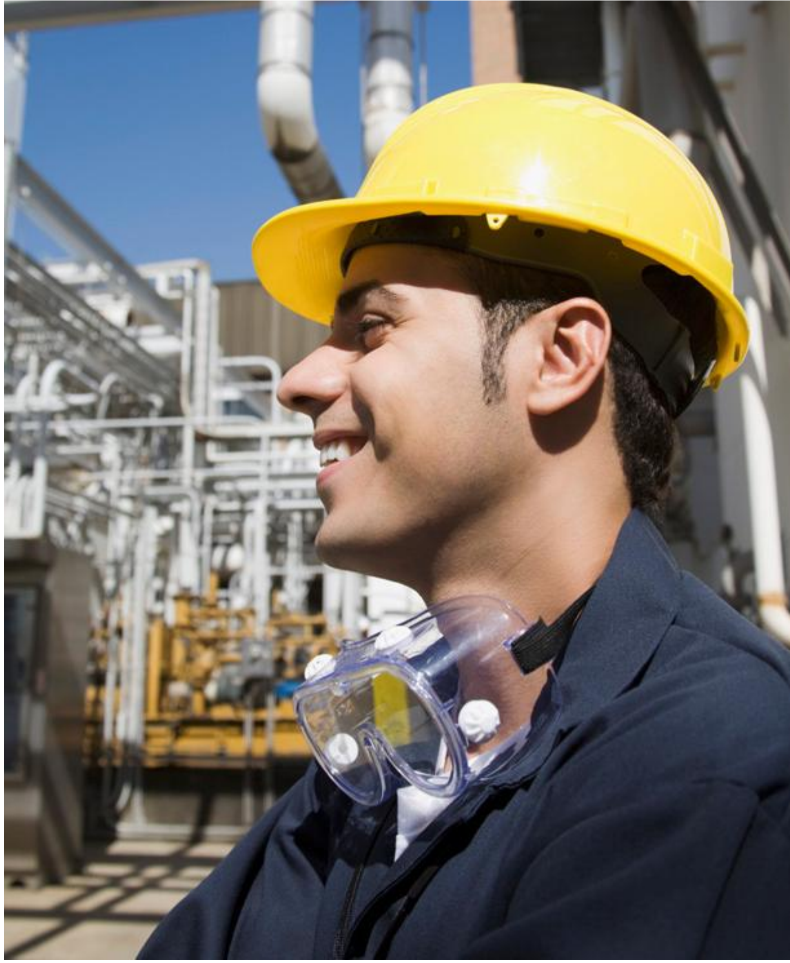


EMERGENCY BLOCK VALVES

L O C K T O N C O M P A N I E S

Introductions

- Emergency Shutdown Valve, ESV, ESD, or ESDV is an actuated valve designed to stop the flow of a hazardous fluid upon the detection of a dangerous event.
- Many types of valves are used in the refinery, chemical and petrochemical industries, and each has a different function. Those of most interest are those which can reduce the size of spills and prevent or hinder catastrophic losses. Many small accidents have become major losses by the addition of more fuel caused by the inability to reach and activate manual block valves.
- Various guidelines can assist to identify where emergency block valves (EBV) in flammable or combustible liquid or gas service should be located, based upon experience in loss prevention, research papers and industry standards.

Valve Types

- Valves regulate fluid flow and isolate equipment. They are normally flanged to allow easy replacement and insertion of blanks or caps. However, valves can also be welded into a piping system. The location of valves can be found by studying piping and instrument diagrams (P&IDs) and the physical placement by on-site review. Valve types include:
- Ball Valves: Operate by aligning an orifice in a sphere with a pipe to allow fluid flow; rotating the sphere 90 degrees blocks the flow.
- Ball valves are used as on/off devices as they are not suited to regulate flow.
- Gate Valves: Operate by raising or lowering a vertical valve disk or gate in the path of fluid flow.
- Isolation Valves: Separate pumps, compressors and other equipment from the pipelines; generally a manual gate valve.
- Block Valves: Separate one item of equipment from another and seals against liquid flow.

Valve Actuation

As shutdown valves form part of a SIS it is necessary to operate the valve by means of an actuator. These actuators are normally fail safe fluid power type. Typical examples of these are:

- Pneumatic cylinder
- Hydraulic cylinder
- Electro-hydraulic actuator
- Fusible Plugs (Pneumatic)

With fusible plugs, excessive heat causes the brass fusible pipe plug to open, allowing air to exhaust from the pneumatic actuator. The spring force closes the valve and stops the media flow.

Plastic Tubing (Pneumatic)

Excessive heat from a fire causes the plastic tubing to soften, melt, and rupture. Once ruptured, air can no longer reach the actuator. When the air exhausts from the pneumatic actuator, the spring force closes the valve and stops the media flow.

Considerations for Placement of EBV (Insurance Criteria)

General

When considering EBVs, include the following:

- Choose the type and location of each valve based on the results of a process hazards evaluation.
- Store enough compressed air or nitrogen at each air-operated valve for three cycles of the valve.
- Fireproof power cables and the motor of each motor-operated valve for 15 min or the valve closure time, whichever is more.
- Fireproof all rods and bolts on flangeless EBVs.
- Use valves with fire resistance at least as great as the piping to which they are connected.
- Arrange remotely-operated valves to be operated from a safe, constantly attended location.
- Locate all manual valves to be easily accessible under adverse conditions.

Process Units

Install valves so that any process unit can be isolated from any other unit. Locate zone valves, ESD valves and fail-safe valves in positions that are readily accessible. Where possible, place zone valves at the ends of pipe racks at ground level and identify clearly (Figure 1). Clear the area of obstacles and protect it with monitors or hydrants.

When arranging valves at ground level for manual operation, avoid tight bends and elbows in the piping as it can lead to cavitation and erosion.

Suggested Valve Locations

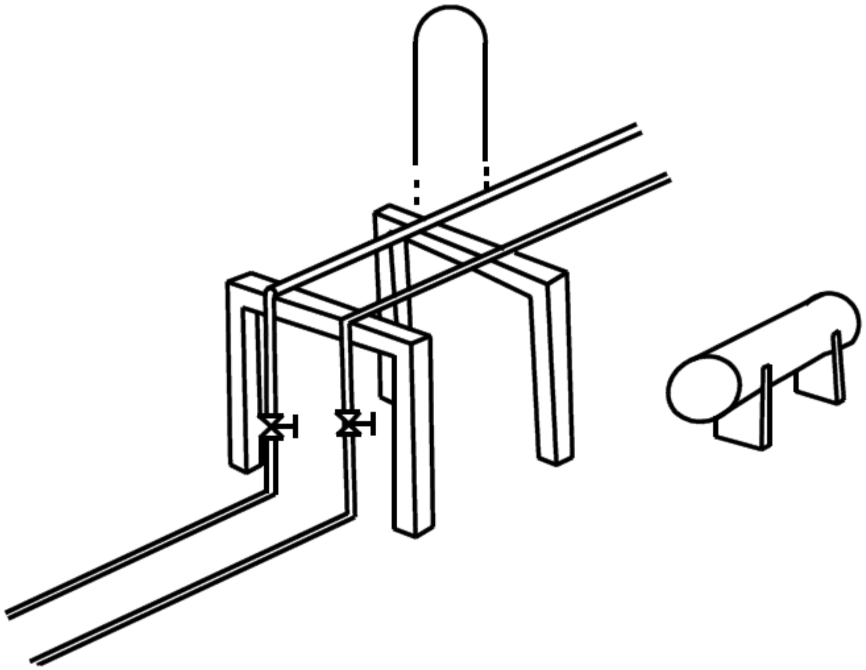


Figure 1. Zone Valves.

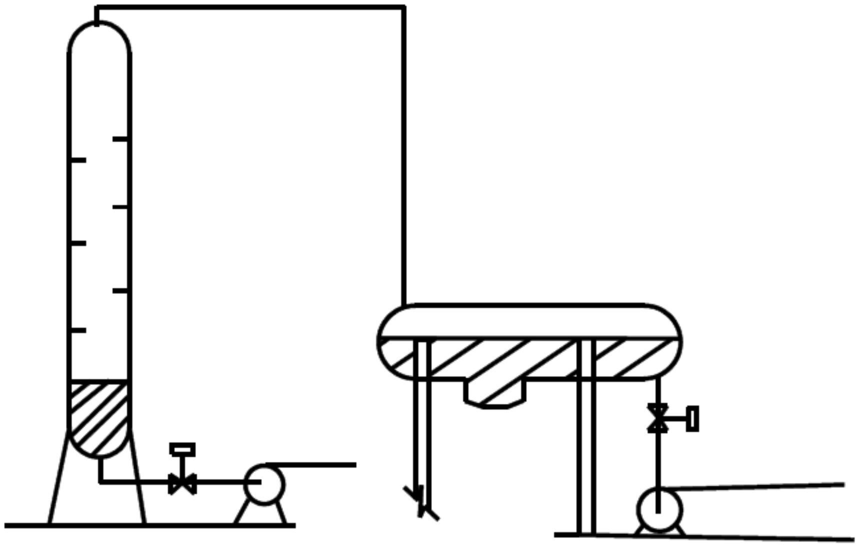


Figure 2. Fail-Safe Emergency Block Valves.

High Fire Potential Equipment

Columns, Reactors and Pumps

Apply the following protection to towers with a bottom liquids hold-up volume of at least 1300 gal (5000 L) and drums with a volume of at least 2100 gal (8000 L):

• Install a FSEBV (fail safe emergency block valve) between the tower bottoms outlet and bottoms pumps (Figure 2). Situate the valve

as close as possible to the bottom flange to reduce the length of exposed piping and liquids.

Introduce additional pipe supports to support the additional weight of these valves. Fireproof these supports if they are located within the drainage area of a sump. Pumps without seals do not require these valves unless indicated by a field review.

• Install FSEBVs between overhead accumulator drums and the bottoms pumps.

• Install FSEBVs between columns when two or more distillation columns are in series and if liquids can flow from one to the other.

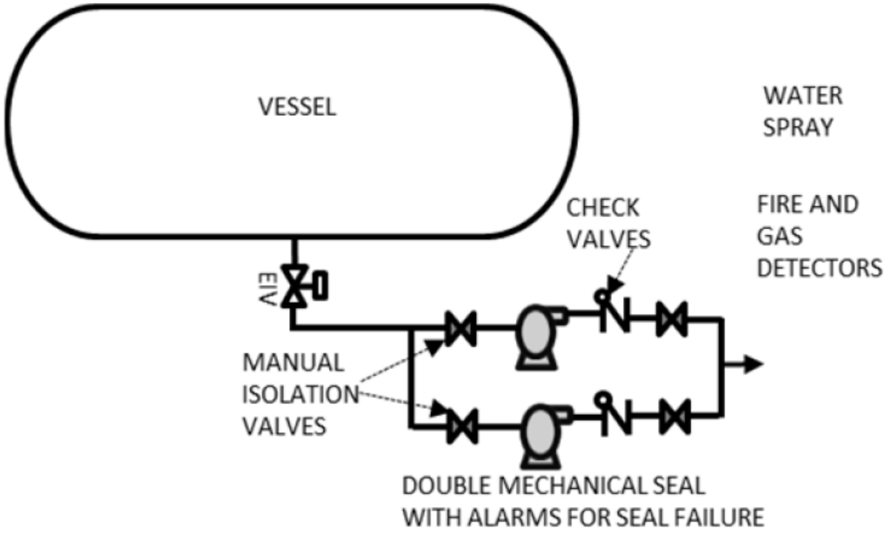
Review each system carefully to ensure the correct types of valves have been installed in the correct locations. Consider the following example: under emergency conditions, the hydrogen feed to a platinum reformer should fail in the open position so the catalyst can be cooled and thermal shock prevented. This results in less damage than stopping hydrogen flow.

Other EBV Considerations

- Fireproofing and protection measures are necessary for the valves, cables (power and control) and actuators per API RP 2218.
- EBVs should be mounted directly to vessel nozzles.
- EBVs should be accessible and identified for use in an emergency. They can be painted yellow and labeled with a sign.
- There should be a remote indication of valve positions in the control room.
- The simplest technology should be used to move the valve to the safe state.
- Bypasses should be managed similar to other safety equipment.
- EBVs should be identified on piping and instrument drawings.
- A formal functional testing program requiring documentation and auditing is recommended. There have been incidents when EBVs did not operate when needed because of a lack of a functional testing program to detect malfunction.
- Emergency responders should be trained on the location of EBVs.

LPG Service

Typical configuration of a pump taking suction from a process vessel, handling LPG (Liquefied Petroleum Gas) or lighter hydrocarbons is shown in Figure 1. To minimize leakage from pump seals, double mechanical seals with alarm for operator action is provided. Fire and Gas detectors are provided in the vicinity of pumps to detect any leakage or fire and automatically initiate shutdown of pump with closure of EIV (to minimize the inventory). Water spray is also provided for cooling in case of fire in the adjoining pump.



FM Data Sheet 7-14 (Fire Protection for Chemical Plants)

Isolation Design

Provide process equipment with block or isolation valves, vents to flare stacks or incinerators (i.e., depressurization system), dump or salvage systems, and quench or purging systems to minimize the quantity of material released in the event of equipment failure or accident. The exact type, extent, and arrangement of such protective equipment will depend on the process involved and are often developed through a process safety review.

Flammable Gas

Provide an FM Approved combustible gas detection system in areas where flammable gases are present. Design the system to sound an alarm to a constantly attended location (e.g., the process control room) upon detection of a gas concentration of 25% of the lower explosive limit (LEL). If appropriate, interlock detection with emergency safety/block valves to shut off incoming LPG or flammable gas to vessels, process units, and other applicable equipment or building areas at 50% of the LEL. For indoor locations, interlock detection to any installed emergency ventilation systems.

Where isolation measures are needed, refer to Figure 10 for a typical arrangement.

FM Figure 10:

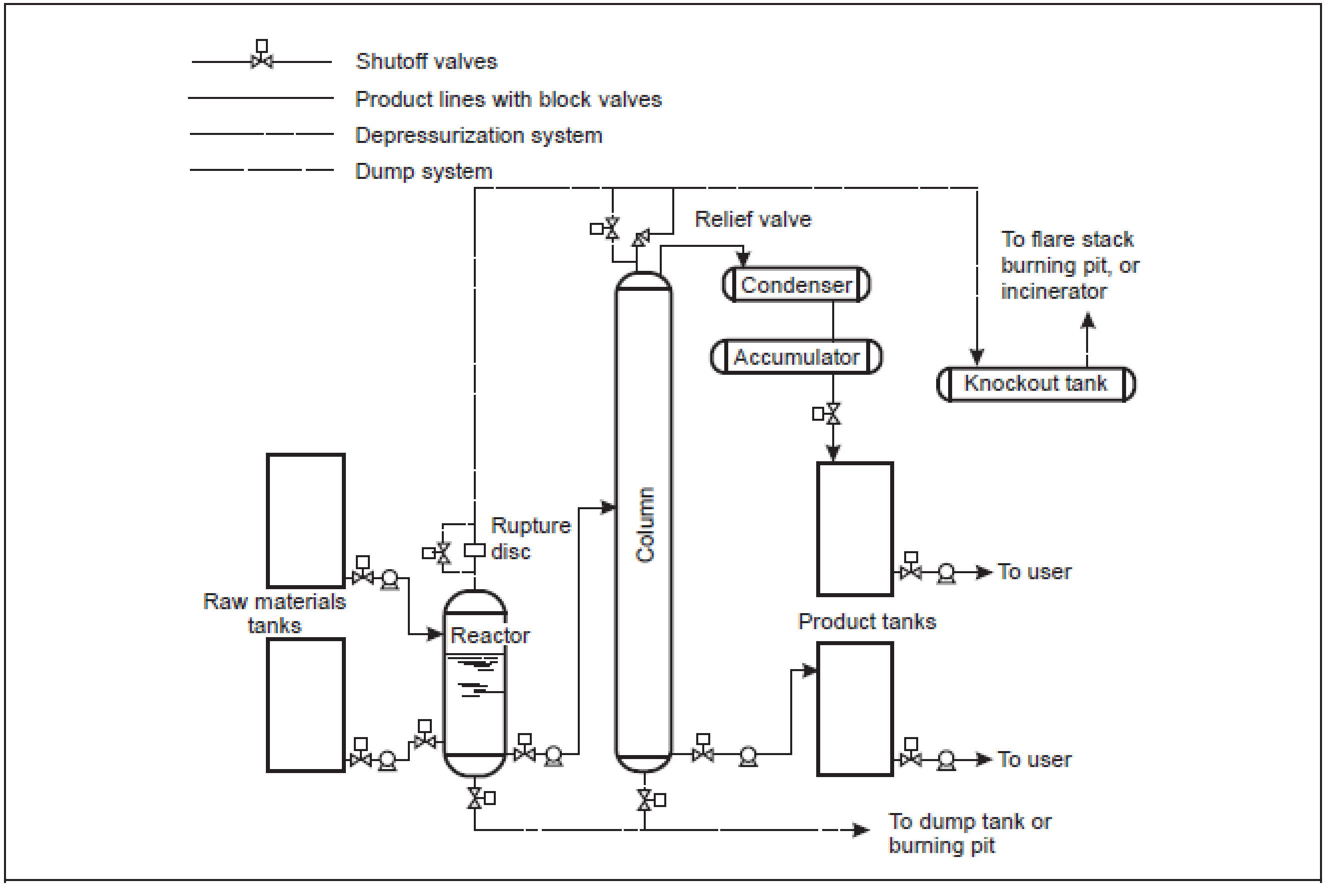


Fig. 10. Accidental release control systems and valves

Emergency Valves API 2218 (Fire Envelope)

Emergency Valves Within a Fire-Scenario Envelope

The operation of emergency valves and valve actuators in areas exposed to fire can be important to shutting down units safely, depressurizing equipment, or isolating fuel feeding a fire. Examples of important emergency isolation valves include suction valves in piping to pumps that are fed from large towers, accumulators, or feed surge drums.

To improve the probability that emergency isolation valves will operate properly, fireproofing should be considered for both the power and signal lines that are connected to the valve. The valve's motor operator should be sufficiently fire-protected to provide enough time for the valve to fully open or close. Valves that fail to the safe position need not be fireproofed.

If the control wiring used to activate emergency shutdown devices (including depressurization or isolation systems) during a fire could be exposed to the fire, the wiring should be protected against a 15 minutes–30 minutes fire-exposure functionally equivalent to the conditions of UL 1709.

Power and Instrument Lines API 2218

Power and instrument lines can be protected as described in 6.1.8.1. Motor operators may be protected by various fire-rated systems that use preformed fire-resistant material, specially designed, lace-up fire-resistant blankets, assemblies that use mastic materials, or intumescent epoxy coatings permanently molded to the equipment. For each of the above options, it is important to confirm that the fireproofing material is suitable for the operating temperature of the equipment being protected. Some are limited to normal non-fire temperatures as low as 160°F (70°C), even though they can provide a 30-minute rating under UL 1709 (or functional equivalent) conditions.

Additional Emergency Valve Considerations API 2218

The following items require special consideration:

a. Thermal-limit switches built into electric motors may cause the motors to fail before valves are fully closed or opened when exposed to fire. Deactivation of the thermal limit switches should be considered; or the equipment supplier should be consulted about possible modifications to ensure that motor operation is of sufficient duration to obtain the desired valve operation.

b. The valve's handwheel and engaging lever should not be fireproofed to the extent that the valve is made inoperable.

c. It is important to ensure that the valve's position indicator remain visible after the valve is fireproofed.

d. The solenoid on solenoid-operated valves may be fireproofed with the materials described above. Because the insulating material retains heat and blocks ventilation, the design should be investigated to ensure satisfactory operation.

e. The diaphragm housing on diaphragm-operated valves should be fireproofed with the materials described above, unless the valve is designed to fail to the safe position.

f. It is important that the fireproofing system selected is rated for use at the operating temperature of the equipment being protected and its environment.

Pneumatically actuated shut down valve

Measuring Performance

- For shutdown valves used in safety instrumented systems it is essential to know that the valve is capable of providing the required level of safety performance and that the valve will operate on demand. The required level of performance is dictated by the Safety Integrity Level (SIL). In order to adhere to this level of performance it is necessary to test the valve. There are 2 types of testing methods
- Proof test - A manual test that allows the operator to determine whether the valve is in the "as good as new" condition by testing for all possible failure modes and may require a plant shutdown
- Diagnostic Test - An automated on-line test that will detect a percentage of the possible failure modes of the shutdown valve. An example of this for a shutdown valve would be a partial stroke test.

Other Criteria / Standards for EBV

1. Facility develops criteria or standards (PHA?)
2. Insurance or others (third party) develops criteria or standards
3. A combination of both Insurance and facility develops criteria or standards

Risk Ranking (Insurance)

1. Effects on quality of risk by using EBV (high, medium, low)
2. Insurance risk ranking and effects on property insurance program

References

1. XL Catlin Gaps Guidelines
2. FM (Factory Mutual Data Sheet 7-14)
3. API (American Petroleum Institute)
4. NFPA (National Fire Protection Association)

Property Conservation Priorities

1. Keep it in the pipe. (Normal Conditions). Regulate release for upset or abnormal process conditions (flare).
2. Limit release in case of equipment failure or other abnormal conditions. Limit the release with the application of EBV or EIV's.
3. Fire protection measures incase release develops into a fire.

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