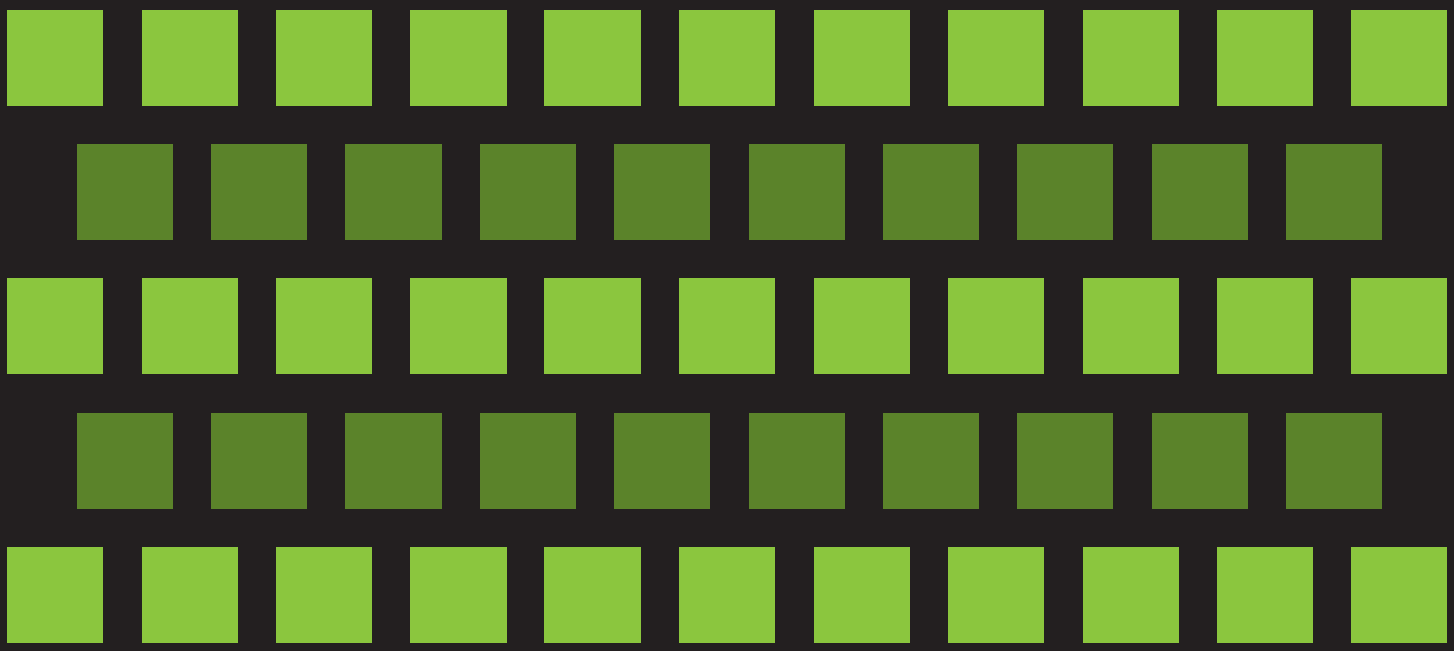
STP-PT-046

REVIEW OF SAFETY CONSIDERATIONS FOR NATURAL GAS PIPELINE BLOCK VALVE SPACING



ASME STANDARDS TECHNOLOGY, LLC

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FOREWORD

Block valves in pipelines have been used since pipelines were first constructed. They have been required in pipeline codes, such as ASME B31.1.8 (predecessor to ASME B31.8 Committee), since 1952. The quantity and spacing of sectionalizing block valves has a significant impact on the construction cost of new pipeline. ASME B31.8 is considering alternative design rules with increased stress levels justified by better quality design and engineering, where different valve spacing allowances may be appropriate. Revisions to the ASME Code can serve as a model for evolution of pipeline safety regulations in the U.S. Findings of this report will assist in defining the requirements for spacing and operator types for block valves in gas pipelines.

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ABSTRACT

The goals of this report are 1) to examine prior studies that have been conducted to define the relationship of block valves on gas transmission pipelines to public safety, 2) to assess the relationship of valve spacing and valve operator type on public safety and 3) to evaluate if valve spacing/valve operator type, or valve location can improve public safety. The presence, location and spacing of main line block valves were found to have no impact on the likelihood of a failure and only a small reduction in the consequences of a failure on a natural gas transmission pipeline. Even if the valves are closed at the start of an incident, calculations and historical records confirm that natural gas pipelines require more than an hour to depressurize. The most severe consequences to the public occur in HCA's in the first 30 seconds after incident initiation. The addition of automatic or remote closing valves was thought to potentially reduce the consequences of gas transmission incidents in about 20 percent of the serious NTSB incidents reviewed.

This review found that all of the prior research studies, the examination of the PHMSA incident database and the examination of NTSB gas transmission pipeline incidents indicate that main line block valve spacing on natural gas transmission pipelines is not related to public safety. Valves are useful for maintenance and line modification but they do not control or affect public safety as the injuries and fatalities on gas transmission pipelines generally occur during the first 30 seconds after gas has been released from a pipeline. The NTSB incidents reviewed indicated that it took at least an hour after the rupture occurred for the natural gas to decompress and exhaust from the pipeline. This exists because a natural gas pipeline is not like a water pipe in a building where, when the valve is closed, the incompressible water stops flowing out of the pipe no matter how far the valve is from the pipe opening. Natural gas is compressed to about 70 to 100 atmospheres[a] for cross country transmission pipelines and it takes time for the decompression to occur. Calculations indicated that smaller diameter pipelines required longer decompression times; i.e., 12 inch (305 mm) diameter pipelines take about twice as long as a 36 inch (914 mm) diameter pipeline of the same length for a worst case full rupture condition due to wall friction effects.

The review of the PHMSA incident database revealed that from 2002 to 2009 the total public damage cost does not correlate with time to make the area safe (related to the depressurization time) or the concentration of the released gas. The public damage correlates to the proximity of the workers/public and whether the gas ignites, neither of which is controllable for the existing pipeline network. The most serious incidents with large property damage and the potential for injuries and fatalities involved early ignition of the natural gas. The examination of the time to make an area safe revealed that the largest public damage costs were associated with an incident that had a 3.5 hour "time to make the area safe" and a total public damage cost of $87.5 million due to the close proximity of a power plant that was damaged by the ignited gas. The longest "time to make the area safe" was 116.8 hours and there was no public damage reported. Of the eleven highest total PHMSA incident costs, all but one had a "time to make the area safe" of less than 4 hours. The one exception had a "time to make the area safe" of 11 hours and had total damage costs of $6.22 million with only $3000 of public damage and no injuries or fatalities.

The review of fourteen NTSB incident reports[b] on gas transmission pipelines indicated that the consequences of the incidents might have been reduced somewhat in 20 percent of the incidents, all of which occurred in HCA's, if the valves had been closed at the instant of gas release. In the incident with the closest spacing between valves (1.25 miles [2km]) twelve fatalities occurred and had

[a] The gas pressure in service pipelines to a house is about 1/10 of an atmosphere.

[b] The other NTSB incident reports dealt with liquid pipelines, distribution pipelines, offshore pipelines, compressor stations and other miscellaneous situations.

the highest fatality count of all the NTSB incidents reviewed. This indicates that if the gas ignites as it is released, the flame will be present for the full time that it takes to blowdown the natural gas (fuel) in the pipeline.

Valves are not safety items in that in 80% of the NTSB incidents, the injuries and fatalities occurred immediately or within 30 seconds after the first release of natural gas, due to either debris, suffocation or fire. This is based on the calculations indicating that the immediate closure of all block valves would still have allowed gas to escape for times up to one hour.

When parallel pipelines are involved determining which pipeline has experienced the incident may be difficult. This occurred in 20 percent of the NTSB incidents reported. Such parallel pipelines are typically linked together with valves and open crossovers. The pressure drop on the ruptured line can be difficult to identify because all of the interconnected lines show a pressure decrease due to the open crossovers[c]. A methodology is needed to help quickly identify which pipeline ruptured when parallel lines exist.

Overall, valve spacing has not been identified as a safety issue. Valve spacing should be based on efficient operation and maintenance of the pipelines. Under some circumstances, early valve closure may result in some consequence mitigation by reducing the heat flux from a gas ignition and allow the emergency responders access for rescue in a more expeditious manner. This would result from the reduced potential for secondary fires and earlier admission of emergency responders to the affected area. Such earlier closure may be accomplished by automatic or remotely-controlled valves. As explained above, however, even instantaneous closure will not prevent the incident or greatly mitigate its consequences.

This review found that external force damage remains the primary cause of death and injury. Therefore, the most significant reduction in risk to the public can be achieved by operator application of an integrity management plan to their pipelines to prevent these third-party damage incidents from occurring.

[c] These open crossover pipelines allow equalization across all (up to seven) parallel lines in the same right of way.