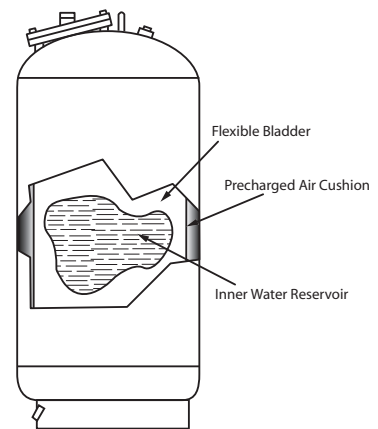


## System Pressurization and its Control Using the EXTROL Diaphragm / Bladder Type Expansion Tank

### The EXTROL Principle

EXTROL expansion tanks provide a pneumatic cushion capable of continued operation without the loss of air into the system through absorption. This is possible because a flexible diaphragm (bladder) separates the water and air in the tank. The permanently sealed-in air cushion can be pre-charged to minimum system pressure to permit the smallest tank possible.



The "L" and LBC series are A.S.M.E. certified and 26 sizes are available in total tank volumes from 10 to 1057 gallons. They are free standing on integral floor stands and are easily installed.

Maximum Working Pressures: 125 PSIG, (175 and 250 PSIG Optional "L" Series) Maximum Operating Temperature: 240°F

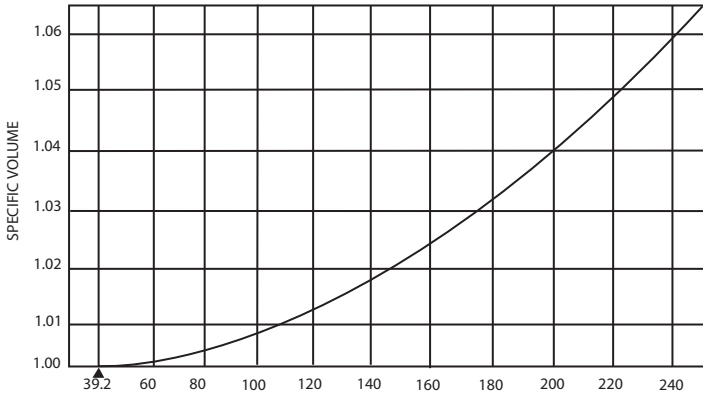
The AX Series EXTROLs are A.S.M.E. certified and come in two styles, vertical and horizontal, that can be installed in a suspended or free-standing configuration. Thirteen sizes are available in total tank volumes from 8 to 211 gallons.

Maximum Working Pressure: 125 PSIG  
Maximum Operating Temperature: 240°F



# Temperature and Pressure Effects in Hydronic Heating and Cooling Systems

**FIG. 1...Net Expansion of Water**



## Temperature Affects Volume

A system is designed to operate within a certain temperature band. One limit is set by the ambient temperature and the other is determined by the function of the system. For example, the temperature is *reduced* in a chilled water system and *increased* in a heating system.

System Type	Minimum System Temp.	Maximum System Temp.
Heating	Ambient	Average Design Temp.
Chilled Water	Average Design Temp.	Ambient

The volume of water within a system varies with the temperature. At any point above 39.2°F, an increase in temperature results in an increase in volume. Therefore, as the temperature of a system changes within the operating band, a change in volume must be accommodated.

## Pressure

Pressures in the system will fluctuate during the operating cycle. It is the function of the expansion tank to prevent an increase in pressure to a level where safety relief valves may operate. Knowledge of the pressure range occurring at the expansion tank is essential in sizing an EXTROL.

**Table 1...Pressure to Prevent Boiling**

Maximum Operating Temperature in °F	Approximate Positive Pressure Required
200°	2 PSIG
205°	3 PSIG
210°	5 PSIG
215°	7 PSIG
220°	9 PSIG
225°	11 PSIG
230°	13 PSIG
235°	16 PSIG
240°	19 PSIG

## Minimum Pressure at EXTROL

$$\text{Minimum Operating Pressure} = \text{Static Pressure} + \text{Pressure to Prevent Boiling}$$

Comprised of static pressure and pressure to prevent boiling.

- i) Static pressure – is the pressure exerted by a column of water. To calculate, estimate height of system in feet above the EXTROL and multiply by 0.433 to give PSIG.
- ii) Pressure to prevent boiling – water boils at 212°F in normal atmospheric pressure, but as the pressure increases, the boiling point also rises. Therefore, if a system is to operate over 212°F without boiling, the pressure must be increased over the static level. The increase necessary for various temperatures is shown in Table 1.

## Maximum Pressure at EXTROL

The upper pressure limit at which the tank will operate is the sum of the minimum pressure plus the system allowable pressure increase.

$$\text{Maximum Operating Pressure} = \text{Minimum Operating Pressure} + \text{Allowable Pressure Increase for System}$$

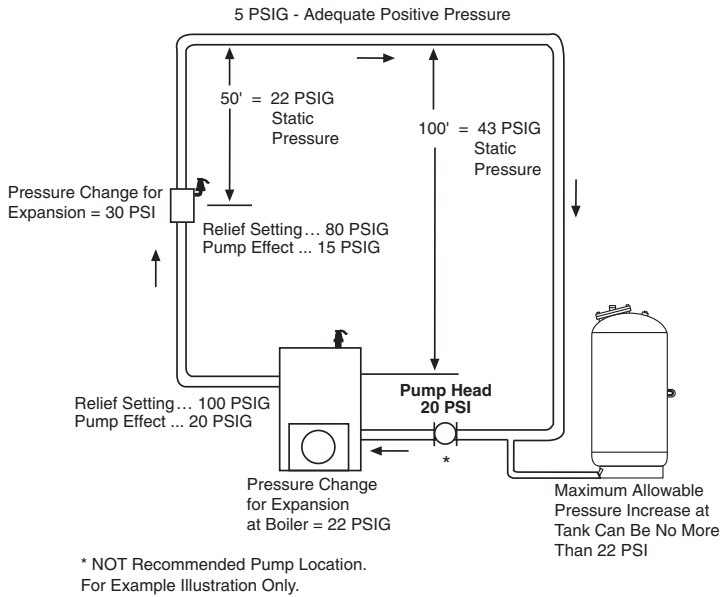
## Allowable Pressure Increase

After evaluating the pressure change for expansion at all critical points in the system, the smallest one is chosen as the allowable pressure increase for the system.

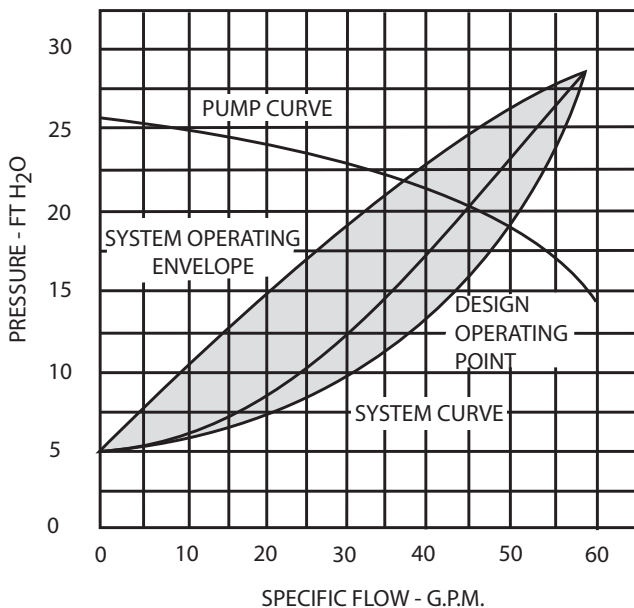
Example – evaluating pressure change for expansion at the boiler.

Relief valve setting at boiler .....	100 PSIG
Minus 10 percent weepage protection .....	-10 PSIG
= Maximum allowable pressure at boiler .....	90 PSIG
Minus minimum pressure at boiler .....	-48 PSIG
= Permissible pressure change at boiler.....	42 PSIG
Minus change due to pump operation .....	-20 PSIG
= Pressure change for expansion at boiler.....	22 PSIG

**Fig. 2 ... Analyzing the Critical Points In System**



**Fig. 3 ... System and Pump Characteristics**



## Pump Effect

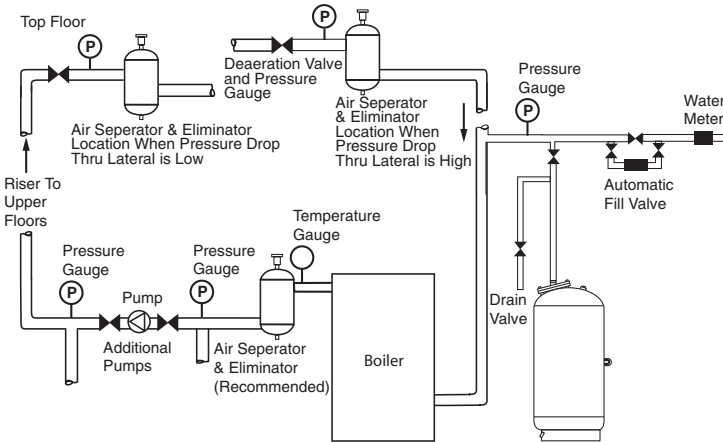
The pressure developed by the system pump is determined by the pipe network to which it is connected. Every system has a unique operating characteristic band, often simplified to a curve on a graph (See Fig. 3). The point where system and pump characteristics intercept defines the point of pump operation. The pressure developed by the system pump is dissipated in overcoming friction as fluid flows through the system. The amount of this pressure change at any given component varies, depending on its proximity to the point of tank connection.

If the EXTROL tank is downstream and the pump is upstream of the component, the pressure will increase when the pump operates. If the reverse is true, pressure will decrease when the pump is running. This is because the hydro-pneumatic tank is the only component that is unaffected by pump operation. The only time pressure at the tank varies is when system temperature changes and expanded water flows to or from the EXTROL, thus changing the volume of the captive air cushion.

The point at which the EXTROL is connected is an important consideration. By locating it at pump suction, it is assured that all pump pressure effects are positive and vacuums cannot be drawn. EXTROL connection at any other point is feasible and occasionally may be desirable, but the pump pressure effects should be considered.

# Typical Specification Pressurization and Air Elimination System

**Fig. 4 ... Typical Air Elimination System**



## Comprising

### 1. AX Series Expansion Tank (Diaphragm type pre-pressurized):

The pressurization system shall include an EXTROL diaphragm-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at those components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the diaphragm-type tank, Model No. \_\_\_\_\_. Dimensions shall be as indicated on the drawings.

The expansion tank shall be welded steel, constructed, tested and stamped in accordance with Section VIII, Division 1 of the ASME Code for a working pressure of (125) (\_\_\_\_)PSIG and air pre-charged.

The tank shall be supported by steel legs or a base (integral ring mount) for a vertical installation or steel saddles for a horizontal installation. Each tank will have a heavy duty butyl/EPDM diaphragm.

The manufacturer shall be AMTROL Inc. The manufacturer will have at least five years experience in the fabrication of diaphragm-type ASME expansion tanks.

### 2. L & LBC Series Expansion Tank (replaceable bladder-type pre-pressurized):

The pressurization system shall include an EXTROL replaceable bladder-type expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at those components in the system to the maximum allowable pressure at those components. It shall maintain minimum operating pressure necessary to eliminate all air. The only air in the system shall be the permanent sealed-in air cushion contained in the replaceable bladder-type tank, Model No. \_\_\_\_\_. Dimensions shall be as indicated on the drawings.

The expansion tank shall be welded steel construction, tested and stamped in accordance with Section VIII, Division 1 of the ASME Code for a working pressure of (125) (175) (250) (\_\_\_\_)PSIG and air pre-charged.

The tank shall be supported by steel legs or a base (integral ring mount) for a vertical installation. Each tank will have a heavy duty replaceable butyl bladder.

The manufacturer shall be AMTROL Inc. The manufacturer will have at least five years experience in the fabrication of bladder-type ASME expansion tanks.

### 3. Air Separator (Tangential Type):

All free air originally contained in the system, and all entrained air bubbles carried by system water shall be eliminated at all system points as indicated in the drawings.

The air separator shall be cast iron or welded steel, constructed, tested and stamped in accordance with Section VIII, Division 1 of the ASME Code for a working pressure of (150) (\_\_\_\_) PSIG as manufactured by AMTROL Inc.

The pressure drop through the air separator at the specified flow rate shall be as shown on the drawings.

## Connection of EXTROL to System

Unlike a conventional tank, the permanently sealed air cushion does not require replenishment so DO NOT connect it to a separator or other "air control" device.

As with any expansion tank, it is recommended that the EXTROL is connected to the suction side of the pump. This will prevent the pump head from becoming subtractive which may result in entry of air and vapor formation at high points in the system.

By connecting the tank on the boiler return, displacement of the coolest system water into the tank is ensured, thus reducing energy wastage. Low pressure drop components, such as separators and boilers, may be located between the point of connection and pump suction if desired. The design of the system will dictate the feasibility of this.

Natural convection losses and the entry of air into the tank are eliminated by connecting to the side or underside of the main pipe. Any potential air traps in the piping connecting the tank to the system should be vented.

**Fig. 5 ... Typical Connection Diagram**

