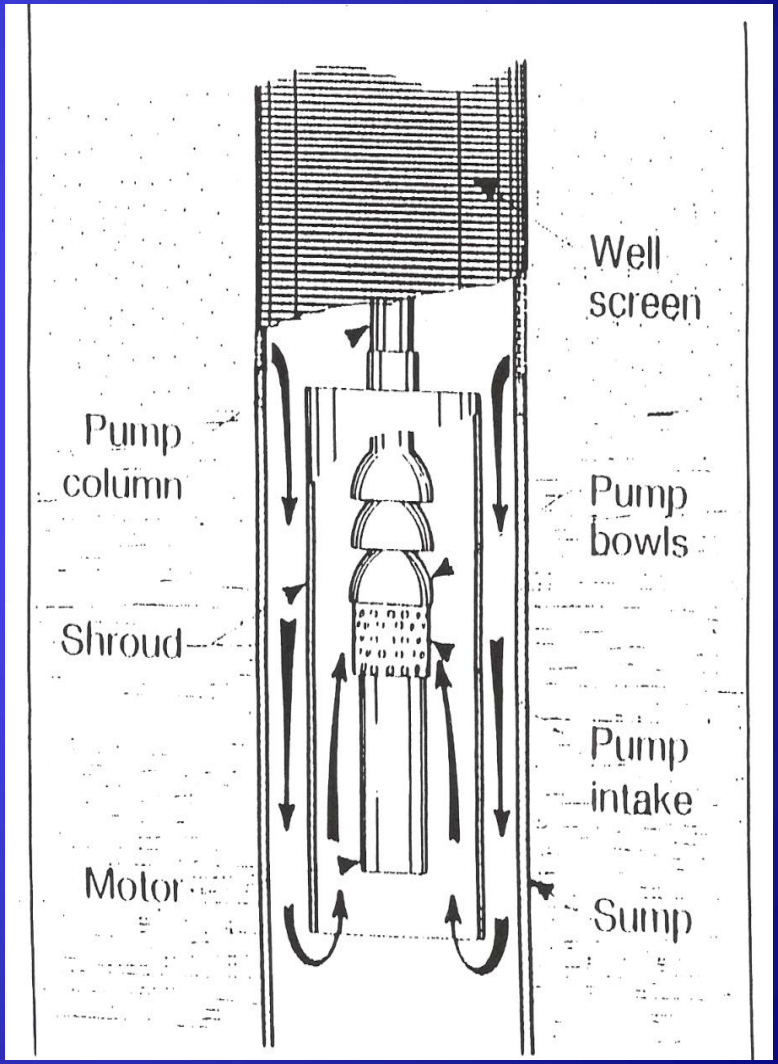
Flow Inducer Sleeve

If the flow rate is less than specified, then flow inducer sleeve must be used.

A flow sleeve is always required in an open body of water.

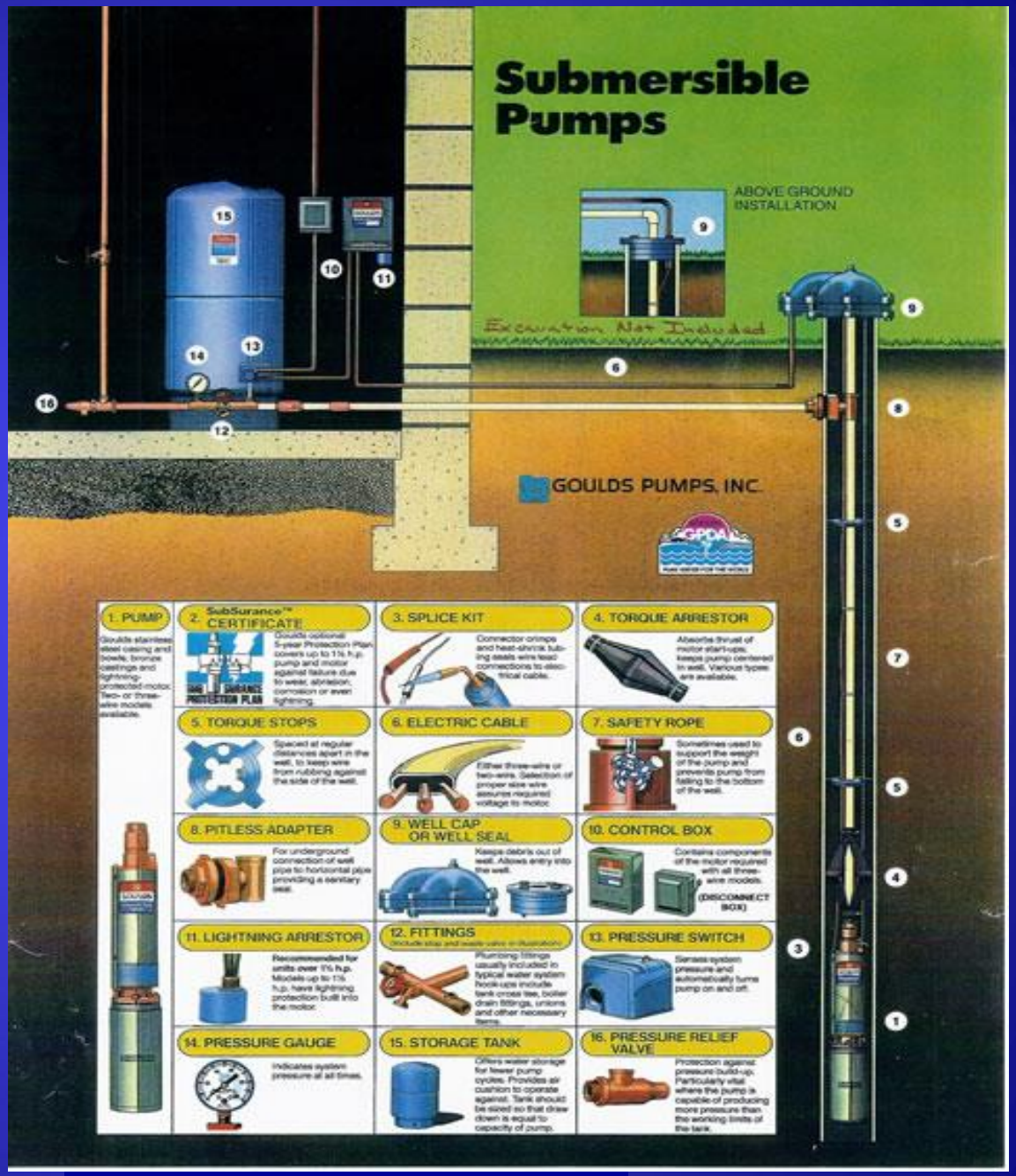
FIG. 1 shows a typical flow inducer sleeve construction.





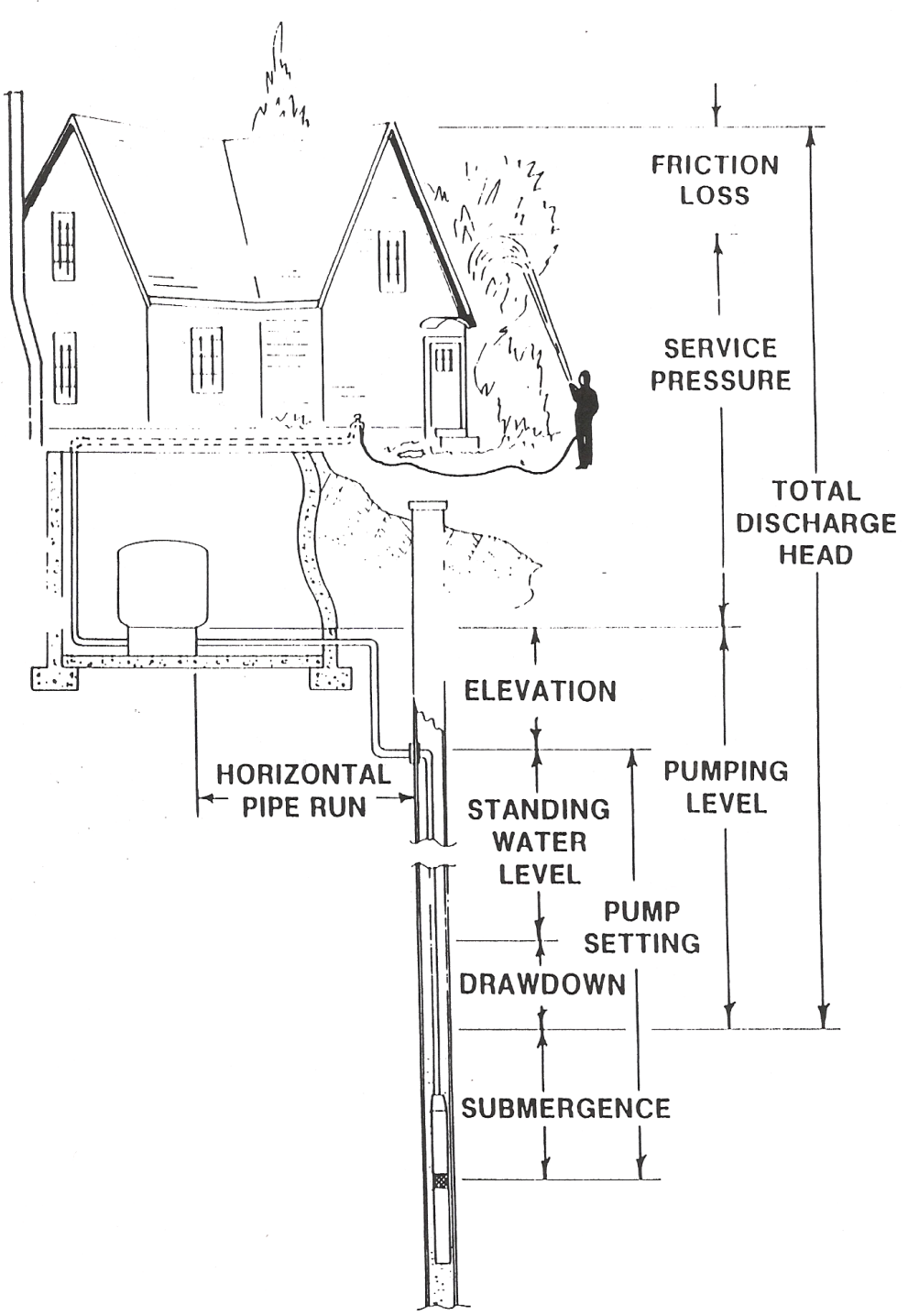
Typical Setup

- Pit
  - 10 feet away
- Connection
  - Water tight
- Cap
  - Water tight
- Height
  - 12” above ground level
- Check Valve
- Tape
- Pressure Switch
- Pressure Relief Valve
- Backflow prevention
- Casing Vent – >50 GPM



Terminology

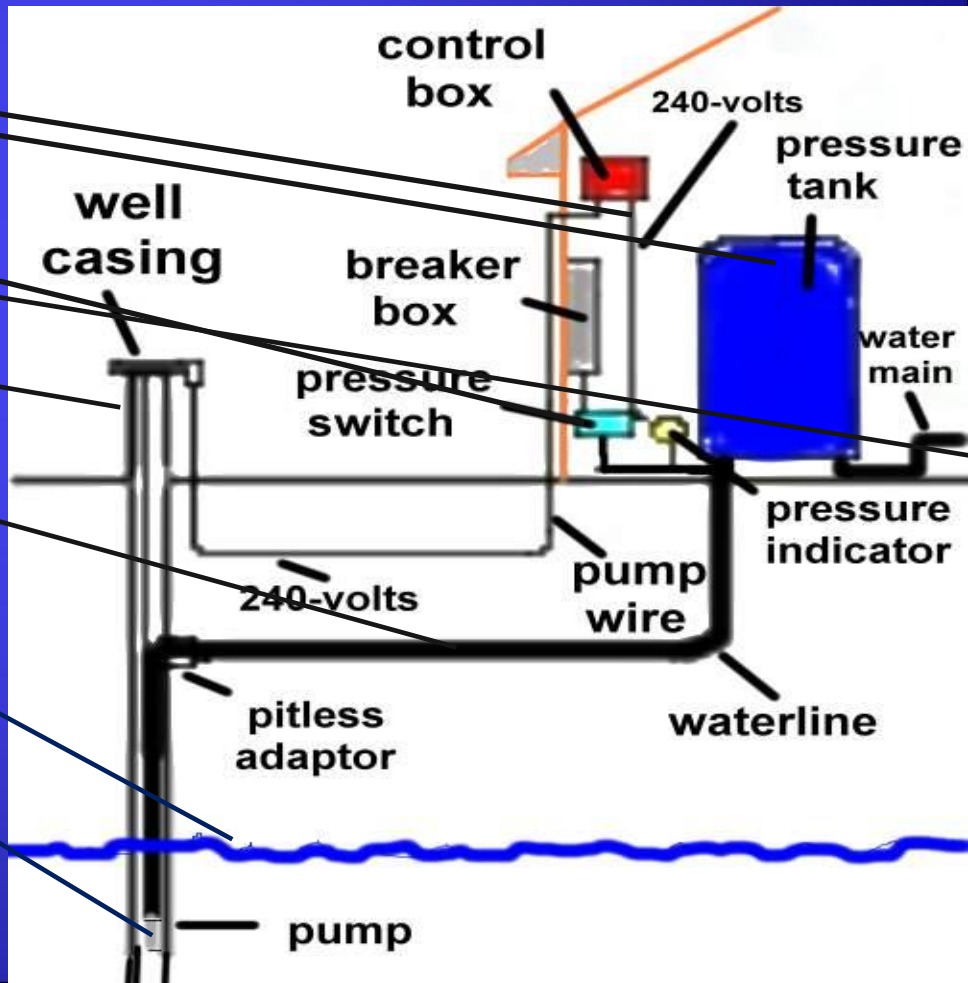
- Head- measurement of the height
- **Friction Loss-** resistance to flow in the pipe
- **Suction** Head- is the reading of the gauge on the suction flange, converted to feet of liquid
- **Pressure** Head- when a pumping system
  either begins or terminates in a tank which is under some pressure other than atmospheric.
- **Total Discharge Head** - The discharge reservoir pressure head plus static discharge head plus the velocity head at the pump discharge flange plus the total friction head in the discharge line



Water System Design

Type of Use/ Dwellings	*Gallonsperday*	*Livestock*	*Gallons per animal per day*
Single family	50-75/person	Cattle/horse	12
Multi-family	40/person	Dairy cow	35
Estate units	65-150/person	Hog	4
Lawn and garden	50-1,000/day	Goat or sheep	2
		Chickens	5-10 per 100

- Electrical Sizing
- Water Demand of the System
- System Pressure
- Desired Flow Rate
- Well Sizing
- Pipe Sizing
- Pumping Level
- Pump Sizing



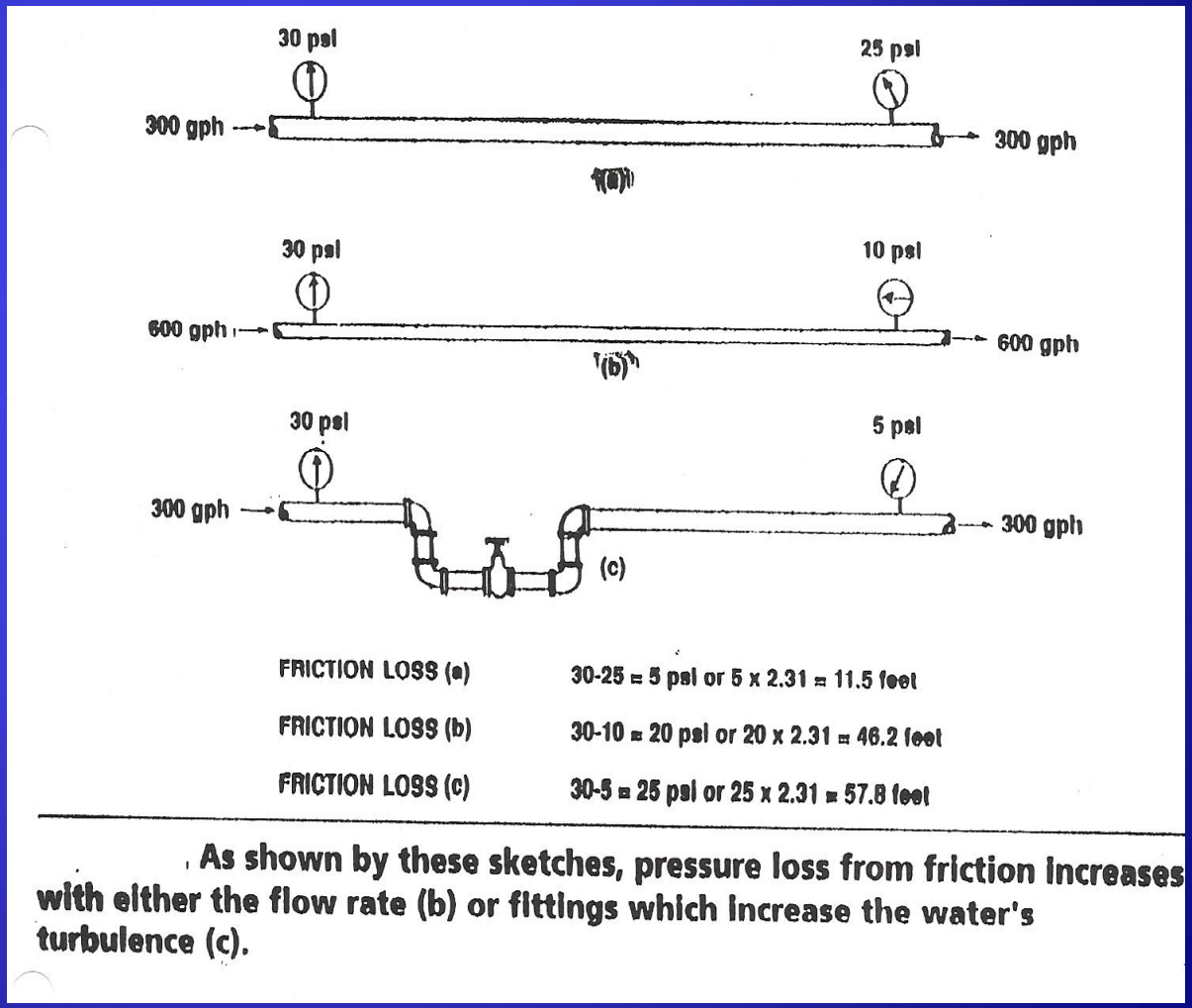
Friction Loss

Friction Head The head required to overcome the resistance to *flow in the pipe* and fittings. It is dependent upon the size, condition and type of pipe, number and type of pipe fittings, flow rate, and nature of the liquid.

Factors effecting friction loss

- –Pipe length
- –Type and diameter
- –Flow

Doubling = 4 times

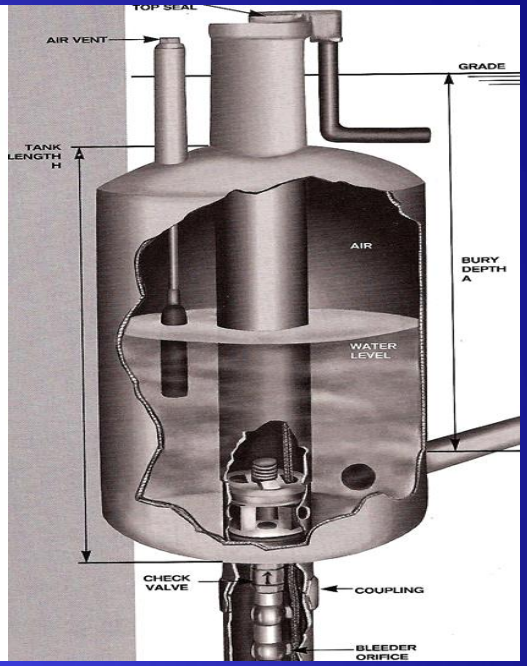


Tanks

- Galvanized
- Captive Air
- 3 Functions
  - Prolonged life of pump
  - Pressurized delivery
  - Help with temporary demand
- Tank must be properly sized
- Number of Starts per Day
- Motors should run a minimum of one minute to dissipate heat build up from starting current. Six inch and larger motors should have a minimum of 15 minutes between starts or starting attempts.

Hydro-Pneumatic Tank

Bladder Hydro-Pneumatic Tank



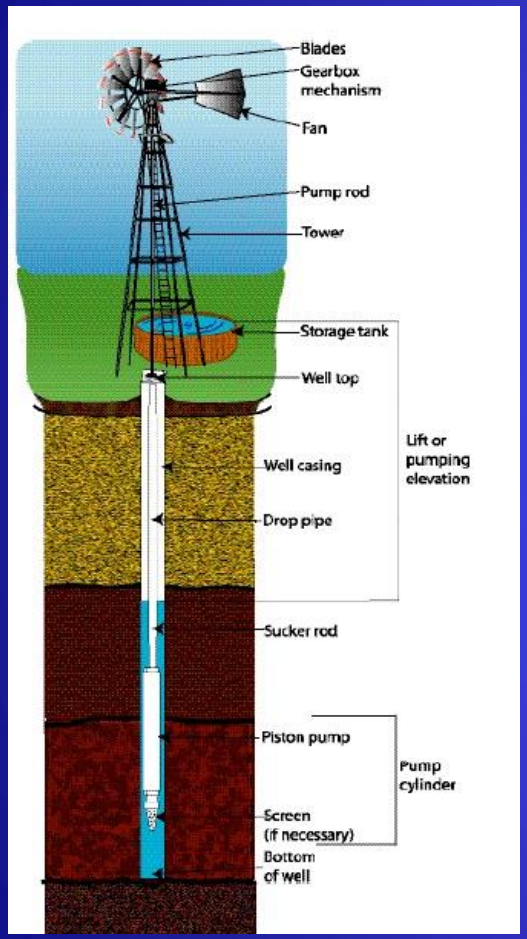
Steel Buried Hydro-Pneumatic Tank with Air Volume Control System

Up to 0.75	300	300
1 thru 5.5	100	300
7.5 thru 30	50	100*
40 and over	–	100

Table 3 Number of Starts

* Keeping starts per day within the recommended numbers provides the best system life. However, when used with a properly configured Reduced Voltage Starter (RVS) or Variable Frequency Drive (VFD), 7.5 thru 30 hp three-phase motors can be started up to 200 times per 24 hour period.

Reciprocating or Piston Pump



How a Windmill Works

Pump Jack

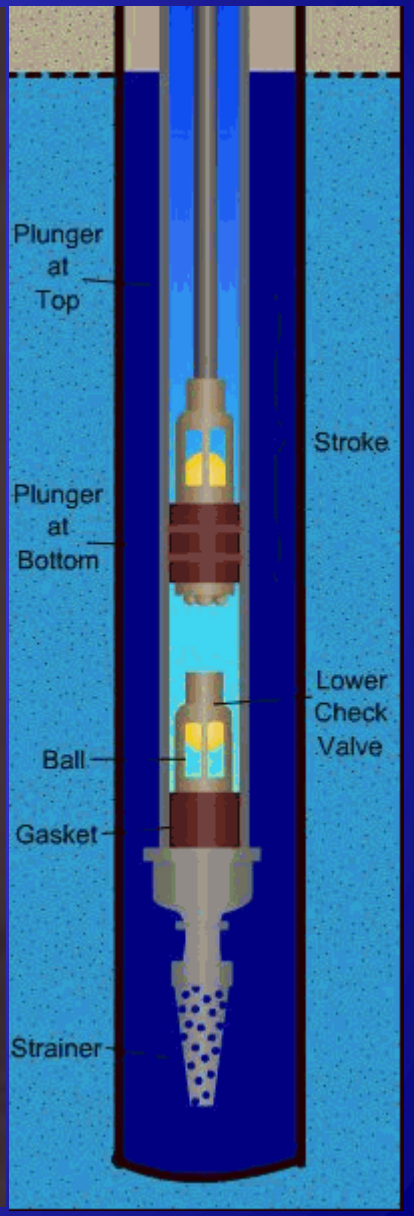
Deep Well Working Head

Hand Pump

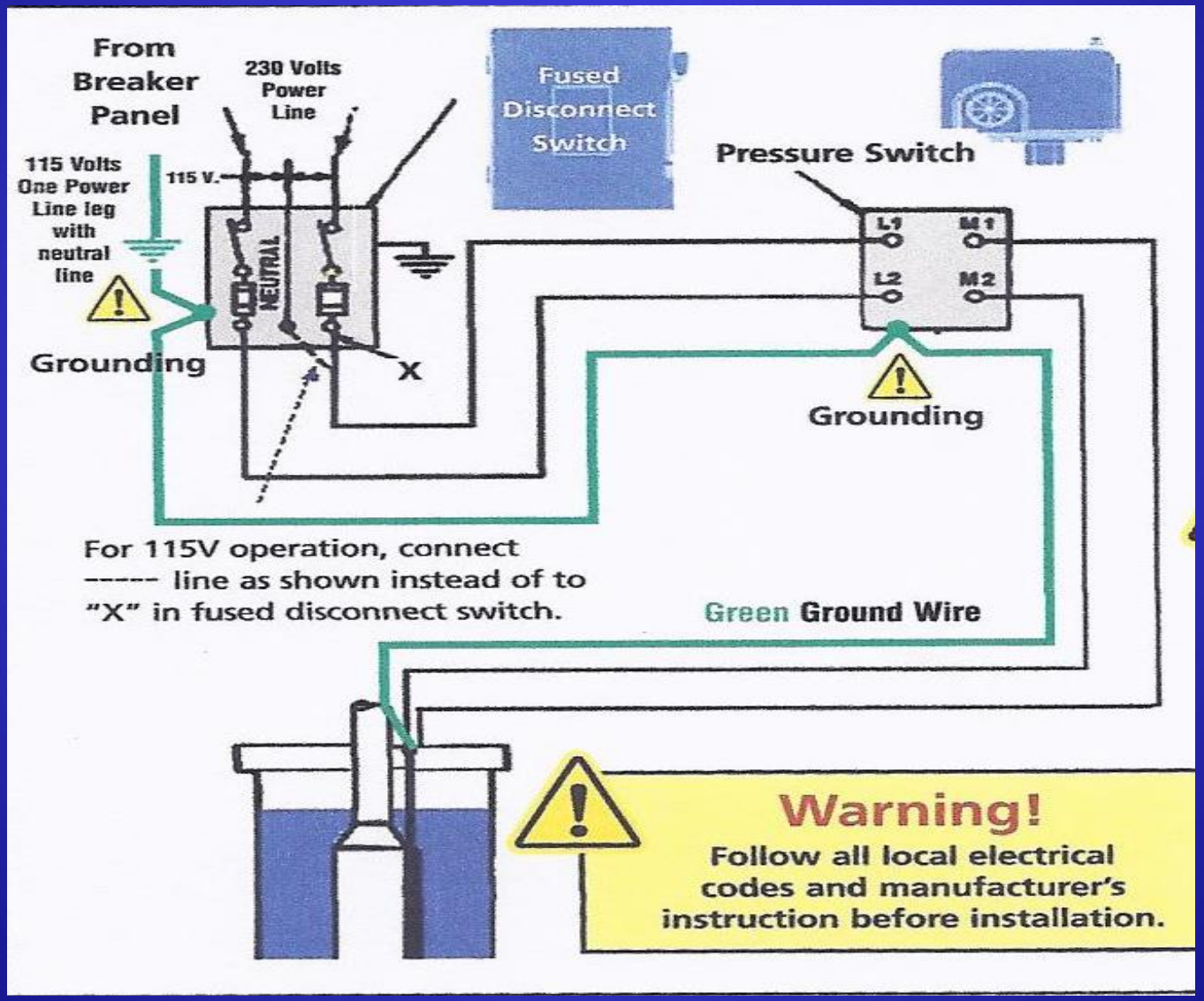
Helical Rotor Submersible Pump

Reciprocating pumps

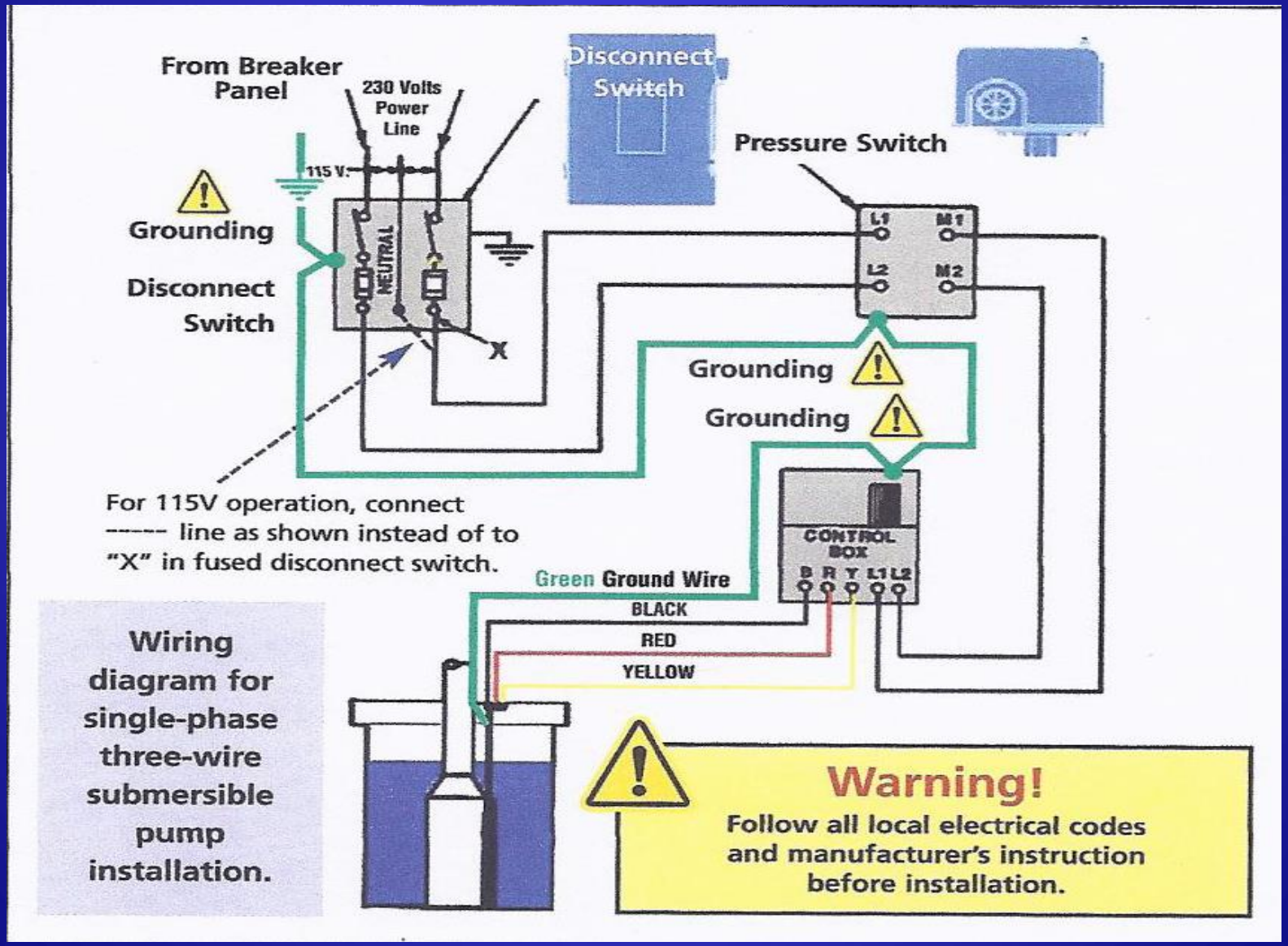
- Also called a piston pump
- Work well when wind is only source of energy
- Hand Pump
- Low flow
- Pressure Relief Valve
- Troubleshooting
  - Broken rod
  - Leaky pipe
  - Stuck valve
  - Worn leathers



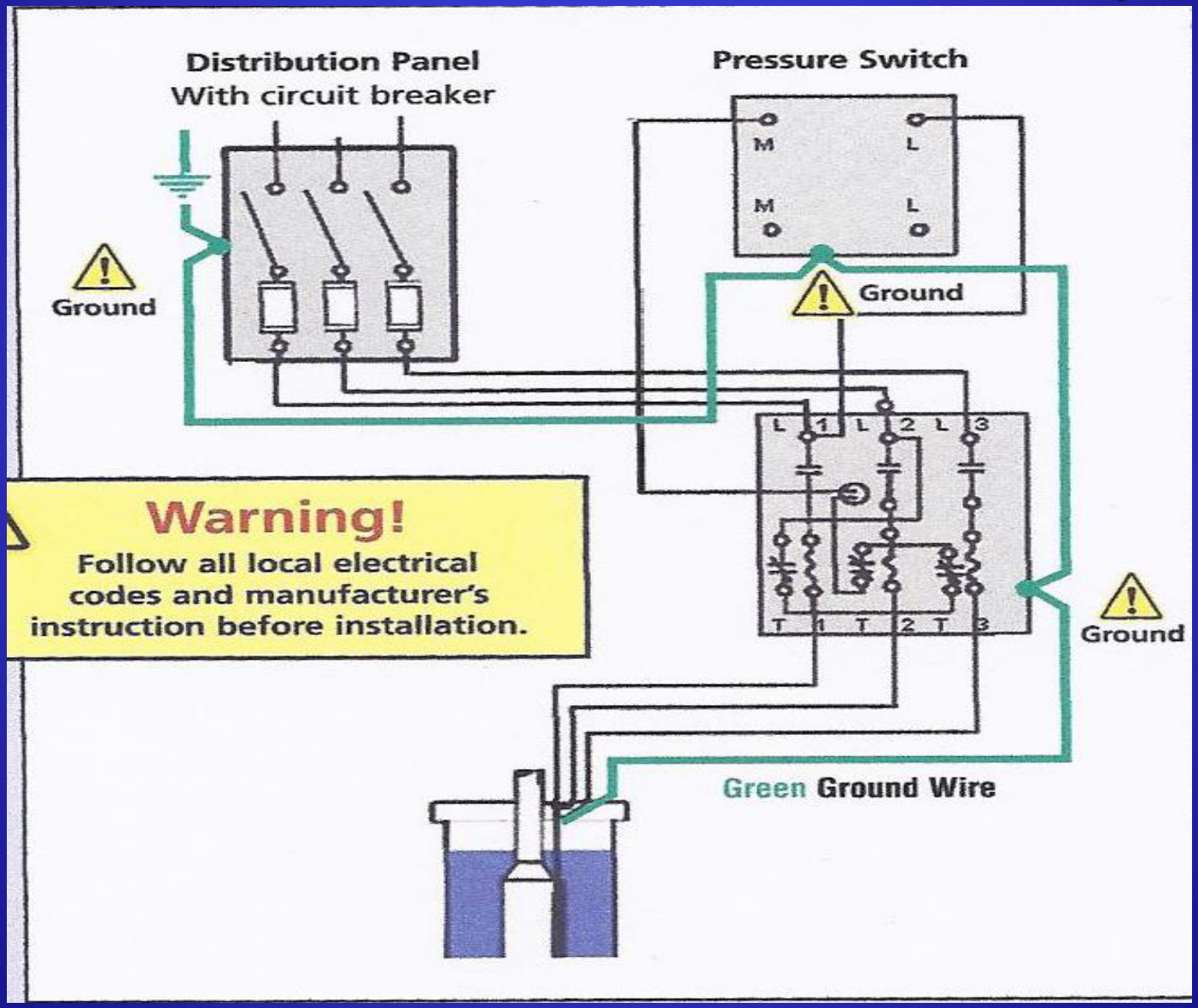
ELECTRICAL WIRING DIAGRAM
115-230 Volt 2-Wire Pumps



ELECTRICAL WIRING DIAGRAM
115-230 Volt 3-Wire Pumps



ELECTRICAL WIRING DIAGRAM
200-230-460-575 Volt 3-Wire Pumps

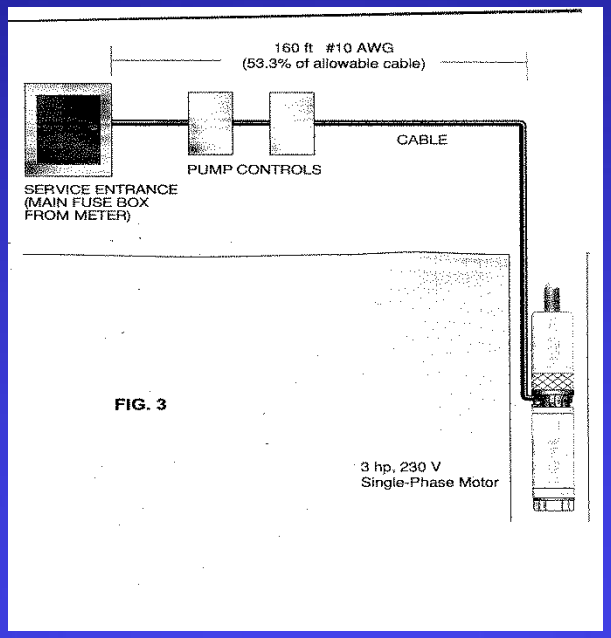


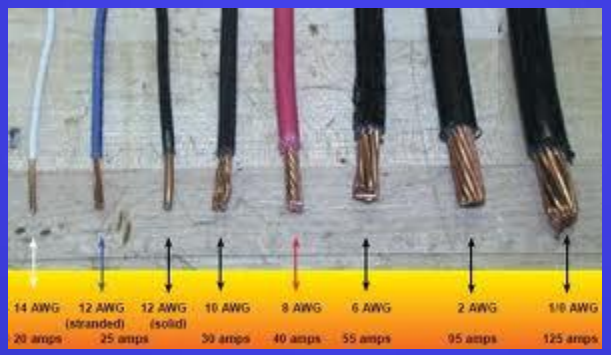
Electrical

- Direct relationship when comparing single-phase motors
- Wire sizing
  - Distance from the power source
  - Total current load
  - Voltage

    + or – 10%
- Equipment Grounding

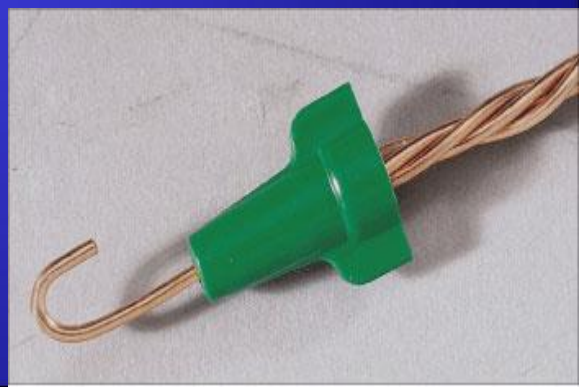
  WARNING: Serious or fatal electrical shock may result from failure to connect the motor, control enclosures, metal plumbing and all other metal near the motor or cable to the power supply ground terminal using wire no smaller than motor cable wires.





½ HP 230V
6 Amp

½ HP 115V
12 AMP



Instruments

Ammeter

Voltmeter Ohmeter

Vacuum-pressure Gauge

Method to measure flow

Electrical Tests

- Motor Continuity
- Insulation Test
- Voltage Drop
- Relay Check
- Capacitor Check
- Measure Amps or Current

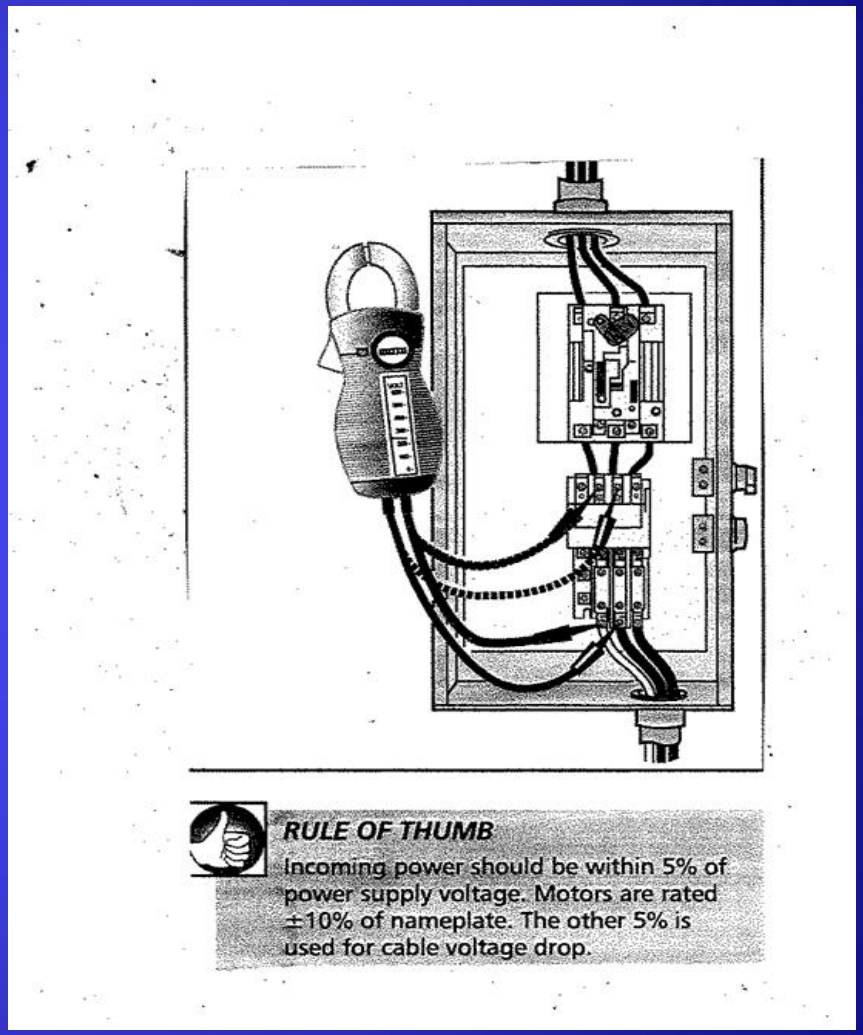
Voltage Checkout

Power is <u>ON</u> during voltage checking.

1. To check voltage**:** Use voltmeter on L1 & L2, check should be made at three locations.

   Step 1 Checking incoming power supply.
   Step 2 Checking fuses.
   Step 3 Checking contact points

2. When checking voltage, all other major electrical appliances (that could be in use at the same time) should be running.



Measuring Insulation Resistance

Open (turn OFF) master breaker or disconnect, Remove all leads from starter or control box to avoid damage to meter or electric shock hazard.

1. Set the scale lever to R x 100K (R x 100,000) and set the ohmmeter on zero.

2. Connect an ohmmeter lead to any one of the motor leads and the other to the metal drop pipe. If the drop pipe is plastic, connect the ohmmeter lead to the metal well casing or ground wire.

What It Means –

1. If all ohm values are normal, the motor windings are neither shorted nor open, and the cable colors are correct.

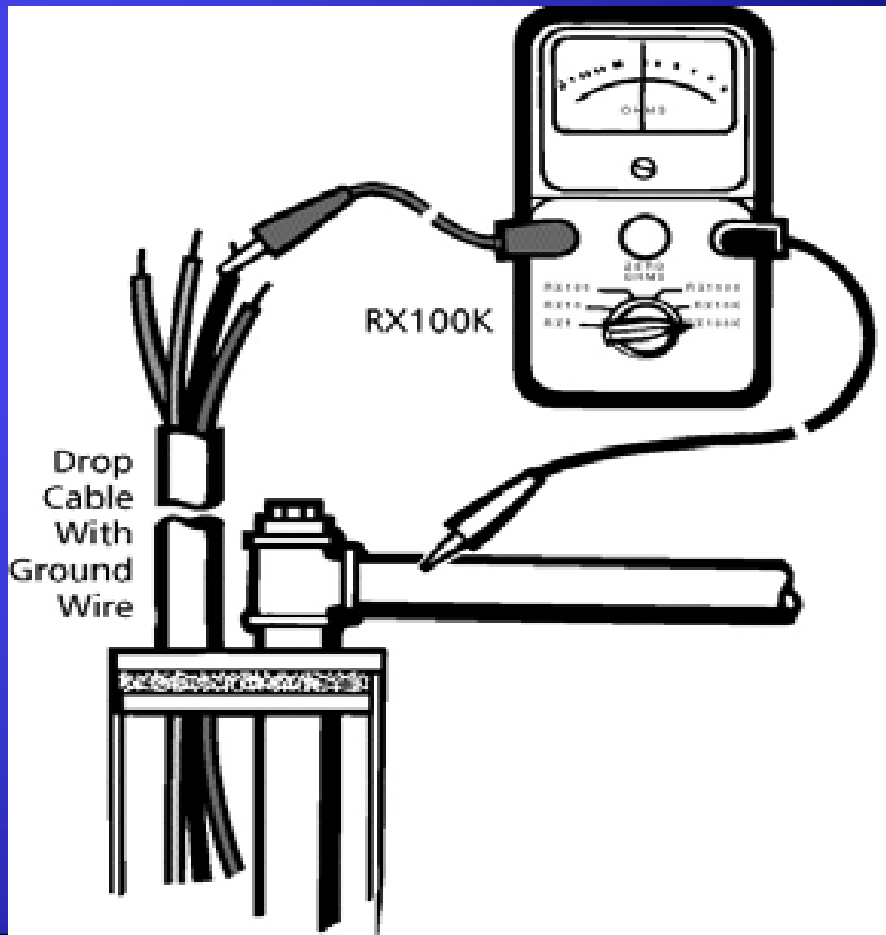
2. If any one ohm value is less than normal, the motor is shorted.

3. If any one ohm value is greater than normal, the winding or the cable is open or there is a poor cable joint or connection.

4. If some ohm values are greater than normal and some less, the leads are mixed.

Insulation resistance does not vary with rating. All motors of all HP, voltage and phase rating have similar values of insulation resistance.

Condition of Motor and Leads	Ohm Value	Megohm Value
New motor	20,000,000	20.0
Used motor	10,000,000	10.0
Damaged motor or cable	20,000 or less	0.02
Bad motor or cable	Less than 10,000	0-00.1



Motor Winding Resistance Checkout

Open master breaker and disconnect all lead to pressure switch(Q-D type control, remove lid) to avoid damage to meter or electric shock hazard.

1. Set the scale lever to R x 1 for values under10 ohms. For values over 10 ohms, set the scale lever to R x 10. Zero balance the ohmmeter as described earlier on page 11.

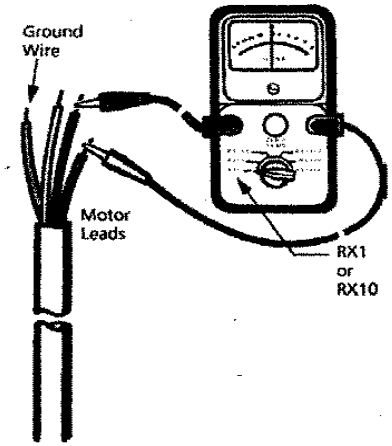
2. Connect the ohmmeter leads as shown

What it means:

1. Motor windings are OK, cable colors are correct
2. If any one value is less than normal motor is shorted
3. If value is greater winding or cable are open.
4. If the value are mixed the leads are installed incorrect, verify cable colors

TABLE 2 – Cable Resistance – Copper

Cable Size	DC Resistance of Cable per 100 Foot Length Ohms per Pair of Leads
14	.544
12	.338
10	.214
8	.135
6	.082
4	.052
2	.032



If aluminum cable is used the readings will be higher. Divide the ohm readings on this chart by 0.61 to determine the actual resistance of aluminum cable.

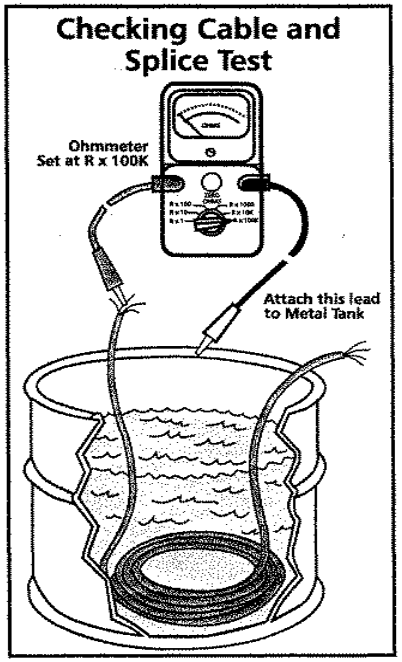
See motor data pages for motor resistance ratings.

RULE OF THUMB

Add resistance of drop cable when checking pump in well. See Table 2 above.

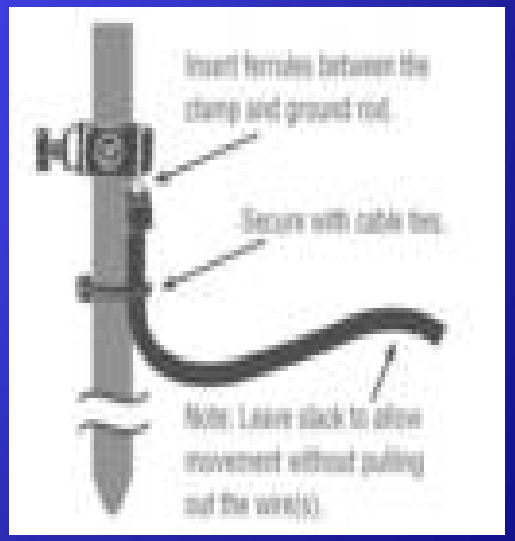
Cable & Splice Checkout

1.Submerge cable and splice in steel barrel of water with both ends out of water.
2. Set ohmmeter selector on RX100K and adjust needle to zero (0) by clipping ohmmeter leads together.
3. After adjusting ohmmeter, **clip one** ohmmeter lead to barrel and the other to each cable lead individually, as shown.
4. If the needle deflects to zero (0) on any of the cable leads, pull the splice up out of the water. If the needle falls back to (∞) (no reading) the
leak is in the splice.
5. If leak is **not** in the splice, pull the cable out of the water slowly until
needle falls back to (∞)(no reading).When the needle falls back, the leak is at that point.
6. If the cable or splice is bad, it should be repaired or replaced.



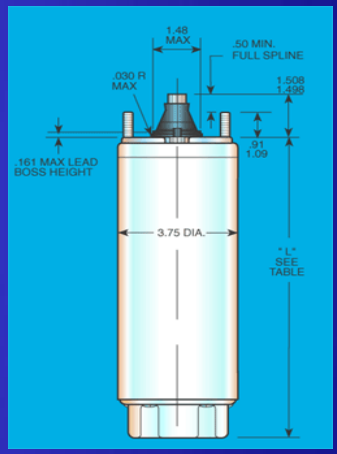
Service Call

- Voltage
  - Fuse box for 2-wire
  - Control box for 3-wire
- Magnetic starter 10 seconds maximum overload trip
- Three-phase motors are self starting- check rotation
- Three-phase is more economical to operate
- Wait 5-minutes before working on a VFD
- Capacitors should be discharge
- **All motor driven water pumps must be grounded**



Service Call

- Cause of overloads or tripping out
  - Incorrect voltage
  - Defective control box
  - Defective motor
  - Defective wiring
  - Defective or worn out pump
  - Sand locked pump
  - Bad check valve
  - Bad pressure tank



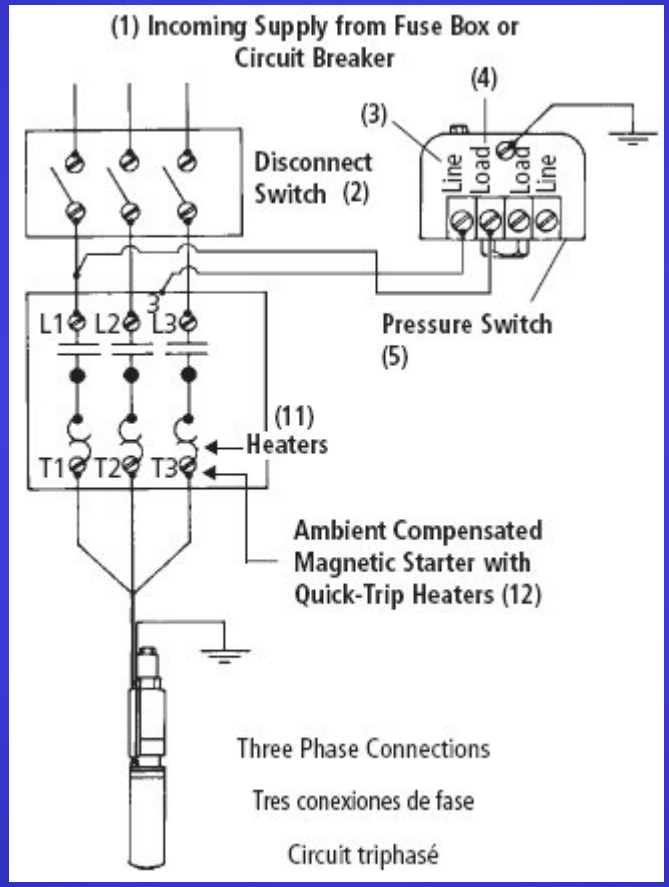
- Shaft height
  -Thrust bearing worn or broke

- Control boxes and pressure switches are not easily checked by a homeowner
  -Bad or broken contacts
  -Blown capacitors
  -Defective relay

3-Phase Wiring Diagram

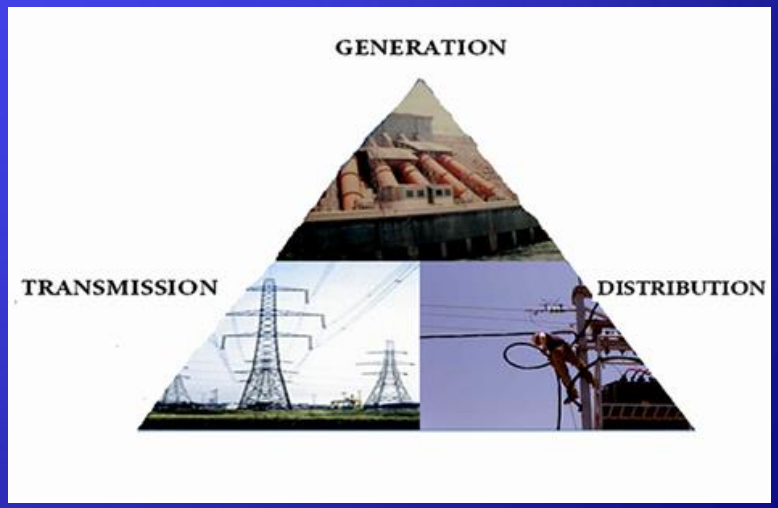
Fused disconnect has 3 quick-blow or time delayed fuses

Magnetic starter has 3 ambient compensated heater- less than 10 second trip



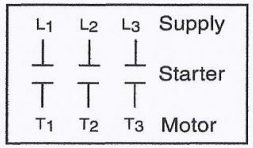
Three-Phase Unbalance

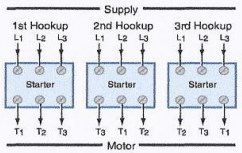
- Incoming voltage is not equal throughout all three legs
- Voltage unbalance causes current unbalance
- Blown fuses or overcurrent protective devices
- Unbalance single phase loadings
- Fault on one of the phases
- Causes overheating of the motor and leads to insulation breakdown

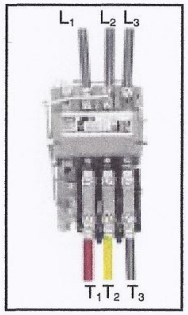


Trouble shooting 3-Phase Unbalance

G Unbalance...







For the best protection, we recommend no more than a 5% current deviation from average current.

Current readings in amps should be checked on each leg using the three possible hookups.

CAUTION

To prevent changing motor rotation, the motor leads should be reordered in the same direction, see example on page 51.

RULE OF THUMB

If the unbalance moves with the motor leads the unbalance is caused by the motor, wet splice, or damaged cable. If the unbalance remains with the terminals the unbalance is in the power supply.

Calculate percentage of current unbalance for all three hookups.

Example:

Hook Up 1	Hook Up 2	Hook Up 3
T_1 = 51 Amps	T_3 = 50 Amps	T_2 = 50 Amps
T_2 = 46 Amps	T_1 = 48 Amps	T_3 = 49 Amps
T_3 = 53 Amps	T_2 = 52 Amps	T_1 = 51 Amps

Add up all three readings for hook up number 1.

T_1 = 51 Amps
T_2 = 46 Amps
+T_3 = 53 Amps
Total 150 Amps

Divide the total by three to obtain the average.

50 Amps = Average
3 | 150 Amps

Calculate the greatest amp difference from the average. Could be greater than average.

50 Amps
-46 Amps
4 Amps

Divide this difference by the average to obtain the percentage of unbalance.

.08 or 8%
50 | 4.00 Amps

Hook Up #1 = 8%
Hook Up #2 = 4%
Hook Up #3 = 2%

Always use hook up with lowest % current unbalance.

Loads on a transformer bank vary. Readings should be taken at peak load period.

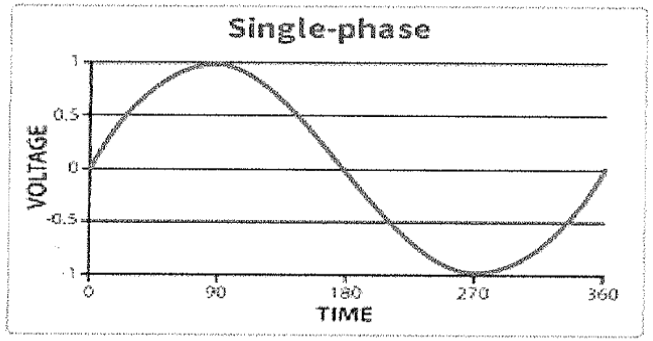
What It Means –

1. Hook ups below 5% = system balanced.
2. Hook ups not below 5% – if the unbalance moves with the motor leads the unbalance is caused by the motor, wet splice, or damaged cable. Check the motor on pages 44-45. If the unbalance remains with the terminals the unbalance is in the power supply – contact power company.

What is the difference between single-phase and three-phase power

Single-phase power is:

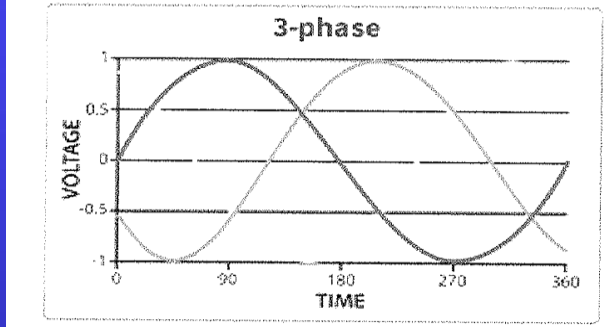
- Used in most homes in North America
- Able to supply ample power for most smaller customers, including homes and small, non-industrial businesses
- Adequate for running motors up to 5 HP; single-phase motors draws significantly more current than equivalent 3-phase motor, making 3-phase power a more efficient choice for industrial applications



With the wave form of single-phase power, when the wave passes through zero, the power supplied at that moment is zero. In the U.S., the wave cycles 60 times per second.

3-Phase power is:

- Common in large business, as well as industry and manufacturing
- Increasingly popular in power-hungry, high-density data centers
- Expensive to convert from an existing single-phase installation, but 3-phase allows for smaller, less expensive wiring and lower voltages, making it safer and less expensive to run
- Highly efficient for equipment designed to run on 3-phase



3-phase power has 3 distinct wave cycles that overlap. Each phase reaches its peak 120 degrees apart from the others so the level of power supplied remains consistent.

Service Factor

- How does Service Factor (S.F.) Apply To A Motor?

To determine the service factor horsepower of a motor, multiply the nameplate horsepower (not amperage) by the service factor. For example, if a 1/2 Hp motor has a service factor of 1.6, the motor's service factor maximum horsepower is:

- (0.5 HP) x (1.6 S.F.) = 0.8 Hp

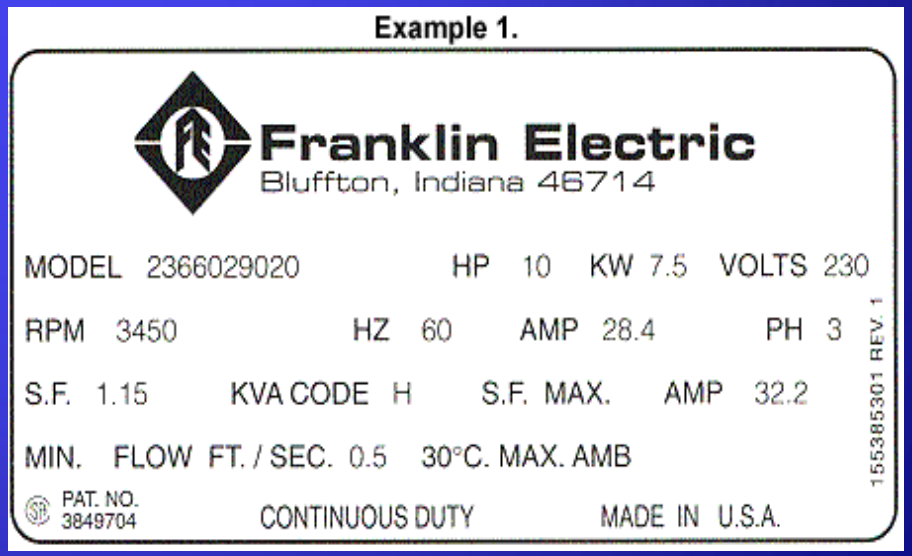
- Likewise, a 10 Hp motor with a nameplate service factor of 1.15, as shown in example 1, has a service factor If maximum horsepower of:

- (10 HP) x (1.15 S.F.) = 11.5 Hp

- Franklin Electric submersible motors have service factor guidelines for "pump motors"

- The service factor is lost above 3300 feet

Example 1.



Variable Frequency Drive Submersible Motor Requirements

- All three-phase, encapsulated submersible motors must have the VFD sized based on the motor's nameplate maximum amps, not horsepower. The continuous rated amps of the VFD must be equal to or greater than the motor's nameplate maximum amps or warranty will be void.
- **Input Current & Motor Overload Protection:**
- • Motor input current should be set at the system's typical operating current when running at nameplate rated voltage and frequency (Hz).
- • Motor overload protection should be set to trip at 115% of the system's typical operating current.
- • Motor overload protection must trip equal to or faster than NEMA Class 10 motor overload curve requirements.

- **Motor Maximum Load Limits:**
- • The system must never operate in excess of the motor nameplate maximum amps.
- • On 50 Hz motors, nameplate amps are maximum amps as these motors have a 1.0 service factor.

- **Starting and Stopping Ramp Settings:**
- • The motor must reach or pass the 30 Hz operating speed within 1 second of the motor being energized. If this does not occur, the motor bearings will be damaged and the motor life reduced.
- • The best stopping method is to turn power off followed by a natural coast to stop.
- • A controlled stop from 30 Hz to 0 Hz is allowed if the time does not exceed 1 second.

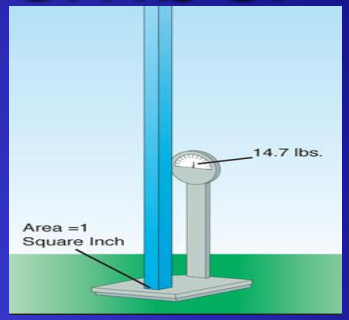
Solar Water Pump Systems

- **Current** - The rate at which electricity flows through a circuit, to transfer energy. Measured in Amperes, commonly called Amps. Analogy: flow rate in a water pipe.
- **DC** - Direct Current, the type of power produced by photovoltaic panels and by storage batteries.
- **PV** - The common abbreviation for photovoltaic.
- **PV Array** - A group of PV (photovoltaic) modules (also called panels) arranged to produce the voltage and power desired.
- **Location of the pump controller** Place the controller close to the solar array, not the pump. This will reduce the risk of lightning damage. Explanation: The controller's input circuitry is more sensitive to surges than its output. It is safest to minimize the length of the input wiring.

- **690.45 Size of Equipment Grounding**
- **Conductors [2008 NEC]**
- • **"(A) General. Equipment grounding conductors in photovoltaic source and photovoltaic output circuits shall be sized in accordance with Table 250.122."**

- **WARNING** The photovoltaic array generates hazardous voltages. A 48 V (nominal) array can generate nearly 100 V when disconnected from load. A short circuit or loose connection will produce an arc that can cause serious burns. All wiring must be done by qualified personnel, in compliance with **local, state, and national electrical codes.**
- **690.45 Size of Equipment Grounding**
- **Conductors [2008 NEC]**
- • **"(A) General. Equipment grounding conductors in photovoltaic source and photovoltaic output circuits shall be sized in accordance with Table 250.122."**
- **4.2 Grounding and Lightning Protection**
- Surges induced by lightning are one of the most common causes of electronic controller failures in solar water pumps. Damaging surges can be induced from lightning that strikes a long distance from the system, or even between clouds. The risk of damage is greatly reduced if these instructions are followed.

Terms and Numbers to Remember



Atmospheric pressure at sea level =
14.7 PSI

- 1 foot of head =
  .433 PSI

- 2.31 feet of head =
  1 PSI
- 1 cubic foot =
  7.48 gallons of water

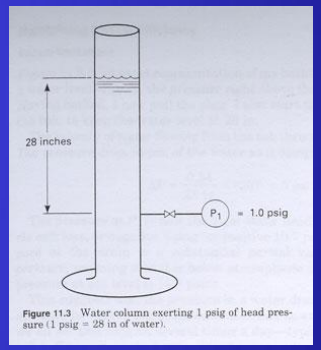
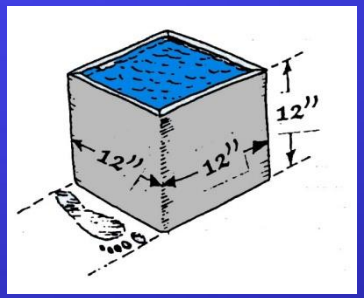
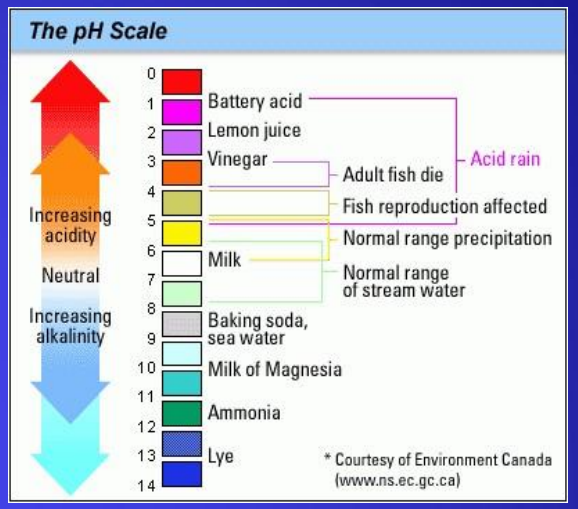


Figure 11.3 Water column exerting 1 psig of head pressure (1 psig = 28 in of water).

- **1 gallon of water weighs**
  8.35 pounds



Terms and Numbers to Remember



- pH = the potential of hydrogen or the power of hydrogen

- To change feet of head to PSI, multiply by .433

  231’ X .433=100 PSI

  100’ X .433= 43.3 PSI

- To change PSI to feet of head, multiply by 2.31

  70 PSI X 2.31= 161.7’ of Head

  50 PSI X 2.31= 115.5’ of Head

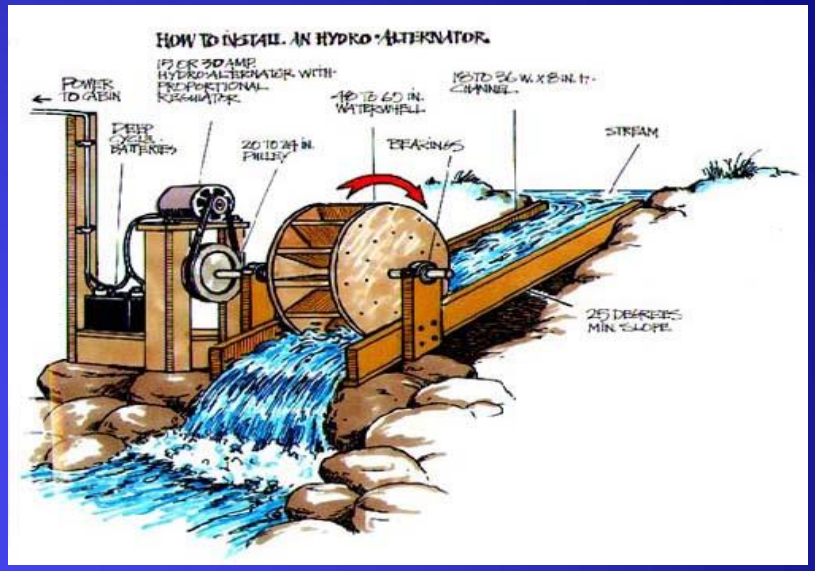
Terms and Numbers to Remember

- Volt =
  measurement of electrical pressure

- Ampere =
  measurement of electrical flow or current

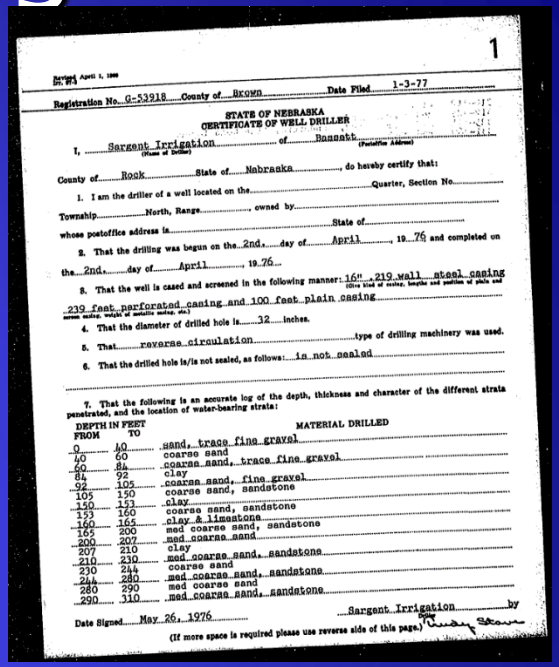
- Ohm =
  measurement of electrical resistance

- NEMA =
  standard for 3-phase electricity
  - Supply voltages 208, 240, 480, 600
  - Motor voltages 200, 230, 460, 575



Decommissioning

- Preliminary actions must be taken before process begins
- Acceptable fill materials
- Acceptable seal materials
- Entire cavity must be filled
- Pressure grouting
- Closed loops
- Flag flowing wells



1

Registration No. G-53918 County of Brown Date Filed 1-3-77

STATE OF NEBRASKA
CERTIFICATE OF WELL DRILLER

I, Sargent Irrigation (Name of Driller) of Bassett (Postoffice Address)

County of Rock State of Nebraska, do hereby certify that:

1. I am the driller of a well located on the Quarter, Section No.
Township North, Range, owned by
whose postoffice address is State of

2. That the drilling was begun on the 2nd day of April, 19 76 and completed on the 2nd day of April, 19 76

3. That the well is cased and screened in the following manner: 16" .219 wall steel casing (Give kind of casing, lengths and position of joints and across casing, weight of metallic casing, etc.)
239 feet perforated casing and 100 feet plain casing

4. That the diameter of drilled hole is 32 inches.

5. That reverse circulation type of drilling machinery was used.

6. That the drilled hole is/is not sealed, as follows: is not sealed

7. That the following is an accurate log of the depth, thickness and character of the different strata penetrated, and the location of water-bearing strata:

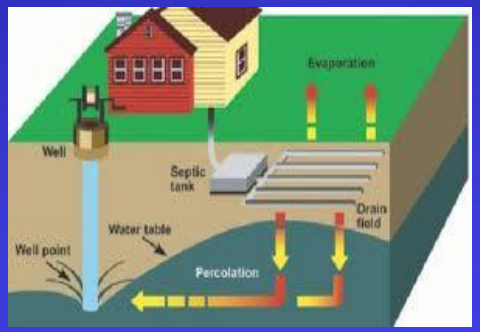
DEPTH IN FEET FROM	TO	MATERIAL DRILLED
0	40	sand, trace fine gravel
40	60	coarse sand
60	84	coarse sand, trace fine gravel
84	92	clay
92	105	coarse sand, fine gravel
105	150	coarse sand, sandstone
150	153	clay
153	160	coarse sand, sandstone
160	165	clay & limestone
165	200	med coarse sand, sandstone
200	207	med coarse sand
207	210	clay
210	230	med coarse sand, sandstone
230	244	coarse sand
244	280	med coarse sand, sandstone
280	290	med coarse sand
290	310	med coarse sand, sandstone

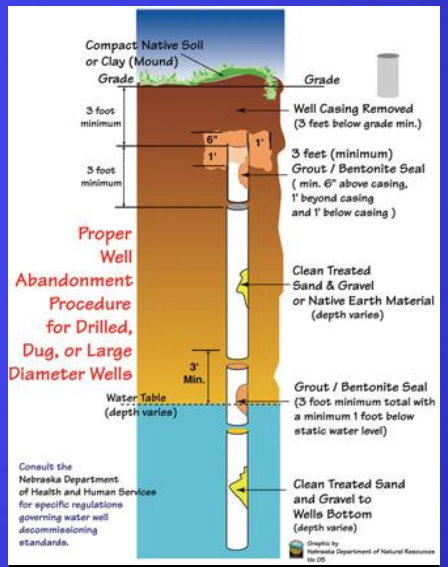
Date Signed May 26, 1976 Sargent Irrigation by (Driller)

(If more space is required please use reverse side of this page)

Decommissioning

- Reasons to abandon water wells
  - Prevent pollution
  - Hazards
  - Maintain confined head conditions

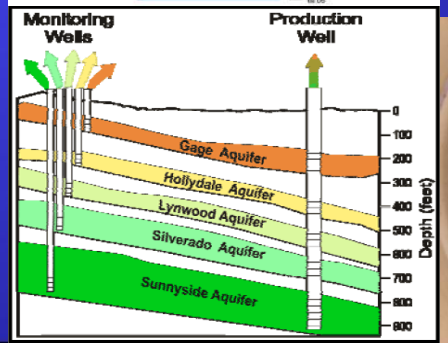




- Primary goal when decommissioning

- Test holes

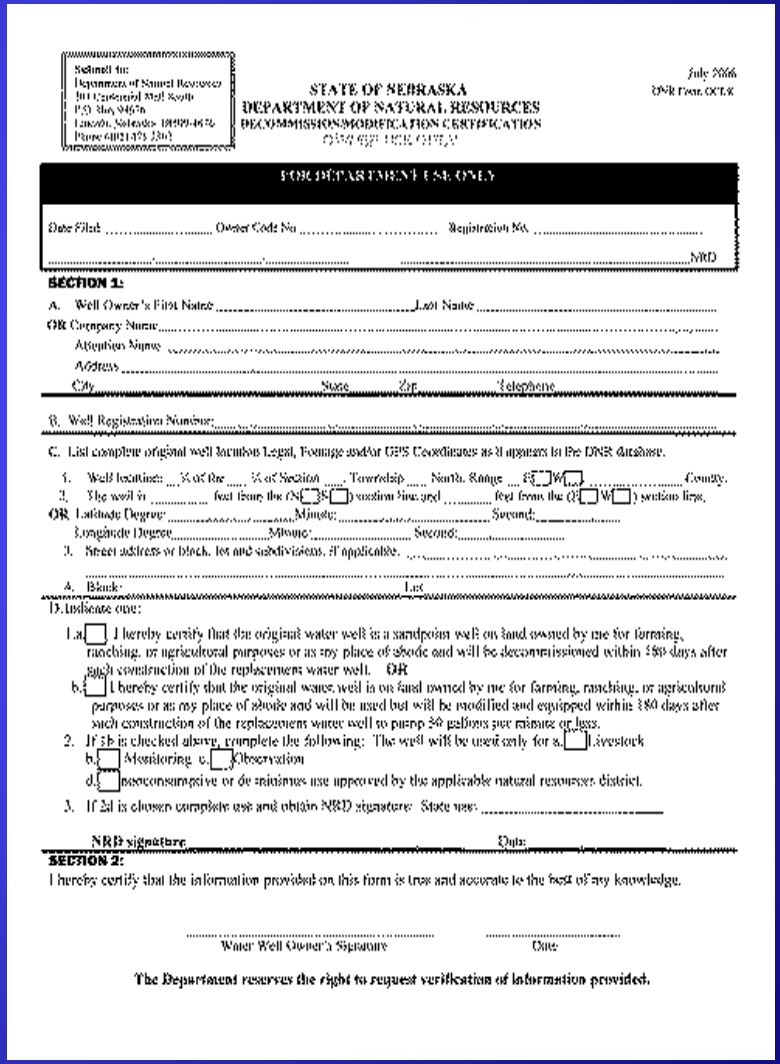
- Multiple aquifers well require more seals



Decommissioning

- **12-012.10 Reporting Decommissioning:** A notice of decommissioning for all water wells except test holes must be submitted to the Director of the Department of Natural Resources on the Notice of Decommissioning form supplied by the Department of Natural Resources within 60 days of the decommissioning of the water well as required in Neb. Rev. Stat. § 46-602 as follows:

- 1. The pump installation contractor or water well contractor must submit written notice of the decommissioning of a water well to the Department of Natural Resources.
- 2. If **both** a water well contractor and a pump installation contractor are involved in the decommissioning of a water well, **the pump installation contractor must submit** the notice of decommissioning to the Department of Natural Resources.
- 3. If a landowner decommissions a driven sandpoint water well on land owned by him/her and used by him/her for farming, ranching, or agricultural purposes or as his/her place of abode, **the landowner must report** the decommissioning to the Department of Natural Resources.



STATE OF NEBRASKA
DEPARTMENT OF NATURAL RESOURCES
DECOMMISSIONING/MODIFICATION CERTIFICATION

FOR DEPARTMENT USE ONLY

Date Filed ..... Owner Code No ..... Registration No. .....

..... NRD

SECTION 1:

A. Well Owner's First Name ..... Last Name .....

OR Company Name .....

Mailing Name .....

Address .....

City ..... State ..... Zip ..... Telephone .....

B. Well Registration Number: .....

C. List complete original well location Legal, Footage and/or GPS Coordinates as it appears in the DNR database.

1. Well location: ... ¼ of the ... ¼ of Section ..... Township ..... North, Range ... E ☐ W ☐ ..... County.
2. The well is ..... feet from the N ☐ S ☐ section line and ..... feet from the E ☐ W ☐ section line.

OR Latitude Degree: ..... Minute: ..... Second: .....

Longitude Degree ..... Minute: ..... Second: .....

3. Street address or block, lot and subdivision, if applicable. .....

.....

4. Block: ..... Lot: .....

D. Indicate one:

1.a ☐ I hereby certify that the original water well is a sandpoint well on land owned by me for farming, ranching, or agricultural purposes or as my place of abode and will be decommissioned within 180 days after such construction of the replacement water well. OR

b. ☐ I hereby certify that the original water well is on land owned by me for farming, ranching, or agricultural purposes or as my place of abode and will be used but will be modified and equipped within 180 days after such construction of the replacement water well to pump 50 gallons per minute or less.

2. If 1b is checked above, complete the following: The well will be used only for a. ☐ Livestock b. ☐ Monitoring c. ☐ Observation d. ☐ Noneconsumptive or de minimus use approved by the applicable natural resources district.

3. If 2d is chosen complete use and obtain NRD signature: State use: .....

NRD signature ..... Date: .....

SECTION 2:

I hereby certify that the information provided on this form is true and accurate to the best of my knowledge.

....

Water Well Owner's Signature Date

The Department reserves the right to request verification of information provided.

Decommissioning a Test Hole

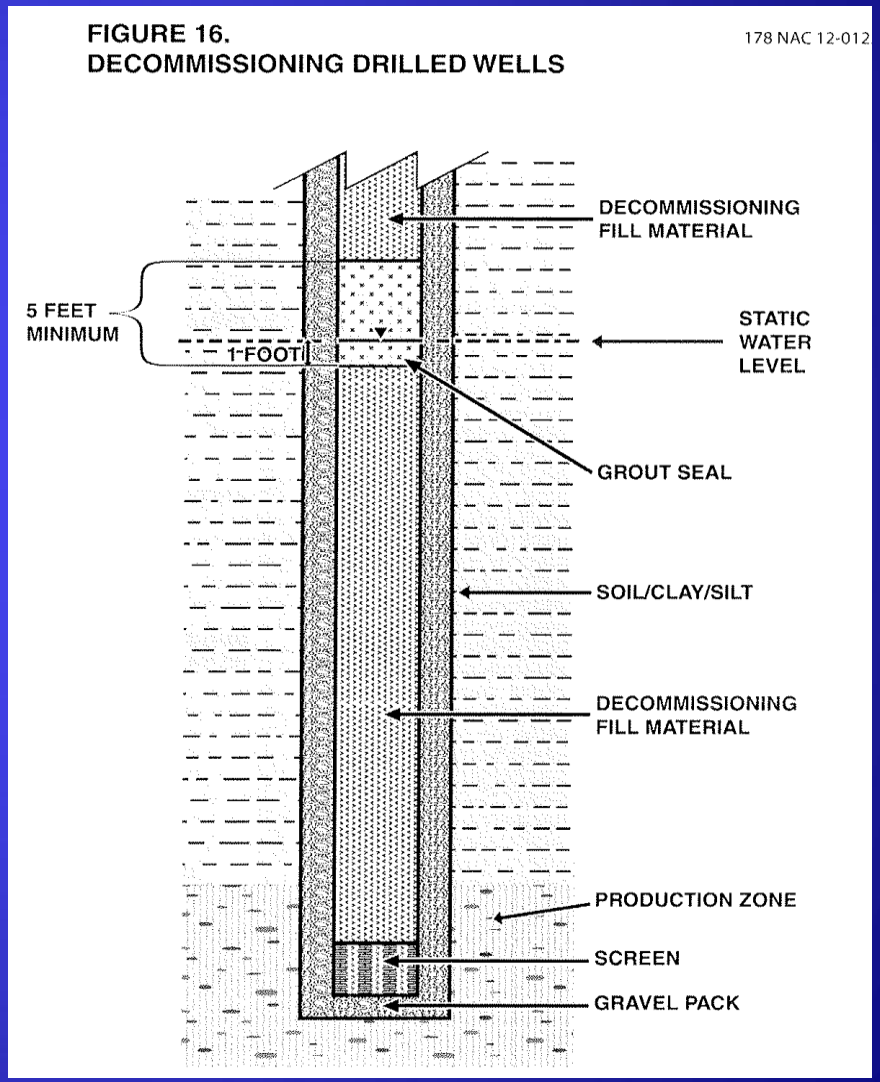
12-012.08A Test Holes

Test holes must be sealed with a 5-foot grout plug placed at static water level and/or confining layer.

Approved fill material must be placed from the 5 foot grout plug to the surface seal within the top 10 feet.

Decommissioned Water Well

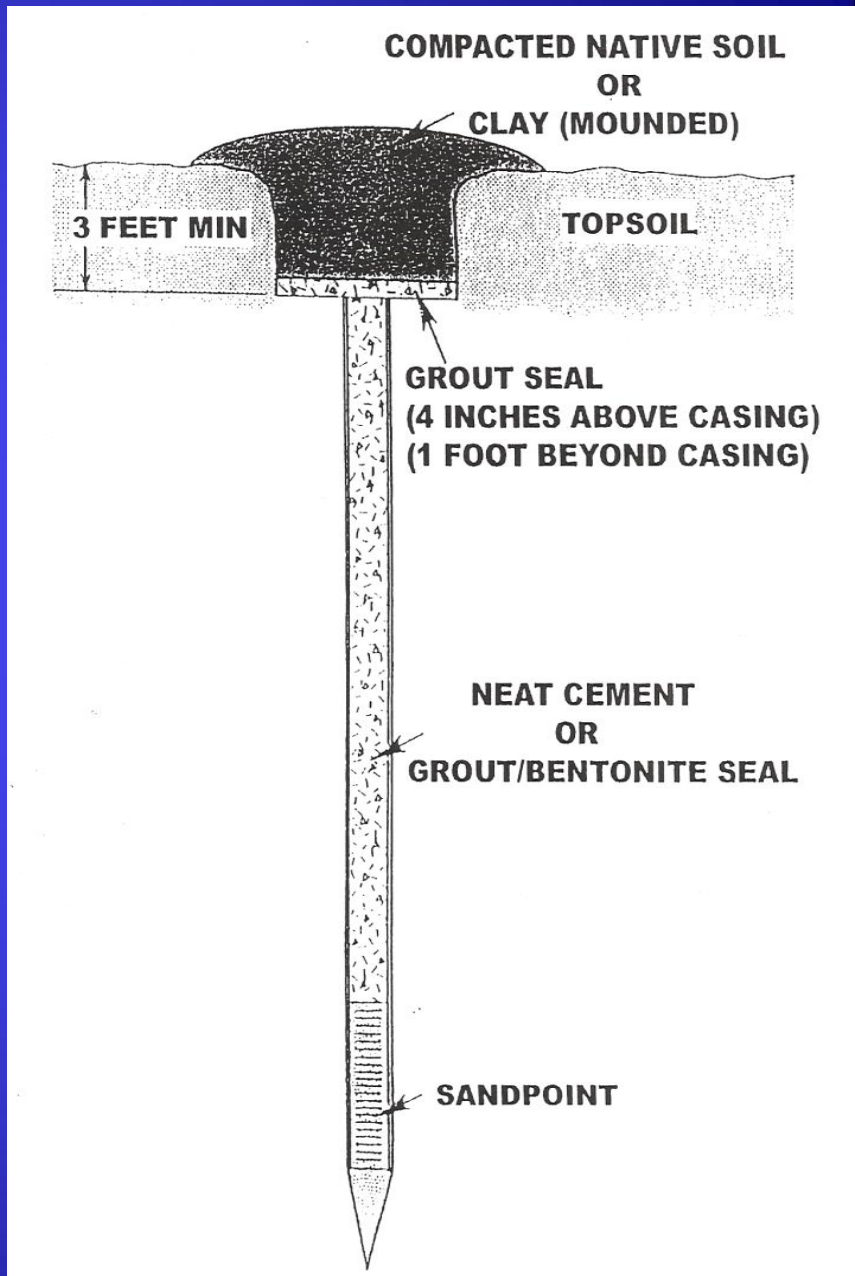
- **12-012.08B Drilled, Bored, or Dug Water Wells**
- 1. Measure the static water level and the total depth of the well.
- 2. Use these measurements and Tables 1 and 2 to determine the volume of material to be used.
- 3. Fill the casing with clean disinfected sand, gravel, or grout up to 1 foot below the static water level.
  - a. If the static water level is less than 6 feet, refer to upper plug procedures for near-surface decommissioning.
  - b. If the static water level is greater than 6 feet, place a seal at least 5 feet thick on top of the sand/gravel fill. (See Figure 16.)
- 4. If water is in the casing, place the grout slurry from the bottom up using a tremie pipe. Non-slurry bentonite material (coarse, chunk, pellets, etc.) may be used if placed slowly to prevent bridging.
- 5. Fill the remainder of the well with clean sand or gravel or grout up to 8 feet below the ground surface. At this point, place a 5-foot grout seal in the casing. (See Figure 17
- 6. The remainder of the water well must be decommissioned as described in the Upper Plug Section.
- 7.The reminder of the water well must be decommissioned as described in the Plug Section. (See Figure 13)



Decommissioned Driven Sandpoint

12-012.08C Driven Sandpoint Wells
1. Fill the entire casing with grout to the top and cut off the casing 3 feet below the ground surface or water level. Place a 6-inch grout seal 1 foot beyond the casing and backfill the remainder of the hole with native soil mounded for settlement. (See Figure 18) or

2. If the casing is pulled, decommission like a test hole as described in 178 NAC 12-012.08A.



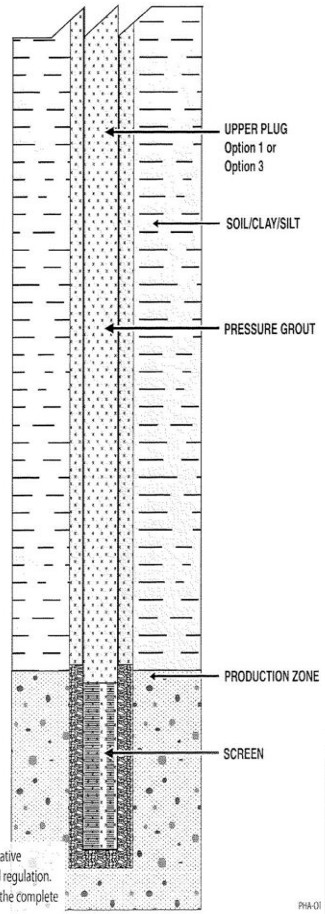
Decommissioned Multiple Aquifer Wells

2-012.08D Full Length Grouted Wells must be decommissioned by pressure grouting the inside of the screen and casing. (See Figure 19) The rest of the well must be decommissioned as described in the Upper Plug Section, Option 1 or Option 3 only, as described in 178 NAC 12-012.07A and 12-012.07C

.

12-012.08E Multiple Aquifer Wells: Water wells that obtained water from more than 1 water bearing zone must have a seal between each zone if each water bearing zone is separated by a confining layer. (See Figure 20) A grout seal not less than 5 feet in length must be placed adjacent to each confining layer and 5 feet of grout must be placed at the static water level.

FIGURE 19.
DECOMMISSIONING FULL LENGTH GROUTED WELLS



This figure is only for illustrative purposes of the referenced regulation. See the regulation text for the complete standard requirements.

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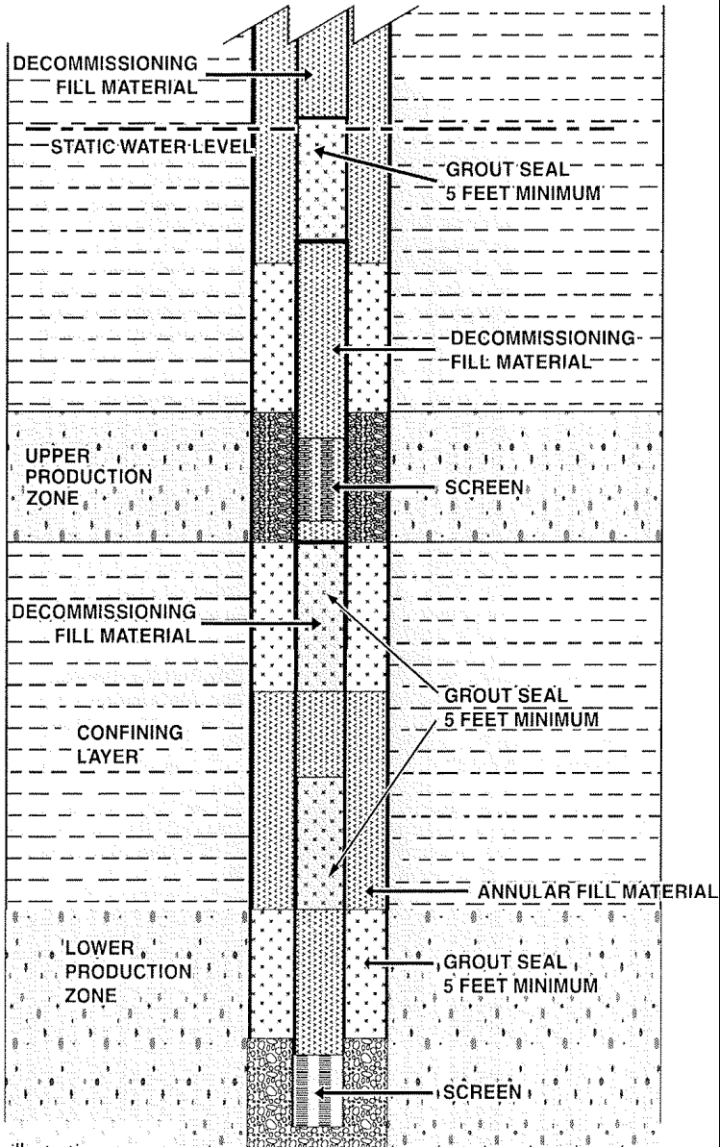
FIGURE 20.
DECOMMISSIONING MULTIPLE AQUIFER WELLS



Decommissioned Flowing Water Wells & Confining Layers

12-012.08F Flowing Water Wells: Decommissioning these wells requires the placement of neat cement through a **tremie line** to stop the flow; otherwise, expandable plugs may be installed in the casing (or bedrock if not cased) to stop the water flow.

12 -012.08F1 If it is known where a confining layer exists, the following procedure to install an intermediate seal (see Figure 21) is required.

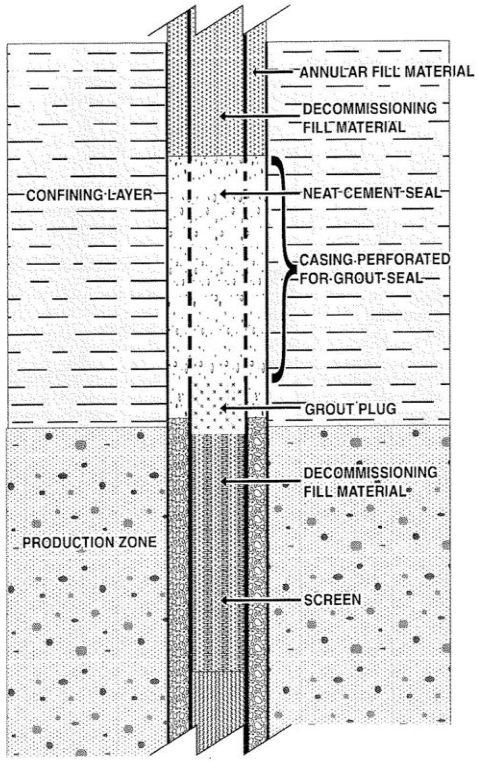
12-012.08F1a If, during construction, the annular space was not grouted at the confining unit, a plug must be set at the bottom of the confining layer and the casing must be perforated a minimum of 3 feet, to allow pressure grouting of the annular space with neat cement.

12-012.08F1b Bentonite grout can be used above the confining layer if the flow has been stopped. The rest of the well must be decommissioned as described in the Upper Plug section, 178 NAC 12-012.07.

12-012.08F2 The exact location of these wells must be flagged for at least 1 year after decommissioning.

FIGURE 21.
DECOMMISSIONING FLOWING WATER WELLS AND CONFINING LAYERS

178 NAC 12-012.08F1



This figure is only for illustrative purposes of the referenced regulation. See the regulation text for the complete standard requirements.

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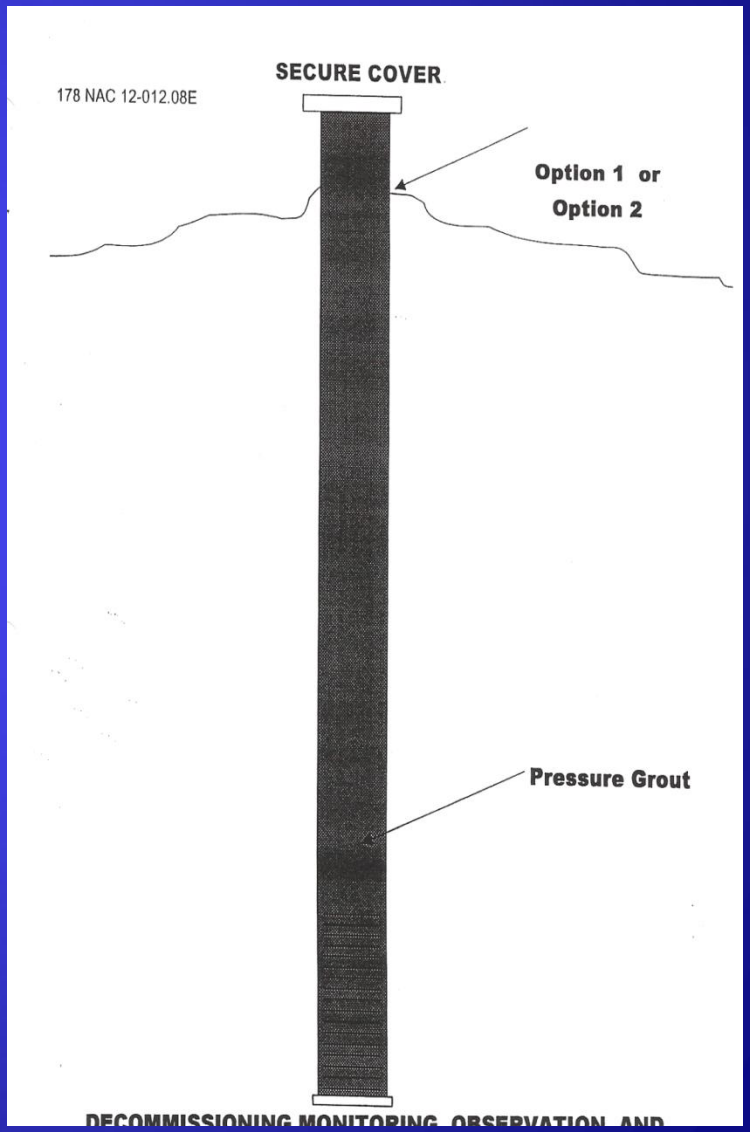
Decommissioned Monitoring, ObservaDtion & Recovery Wells

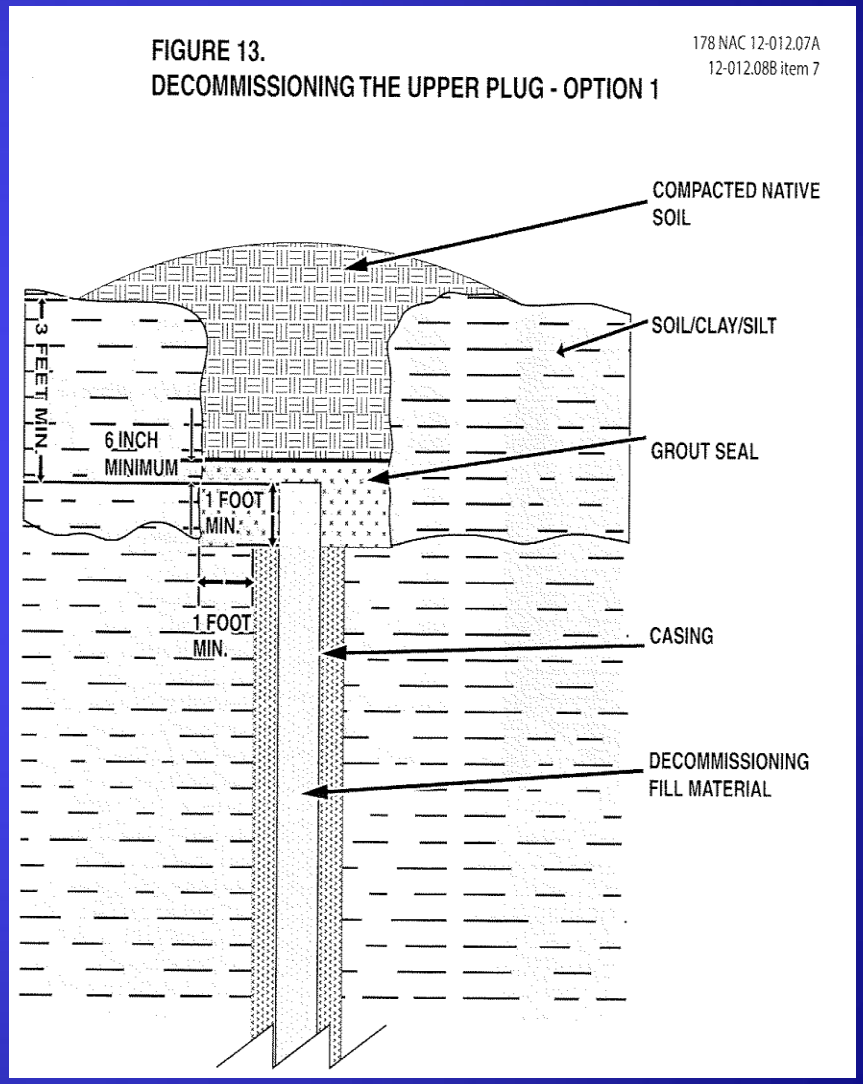
12-012.08E Monitoring, Observation, and Recovery Wells:

Must be decommissioned by pressure grouting the inside of the screen and casing. (See Figure 16.) A secure watertight cover must be installed on top of the casing. The rest of the well is decommissioned as described in the Upper Plug Section.



Upper Plug

- **12-012.07 Upper Plug**: All cased water wells to be decommissioned must have an upper plug to prevent surface and near-surface contaminants from entering the well casing. Only non-slurry bentonite and sand cement grouts are allowed in the upper plug. If the water well records indicate that a surface seal was installed during construction, then any option below can be used. If a surface seal was not installed or it is not known if a surface seal was installed, then Option 1 or Option 3 must be used.
- **12-012.07A Option 1:** Remove the top 3 feet of the well casing and grout the upper 5 feet of the remaining casing. Install a 6-inch thick grout seal above the top of the casing that extends a minimum of 1 foot past the walls of the original borehole and extends at least 1 foot below the top of the cut-off casing. Backfill the remainder of the hole with native soil mounded for settlement and proper drainage. (See Figure 13)



Upper Plug

- **12-012.07B Option 2**: For all other wells not located in a structure and if the water well was constructed with an annular surface seal, the water well casing may be left in place. A 5-foot long grout plug must be placed in the casing within the top 10 feet. If the casing is going to remain above the concrete surface, a watertight secure cover or cap must be installed on top of the casing. (See Figure 14)

- **12-012.07C Option 3:** If the water well is surrounded by concrete/asphalt that extends 1 foot beyond the original borehole, and the casing is to be cut off flush with the top of the concrete, then a 5 foot minimum grout plug must be placed 10 feet below the concrete pad, and a minimum of 5 feet of concrete must be installed above the grout plug and struck off level with the top of the concrete. (See Figure15)

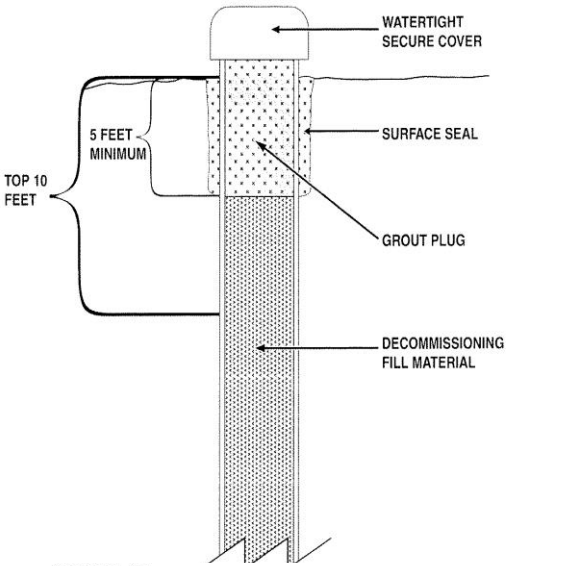
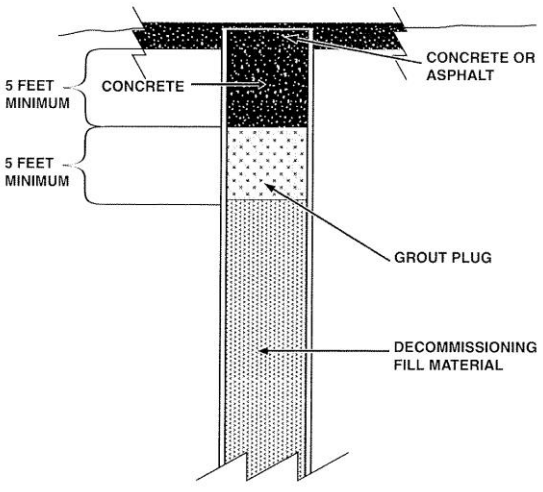
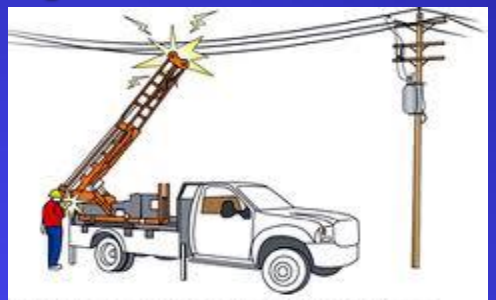


FIGURE 15.
DECOMMISSIONING THE UPPER PLUG - OPTION 3



Safety First

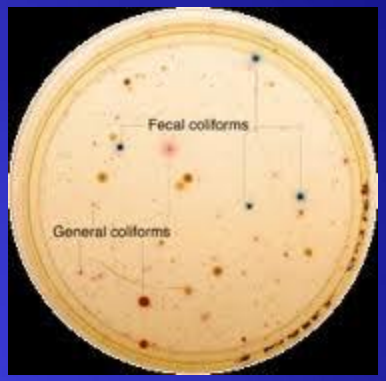
- SAFETY ON THE RIG
  - 20 ft. clearance for wires
  - Worn wire rope
  - Adequate blocking material
  - Safe clothing and adequate protection

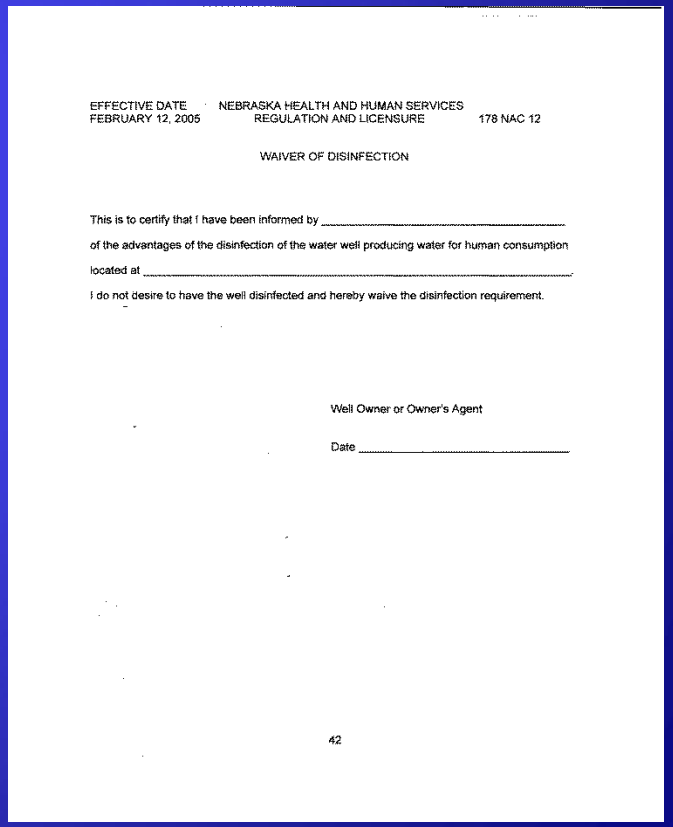


- SAFETY AT THE WELL OR PUMP SITE
  - Electrical shock
  - Acids
  - Hydrogen Sulfide

Misc. Information to Remember

- Coliform Bacteria are a commonly used indicator of sanitary quality of foods and water.
- E. coli Bacteria There are many types of **E. coli**, and most of them are harmless. But some can cause bloody diarrhea. Some strains of **E. coli bacteria** (such as a strain called O157:H7) may also cause severe anemia or kidney failure, which can lead to death. Other strains of **E. coli** can cause urinary tract infections or other infections.
- 200 ppm chlorine concentration for disinfection
- Household bleach will be highly effective for around 6 months
- Disinfection may be waived
- Water level Tester





EFFECTIVE DATE FEBRUARY 12, 2005 — NEBRASKA HEALTH AND HUMAN SERVICES REGULATION AND LICENSURE — 178 NAC 12

WAIVER OF DISINFECTION

This is to certify that I have been informed by _____

of the advantages of the disinfection of the water well producing water for human consumption

located at _____.

I do not desire to have the well disinfected and hereby waive the disinfection requirement.

Well Owner or Owner's Agent

Date _____

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Licensure Qualifications

- Qualifications for licensure:
  - Age of Majority-19
  - Good Moral character
  - Pass the test
  - Pay the fees for license/certificate
  - Proof of insurance-$100,000 liability
  - Comply with act

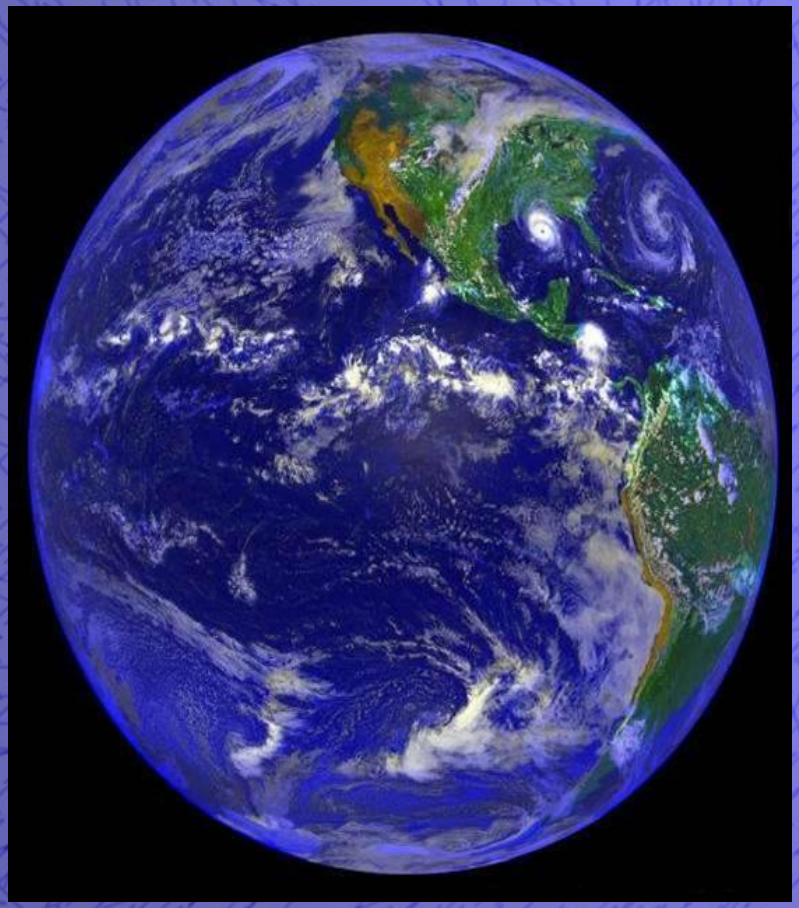
✓Qualifications for Certificate:

✓Pass the test

✓Pay the fee for certificate

✓Comply with the Act

Where is Earth's Fresh Water Located



Where is Earth's water located?

For a detailed explanation of where Earth's water is, look at the data table below. Notice how of the world's total water supply of about 332.5 million mi^3 of water, over 96 percent is saline. And, of the total freshwater, over 68 percent is locked up in ice and glaciers. Another 30 percent of freshwater is in the ground. Rivers are the source of most of the fresh surface water people use, but they only constitute about 300 mi^3 (1,250 km^3), about 1/10,000th of one percent of total water.

Note: Percentages may not sum to 100 percent due to rounding.

One estimate of global water distribution
(Percents are rounded, so will not add to 100)

Water source	Water volume, in cubic miles	Water volume, in cubic kilometers	Percent of freshwater	Percent of total water
Oceans, Seas, & Bays	321,000,000	1,338,000,000	--	96.54
Ice caps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.7	1.74
Groundwater	5,614,000	23,400,000	--	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	--	0.013
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	--	0.006
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York).

References for Pump Exam

References

- Title 178 NAC 12 Water Well Construction, Pump Installation and Water Well Decommissioning-Effective 8/26/2014
- ANSI/NWGA-01-14 Water Well Construction Standards-Effective 5-2014
- Ground Water Handbook 1st Edition 1998
- Water Systems Handbook-Water System Council-11th Edition Copyright 2000
- Franklin AIM Manual 2007 thru 2015
- Groundwater & Wells 3rd Edition-2007
- Groundwater & Wells Appendices RW DVD 1-15
- 2014 National Electric Code Book

Web Sites

- Watermanusa.com/
- Spicerparts.com/calculators/driveline-operating-angle/calculator
- B TURBINE LINESHAFT AND SUBMERSIBLE TURBINE PUMPS
- IMDWT R02MODEL Deep well Turbine pumps
- www.cornellpump.com/lit/pdf/Book-Installation%20Care.pdf
- Safety and Health Regulations for Construction

Examination

- The examination is designed to test your knowledge of pumps, how they operate, proper installation and troubleshooting techniques
- The Exam consists of 50 questions
- Must achieve a score of 70%
- Will be notified within 14 days
- Good Luck