SLAM SHUT STRATEGY

NATHAN GOVI
SENIOR GAS ENGINEER
PACIFIC GAS & ELECTRIC CO

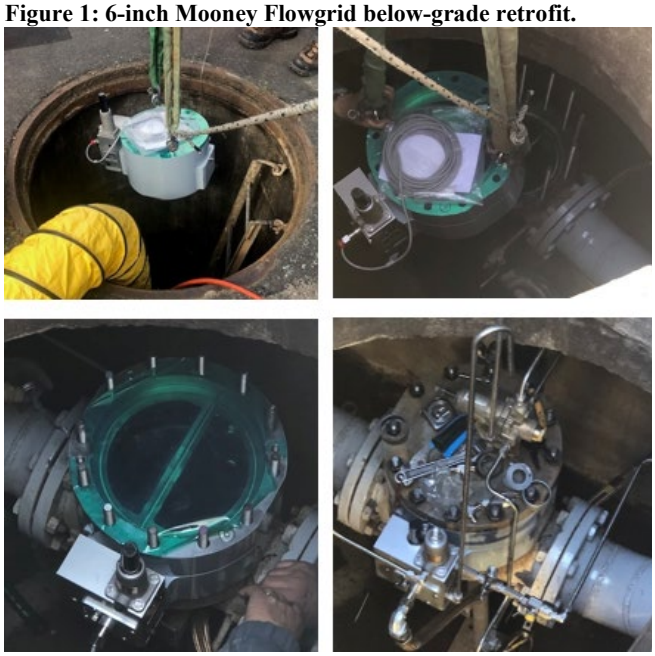
Introduction

It is common across the industry to use a regulator-monitor setup in regulator stations, industrial meter sets, and similar applications. However, some utilities have been considering slam shut devices as either a primary overpressure protection (OPP) device or secondary device. Whether a slam shut device is used as primary or secondary OPP, its main function is to stop the continuation of increasing gas pressure between an upstream system with a higher Maximum Allowable Operating Pressure (MAOP) into a downstream system with a lower MAOP caused by equipment failure or human error. This functionality is beneficial in areas where a continuous release of gas can lead to health or safety concerns. The capability to integrate the slam shut device on an existing regulator without major station alterations provides an optimal mitigation tool operators can use to reduce the likelihood of OP events. However, shutting in a system to prevent an OP event could lead to unintended consequences if the right guidance and safeguards are not in place. The purpose of this White Paper is to provide considerations for evaluation before introducing a slam shut device into a natural gas system.

Retrofit Installations

With slam shut strategies becoming more widely implemented, operators are more likely to consider retrofit installations at existing regulator stations for ease of installation (See Figure 1). Retrofitting existing stations require considerations in constructability and maintainability as the facility was not originally designed to incorporate a slam shut device. Horizontal and vertical clearances will change, which may require surrounding structure alterations or piping modifications (e.g., vault installations). In some cases, existing regulation may need to be replaced with another manufacture's regulation if structural alterations or piping reconfiguration are not feasible. Additional taps for the slam shut devices sense line may be needed if tap sharing is undesirable. This may lead to the need to excavate to accommodate additional tap installations.

Figure 1: 6-inch Mooney Flowgrid below-grade retrofit.



Standalone Vs Integrated Slam Shut

Depending on the operator's existing preference on regulation equipment, a standalone slam shut device will be preferred over an integrated slam shut device by field personnel. A top entry design maintains ergonomic stability when operational checks lead to internal inspections and component replacement. However, the integrated slam shut device option reduces the amount of work that may be required to accommodate an additional standalone slam shut (e.g., welding, cutting, pipe alteration and strength testing) at existing stations. Dependent on regulation manufacturer, removal tools may be needed to lessen the ergonomic impact when the slam shut device undergoes an internal inspection. An integrated slam shut unit may be more beneficial since it provides additional OPP.

Slam Shut Position

Consideration for constructability, maintainability and station configuration will be the main driver of position placement. Installation at an MAOP delineation assigned immediately downstream of the slam shut device should be avoided as an exceedance of MAOP may be needed during equipment inspection depending on the established set points.

Slam Shut Set Point

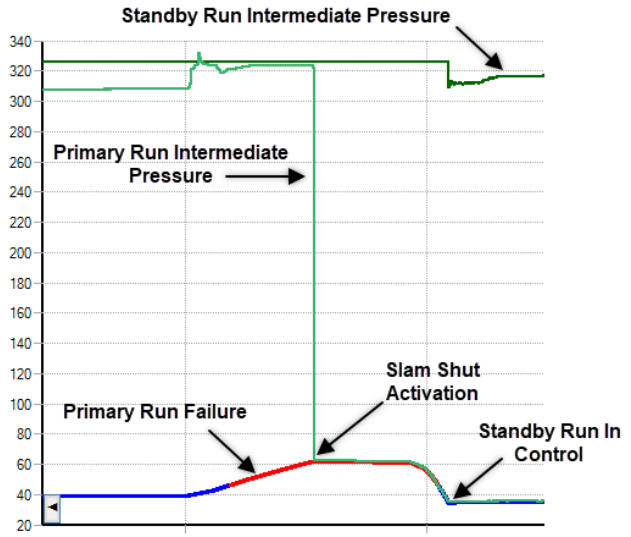
Establish the slam shut device's set point to prevent downstream pressure from exceeding the MAOP limitations set in CFR Title 49 Section (§)192.201, "Required capacity of pressure relieving and limiting stations," with additional consideration of equipment operational tolerances including the slam shut device and other pressure limiting devices (e.g. lockup tail and monitor overshoot). Greater set point separation between the slam shut device and a regulating device will lower the likelihood of unintended activations.

Table 1: § 192.201 Required capacity of pressure relieving and limiting stations

MAOP	Pressure May Not Exceed
60 psig or more	MAOP plus 10% OR 75% SMYS, whichever is lower
12 psig or more AND less than 60 psig	MAOP plus 6 psig
Less than 12 psig AND greater than low pressure	MAOP plus 50%
Low pressure	Pressure not to exceed the safe operating pressure for any connected and properly adjusted gas utilization equipment

Operators using dual run station configurations should consider staggering the slam shut set points on each run. Set the primary slam shut device lower than the standby slam shut device. In the event the primary run fails the slam shut activation will not affect the standby run's ability to provide uninterrupted service as it comes into control. See Figure 2 for an example of slam shut activation and control at a dual run regulator station.

Figure 2: Pressure trend data displaying a primary run failure and slam shut activation on a dual run station.



Single Vs Dual Slam Shut Functionality

Operators have the option to install a slam shut device using the single (over or under) or dual (over and under) pressure shutoff functionality. The dual functionality option can be useful at locations prone to third party dig-in or vehicular damage. Consider a common sense line for the over and under pressure shutoff control which will allow slam shut activation of in the event the sense line is severed due to external forces. Otherwise, there is a likelihood the over pressure shutoff functionality could be disabled without slam shut activation. This scenario leaves the station vulnerable to an over pressure event.

Activation Indication

Any form of indication notifying an activation of a slam shut device will improve response readiness. A couple options to consider include a switch integrated on the slam shut device or system pressure monitoring. Each option relies on a form of Supervisory Control and Data Acquisition (SCADA) device capable of communicating system changes to responding personnel.

An indication switch provides a real time change in condition and location. The latter being most beneficial on systems with multiple station feeds. Mooney, Pietro Fiorentini and Fisher offer the option to have the indicator switch integrated into their slam shut device. The switch includes certifications supporting the installation in Class 1 Div 1 area classifications and locations prone to water submersion. The switch is compatible with any pressure recording device equipped with digital I/O's. Preventing an unacknowledged activation due to external forces disrupting the mechanical or electrical components of the switch is accomplished by using the normally closed position wiring configuration. When a loss of signal occurs the SCADA device will generate an activation notification. See Figure 3 for an example of wiring damage that could generate an activity notification.

Figure 3: Severe corrosion on wiring terminal between indication switch and RTU causing activation indication.

A rigorous approach for activation indication can be accomplished through system pressure monitoring and a robust alarm management program. However, reliance solely on pressure monitoring has the following short falls; delayed response time from time of slam shut activation to alarm notification and the ability to identify the activation location for systems with multiple feeds. This approach also requires thorough system analysis to confirm existing system pressure visibility is adequate to capture an activation or warrants the installation of new visibility equipment.

Station visibility is the preferred location for pressure monitoring. It provides station and system health and allows for multiple monitoring points within the station. If system pressure monitoring is the preferred method of slam shut activation indication, consider using the pressure alarms built into the SCADA devices.

Alarm Settings

Depending on the number of pressure alarms available there are various scenarios based on the number of monitoring points to consider. These alarms can be used to validate a slam shut activation.

When using single point monitoring downstream of the station, consider setting a high pressure alarm at the slam shut device's set point. Operational tolerances of the pressure transducer and slam shut device should be factored when establishing this alarm. A low pressure alarm at the same monitoring point can also be used to validate a slam shut activation. Establishing this alarm can be useful to identify an accidental slam shut activation or an activation caused by a brief pressure spike not captured on the SCADA device. Consider setting this low pressure alarm between regulator set point (minus droop) and the minimum system design pressure.

When using multiple point monitoring within a station, alarm settings for the monitoring point downstream of the station will follow single point monitoring guidance. For a monitoring point installed between the regulator and OPP device, consider setting the low pressure alarm to the downstream normal operation pressure. This alarm is extremely useful in the identification of an accidental activation in a low to no flow scenario. In the event the slam shut activates, intermediate pressure will equalize with the downstream system pressure. Multiple point monitoring within a station is only useful for activation indication when the slam shut device is installed upstream of the downstream controlling regulator.

Maintenance

To ensure the slam shut operates as intended when needed, it's advisable to inspect the device annually during regulator station component testing, unless environmental or gas quality factors support increased inspection frequencies. This inspection would support compliance with CFR Title 49 Section (§)192.739, "Pressure limiting and regulating stations: Inspection and testing." As such, it would be prudent to notify the public utilities commission or other regulating agencies of the implementation of slam shut strategies since the new slam shut maintenance requirements will be reviewed during O&M audits.

The ideal inspection includes repeatability (i.e. device activates within set point tolerances after multiple tests) and bubble tight shutoff. The operator may also consider internal rubber component replacement work at specific intervals to prolong the life of the slam shut device. Consider developing training and procedures to inspect, troubleshoot, assemble, and disassemble the slam shut device. Training and procedures should include specific steps to reset the slam shut since some devices require equalization of pressure on either side of an activated slam shut before rearming the device. Also, certain slam shut models require a minimum rate of increase in sense pressure to activate the overpressure set point of the slam shut and overcome internal relief devices originally designed to prevent accidental slam shut activations. Familiarity with the slam shut device's external and internal components can decrease time out of service during maintenance inspections and activation events.

Response Plan

Paramount to the success of slam shut installations is a vigorous response plan. The

response plan is designed to assist personnel with safe, efficient, and coordinated response to a slam shut activation affecting a transmission or distribution system. The plan should describe response priorities and roles of employees responding to the slam shut activation. It should also provide references to relevant response procedures and guidelines to follow. At a minimum, these procedures and guidelines should include the following: make safe operations, steps taken before returning a station back into operation (e.g., cause of failure, equipment rebuild/replacement, leak survey of affected system), determination if CNG/LNG may be needed to supplement the affected system if system demand begins to increase, identification of an injection point to supplement the affected system and a restoration plan in the extreme case the system cannot be supplemented by any other source.

Response Plan Training

A response plan coupled with adequate scenario-based training, reduces the likelihood of customer outages and other unintended consequences after a slam shut device has activated.

Conclusion

The slam shut device provides a means of OPP that may be of value for Operators. It can be a valuable risk mitigation tool in preventing over pressure events like Merrimack Valley.