19. Air Valves.

a. General.

1) WSSC defines air valves as referenced in this manual as follows:

a) The 2-inch air valve is a universal type, combination air/vacuum valve and air release valve. For more information, see Specifications.

b) The 3-inch and larger combination air and vacuum valve incorporates the functions of two (2) valves. The first valve connects directly to the pipeline and is an air/vacuum valve. The second is an air release valve that is connected on the side of the air/vacuum valve. For more information, see Specifications.

2) Generally, air valves or combination air and vacuum valves include two different types of valves; a large orifice air/vacuum valve and a small orifice air release valve. Air/vacuum valves allow the escape of large quantities of entrapped air during line filling and permit air to enter during line draining. In both cases, relatively small pressure differentials are produced across the valves. Air release valves also allow the escape of accumulated air at relatively high pressures experienced under normal pipeline operating conditions.

b. Specification Requirements.

1) Size of the air valve and orifice: see Specifications.

2) Combination air and vacuum valve: see Specifications. Show the following on the drawings:

a) Size of both the air/vacuum valve and air release valve, including the orifice size of the air release valve.

b) Model numbers of the air/vacuum valve and air release valve.

c) Type of flanged joint for the inlet of the air/vacuum valve and the gate valve, either ANSI B16.1, Class 125 or 250 flanges.

c. Design Requirements for 16-inch and Larger Pipelines.

1) Determine the appropriate location for all air valves or combination air and vacuum valves, see Location of the Air Valve or Combination Air and Vacuum Valve, in this section.

2) Determine the size air valves or combination air and vacuum valves as follows:

a) Pipelines 16-inch to 24-inch. Use a standard 2-inch air valve, see Standard Detail W/2.0. Considerations should be given to assessing possible cases or operating conditions that may call for different valve and orifice sizes.

b) Pipelines larger than 24-inch. Submit design and computations for sizing of combination air and vacuum valves. Indicate the type and size of valves on the drawings, and refer to Standard Details W/10.0, W/10.1 and W/10.2. Also see the Specifications and Drawing Requirements in this section.

c) Check the type and size of air/vacuum valves and air release valves against the manufacturer's specifications to ensure consistency between valve type, size, model number and applicable operating pressure range.

d. Sizing of Air/Vacuum Valves.

1) The size of the air/vacuum valve is based on manufacturer's valve performance curves. Determine the largest valve size required by considering both normal operating conditions and catastrophic conditions. Air/vacuum valve sizes need not be the same for all locations.

2) Consider air/vacuum valve sizing for slow venting of air during line filling. The rate of air venting should equal the rate of line filling to minimize surge effects, which tend to generate high in-line pressures.

3) Consider air/vacuum valve sizing for admission of air into the pipeline to compensate for negative pressures generated under normal operating conditions, thereby maintaining a balanced atmospheric pressure in the line. Evaluate the extent of negative pressure that a pipeline can withstand under buried conditions using acceptable calculations and structural design. Use manufacturer's recommendations for appropriate valve sizing.

4) Negative pressures may develop in the pipeline under normal operation or catastrophic conditions. Under normal operations, the design of air/vacuum valves shall consider the following situations:

a) During draining of a pipeline, the blowoff connection will be opened to drain the pipeline. Size the air/vacuum valves to admit air into the pipeline at the maximum, instantaneous rate of water discharging through the blowoff connection. Depending on the pipeline profile configuration and the relative locations of air valves and blowoff connections, one air/vacuum valve may respond to more than one blowoff. In such cases, consider operating multiple blowoffs.

b) During closure of mainline valves, negative pressure may develop in the pipeline, downstream of the mainline valve. The air/vacuum valves can be sized to admit air at the flow rates under which closure of mainline valves can occur. For a large transmission pipeline, a transient water hammer analysis may be required to determine the appropriate size for the air valve or other methods of transient control.

5) Consider the possibilities of the occurrence of catastrophic conditions, such as water column separation due to hydraulic transient conditions or line breakage at a low point. Under such conditions, it is necessary to estimate the rate at which an internal vacuum may occur. Large size air/vacuum valves may be used as a method to relieve the vacuum pressure. It may be impractical to size vacuum valves due to an excessively high rate of vacuum occurrence, such as caused by gravity drain of a downward sloping pipeline under high head. Therefore, make reasonable assumptions.

e. Sizing of Air Release Valves.

1) Use design charts provided by the manufacturer to determine the orifice size required for an estimated rate of air release under a certain range of operating pressures.

2) Consider design flow demands, pipe slopes, solubility of air in water as affected by temperature and air intake rate through air/vacuum valves under normal operating conditions for the estimation of rate of air release.

3) Consider various combinations of operating pressures and air release rates to determine the optimum size of the air release valve. The sizes of air release valves need not be the same for all locations along the pipeline.

f. Location of the Air Valve or Combination Air and Vacuum Valve.

1) At a minimum, design the air valve or combination air and vacuum valve at each high point of the pipeline in profile.

2) Minimize the number of air valves or combination air and vacuum valves required since these valves are susceptible to problems in operation and maintenance.

3) A profile which clearly shows the high points, low points and slope changes shall be prepared for the pipeline under design, see requirements for profiles in Part One, Section 11 (Vertical Alignment - Profiles). Upward sloping and downward sloping sections shall be identified in reference to the predominant flow direction. Select locations of the air valves prior to sizing and show on profiles.

4) Exercise judgement in selecting the number and location of the air valves or combination air and vacuum valves. Consider the following guidelines, in selecting the locations of the air valves or combination air and vacuum valves (The following guidelines discuss the need for air/vacuum valve and/or air release valves, which are part of the air valve or combination air and vacuum valve.)

a) The high point is a location where an upward sloping profile changes to a downward sloping profile. Place air/vacuum valves and air release valves at all high points.

b) For pipelines with a decrease in upward slope, small orifice air release valves shall be placed on the downstream, less steep side of the slope change. Where there is a drastic decrease in upward slope, a large orifice air/vacuum valve may be needed.

c) For pipelines with an increase in downward slope, place the air release valves on the downstream, steeper side of the slope change.

d) For pipelines with long ascending slopes, place the air/vacuum valve at 1/4 to 1/2 mile intervals along the upward sloping profile.

e) For pipelines with long descending slopes, place the vacuum valves and air release valves at 1/4 to 1/2 mile intervals along the downward sloping profile.

f) For pipelines with horizontal profiles (zero slope), place the air/vacuum valves and air release valves at 1/4 to 1/2 mile intervals. Ideally long horizontal lines should be avoided in profiling a water pipeline.

g) At mainline valves on the pipeline, air/vacuum valves may be used to relieve negative pressures that may develop on the downstream side of the mainline valves when they are closed.

h) For pipelines where a predominant flow direction cannot be defined, place the air/vacuum valves and air release valves at or near the high points, slope changes and along long pipeline profiles.

g. Connecting the Air Valve or Combination Air and Vacuum Valve to the Mainline Pipe.

1) Type of connection for the air valve or combination air and vacuum valve on the pipe section: On 2-inch and smaller valves, use a tapped corporation stop. On 3-inch and larger valves, use a flanged welded-on connection and coordinate the flanged inlet of the air valve with the design of the gate valve, see Part One, Section 18 (Pipeline Valves).

2) Locate the air valve or combination air and vacuum valve, centered on a twenty (20) foot length of pipe with both ends of the pipe section having the same elevation.

h. Piping and Vault Configuration.

1) Pipelines 24-inch and smaller. Use a 2-inch air valve, see Standard Details W/2.0.

2) Pipelines larger than 24-inch.

a) 2-inch air valve on pipelines larger than 24-inch. If the design requires a 2-inch air valve modify Standard Detail W/2.0. Modifications to the standard detail must be shown on the drawing, see Part Three, Section 6 (Modifications to Specifications and Standard Details).

b) 3-inch and larger air valve. If the design requires a 3-inch and larger valve, see Standard Details W/10.0, W/10.1 and W/10.2.

c) The discharge piping for combination air/vacuum valves with air release valve has two (2) different discharge outlets that are not to be connected together. The discharge piping shall be designed to discharge freely outside the vault/structure to the atmosphere. See Standard Details W/2.0, W/2.0a, W/2.0b, W/10.0, W/10.1 and W/10.2.

3) On profile, determine the invert of the pipeline by using the design depth as shown on the details for the above mentioned vaults and manholes, see the requirements in Part One, Section 16 (Design of Structures).

4) Vent boxes.

a) For 2-inch air valve, show the vent box location on the drawings, see Standard Detail W/2.0a.

b) For 3-inch or larger air valve, show the vent box location on the drawings, see Standard Detail W/2.0b.

c) Provide the dimension from the centerline of the air valve structure to the centerline of the vent box on the drawings.

d) If the vent box is located in the 100 year flood plain set the discharge of the vent pipe outlet one (1) foot above the 100 year flood plain elevation. Indicate the discharge elevation and the 100 year flood plain elevation on the drawings.

e) If the vent box is to be located in a proposed area (grading), indicate the finished grade elevation at the vent box on the drawings.