



## Emergency isolation of process plant in the chemical industry

### Chemicals Sheet No 2

#### Introduction

In the chemical industry there has been a number of major incidents in which loss of containment of a hazardous substance was one of the main factors. These losses occurred because vessels or process plant containing large quantities of hazardous substances could not be isolated quickly enough. Installations which can cause this type of major incident should have emergency arrangements for the safe and effective shutdown of plant and equipment in a controlled manner.

This information sheet considers the general principles of isolation of hazardous inventories to prevent or minimise loss of containment. It is aimed at designers and managers of chemical manufacturing and onshore oil processing operations. The advice given here is relevant when considering preventive and mitigation measures, mainly at process plant, but also at storage tanks and long pipe runs containing hazardous substances and where there is potential to cause a major accident. It does not give detailed guidance on preventive measures for process control, pressure relief arrangements, or emergency shutdown systems in general.

Measures taken to isolate inventories are part of a whole range of means available to manufacturers to ensure that they can take appropriate action in an emergency. Sites may well have different combinations of preventive and mitigation measures.

#### Risk assessment

Emergency isolation arrangements are not only needed at those sites subject to specific major hazards legislation. All operators of chemical plant capable of causing a major accident must carry out a risk assessment as required by the Management of Health and Safety at Work Regulations 1992. You must be able to demonstrate that you have adequate arrangements for preventing a major accident and for limiting the consequences of those which do occur. These include the means to stop or substantially reduce release rates by physically isolating large inventories of hazardous substances.

Manufacturers should be able to demonstrate that they have considered a hierarchy of measures, ie inherent safety followed by measures to prevent, control and minimise the consequences of loss of containment incidents.

#### Inherent safety and safe operation

Any active safety shutdown system or procedure should not be used to rectify or mitigate a potentially hazardous situation brought about by poor plant design. A major objective in the design of any plant should be to make the plant inherently safe - as far as possible by 'designing out' the hazards - so reducing reliance on protective systems. At the initial design stage manufacturers should actively consider using, for example:

- a safer and/or simpler process;
- less hazardous materials;
- reduced pressures and temperatures; and
- reduced inventories.

It is also important that such matters are reviewed regularly during the plant's life, particularly if there is any change, for example introducing a new process or manufacturing system.

Risks arising from site operations should be controlled by good design and plant integrity and effective safety management systems. However, even following these principles, there may still be situations where loss of containment of a dangerous substance could cause a major accident. Emergencies may be dealt with in a number of ways. The most appropriate measures should be determined by risk assessment.

#### Emergency shutdown arrangements

Emergency shutdown arrangements should provide protection against those potentially hazardous conditions remaining in the final plant design and be considered as part of the formal process hazard review.

The action of an emergency shutdown system should be to bring the plant to a safe state. You could do this by:

- closing valves;
- removing power from motors etc;

or it may be more complex involving:

- the venting of process systems simultaneously or in a predetermined sequence;

- providing pressure relief, cooling systems, purging etc.

All these options will depend on the nature of the processes and foreseeable plant conditions.

### **Isolation of hazardous inventories**

In an emergency, rapid isolation of vessels or process plant is one of the most effective means of preventing loss of containment or limiting its size. The extent of isolation provision should be designed to ensure a safe process state and minimise loss of containment.

Emergency isolation facilities and procedures for all significant inventories should be included in emergency plans. Giving information and training to operations and maintenance staff is important. Site personnel should know the contents of the plan, including specific action they should take in an emergency.

Systems for achieving emergency shutdown are given here. The range is not exhaustive.

### **Manually operated valves**

Manual valve isolation may be acceptable in some cases where more rapid emergency isolation is not necessary for preventing a major accident. Manually operated valves should be readily accessible and clearly marked, considering the difficult and confusing circumstances in which emergency shutdown will probably take place. You should not use them in situations where the operator effecting the isolation would be placed in any danger. This will be a major factor in deciding when to use remotely operated shut-off valves (ROSOVs).

However, manual valves will often have been fitted mainly for maintenance work and might not provide the safest or most effective way of achieving emergency isolation. Any mitigation function needs to be specifically recognised and separately considered.

### **Automatic process trips or shutdown valves**

Valves which are activated by process measurement sensor and close automatically on detection of abnormal process or equipment conditions, such as increased pressure or temperature, normally function as part of a trip or shutdown system. They can be designed with an additional function in mind, ie a role in some circumstances in emergency isolation. However, this needs careful consideration, as the valves may need to be capable of providing tight shut-off. Fireproofing may also be necessary to ensure they continue to function in emergency situations.

### **Remotely operated shut-off valves**

Risks from a major accident hazard can be reduced more effectively by fitting pipework with ROSOVs which can be closed quickly in an emergency. They should be installed if a foreseeable release of a dangerous substance from a section of pipework or associated plant could cause a major accident and the consequences could be significantly reduced by rapid isolation. Although ROSOVs are the preferred option other measures might be appropriate, provided the site operator can demonstrate that they can give a similar level of protection.

ROSOVs may be manually activated through push-buttons located at some distance from the valve. Leak detection may trigger an alarm, usually both on the plant and in the control room, to which the operator can respond by operating the ROSOVs and other systems as necessary.

The advantages of manual activation include:

- the value of an operator's assessment regarding the most appropriate measures for dealing with the leak, including isolation;
- avoidance of spurious trips;
- avoidance of the potential failure of an automatic device.

Manual activation should be justifiable and the location of push-buttons must not endanger the operator. They should be accessible and in a safe and suitable place in relation to the emergency which may occur. There should normally be at least two activation points, one of which should be in the plant area. The control room would normally be the best place. Activation points should be readily identifiable both on the plant and in operating instructions.

A more immediate response to potential danger can be provided by ROSOVs which can be activated by a detection system (for example, detectors for toxic or flammable gas or smoke, situated around critical plant.)

Advantages of such automatic activation include:

- elimination of potential operator error;
- more rapid isolation;
- reduction in calculated releases for risk assessment purposes and consequent off-site effects.

Facilities for the manual activation of ROSOVs should be provided as a back-up to automatic activation, which may result in a faster response in some circumstances, for example, on emergency escape routes from plant.

## Design consideration for ROSOVs

Emergency isolation systems should be planned to suit the plant system design and operating practices. ROSOVs may be needed at process vessels, pumps and other ancillary equipment and pipework, taking into account likely points of release such as equipment joints and fittings and rotating equipment, for example pump seals. They should be installed as close as possible to the vessel or plant and be accessible for routine testing and maintenance. Generally, valve closure should be as quick as is possible, bearing in mind system design limitations.

On complex or interconnecting plant the location of ROSOVs requires careful consideration due to the potential for 'boxing-in' of inventories. This can lead to, for example, overpressurisation of the pipework at increased temperatures. The possible effects of spurious trips should also be considered. A formal assessment such as a hazard and operability study (HAZOP) should consider these aspects. Generic assessment based on sound site standards for isolation and other mitigation measures is acceptable. However, it is important to recognise that release scenarios may be specific.

### ROSOV selection features

There are some important features to be considered in selecting an appropriate ROSOV. The valves should:

- be classified as 'safety critical' valves and be subject to appropriate inspection and maintenance requirements. Regular testing is required, especially where valve operation is infrequent. Companies should determine the frequency and nature of testing based on design and use. In the absence of this assessment, a minimum of three-monthly intervals is recommended;
- only perform a dual function (ie control and emergency isolation) in special circumstances and their role in emergency isolation of inventories must be recognised and justified by design;
- employ fail-safe principles. ROSOVs are generally configured to fail closed. Back-up power/air supplies should be provided if closure on failure of plant systems is not acceptable;
- remain in the fail-safe position once operated until manually reset;
- provide effective leak tightness throughout the emergency;
- be protected against external hazards such as fires or explosions, where the major accident hazard is a fire or explosion risk, for example where the valve could be subject to flame impingement.

## Conclusion

Measures designed to prevent loss of containment of dangerous substances in an emergency require detailed consideration. Fitting pipework with ROSOVs which can be closed quickly in an emergency, will often be the most effective option, although other methods might be appropriate, provided they can give a similar level of protection.

### Further reading

*Guidance on the Control of Major Accident Hazards Regulations 1999* L111 HSE Books 1999  
ISBN 0 7176 1604 5 (available in Spring 1999)

*Management of health and safety at work: Management of Health and Safety Regulations 1992 Approved Code of Practice* L21 HSE Books 1992 ISBN 0 7176 0412 8

*Five steps to risk assessment* INDG163 HSE free leaflet 1995; also available in priced packs of 10,  
ISBN 0 7176 0904 9

*Selection criteria for remote isolation of hazardous inventories* CRR 205 HSE Contract Research Report HSE Books 1998 ISBN 0 7176 1678 9  
(available in Spring 1999)

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