EMERGENCY BLOCK VALVES

INTRODUCTION

Many types of valves are used in the chemical and petrochemical industries, and each has a different function. Those of most interest to AXA XL Risk Consulting 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.

This AXA XL Risk Consulting Guideline identifies 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. It also describes how to install and protect them.

Definitions

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.
- **Emergency Block Valves (EBV)**: Separate one item of equipment from another during fire or other emergencies. These are usually arranged as fail safe emergency block valves (FSEBV).
- **Zone Valves**: Isolate units; generally located at the end of pipe racks and at ground level. Also known as battery limit valves.
- **Fail-Safe Valves**: Fail in a fully opened or fully closed position upon loss of power. The correct fail-safe position must be determined by process hazard evaluation. There are two types:
- Air Operated Valves: Use air as the control medium to operate the valve; at air failure, the valve fails to the safe position. They may have compressed air or nitrogen tanks to power the valves to the safe position.
- Motor Operated Valves: Use electric power; upon power failure, they fail to the safe position. They may have batteries to power the valves to the safe position.

- **Emergency Shutdown (ESD) Valves**: Ball valves that close within 1 to 1.5 sec per in. of valve diameter; and seals in both the up and down stream directions. Same as block or zone valves, except that they fail closed, seal the equipment, operate under elevated temperature and are interlocked to the critical alarms associated with that unit.
- **Flange-less Valves**: Standard valves without flanges. Held in place by rods or long bolts placed between the pipe flanges.
- **Fire Rated Valves**: Listed by a nationally recognized testing laboratory as being capable of retaining liquid or gas without leaking even though subjected to a hydrocarbon exposure fire.
- **Check Valves**: Allow fluid flow in only one direction.
- **Excess Flow Valves**: Close automatically if fluid flow rates exceed a critical value. The critical flow rate of excess flow valves depend upon the physical characteristics of the fluids as well as flow rates.
- **Safety Relief Valves**: Open automatically if pressures exceed set values.

POSITION

General

When considering EBVs, include the following:

- Choose the type and location of each valve based on the results of a process hazards evaluation.
- When a ball valve is used as a block valve, use only listed fire rated valves. Use valves with a primary seal and a secondary metal seal for fire exposure use.
- Follow the manufacturer's testing recommendations for those ball valves which cannot be hydrostatically tested while in the closed position. Fit ball valves used in low temperature conditions (-49°F [-45°C]) with a bleed in the body cavity in case the valve heats up while out of service or during a fire.
- 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.

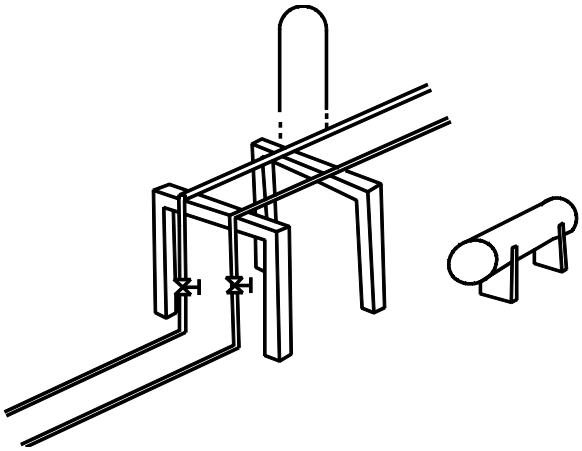

Figure 1. Zone Valves.

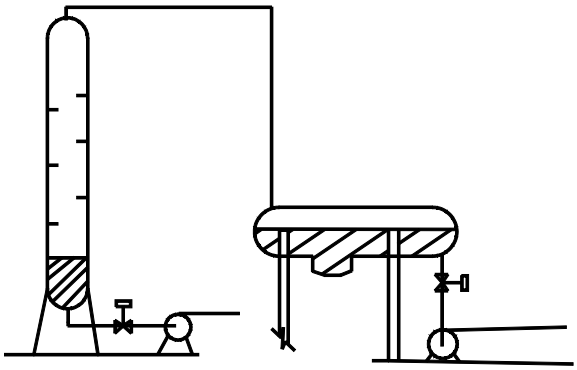

Figure 2. Fail-Safe Emergency Block Valves.

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 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.

Install fail-open valves at reactor water cooling jacket inlets to cool exothermic reactions. Reverse this where circumstances justify. For example, chlorosulphonic acid reacts exothermally with water, so, upon vessel failure, the water supply must be shut off to prevent water from entering the reactor. The loss of cooling would cause less damage than water reacting with the acid.

Make polymerization reactions safe in one of the following ways:

- Install a blow-down system to relieve high reactor pressure. Use a fail-open valve on the discharge of the reactor to empty into a catch tank. Prevent valve clogging with a rupture or bursting disk. Choose a disk rated at a higher pressure than the fail-open valve so once the rupture disk is open, the reactor contents are transferred automatically to the catch tank.
- Install an anticatalyst or “short stop” system to terminate the chemical reaction directly. If using hydroquinone powder to halt polymerization reactions, locate the powder in a tank on the top of the reactor. Use the fastest possible gate valve to avoid clogging in the presence of powders. Activate the valve electrically and disperse the powder using a rotating nozzle and CO_2 or N_2 propellant.
- For nitration reactions, provide a reactor emergency dump valve to discharge contents into a neutralizing medium, such as chilled sulfuric acid, contained in a dump tank.

Compressors

Avoid fast-acting fail-safe valves which could cause pressure waves and condensation in compressor gas streams. Isolate compressors using antisurge block valves only. Install interlocks so the driver is

included in the shutdown sequence before the compressor is blocked in. Install remotely operated isolation valves on both the suction and discharge lines of compressors with drivers over 150 kW and which handle flammable gases. Install remote valves on any normally open suction and discharge line of all multistage compressors. Install remotely operated isolation valves between the intermediate stages of compression on all large compressors with interstage condensers and knockout drums or pots over 1000 gal (3800 L) (Figure 3). Use only antisurge valves which can go from open to closed in less than two seconds. Upgrade the control system and shorten the runs of pneumatic piping as necessary to achieve this speed.

Install a recycle line and valve upstream of the separation drum and upstream of the coolers.

Place a check valve downstream of the recycle line to separate each compressor stage from its downstream process and to ensure a recycle if the check valve is damaged. Place this check valve as close as possible to the recycle line. Eliminate potential oscillations and the need to flare wet gas in two-stage compressor systems by installing loop decouplers such that the action of the first stage controller is added to the action of the second controller.

Install fail-open valves on compressor lubrication oil lines of all large compressors so the bearings remain lubricated during coast down.

Marine Terminals

Use FSEBVs to reduce the loss potential in this type of terminal. Install isolation valves on all loading arms so the arm or pipeline can be isolated in case of hose or arm failure, mechanical damage or fire exposure, or an emergency on a tanker being loaded. Use valves appropriate to the product being loaded or unloaded.

Install fail-safe ball valves on each side of the connecting flanges of all loading arms handling flammable liquids, such as crude oil or kerosene, and liquefied petroleum gas (LPG). Use quick-release type flanges so the ship can be cut adrift from the dock in emergencies (Figure 4).

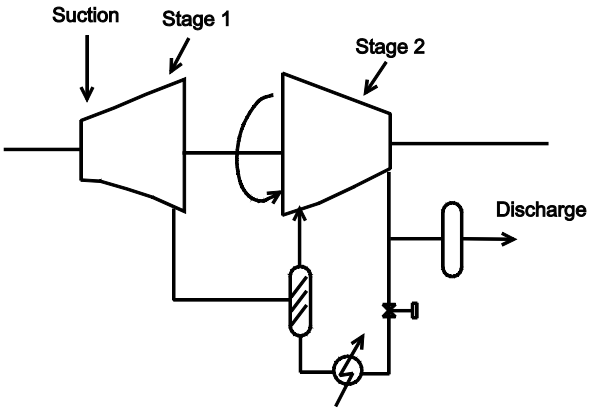

Figure 3. Isolation Valve.

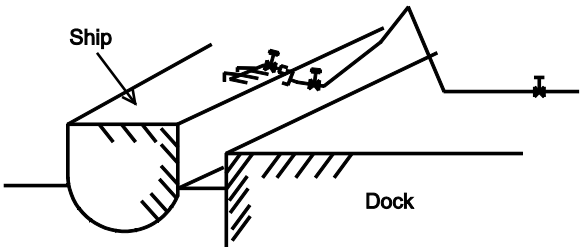

Figure 4. Quick Release Valve.

Interlock the shipping pumps to shut down whenever one of these valves is closed.

Install push button controls in control rooms, at doors and at the loading platforms to stop the pumps, give an audible alarm, and close valves. Keep these buttons at least 25 ft (7.5 m) from the valves.

Determine the speed of closure for these valves, the fireproofing rating for the power cables, and relative size of the air tanks as follows:

- Close cross-country pipeline valves at 10 in. – 14 in. (250 mm – 355 mm) per minute up to the last 25% of closure which must be determined by the surge characteristics of the liquid.
- Close oil loading arm valves and isolation valves in a minimum of 30 s.
- Close gas line valves for operating equipment as fast as possible.

Tank Farms

Choose valving according to the type of tank.

- Install one FSEBV just after the manual valve on the first flange at the bottom of LPG or LNG spheres (Figure 5) and bullets (Figure 6) to prevent liquid escape from a broken flange or damaged discharge line. If the inlet pipe is at the top of the tank and there is no air break, locate FSEBVs on the inlet lines. Install FSEBVs on all bottom fill tanks. Install FSEBVs on all pipes entering and leaving tanks including drain lines, water injection lines and steam heating coils. Also, install excess flow valves inside spheres. Fireproof all piping supporting legs within the tank diked area. Fit FSEBVs on the suction side and a check valve on the discharge side of pumps handling LPGs or LNGs. Activate these valves by a gas detection system or optical detectors. Bond the pipe work to prevent the induction of stray electrical currents.
- Install motorized block valves on the discharge side of crude oil tanks. Locate the cables to these valves underground or in conduit. Fireproof the valves. Choose the fireproofing rating based upon the time required to close the valve under fire conditions. Install manually operated valves 8 in. (20 cm) above the ground for rain water and bottom water drains. Keep these valves closed at all times and supervise them when they are opened after a rain storm.

Many types of tanks are used for different products. Carefully review each installation to ensure the correct valves have been installed.

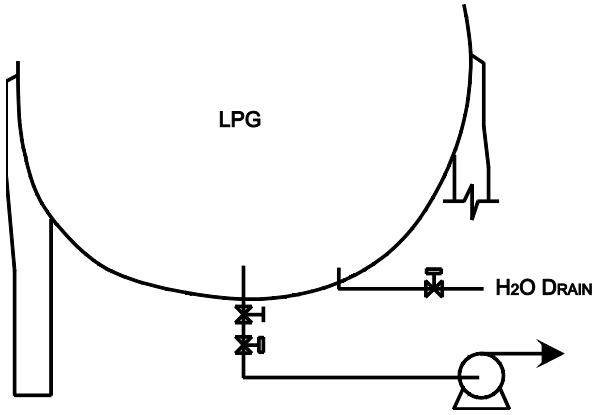

Figure 5. Spherical Bulk Storage Tank.

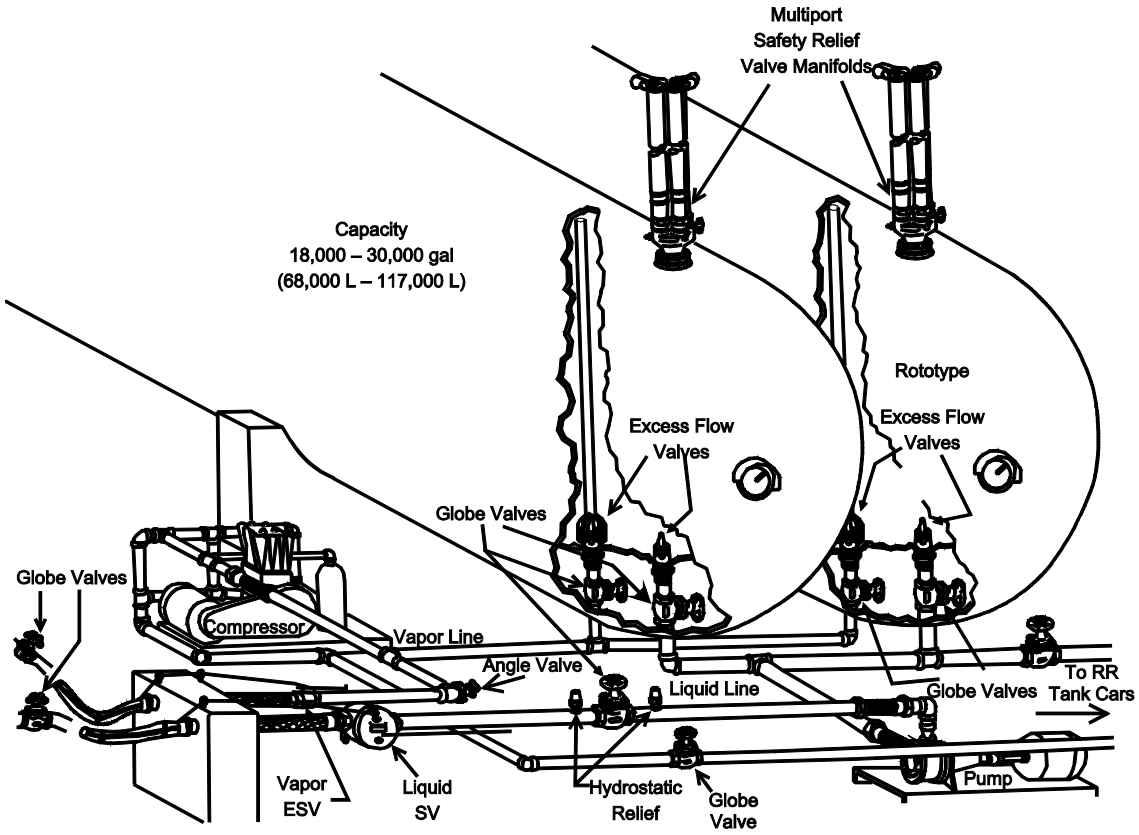

Figure 6. Horizontal Bulk Storage Tanks.

Loading Facilities

Apply the following provisions to tankers that transport flammable liquids (Figure 7):

- Install an excess flow valve inside the tanker to close upon pipe rupture.
- Install internally recessed safety relief valves on the top of the tanker.

Apply the following provisions to tankers that transport LPG:

- Fit both the truck fill line and the vapor recovery line with FSEBVs. Activate them automatically when the tanker moves away without decoupling or manually from a remote location.
- Install interlocks between the grounding wire and the shipping pumps to prevent sparks or static electricity buildup.
- Install safety relief valves at both ends of long runs of pipe to accommodate product expansion due to climate or friction in the pipe. Fit each loading arm with a FSEBV and a breakaway flange or quick release coupling so trucks can be driven away in an emergency. Install excess flow valves in the loading arm pipe work to avoid large spills.
- Install the same features on rail car loading racks as truck loading racks. Also, install a FSEBV as the bottom loading valve. Activate it by a drag wire, which is a 50 ft (15 m) wire attached to the bottom valve (Figure 8).

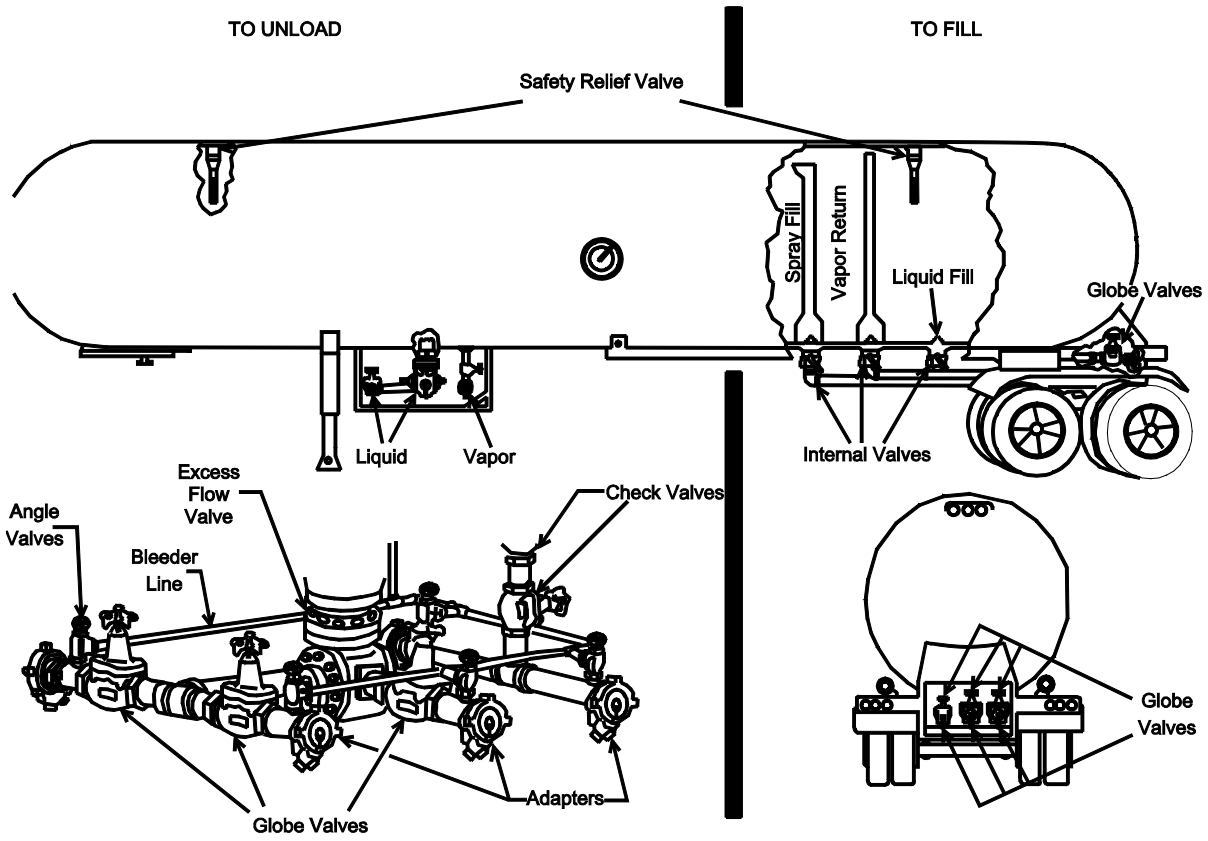

Figure 7. Flammable Liquids Tank Truck.

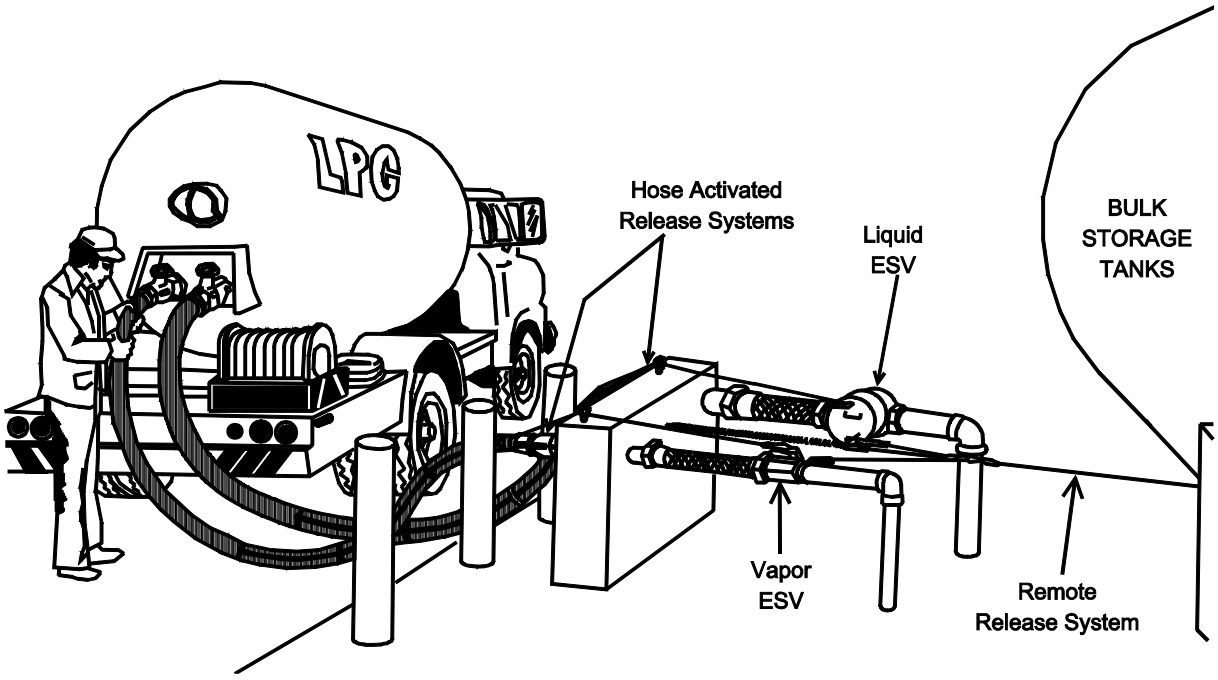

Figure 8. Tank Truck Unloading Station.

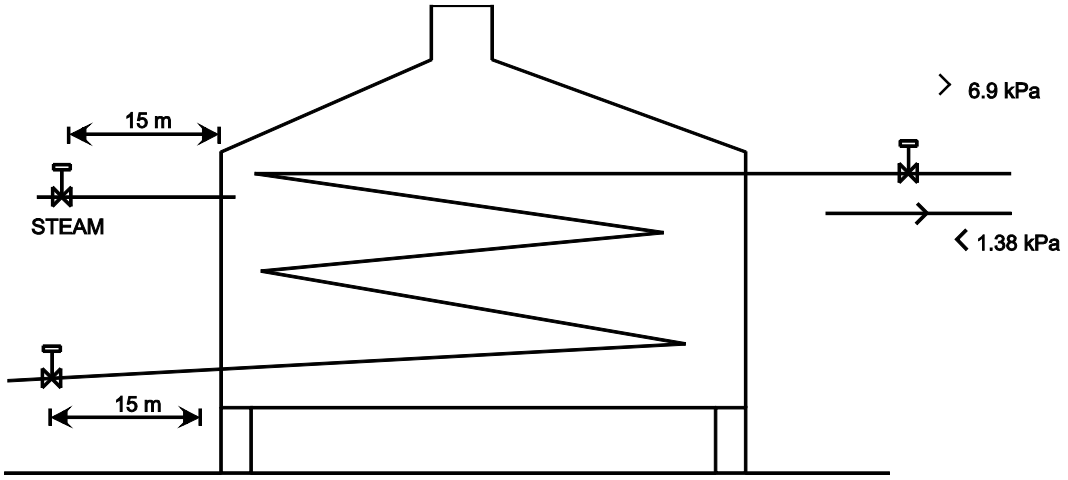

Figure 9. Furnace Product Line Block Valves.

Boilers and Process Furnaces

Arrange combustion controls in accordance with NFPA 85 and NFPA 86. Provide each fuel line with a remotely operated emergency shutdown valve controlled from the control house. Fit each main burner line and pilot line with a manually operated block valve located at least 50 ft (15 m) horizontally away from the furnace. This valve can be a unit block valve.

Locate block valves at least 50 ft (15 m) horizontally from furnaces processing flammable liquids or gases. Block valves located at adjacent pumps and compressors can fulfill this requirement. Use manual valves to prevent blocking in of the process mediums and overheating them in the still hot furnace.

Keep the liquid flowing to cool the tubes slowly and prevent thermal shock. Emergency isolation on the downstream side of a furnace may be required. If flammable liquids are being processed and if vapor blowdowns or liquid pulldowns are absent, do the following (Figure 9):

- If the pressures are between 200 psi (1.38 kPa) and 1000 psi (6.9 kPa), use a swing-check valve to isolate the furnace.
- If the pressure is above 1000 psi (6.9 kPa) then install remotely operated block valves and a furnace overpressure system that can be activated from inside the control room.

Locate steam snuffing valves at least 50 ft (15 m) from the furnace being protected and clearly mark them. If there is a tube rupture and ensuing firebox fire, activate these valves to remove oxygen from the furnace and absorb heat.

DISCUSSION

If a ball valve is equipped with only one seal, the back pressure during a fire could blow this seal, contributing more fuel to the fire.

Many chemical and petrochemical plants are congested, and valves are placed high up in pipe racks to save piping costs. Valves in column, reactor and pump piping systems are the most important in terms of loss prevention and loss reduction and should be easily accessible. Different process units require different types of shut down as temperatures or pressures should be reduced or catalyst removed, depending on the process. The distillation section of a petrochemical plant consists of the following: a tower or column with the bottoms pumps below on ground level; an overhead accumulator or reflux drum supported on a pedestal; and the associated pumps below. In some plants, the reflux drums could be located at the top of the tower and thus the spill volume could be increased to include both the tower and the drum contents.

If the tower bottoms contain 1300 gal (5000 L) then the total liquid holdup on all trays and in the pipe work is probably twice this value. Petrochemical industries should use a 2100 gal (8000 L) limit for

drums since the drainage system, operators and fire crew could probably contain and control a spill fire up to this size.

Check valves will serve to prevent back flow but could warp and stick open in the heat of a fire. They should be avoided if possible.

The response time of compressor isolation systems can be affected by the distance between the compressor discharge and the recycle valve. This volume of gas effects the time constant of a system and leaves the initial compression stages unprotected. The intercooler stages of large compressors increase the working volume and thus affect the time constant. The best method of protection is to have a recycle line and valve upstream of the separation drum and upstream of the coolers. This is costly, since coolers are needed on each process and recycle line.

At marine terminals, manually operated block valves are generally located at loading manifolds and at the shore end of all product lines. Some companies are using remotely operated valves instead, which is better loss prevention practice.

Although tank farms are considered relatively safe, accidents can occur because liquids are being moved, pumped and mixed, leading to splashing, vapor release and mechanical failures.

Crude oil tanks generally do not require fail safe valves since time is usually available to shut down the tank farm before the fire spreads.

Motor operated valves are used in crude oil handling operations because air operated valves do not have the force required to close the valve under full flow conditions. With motor-operated valves, however, entering the diked area could be dangerous because of the electrical ignition potential.

In old facilities, pumps can still be found in the diked area; this is not good loss prevention practice.

Truck and rail car loading and unloading terminals are considered high risk areas. Outside personnel are handling flammable liquids, vehicles may be in poor repair and management programs are difficult to enforce. Some of the risk has been reduced with the industry move toward bottom loading trucks because of vapor recovery units, lack of splashing, low air ingress and special couplings to avoid switchloading. This remains a risk area due to the business interruption potential associated with losing loading racks.

When retrofitting a large existing facility, priority should be given to the most critical valves (Figure 10).

Additional references can be found among API Specification 6FA and API Standard 607.

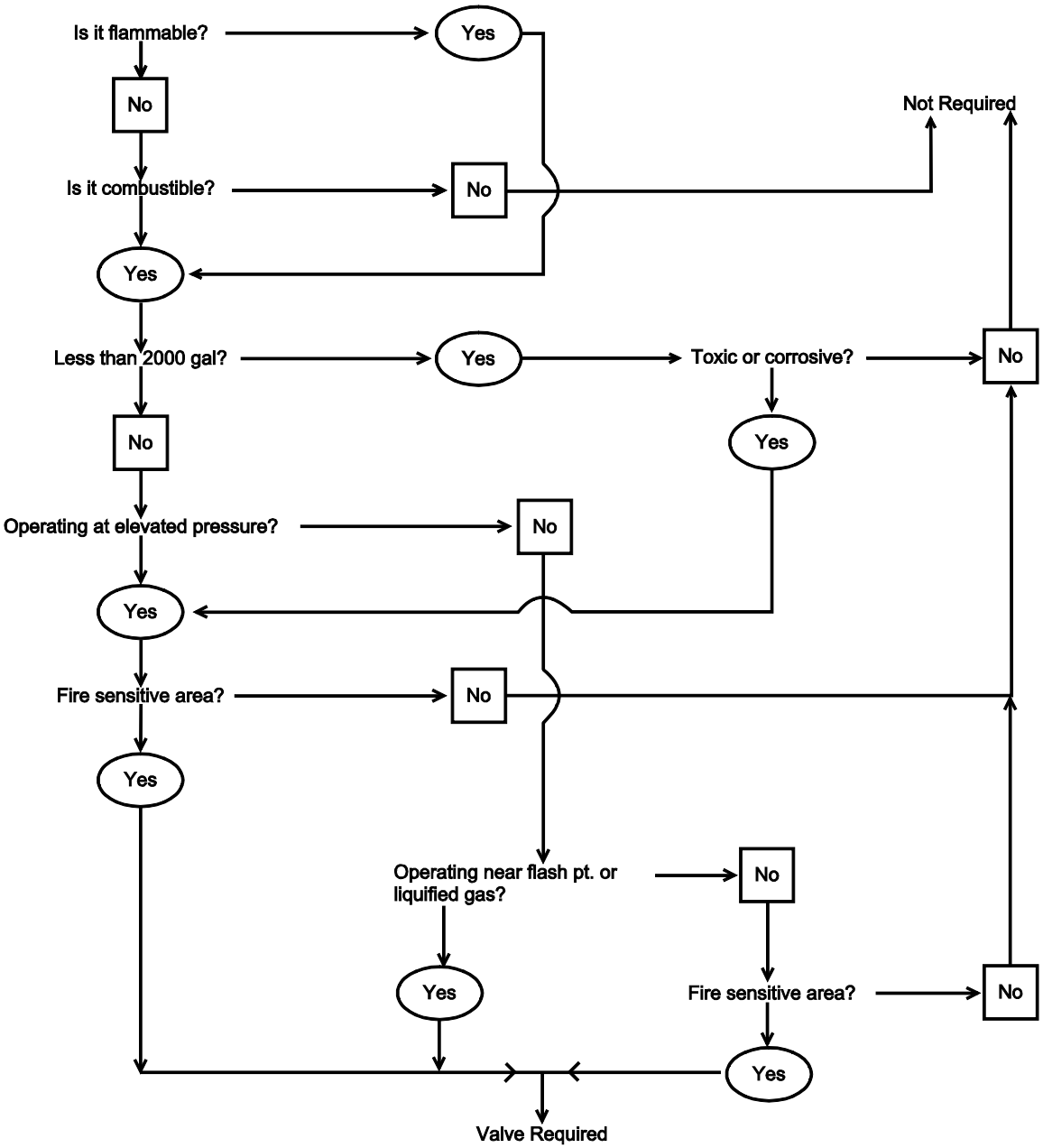

Figure 10. Vessel Liquid Outlet Valve Retrofit Criteria For Refineries.