SIZING INSTRUCTIONS
WELL-X-TROL®
POTABLE WATER WELL TANK

AMTROL®
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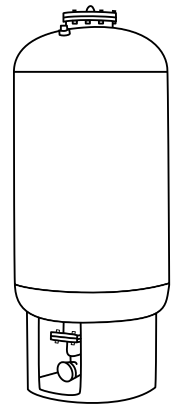


Series 420 & 447

Pressure Switch

This handbook will discuss the basic sizing used for our larger **Well-X-Trol®s** such as WX-400, 420, 440, and 450 series. This allows you to use the **Well-X-Trol®** "principle of separation of air and water" on larger jobs that are beyond the typical residential range.

The **Well-X-Trol®** models we'll be working with in this handbook are listed in Table 1.

The design features of these larger models allow us to apply them more creatively than the smaller residential models found in the **Well-X-Trol®** 100, 200, and 250 series.

The Larger Well-X-Trol®s are Designed and Built for Maximum Acceptance on Each Operating Cycle

In the smaller residential **Well-X-Trol®s**, the design is for basic intermittent use and for the usually found in residential applications. Standard pressure ranges of (20) PSIG (between pump cut-in and pump cut-out) are used.

In these applications, full use of the maximum acceptance volume of the **Well-X-Trol®** is rarely required to meet job conditions.

Table 1.

WX Model No. NON-CODE (NON-ASME)	WX Model No. CODE (ASME)	Total Volume (Gallons)	Maximum Acceptance Volume (Gallons)	Maximum Acceptance Factor (MAF)
WX-401	WX-401-C	17.5	11.25	.65
WX–402	WX–402-C	25	11.25	.45
WX-403	WX-403-C	34	11.25	.33
WX-404	WX-404-C	68	34	.50
WX-405	WX-405-C	90	34	.39
WX-406	WX-406-C	110	34	.31
WX-407	WX-407-C	132	46	.35
WX-421	Not available	158	103	.65
WX-422	Not available	211	137	.65
WX-423	Not available	264	172	.65
WX-424	Not available	317	206	.65
WX-426	Not available	422	274	.65
WX-427	Not available	528	343	.65
WX-447	WX-447-C	53	34	.65
WX-448	WX-448-C	80	52	.65
WX-449	WX-449-C	106	69	.65
WX-450	WX-450-C	132	86	.65
WX-451	WX-451-C	158	102	.65
WX-452	WX-452-C	211	136	.65
WX-453	WX-453-C	264	170	.65
WX-454	WX-454-C	317	205	.65
WX-455	WX-455-C	370	239	.65
WX-456	WX-456-C	422	273	.65
WX-457	WX-457-C	528	341	.65

Based on 30 PSIG pre-charge (P_1)

Utilizing the Maximum Capacity of Full Acceptance Well-X-Trol®s Series 400, 420, 440 and 450

When used with conventional pressure ranges, these **Well-X-Trol** models use only a fraction of their maximum capacity.

For Example:

A WX-423 with a total volume of (275) gallons will accept the following:

at 30/50 – (85) gallons or 30.9%

at 40/60 – (74) gallons or 26.7%

By using the maximum acceptance of series 420 and 450 **Well-X-Trol®**, you can replace very large, cumbersome galvanized tanks.

Let's Compare:

A 900 gallon galvanized tank is (48″) in diameter; (168″) long, and weighs approximately (10,000) pounds when filled with water.

Aside from initial cost, the cost of rigging and handling a tank of that size; (providing adequate support and the cost of space required) significantly adds to the overall installation cost.

Requires Air Control

Since at the higher pressures, the galvanized tank will waterlog at an accelerated rate, some provision must be made to maintain the required air cushion. This means the cost of an air compressor or other means of recharging must be added to the installation.

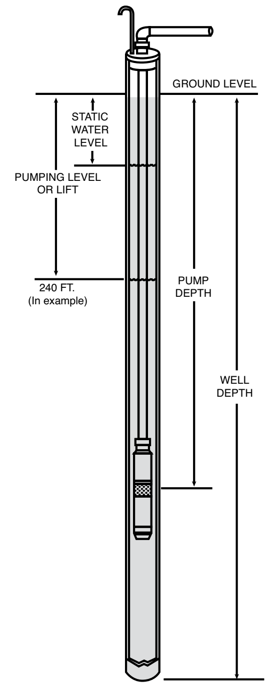
On the Other Hand

The WX-423 has a total volume of only (275) gallons; is only (36″) in diameter; and (84″) high. When filled with water (to the 65% maximum acceptance) it only weighs (1489) pounds.

It can be easily handled by two men, requires no support structures and occupies a fraction of the space of the galvanized tank. Since the **Well-X-Trol®'s** air cushion is sealed-in, there is no need for external air compressors or control devices.

If we can use the maximum acceptance of the 420 and 450 Series **Well-X-Trol®**, we can service much larger jobs…with large pumps, without paying the penalty of higher installation and maintenance costs.

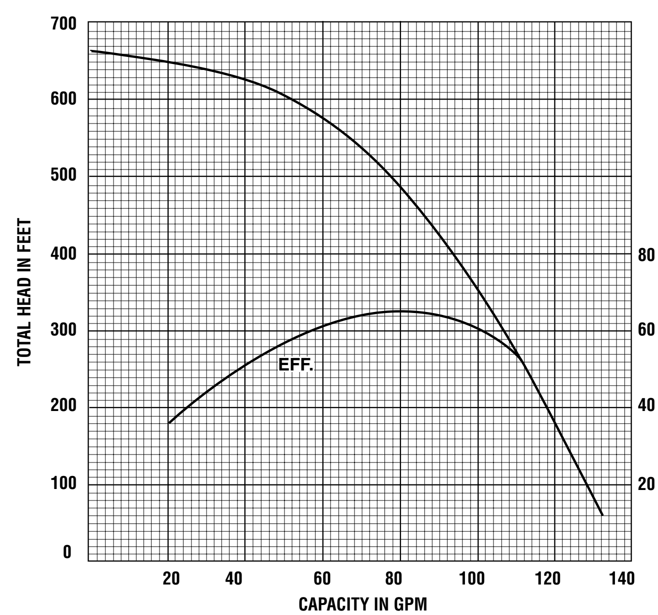
Step One – Determine the Best Operating Pressure Range – Pump Cut-In (P2) to Pump Cut-Out (P3):



The first thing we must do in sizing the bladder is to determine the best pressure range that will achieve maximum acceptance.

. We can be accurate by letting the pump tell us at which maximum range it will operate best.

If we look at the pump curve for the pump which is to be installed…we can easily determine the pump cut-in pressure (P_2) and pump cut-out pressure (P_3) that will give us the widest range.



For example, if we look at a typical pump curve for a (15) HP – (85) GPM submersible pump – we can select a pump cut-in and cut-out point on the curve which will provide optimum pump operation.

The pump curve shows pump performance as its pressure rises from cut-off ((0) head in test) to maximum head in feet.

On this curve, for a (15) Hp (85) GPM pump we can see that at approximately (100) feet the pump stops pumping and will pump up to (660) feet of head.

What we want to determine is at which point on the curve do we want to have the pump cut-in, and at which point on the curve do we want it to cut-out.

The pump operates in its best efficiency range at the mid-range of the curve.

The cut-in point can't be too low on the curve, as this would cause inefficient operation. We should choose a point just before the curve drops off rapidly…and at a point still within the best efficiency range (60% to 80%).

The pump curve for the pump selected indicates the total pressure range of the pump or its dynamic head measured in feet of head.

The pump must have enough head, or pressure differential to:

- Bring water from the level of the well to the well head at the surface of the ground.
- Provide head capacity to pressurize system piping to overcome elevation (static height) and friction (friction loss) and deliver required pressure.

Since the **Well-X-Trol®** will control the pump operation throughout system pressurization, we must select our pump cut-in pressure and pump cut-out pressure.

For example:

In a well with water level (240) feet down in the well, system pressurization by pump will be shown on the pump curve at some point above the intersection of the line indicating (240) feet of head.

In other words, at (240) feet of head we can assume that the pump will have brought water from the pumping level of the well to the surface and pressure in the system piping will be (0) PSIG.

We now must select a pressure range (min. to max.) to establish pressurized delivery of water to the system and that we overcome elevation (static height) and friction loss of the piping.

We must select a minimum pressure at the **Well-X-Trol®** location that will insure enough pressure to keep water flow under pressure at the top of the system…overcoming both the static height and the resistance to flow through the piping.

We'll do this by pre-charging the **Well-X-Trol®** to a pressure (P_1) equal to the minimum pressure required at the **Well-X-Trol®** location. In addition, we'll select a pump cut-in pressure (P_2) which is at the same pressure to start the pump whenever system pressure drops to this point.

We'll assume that a minimum system pressure at the **Well-X-Trol®** location of (30) PSIG. This pressure will be adequate to insure system pressurization to overcome elevation and friction loss and provide adequate pressure at the fixture.

To find this pump cut-in point on the pump curve, we'll have to convert (30) PSIG to feet of head.

To convert PSIG to feet of head, we must multiply PSIG by (2.31).

30 PSIG x 2.31 = 69.3 or 70 feet of head

To locate this point on the pump curve, we must add 70 feet of head…the pump head required to pressurize the system to 30 PSIG…to the feet of head required to lift the water to the surface:

Minimum System Pressure	= 70 Ft. of Head
Plus Lift	= 240 Ft. of Head
* Pump cut-in point on curve	= 310 Ft. of Head

We have selected the point on the curve which will be the pump cut-in setting (P_2) of 30 PSIG on the pump switch, and we will pre-charge the **Well-X-Trol®** to 30 PSIG (P_1).

Now we will select the maximum pump cut-out point on the curve which will allow the widest possible pressure range without impairing pump performance and efficiency.

We will do this by moving up the curve to find a point that:

- Is just before the curve begins to "flatten" out
- And is still within the upper limits of best efficiency range of the pump

In this example, that point would be at the intersection on the curve of the horizontal line indicating (410) or (420) feet of head… let's say (420) feet.

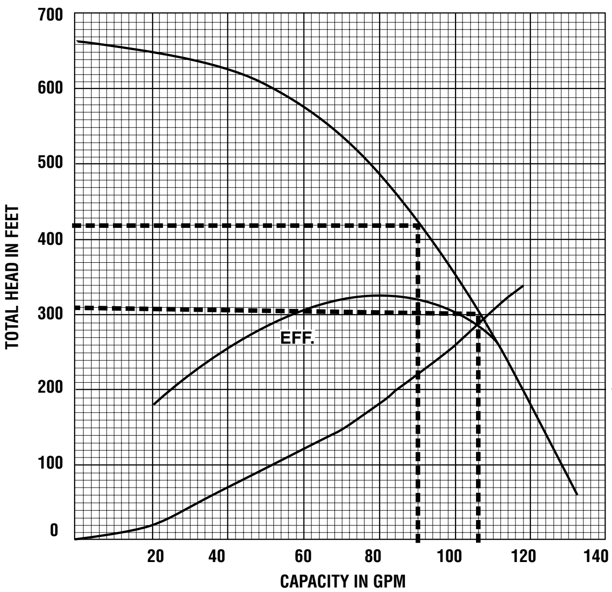
This is the point on the curve which will be the maximum pump cut-out for this particular pump.

Subtracting the feet of head required for lift (240′) we can convert this point to PSIG:

Maximum pump cut-out	= 420 feet
Less lift	= 240 feet
Maximum pressure	= 180 feet

To convert feet of head to PSIG, we divide by (2.31) (there is (2.31) feet of head for each PSI):
180 ÷ 2.31 = 77.9 or 78 PSIG.

Or pump cut-out pressure (P3) is 78 PSIG.



To Summarize:

We have used actual pump performance as shown on the pump curve for the pump selected, to complete step one in utilizing maximum capacity of the full acceptance **Well-X-Trol**® models, Series 420 and 450.

In this step we have determined:

- System minimum pressure of 30 PSIG. To establish the **Well-X-Trol**® precharge pressure.
- (P_1) Pump cut-in pressure (P_2) of 30 PSIG.
- Pump cut-out pressure (P_3) of 78 PSIG.

Step Two – Determine, ESP volume required to control pump cycling. Determine average capacity in GPM:

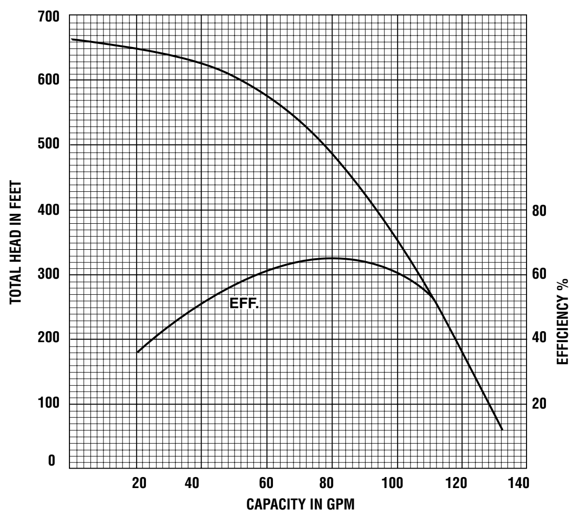
With larger pumps, capacity, or flow of the pump will vary depending upon the pressure or feet of head at which it is operating.

Even though the pump may be rated as a (85) GPM pump (as in our example) the actual capacity in GPM will vary as the pump operates throughout its pressure range from pump cut-in (30 PSIG) and pump cut-out (78 PSIG).

So, we'll go back to our curve and determine what capacity in GPM the pump will deliver at its cut-in point, and what capacity in GPM it will deliver at its pump cut-out point. Then, we'll average these two capacities by adding them together and dividing by two.

Reading the curve, we can find the point that indicates pump cut-in. We already know that this is:

30 PSIG x 2.31	= 70 Ft. of Head
Plus “Lift”	= 240 Ft. of Head
Point on Curve	= 310 Ft. of Head



Reading down to capacity we can determine that, at (310) feet of head, the pump will deliver **(106) GPM**.

We then read the curve to determine the capacity at pump cut-out:

78 PSIG x 2.31	= 180 Ft. of Head
Plus “Lift”	= 240 Ft. of Head
Point on Curve	= 420 Ft. of Head

Capacity at (420) Feet of Head = 90 GPM

Determine ESP Volume:

Being a large pump, we will want to have a minimum run time of at least (2) minutes on the pump:

Average Capacity	Average Capacity
at P2: 106	98 GPM x 2 = 196 ESP Volume
at P3: +90	
196 ÷ 2 = 98	

Step Three: Calculate Acceptance Factor (AF)

Remember our formula for calculating the acceptance factor (AF) for diaphragm tanks?

$$AF = 1 - \frac{30 + 14.7}{78 + 14.7}$$

$$AF = .518$$

Step Four: Maximum Acceptance Factor Verification

After calculating the acceptance factor (AF), we must compare the value to the maximum acceptance factors shown in Table 1. In the case of our example, an AF of 0.518 is less than the maximum acceptance factor of all WX-420 + WX-450 series models. Therefore, either series can be used.

Step Five: Calculate Minimum Total Volume (T_v) of Full Acceptance Well-X-Trol®

Remember the formula:

$$T_V = \frac{\text{ESP Volume}}{\text{AF}}$$

$$T_V = \frac{196}{.518} = 378 \text{ gallons}$$

Step Six: Select Well-X-Trol® Model that is Equal to or Greater Than "T_v".

If ASME construction is not required, select from 420 series, Table 1.

This example would be a WX-425.

To Recap:

We went through six steps to size a full acceptance **Well-X-Trol®** to gain maximum acceptance:

Step One Determine pre-charge pressure (P_1); pump cut-in pressure (P_2) and pump cut-out pressure (P_3) from pump curve of pump selected for system.

Step Two Determine ESP Volume (Average GPM x run time) From pump curve:

Step Three Determine AF:

$$1 - \frac{P_2 + 14.7}{P_3 + 14.7}$$

Step Four Verify the calculated AF is less than or equal to the maximum acceptance factor for the **Well-X-Trol®** required.

Step Five Calculate total **Well-X-Trol®** Volume:

$$T_V - \frac{\text{ESP Volume}}{\text{AF}}$$

Step Six Select series 420 or 450 **Well-X-Trol®** Model

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