



AGA White Paper
Automatic Shut-off Valves (ASV)
And
Remote Control Valves (RCV)
On Natural Gas Transmission Pipelines

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Executive Summary

This AGA white paper was developed to provide information regarding the relative benefits, challenges, issues, feasibility, costs and performance expectations associated with the installation of Automatic Shut-off Valves (ASVs) or Remote Control Valves (RCVs) on existing and new natural gas transmission pipelines. This white paper provides natural gas pipeline operators, federal and state regulators, public interest groups and the general public with information and guidance on considerations for the use of such valves in existing and new natural gas transmission pipeline systems within populated areas.

Federal pipeline safety regulations require operators to install in-line sectionalizing valves (“block valves”) on natural gas transmission pipelines at prescribed intervals in order to completely shut off the flow of gas for both routine maintenance activities and emergency response. One of the existing provisions of the Transmission Integrity Management Program (TIMP) rule is for operators to evaluate if the use of ASVs or RCVs would be an efficient means to add protection to High Consequence Areas (HCAs) in the event of a natural gas release.

An Automatic Shut-Off Valve (ASV) is a valve that has electric or gas powered actuators to operate the valve automatically based on data sent to the actuator from pipeline sensors. The sensors will send a signal to close the valve based on predetermined criteria, generally based on pipeline operating pressure or flow rate. The ASV does not allow or require human evaluation or interpretation of information surrounding an event to determine if the event is a legitimate incident, and will close automatically based on the established criteria.

A Remote Control Valve (RCV) is a valve equipped with electric or gas powered actuators to operate (open or close) the valve based on an order (signal) from a remote location, such as a gas control room. The RCV requires operating personnel in the remote location to review and evaluate data in their system and make a determination whether a problem does, or does not, exist based on available information, such as operating pressure and flow data transmitted from the pipeline, or communications from the public, emergency responders or company personnel on site. Based on available information, if the operator determines that there is a problem that would require a valve closure, they may execute a command to close the valve remotely. The RCV introduces human intervention, decision making, evaluation and the possibility of human error into the process.

There are potential benefits associated with the use of ASVs and RCVs. The primary benefit is that ASVs and RCVs normally close more rapidly than a manually operated valve that requires operating personnel to travel to the valve location.

Operators have installed ASVs on pipeline segments that have not experienced wide pressure fluctuations, and are not expected to experience wide pressure fluctuations in the future, and where the risk analysis indicates the ASV will provide added protection to an HCA or in certain remote locations.

An RCV allows a control room operator to execute a signal to close a line valve when an incident occurs. The RCV allows a line valve to be operated sooner than a manually operated valve, once a decision has been made by personnel monitoring the remote pipeline data that an emergency condition exists. The potential time savings of an RCV is based on a number of variables, including the physical location of the valve relative to available operating personnel and the amount of time before the controller determines that an emergency condition exists and acts to close the valve. Whenever possible, it is prudent for the gas controller to confirm actual field conditions prior to executing an order to close a transmission line valve. Operators have installed RCVs in locations where the risk analysis indicates the RCV will provide added protection to an HCA or in certain remote locations.

Operators should recognize that the presence of an ASV or RCV on a transmission pipeline will not prevent an incident from occurring and may not lessen any related injury to persons or damage to property. Studies on the potential benefits of ASVs and RCVs for natural gas transmission pipelines have concluded that the vast majority of injuries, fatalities and property damage occur within the first few minutes of a pipeline failure. For example, the July 2010 study *“Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing”* conducted by Robert J. Eiber Consultant Inc and Kiefner and Associates, concluded that “injuries and fatalities generally occur within the first 30 seconds following gas release” and “closure of a block valve does not immediately reduce the release of natural gas from the pipeline”. The study’s review of 13 NTSB gas transmission pipeline incidents indicated that the consequences of the incidents examined would not have changed if the valves closed immediately after the release of gas. An ASV or RCV will not react quickly enough to prevent serious consequences from happening following pipeline failure. The primary benefit of an ASV or RCV is the ability to control the amount of natural gas released after the incident has occurred.

Operators should also recognize that the conversion of a manual valve to an ASV or RCV in an urban environment will be challenging and may not be possible. The vast majority of existing transmission

lines in urban areas and those integrated within distribution systems were not designed or constructed to accommodate the retrofit installation of ASVs or RCVs. For transmission lines in urban areas or contained within distribution systems, the lack of underground space immediately adjacent to the existing valve, which is necessary to install a vault to contain the ASV or RCV and the valve actuating equipment, make the conversion of a manual valve to an ASV or RCV extremely difficult to virtually impossible.

Where physical space is available, the cost of converting an existing manual valve in an HCA to an ASV or RCV will range from approximately \$100,000 to \$1,000,000. The cost to install a new ASV or RCV in an existing transmission pipeline will range from approximately \$200,000 to \$1,500,000 (costs may be more in dense urban areas). The cost to install a new ASV or RCV on a new transmission pipeline or fully replaced transmission pipelines will range from approximately \$100,000 to \$1,000,000. The range of costs is significantly affected by a multitude of factors such as pipe size, location, operating pressure, proximity to adjacent utilities, etc. The costs to install an ASV or RCV in a rural location is typically lower than the costs referenced in this white paper due to less congestion of other utilities in the underground rights-of-way and the possibility of installing the ASV or RCV in above-ground locations that do not require the installation of a vault.

While ASVs and RCVs may provide faster closure of a valve than a manually operated valve, they also introduce the possibility of a false valve closure with unintended consequences. For example, ASVs could inadvertently close due to routine events such as a decrease in pipeline pressure due to peak cold or hot weather flow rates. An RCV could be closed without confirmed information or observation of the appropriate pipeline segment, especially where there are multiple pipelines in close proximity or valves close together. The resulting impact could be the loss of service to thousands of customers for multiple days or weeks, including sensitive customers such as hospitals, schools, chemical plants and power plants.

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I. Purpose and Scope

The intent of this white paper is to provide information and guidance for operators on considerations for the use of Automatic Shut-off Valves (ASVs) and Remote Control Valves (RCVs) in existing and new natural gas transmission pipeline systems within populated areas. Please note that this paper does not serve as a technical standard and does not provide instruction on state or federal regulatory compliance. Each operator should develop a policy with respect to the installation of ASVs and/or RCVs that is appropriate for its system.

There are fundamental differences in the use of in-line valves in natural gas transmission pipelines and those used in hazardous liquid pipelines. This document does not attempt to discuss the benefits or problems associated with ASV or RCV applications in liquid pipelines.

II. General Definitions

Actuator: A mechanism that operates (opens or closes) a valve by the use of electric, pneumatic or hydraulic power.

Automatic Shut-Off Valve (ASV): A valve that has electric or gas powered actuators to operate the valve automatically based on data sent to the actuator from pipeline sensors. The sensors will send a signal to close the valve based on predetermined criteria, generally based on pipeline operating pressure or flow rate. The ASV does not allow or require human evaluation or interpretation of information surrounding an event to determine if the event is a legitimate incident, and will close automatically based on the established criteria.

Class Location: Pipeline locations as classified by criteria found in 49 CFR 192.5. A given pipeline segment's classification is based on the population density along its route as characterized by the number and type of buildings as well as any places of public assembly found in a defined area surrounding the segment. See Appendix A for details.

Control Room: An operations center staffed by personnel charged with the responsibility for remotely monitoring and controlling entire or multiple sections of pipeline systems.

Gas Controller: A qualified individual whose function is to remotely monitor and control the safety-related functions of entire or multiple sections of pipeline system via a SCADA system from a pipeline operator's Control Room, and who has operational authority and accountability for the remote operational functions of pipeline systems as defined by the operator.

High Consequence Area (HCA): Is defined in 49 CFR §192.903. Generally, for the purposes of this white paper, a HCA is an area that is defined by the population density or calculated by using a formula that accounts for product transported, the pipeline's diameter and the pipeline's operating pressure. This area lies along either side of a pipeline in areas where a pipeline failure could affect a large number of people causing injuries, fatalities and/or extensive property damage.

In-Line Inspection (ILI) Tools: Tools used to inspect a pipeline from the interior of the pipe. May also be referred to as intelligent or smart pigging tools.

MAOP: The Maximum Allowable Operating Pressure for a specific section of pipeline.

Remote Control Valve (RCV): A valve equipped with electric or gas powered actuators to operate (open or close) the valve based on an order (signal) from a remote location, such as a gas control room. The RCV requires operating personnel in the remote location to review and evaluate data in their system and make a determination whether a problem does, or does not, exist based on available information, such as operating pressure and flow data transmitted from the pipeline, or communications from the public, emergency responders or company personnel on site. Based on available information, if the operator determines that there is a problem that would require a valve closure, they may execute a command to close the valve remotely. The RCV introduces human intervention, decision making, evaluation and the possibility of human error into the process.

Remote Shut-Off Valve (RSV): A Remote Control Valve, as used in this white paper.

Supervisory Control and Data Acquisition System (SCADA): A computer-based system or systems used by Gas Controllers in the Control Room that collects and displays information about pipeline systems and has the ability to send commands back to the pipeline systems.

III. Shut-Off Valves on Transmission Lines - Background

Shut-off valves, known as sectionalizing block valves or “block valves,” are installed in transmission lines primarily to isolate pipeline segments to facilitate future maintenance, operations or construction work. In the event of a pipeline leak, rupture or other component failure unintentionally releasing natural gas, block valves are closed to limit the amount of product lost.

a. Regulatory Requirements

The federal pipeline safety regulations (49 CFR 192.179) require all transmission lines to have sectionalizing block valves installed at specific intervals, based on population density, to allow the timely interruption of gas flow in the event of an emergency. Natural gas sectionalizing valves are required at a reduced spacing between valves as population density increases as follows:

- Each point on a pipeline in a Class 1 location must be within 10 miles of a valve
- Each point on a pipeline in a Class 2 location must be within 7 ½ miles of a valve
- Each point on a pipeline in a Class 3 location must be within 4 miles of a valve
- Each point on a pipeline in a Class 4 location must be within 2 ½ miles of a valve

In addition to minimum spacing requirements, 49 CFR 192.179 requires sectionalizing block valves to be readily accessible and protected from tampering and damage, as well as properly supported to prevent settling of the valve or movement of attached pipe.

49 CFR 192.935 requires the pipeline operator to take additional measures to prevent or mitigate the consequences of pipeline failure in a High Consequence Area (HCA). The use of ASVs/RCVs is addressed in 49 CFR 192.935(c). Specifically:

(c) Automatic shut-off valves (ASV) or Remote control valves (RCV). If an operator determines, based on a risk analysis, that an ASV or RCV would be an efficient means of adding protection to a high consequence area in the event of a gas release, an operator must install the ASV or RCV. In making that determination, an operator must, at least, consider the following factors—swiftness of leak detection and pipe shutdown capabilities, the type of gas being transported, operating pressure, the rate of potential release, pipeline profile, the potential for ignition, and location of nearest response personnel.

b. Current Industry Practice

Operators generally use manually operated valves to comply with the requirements of 49 CFR 192.179. The specific types of block valve configurations include plug valves, reduced-port and full-port ball valves and gate valves.

A “gate valve” contains a rectangular or circular plate that is lowered into the pipe to stop the flow of gas when closed. A “plug valve” contains a tapered plug with a rectangular opening to stop the flow of gas when closed. The rectangular opening is relatively small compared to the inside cross-section of the pipe, restricting the flow of gas significantly and presenting an obstacle to the passage of in-line inspection (ILI) tools. A “reduced-port ball valve” contains a spherical ball to stop the flow of gas when closed. The reduced-port opening is larger than the opening in a plug valve, but still smaller than the cross-section of the pipe, restricting the flow of gas somewhat and presenting a potential obstacle to the passage of ILI tools. A “full-port ball valve” is similar to a reduced-port ball valve except that the opening in the spherical ball is approximately the same size as the cross-section of the pipe, presenting little restriction to the flow of natural gas or the passage of ILI tools. Plug valves and gate valves were generally installed in older transmission lines, whereas the majority of block valves installed in newer transmission lines are reduced-port or full-port ball valves. Since 1994, federal pipeline safety regulations required all new transmission pipeline installations to be capable of passing an ILI tool. For that reason, operators have generally used full-port ball valves after that time.

Operators may choose to install block valves at additional locations beyond the minimum requirements of 49 CFR 192.179 based on a multitude of factors such as pipeline size, operating pressure, location, response time, branch connections, and physical factors such as river, railroad or bridge crossings. Block valves may also be spaced more closely in anticipation of future construction, operations or maintenance work.

Over the years, operators have considered the use of ASVs/RCVs at locations where the unique operating characteristics of these valves add operational flexibility and makes safe operation of the system more efficient. Although not extensively used in natural gas transmission infrastructure that is associated closely with distribution systems, a number of such valves have been installed to control the flow of gas at city gates and other major measurement and regulation (M&R) stations, large end users, storage facilities, system interconnects and as shut-off valves at remote locations.

c. Depressurization Times

The amount of time for a section of transmission pipeline to “blow down” (depressurize to 0 psig) if it is isolated by closing block valves (manually operated, automatic shut-off or remote control valve) is based on a number of variables, including: diameter of pipeline, distance between isolation valves, internal pipeline restrictions, operating pressure of the line at the time of valve closure and physical dimensions of the opening at the point of pipeline failure. Depending on these physical parameters, a pipeline may take a considerable amount of time to reach 0 psig after the valves are closed (ranging from tens of minutes to several hours).

IV. Automatic Shut-Off Valves (ASVs)

a. Benefits

An ASV will automatically close when the pressure sensors near the valve detect a pressure drop that meets predetermined operating criteria. An ASV normally closes more rapidly than a manually operated valve that requires operating personnel to travel to the valve location. Operators have installed ASVs on pipeline segments that have not experienced wide pressure fluctuations, and are not expected to experience wide pressure fluctuations in the future, where the risk analysis indicates the ASV may provide added protection to a HCA or in certain remote locations.

b. Challenges and Issues

An ASV will automatically close if the pressure sensors near the valve detect a pressure drop that is representative of the large gas loss that would be associated with a pipeline rupture. However, since the valve will operate automatically without human evaluation or interpretation of system operating data, there is a possibility of an unintended valve closure and related consequences. For example, during winter peak load operations, it is possible for a transmission line to experience significantly increased flow rates and reduced system operating pressures that may have operating similarities to a transmission line failure. Since the valve is programmed to close under these types of conditions, it may incorrectly sense that there is a transmission line failure and close the valve. The false closure of a transmission block valve under

peak load conditions may subject the operator to widespread customer outages, customer product losses and safety impacts. Reintroduction of gas into a system that has experienced loss of supply must be performed carefully to prevent serious safety implications.

Contingencies, such as temporary reconfiguration of pipeline flow and pressure, which are common on local distribution company (LDC) transmission systems during routine construction, maintenance or cold weather operations, can be complicated by the presence of ASVs. During these types of situations, the pressure in the pipeline may be reduced to unusually low levels and the ASV may close, incorrectly sensing that a gas release has occurred. In addition, it is possible for an ASV to malfunction and partially or completely close, presenting a serious flow restriction that may be difficult to identify and correct. It is also possible for a serious incident to occur without initiating an ASV closure. Finally, ASVs must be kept secure to prevent vandalism or sabotage.

V. Remote Control Valves (RCVs)

a. Benefits

An RCV allows a control room operator to execute a signal to close a line valve when an incident occurs. The RCV allows a line valve to be operated sooner than a manually operated valve, once a decision has been made by personnel monitoring the remote pipeline data that an emergency condition exists. Whenever possible, it is prudent for the gas controller to confirm actual field conditions prior to executing an order to close a transmission line valve.

The potential time savings of an RCV is based on a number of variables, including but not limited to the physical location of the valve relative to available operating personnel and the amount of time before the controller determines that an emergency condition exists and acts to close the valve.

Operators have installed RCVs in locations where the risk analysis indicates the RCV may provide added protection to an HCA or in certain remote locations.

Figure 1 shows an example of a typical RCV valve installation contained in an underground vault.



Figure 1

b. Challenges and Issues

The installation of an RCV does not ensure immediate valve closure during an incident. The RCV requires personnel (usually gas controllers) responsible for monitoring system operating conditions to evaluate system conditions based on pressure or flow data transmitted from the pipeline in remote locations. Based on available information, the gas controller must evaluate whether an apparent anomaly in operating conditions constitutes an incident or emergency, requiring an immediate valve closure, or whether the unusual condition is based on a routine event, such as a high flow condition due to peak cold weather system flow rates, the start-up of a major industrial customer, or simply instrumentation malfunction.

The RCV presents the possibility that the control room operator could execute a signal to close a line valve, based on incomplete information, before a field situation has been appropriately evaluated. Unnecessary valve closure could compromise public safety and cause serious consequences, such as product loss and widespread customer outages, including outages to sensitive customers such as hospitals, schools, chemical plants and power plants.

In addition, the equipment necessary to monitor and actuate RCVs may be susceptible to physical and cyber security issues and sabotage such as intrusion into computer systems, communications links, breaching of physical security at valve locations and vandalism. There is also the possibility of routine equipment failure. Any equipment failure could have severe adverse consequences to the public.

VI. Converting Existing Manual Valves to ASVs/RCVs

ASVs and RCVs are significantly more complicated to install than manually operated sectionalizing valves. A manually operated valve is generally welded into the pipeline during the initial construction process. The valve assembly, which occupies little physical space, is typically buried along with the pipe. The operation of such a buried valve is typically performed by way of a valve access box at the surface.

There are several challenges that must be overcome when converting a manually operated valve to an ASV or RCV. An ASV or RCV requires additional equipment such as actuators, pressure and/or flow sensing devices and associated piping, power and telecommunications equipment. This equipment requires a relatively large space either above ground or below ground. In a HCA, such as a subdivision or downtown location, this equipment must be installed in an underground vault large enough to house the valve, equipment and a person conducting maintenance or repair around the valve or equipment. These vaults are approximately 10'x16'x10' and may be larger depending on the size of the valve. Since pipelines in HCAs are generally in city streets, the underground infrastructure around the pipeline is typically congested with water, sewer lines, telecommunications, power, traffic signal lines and other underground infrastructure. The challenge is finding enough underground real estate to house the ASV or RCV and the equipment necessary to operate the valve. In addition, the vault must be designed and constructed to structurally support large vehicular loads.

Due to the limited availability of underground real estate in urban and suburban areas, it is possible that an existing sectionalizing valve may have to be relocated to allow the installation of ASV or RCV

capabilities. The valve relocation may result in valve spacing exceeding the maximum spacing allowed by federal code, requiring the installation of additional sectionalizing valves.

Other factors that must be considered when converting from an existing manual valve to an ASV or RCV include:

- Most existing buried valves are not deep enough to accommodate installation of an actuator or other ASV or RCV equipment. This requires off-setting of the pipeline to provide sufficient depth for the valve and related equipment
- Many existing valves are not compatible with available actuators
- Above ground space is generally not available for ASVs or RCVs in HCAs
- Areas with a high water table or flooding conditions may create reliability problems for electronic or pneumatic actuators and related instrumentation installed in vaults below grade
- Power and telecommunication access may need to be installed to the area where the ASV or RCV will be located

The cost to convert an existing valve to an ASV or RCV will vary due to the technical challenges referenced above. The most significant cost factors are the pipeline (valve) size, operating pressure, and site specific conditions. Generally, the cost to retro-fit an existing manually operated transmission line valve with ASV or RCV capabilities is estimated to be between \$100,000 and \$1,000,000 with higher costs in dense urban areas, especially if offsets are required.

VII. Adding ASVs/RCVs to an Existing Transmission Line

As noted in section VI above, ASVs and RCVs are more complicated and challenging to install and operate than manually operated sectionalizing valves. The installation of a new block valve, equipped with either ASV or RCV functionalities, on an existing pipeline, presents the challenges and obstacles identified in section VI above and some additional challenges.

There are a number of considerations that must be taken into account when installing an ASV or RCV on an existing pressurized transmission line, especially transmission lines that are integrated within distribution systems. Transmission pipelines that are integrated with distribution systems typically do not

have parallel transmission lines or integrated, back-fed systems. In order to install the new valve, operators must identify a location that has sufficient underground vault space available to accommodate the new valve, actuators, instrumentation and related appurtenances. The operator must then install line stopper (flow stopping) equipment on the live pipeline, upstream and downstream of the new valve location, allowing the line to be taken out of service while the new valve is installed. In order to maintain the continuity of safe and reliable service to customers served by the transmission line, a temporary “bypass pipeline” must be installed around the valve installation site. Operators must consider downstream system demands when scheduling the installation of ASVs or RCVs. Due to system reliability considerations, there may be limited times during the year that transmission lines serving critical customers can be shutdown. NOTE: Working on a live natural gas transmission pipeline under pressure presents some of the most safety sensitive work performed by natural gas operating companies. Operators need to strictly follow company safety practices when conducting such work.

The cost to install an ASV or RCV on an existing transmission line will vary due to the technical challenges referenced above. The most significant cost factors are the pipeline (valve) size, operating pressure, and site specific conditions. Generally, the cost to install a new transmission line sectionalizing valve, equipped with ASV or RCV capabilities, in an existing transmission line is estimated to be between \$200,000 and \$1,500,000 with higher costs in dense urban areas.

VIII. Installing ASVs/RCVs on New Transmission Lines

The installation of block valves equipped with ASV or RCV capabilities on a newly constructed transmission pipeline presents significant challenges and additional costs compared to the installation of typical manually operated valves. The installation of a new ASV/RCV-equipped valve on a new line requires the acquisition of a large volume of scarce real estate in a congested right-of-way to accommodate the traffic bearing vault, valve, actuators and related equipment identified in sections VI and VII above. In addition, many of the challenges to ASV/RCV installation discussed in sections VI and VII are also applicable to the installation of new ASV/RCV valves on new transmission lines, including the design and construction of large traffic bearing vaults, vault flooding and associated reliability issues, availability of power and/or telecommunication equipment.

However, if an operator elects to install sectionalizing valves with ASV or RCV capabilities on a new transmission pipeline, the most effective timing is to design and construct the pipeline with the

installation of these valves in the original project scope. This foresight allows the operator to identify valve spacing, valve location, pipeline alignment and other design parameters to accommodate the significant additional demands of an ASV/RCV installation in an HCA application.

Based on the technical challenges referenced above, and considerable variability based on pipeline (valve) size, operating pressure, and site specific conditions, the cost to install a new transmission line block valve, equipped with ASV or RCV capabilities, in a new transmission line at the time of pipeline construction is estimated to range from approximately \$100,000 to \$1,000,000; costs could be significantly higher in dense urban areas.

IX. ASV/RCV Performance Expectations During Pipeline Incidents

Several studies have been conducted on the potential benefits of ASVs and RCVs. The results were summarized in a report by the Department of Transportation (DOT), Research and Special Programs Administration (RSPA) in September 1999, titled “*Remotely Controlled Valves on Interstate Natural Gas Pipelines*”, and updated in a report by Robert J. Eiber Consultant Inc. and Kiefner and Associates in July 2010, titled “*Review of Safety Considerations for Natural Gas Pipeline Block Valve Spacing.*”

Based on these reports and underlying studies, the vast majority of injuries, fatalities, and property damage associated with a catastrophic pipeline incident occur within the first few minutes of the event, well before activation of ASVs or RCVs are possible. The 2010 study’s review of 13 NTSB gas transmission pipeline incidents indicated that the consequences of the incidents examined would not have changed if the valves closed immediately after the release of gas.

The primary benefit of an ASV or RCV is the ability to control the amount of natural gas released after the incident has occurred. An ASV or RCV will normally close more rapidly than a manually operated valve that requires operating personnel to travel to the valve location. An ASV or a RCV will not close immediately after a pipeline incident. In the case of an ASV, the amount of time before the valve closes is dependent on a number of factors, including the initial operating pressure of the pipeline, distance from the pipe rupture to the ASV, physical characteristics (size) of the pipeline failure, set point of the actuator to initiate valve closure, and amount of time it takes the valve to actually close after actuation.

In the case of a RCV, the time to closure will be impacted by similar factors, including the initial operating pressure of the pipeline, distance from the pipe rupture to remote pressure sensing equipment, physical characteristics (size) of the pipeline failure, and the amount of time that it takes the pipeline to de-pressurize to an alarm level, gas controller to evaluate the situation and recognize that a pipeline failure may have occurred, controller to execute an RCV closure, and valve to close after the order is issued.

The decision to execute an RCV closure should not be taken lightly due to the high potential for adverse consequences to the public downstream of the closure. The evaluation process may include, but not be limited to:

- Reviewing the alarm data and looking for collaborating data.
- Performing diagnostics.
- Performing a system impact study downstream of the valve closure.
- Dispatching personnel to the scene to verify situation and data.

After the ASVs or RCVs are closed to isolate a pipeline incident, it will take additional time to depressurize the pipeline to 0 psig. This time will depend on the physical parameters of the pipeline and the pipeline failure.

X. Appendix A

Class location factor is defined by 49 CFR, § 192.5 as follows:

- a. This section classifies pipeline locations for purposes of this part. The following criteria apply to classification under this section.
 - (1) A “class location unit” is an on-shore area that extends 220 yards (200 meters) on either side of the centerline of any continuous 1-mile (1.6 kilometers) length of pipeline.
 - (2) Each separate dwelling unit in a multiple dwelling unit building is counted as a separate building intended for human occupancy.
- b. Except as provided in paragraph (c) of this section, pipeline locations are classified as follows:
 - (1) A Class 1 location is:
 - i. An offshore area; or
 - ii. Any class location unit that has 10 or fewer buildings intended for human occupancy.
 - (2) A Class 2 location is any class location unit that has more than 10 but fewer than 46 buildings intended for human occupancy.
 - (3) A Class 3 location is:
 - i. Any class location unit that has 46 or more buildings intended for human occupancy; or
 - ii. An area where the pipeline lies within 100 yards (91 meters) of either a building or a small, well-defined outside area (such as a playground, recreation area, outdoor theater, or other place of public assembly) that is occupied by 20 or more persons at least 5 days a week for 10 weeks in any 12-month period. (The days and weeks need not be consecutive.)
 - (4) A Class 4 location is any class location unit where building with four or more stories above ground are prevalent.

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