Becker* Products
Below Ground Ball Valve Regulators

Reduce Noise Levels at Large Volume Regulator Stations

GE's Becker* Below Ground ball valve regulator has the long-term proven reliability, high-quality construction, noise attenuating capabilities and simple maintenance needed throughout the gas industry. With its high capacity, control capabilities, rangeability and dependability, it is well suited for high volume regulator stations, where it substantially reduces noise at a lower cost.

All regulators create noise, but that noise may be substantial – even going beyond station boundaries to become an irritant to neighbors and passersby. OSHA, too, has mandated ear protection requirements for various noise levels and exposure duration.

Although there are many ways to treat noise – extra-heavy pipe, pipe wrap, downstream silencers, quiet trim valves and regulator run enclosure buildings, for instance – these methods provide only a partial, and rather costly, solution.

Problem Solved

Directly burying the Below Ground ball valve regulator maintains superior flow characteristics and greatly reduces noise created in the station facilities. Depending upon the depth, burial of regulator

Figure 1 - Installation of Becker Below Ground Ball Valve Regulator.

Becker Below Ground Ball Valve regulators may be installed to achieve maximum noise attenuation, minimal maintenance, and optimum cost effectiveness. The Below Ground Regulator can provide up to 37 dBA noise attenuation with minimal additional costs.

Figure 2 - Below Ground Ball Valve Regulator combined with Control Valve Silencer.

The Below Ground Ball Valve Regulator may be combined with other noise attenuating devices in order to achieve additional noise attenuation. Noise Attenuating Control Valves, Control Valve Silencers, and Control Valve Diffusers may be combined with Below Ground Regulators for additive noise attenuation when conditions require extreme noise attenuation. Notice Becker Model CVS Control Valve Silencer installed at outlet flange of Below Ground Regulator prior to backfill of pipeline trench.

piping reduces noise by 25 to 37 dBA, which normally is enough to considerably reduce any ambient noise problems.

The Below Ground ball valve regulator can be combined with other noise attenuation devices to further reduce noise, and it can be partnered with noise attenuating control valves, control valve silencers and control valve diffusers when extreme noise reduction is required.

Since the Below Ground ball valve regulator takes up less space, the size of any needed building enclosures is reduced.

Features and Benefits

- Typically reduces noise between 25 and 37 dBA over above-ground applications
- Saves costs because smaller piping – and therefore smaller block valves – may be used for the higher velocities that are allowed below ground
- Attenuates noise even when pipe does not remain buried
- Somewhat enlarges the station capacity with the elimination of the fitting capacity necessary for above ground regulators
- Offers typical life span of more than 20 years
- Provides easy maintenance and/or operational checks with lubrication line and drain line extensions on the control valve
- Allows generated noise to be absorbed by soil surrounding the pipe, thus eliminating risk of noise damage to downstream piping

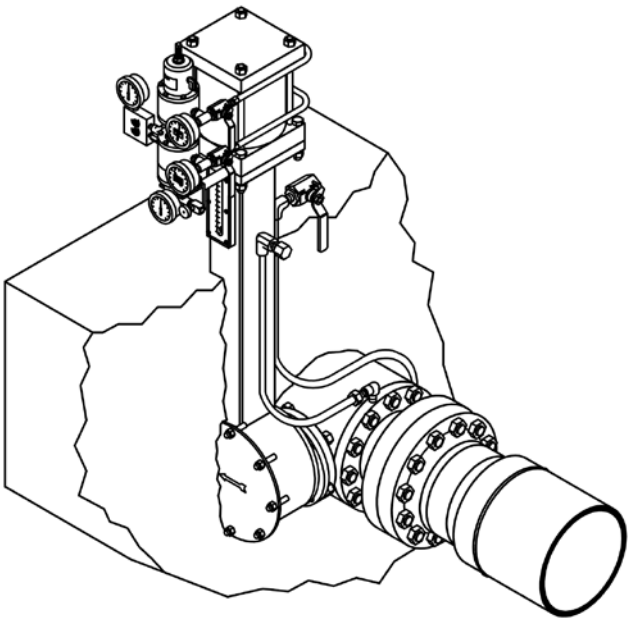

Figure 3 - Below Ground Regulator Design Permits Easy Maintenance.

The Below Ground Regulator incorporates lubrication line and drain line extensions on the control valve that allow for maintenance and/or operational checks. The typical life span of a Below Ground Regulator is in excess of twenty years.

Construction and Design

The ball valve is smoothly machined and polished to provide low breakaway requirements, allowing for very accurate control. All connecting links, bearings and crank arms are made of high-quality material and machined to close tolerances, decreasing lost motion and resulting in the long, dependable service of each individual part.

The control system may consist of the standard pneumatic controller/positioner system or the newer pilot control system. The pilot control system is capable of discharge to a downstream pressure system, which completely eliminates atmospheric bleed.

To take full advantage of the regulator's operating capabilities, careful consideration must be given to the station design. Maximum gas flow velocity calculations should be made for regulator run piping. Maximum velocities should be maintained below 100 fps for above-ground piping and below 200 fps for below-ground piping. Adhering to these velocity standards should eliminate vibration and its associated mechanical damage. Furthermore, lower gas velocities result in lower noise levels and less pressure drop in the station piping.

Regulator capacities are greatly affected by the configuration of the regulator run. Major design considerations should include:

- Whether or not a monitor regulator will be used for over-pressure protection. In large volume regulator stations, monitor regulators are preferred over relief valves. Over-pressure protection prevents the emission of large volumes of natural gas to the atmosphere in the event of any malfunction of the primary control element.
- The relative size of the inlet and outlet piping in relation to regulator size. The ratio between regulator run piping and the regulator should not exceed 3:1.
- Relative size of the block valve. Block valve size should equal station inlet/outlet pipe size. Regulator capacities should always be verified by the manufacturer for accuracy.

Field Examples

Two randomly selected stations were tested with sound measurement equipment to compare actual field conditions with the calculated predicted noise attenuation between above ground and below ground regulator runs.

Station one originally incorporated 4" above ground regulators with a flow of 2.4 MMscfh and 157 psi outlet pressure. The noise level on station one was measured at 106 dBA for the above ground regulators. During major station revision, 8" valve regulators were installed below ground and sound readings were taken with a flow of 2.9 MMscfh. The newer sound level readings registered at 77 dBA, which was reduction of 29 dBA. Sound level calculations predicted a sound level of 86 dBA, which ultimately proved to be very conservative.

In station two, parallel regulator runs, identical in size, were installed. One run was installed above ground, and the other below ground. Although these runs were not designed under today's guidelines, they do offer a good comparative example. With a flow of approximately 10.0 MMscfh, a noise reduction of 27 dBA was achieved in the below ground run. At a high flow of 28.0 MMscfd a noise reduction of 34 dBa was achieved. No costly methods of noise attenuation were needed other than that provided by the earth itself.

There have been numerous field tests done to obtain noise readings on several below ground stations. These readings were compared to the calculated noise levels predicted for the stations if they were to be installed above ground.

Figure 4 - Below Ground Regulator with Fiberglass Cabinet.

Control valve actuator topworks and control instrumentation may be conveniently enclosed in a small fiberglass cabinet for security and protection from the elements. The small size of the cabinet enclosure typically eliminates the need for building permits and reduces overall costs.

In 1992, a high volume regulator station was installed in order to supply gas to a power plant. The station consisted of three parallel Below Ground Ball Valve Regulator runs (one of which was on standby) using 10" ball valves (primary and monitor), with 16" inlet piping, 24" outlet piping, 30" headers, and a small start up/pilot gas regulator run of 4" boot-type regulators. Pipeline pre-heaters and orifice meters completed the station, giving an overall flow capacity of 28 MMscfh. Maximum noise levels were predicted at 127 dBA (maximum flow) for above ground and 93 dBA for below ground. Noise tests were recently taken at this station. With a volume of 4.7 MMscfh flowing through the station (approximately 75% through a buried ball valve regulator and 25% through the boot-type regulator), the noise level at the buried ball valve regulator was 85 dBA. If this were an above ground regulator, the predicted noise level would be 109 dBA. 220 feet downstream of regulation, the station's piping returns above ground to go through a series of liquid separators. A reading of 84 dBA was taken at this point. This reading showed a 25 dBA drop from the sound level predicted from an above ground regulator. Even at low flows this test indicates that a large portion of the regulator noise is absorbed by the earth as the gas moves downstream. There is obvious noise attenuation as the distance from the noise source increases.

If noise levels are in the 70 dBA range at the regulator, and the property line is 40 to 50 ft. away, any noise resulting from regulation would be indistinguishable from normal background noise levels.

Cost savings may be realized with use of the Below Ground Ball Valve Regulator. This is due to the smaller piping (and therefore smaller block valves) which may be used for the higher velocities that are allowed below ground (200 fps vs. 100 fps above ground).

Distance from Noise Source (feet)	Reduction of (dBA)
20	7
40	10
60	17

Table 2 - Noise Attenuation as a factor of distance from the noise source.

Audible noise further attenuated when measured from a distance from the noise source. Common designs specify "allowable noise" at the "property line" or "fence line" thus providing additional noise attenuation.

Test Case	A	B	C	D	E
Flow (Mcfh)	1180	2720	775	173	7800
Inlet Pressure (psig)	467	398	565	416	393
Outlet Pressure (psig)	154	60	275	151	155
Actual Noise (dBA) Below Ground	82 dBA	70 dBA	<70 dBA	72 dBA	86 dBA
Calculated Above Ground Noise (dBA)	108 dBA	117 dBA	91 dBA	96 dBA	118 dBA
Actual Below Ground Noise Attenuation (dBA)	26 dBA	47 dBA	>21 dBA	22 dBA	32 dBA

Table 1 - Resultant Noise Attenuation for Below Ground Ball Valve Regulator Applications.

The Below Ground Ball Valve Regulator can typically provide between 25-37 dBA over above ground applications.
Note that the actual noise attenuation for these particular below ground regulator stations ranged from 21 dBA to 47 dBA.
Actual below ground noise attenuation is contingent upon buried depth and soil mechanics.

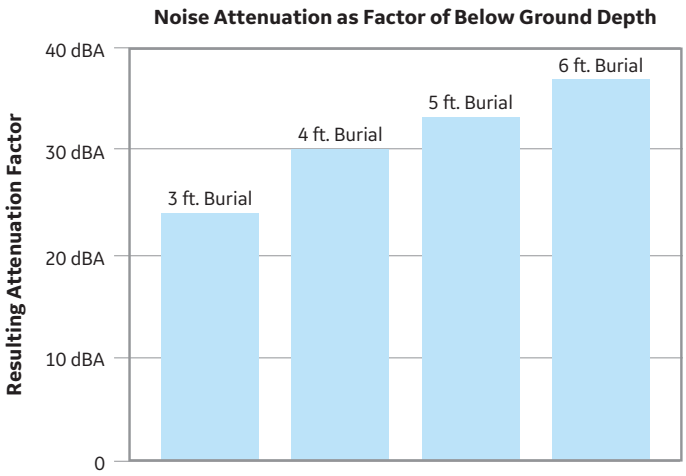

Figure 5 - Noise Attenuation as Factor of Depth.

Typical below ground depths range from 3 feet burial to 6 feet burial. The below ground depth is measured from centerline of pipe to grade. Below Ground noise attenuation usually provides from 25 dBA to 37 dBA noise attenuation for these buried depths.

In addition there is a small gain in station capacity as well as a cost savings in the elimination of need for the fitting installation necessary for above ground regulators. A number of pipe support posts may also be eliminated by moving the regulators underground. Only small concrete pads are necessary for below ground support. In addition to the cost savings, noise level is substantially reduced.

For example, a theoretical station is to be designed to regulate 2.0 MMscfh with an inlet pressure of 450 psi and an outlet of 150 psi. A regulator run was sized for above ground and below ground installation with the results listing in Table 3.

	Above Ground	Below Ground
Flow	2.0 MMscfh	2.0 MMscfh
Inlet Pressure	450 psi	450 psi
Outlet Pressure	150 psi	150 psi
Regulator Size	4”	4”
Inlet Hdr.	6”	6”
Inlet Block Valve	6”	6”
Inlet Velocity	87 fps	194 fps
Outlet Hdr.	10”	8”
Outlet Block Valve	10”	8”
Outlet Velocity	94 fps	137 fps
Calculated Noise Level	109 dBA	85 dBA

Table 3 - Comparison of Theoretical Design of Above Ground versus Below Ground Regulator Station

Calculated noise for above ground station is 109 dBA, while calculated noise for the below ground station is 85 dBA. The below ground station should provide 24 dBA noise attenuation based upon calculations. Note that smaller adjacent piping and block valves may be utilized for Below Ground Regulator installations, resulting in lower costs.

It thus becomes apparent that one concern regarding the Below Ground Ball Valve Regulator is that burying regulators simply “hides” the noise and that serious damage may be caused to downstream piping. These concerns are unfounded as there are many buried valve regulator stations that have been in service in excess of thirty years without mechanical problems involving the downstream piping.

Measurements indicate that the generated noise is actually absorbed by the soil surrounding the pipe. A buried valve regulator station was tested to check this theory.

The noise level at the buried regulator was 76 dBA. The predicted noise level was calculated at 82 dBA for the below ground regulator and 106 dBA for the above ground regulator. The pipe was exposed 10 ft. downstream of the regulator where the noise level registered at 96 dBA. This indicates a 10 dBA drop from the predicted noise level for above ground regulators.

Actual Below Ground Noise Level	76 dBA
Predicted Below Ground Noise	82 dBA
Predicted Above Ground Noise	106 dBA
Actual Reading with Pipe Exposed (10 ft. downstream of regulator)	96 dBA
Noise Attenuation Due to 10 ft. of Buried Pipe	10 dBA

Table 4 - Below Ground Regulators Attenuate Noise Even When Pipe Does Not Remain Buried.

Noise readings were taken at a Below Ground Regulator with downstream piping exposed. The actual noise reading at an excavated point suggest that 10 feet of buried piping provided approximately 10 dBA of noise attenuation. This suggests that the Below Ground Regulator does provide a “source attenuation” thereby eliminating noise over a length of buried pipe.

Further testing will be done in this station, but preliminary studies indicate that, although some noise is transmitted downstream, a large amount is also absorbed by the soil surrounding the pipe. If it becomes necessary to bring the piping above ground down-stream of regulation (for metering, etc.) an alternate option would incorporate a Below Ground Ball Valve Regulator with a noise attenuating ball control valve. Proper design and reduction of velocities within the prescribed limits will minimize any problems.

Maintenance and Inspection

The maintenance procedures for a buried ball valve regulator are quite similar to those for above ground installations. A direct quote from the code of Federal Regulations regarding maintenance, Part 192.739 reads:

Pressure limiting and regulating stations: Inspection and testing.

Each pressure limiting station, relief device (except rupture discs), and pressure regulating station and its equipment must be subjected at intervals not exceeding 15 months, but at least once each calendar year, to inspections and tests to determine that it is:

(a) In good mechanical condition;

(b) Adequate from the standpoint of capacity and reliability of operation for the service in which it is employed;

(c) Set to function at the correct pressure;

(d) Properly installed and protected from dirt, liquids, or other conditions that might prevent proper operation.

There are no federal requirements that dictate the need for the physical internal inspection of any regulator. This includes ball valves as well as globe type regulators, boot-type regulators, etc. The trend of the gas industry over the last decade has been to minimize inspection of the internal regulator body, overhaul the regulator control system-pilots, pneumatic controllers, positioners, etc. and check the entire system for proper operation.

As far as ball valve regulator inspection is concerned, very few companies inspect the ball internally on an annual basis. This is generally the case regardless of whether the regulator is above or below ground. Valve leakage can be checked on a proper installation by use of pipe blow offs and block valves. As far as normal maintenance, the control system should be checked and parts replaced as necessary. The only remaining parts requiring inspection are those associated with the linkage, crank arm assembly, etc. The procedure for checking for wear in these areas is called “lost motion” inspection. “Lost motion” is easy to spot and should not be experienced for many years.

These maintenance procedures, as explained, are the same for both below ground and above ground ball valve regulator installations. Furthermore, there is no additional cost for man-power or testing associated with the Below Ground Regulator.

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