

Guide to the Isolation of Pressure Relieving Devices

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Guide to the Isolation of Pressure Relieving Devices

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Engineering Equipment and Materials Users Association

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Foreword

In order to permit their removal and replacement without plant shutdown, pressure relieving devices may need to be isolated from the equipment they protect. The installation of isolating valves around protective devices is however potentially hazardous as it introduces the risk of a system being left unprotected against over-pressure due to the relief path being inadvertently closed off. Existing standards offer little or no detailed guidance in this area.

The EEMUA Pressure Relieving Safety Systems Technical Committee has developed this guide from the experience and practices of its member companies in the petroleum, chemical and power industries. The document expands on the guidance given in API RP 520 Part II.

Abbreviations used in this Guide

PHA: Process Hazard Analysis

LOPA: Layers of Protection Analysis

SIS: Safety Instrumented System

SMS: Safety Management System

CSO: Car sealed open

Relief valve / Safety valve / Safety relief valve:

These terms are widely used in industry and have specific meanings in US standards; however, only 'safety valve' is defined in ISO standards (see API RP 520 Part I and ISO 4126). No distinction is made between these terms in this guide.

HAZOP: Hazard and Operability Study

TAR: Turnaround (maintenance shutdown)

RA: Risk Assessment

RAGAGEP: Recognised and Generally Accepted Good Engineering Practice

1 Introduction

1.1 Purpose

The inspection and maintenance of pressure relieving devices is often required at more frequent intervals than major plant shutdowns (turnarounds). It may also be beneficial to spread-out this work to avoid peak loading during a TAR. Therefore, the means to remove pressure relieving devices without affecting plant operation and with the process on-line is often desirable. This may necessitate the installation of one or more additional relieving devices together with provision for their isolation.

Such isolation introduces the possibility of a vessel or system being inadvertently closed off from its relieving device during normal operation, with the consequential risk of the equipment being subjected to excessive overpressure (or under-pressure). Isolation should therefore be installed only where essential and where the risks have been thoroughly evaluated. Many (but not all) pressure vessel/system design standards allow the isolation of relief devices where a duplicate device with full relieving capacity is installed.

The isolation of all relief systems should be regulated by robust procedures that are strictly adhered to. Where permissible, failsafe design and the locking, or interlocking, of isolation valves may be employed to minimise the risk of inadvertent or unauthorised operation. The safety criticality of procedural controls and the human factor element become even more pronounced where this is not provided. It is essential that systems ensure that an isolating valve cannot be inadvertently left in a position which would allow equipment to be operated without protection against overpressure or underpressure.

There are a variety of procedures and engineering solutions for the control of isolation of relief devices and there are a number of important considerations therein. These are discussed in this Publication.

1.2 Scope

This document sets out guidance for the installation and operation of isolating devices (typically valves) which allow the removal of relief devices from operating plant. It draws on the experience and different practices of EEMUA members to identify the key points which should be considered in the design and management of such isolation systems.

The term 'isolation valve/device' may be interpreted to include spectacle blinds or slip plates where these are used instead of valves for the isolation of relief devices.

The term 'relief/relieving device' normally refers to a safety/relief valve, bursting disc or other mechanical relieving device.

Important: None of the comments or recommendations made in this guide removes from the designer and/or user the responsibility of ensuring that the relief device installation is safe and that it complies with the applicable national and industry standards and regulatory requirements.

1.3 About this Edition

This third edition revises and updates the 2009 second edition. Significantly it also incorporates EEMUA Information Sheet 50 issued 2012, which was issued to provide detailed supplementary guidance on the topic of isolation management around relief systems.

2 Legislation and Standards

2.1 Legislation

It is essential to conform to local statutory legislation or regulations in relation to the use and isolation of, relief devices. In certain countries the conformance to particular standards and codes may be a mandatory requirement and some standards – e.g. those pertaining to boilers – specifically prohibit the installation of isolation devices.

Attention should also be given to industry relief “RAGAGEP” standards such as API / ISO. It is however recognised by the EEMUA Pressure Relief Systems committee that there is limited guidance on how to manage isolations within these documents – hence the role of this guidance document.

In the UK, COMAH regulations require that “all measures necessary are taken to prevent major accidents and limit their consequences to persons and the environment”. For higher hazard sites therefore, the onus is clearly on the operator to demonstrate effective SMS controls.

2.2 Standards

In this guide the term ‘standard’ refers to either design codes or industry recognised “RAGAGEP”. The references and bibliography sections at the end of this text, contain a list of some of the main internationally recognised RAGAGEP, codes and other literature relating to the design, operation, maintenance and management of relief devices. The user or designer should ensure that an appropriate standard is specified or used.

The user or designer should check that the applicable standard does not prohibit the installation of an isolating valve between a relief device and the equipment it is protecting or downstream of the relief device; they should also take account of any special provisions within the standard. While many national standards concerning pressure vessels or systems do not preclude the use of isolating valves around relief devices, certain standards currently prohibit such installations (e.g. EN 12952 for water-tube boilers and EN 12953 for shell type boilers).

Where allowed, the installation of valves to enable relief devices to be isolated from an operating pressure system will require the designer, or user, to ensure that sufficient relief capacity for the system is available at all times when there may be a risk of overpressure. This may necessitate the installation of additional devices and the implementation of procedures over and above those which would otherwise have been required, to ensure the system is adequately protected at all times. The guidance given in this document assumes that the applicable standard does not disallow the use of isolating valves.

3 A Process Safety Viewpoint

A pressure relief device is a safety critical protection. Failure to adequately manage isolations around a relief device can have serious consequences – as illustrated by the examples below. For Process Safety Hazard risk analysis (of the relevant overpressure scenarios), it is important to ensure that the reliability credit taken for the relief device as a layer of protection is not compromised by weaknesses in the management of the isolations around it.

3.1 Learning from Industry Incidents

There are many examples in loss prevention history where the failure to manage relief system isolations adequately has been a major factor in causing process safety incidents, where consequences have ranged from loss of life or serious injury, to major business loss.

Some examples are cited below which illustrate this:

3.1.1 Heat exchanger rupture and ammonia release (1 fatality, 6 injuries), Houston, Texas, June 2008

This incident highlights the consequences of failure to manage isolations to a safety critical protection system. It also highlights the importance of adequate assessment and management controls for abnormal or infrequent activities.

3.1.2 Catastrophic rupture of a liquid nitrogen tank, Japan, August 1992

The danger of using isolation valves below relief devices without a robust system in place to ensure that overpressure protection is always available is clearly illustrated by this incident.

3.1.3 Reboiler explosion (BLEVE) and Fire at Olefins Plant (2 fatalities, multiple injuries), Louisiana, 2013

This incident highlights the dangers of over-reliance on administrative controls for safety critical isolations. This can be a less reliable control due to the possibility of human implementation errors.

Further information on these and other incidents highlighting learnings is presented in Appendix B of this document.

3.2 Relief Valves as a Layer of Protection

It is important to recognise a relief device as a safety critical item of equipment that, if not designed and managed accordingly, can have a major impact on the safety of plant and personnel. This is illustrated by the simple model below (James Reason):

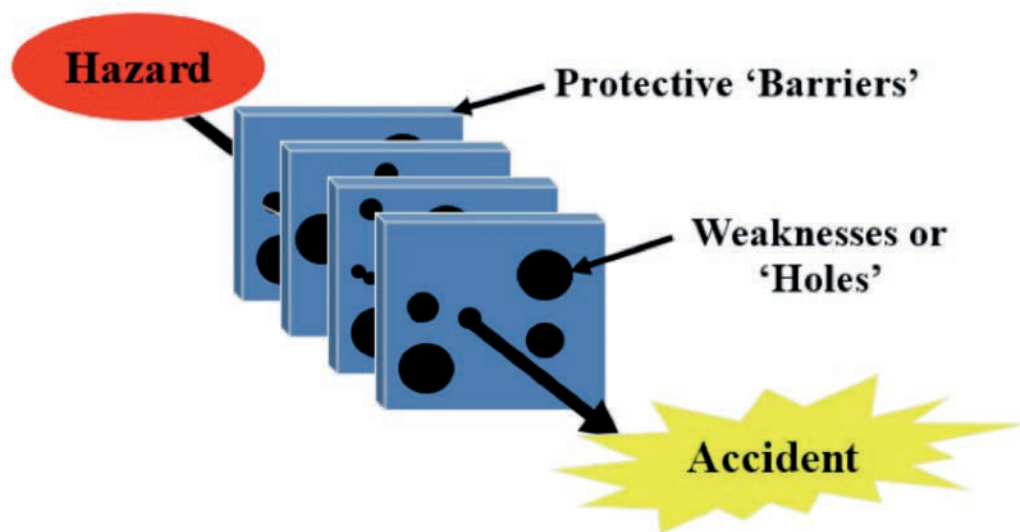


Figure 1: Swiss cheese model

Hazards are typically contained by multiple protective barriers (or layers). Barriers may be physical engineered containment, protective systems or procedural and dependent on people. All barriers may have weaknesses or 'holes'. Human (soft) barriers tend to have more holes than engineered layers.

For effective management of relief system isolations, all the following are important:

- 1) Adequate design
- 2) An effective safety management system for managing relief system isolations
- 3) Good operational discipline
- 4) Regular active monitoring checks to identify gaps / vulnerabilities.

The more the human error aspect can be designed out the better. This document provides some guidance on how this may be possible.

3.3 Reliability

Relief systems can demonstrate a reliability on a par with SIS SIL 1 systems: 90-99% reliability. Such reliability performance is however system and application specific and care needs to be taken when claiming and taking credit for relief systems as an effective and proven layer of protection. The reliability can be used in PHA / LOPA if there is sufficient service data to justify the claimed reliability. A more conservative figure is often used for the relief system as a layer of protection in these analyses.

As with safety critical SIS instruments, isolations must be managed so as not to compromise the reliability expected of the protective device – this can often be the weak link. Human factor analysis techniques can be applied to validate the reliability claimed in the context of the potential hazard and risk for the system that the relief system is protecting.

4 Managing Safe Isolation for Maintenance

4.1 Managing Safe Isolations for Relief System Work

The removal of relief/safety valves for maintenance and testing on live plant is a common requirement. The principles of safe isolation per HSG 253 (or equivalent) should be followed. However, operators are often unclear on what approaches are acceptable. This document is intended to provide some guidance for some particular situations via illustrated examples based on EEMUA member companies experience within the Pressure Relief Systems (PRS) committee.

4.1.1 Examples of Typical Chemical Industry Arrangement

4.1.1.1 Relief system comprised of a duty standby system with each leg containing a bursting disc and relief valve with discharge to atmosphere

In this example, a relief system comprises a duty standby system with each leg containing a bursting disc and relief valve with discharge to atmosphere. Isolation of each leg from the process is via a 3 way valve (or an equivalent system of mechanically interlocked single isolation valves).

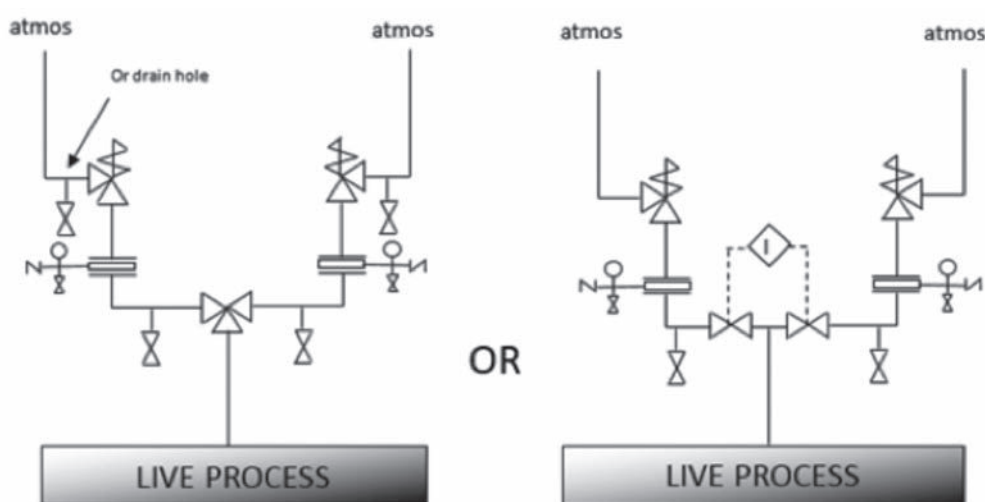


Figure 2: Relief system schematic – Duty standby system with each leg containing a bursting disc and relief valve with discharge to atmosphere"

If on-line maintenance with removal of the relief valve is required, then the principles of HSE Guidance document HSG 253 should be applied. Depending on the hazard condition presented by the live process (chemical hazard, pressure, temperature, etc.) the adequacy of single valve isolation and the ability to safely and reliably test the isolation should be assessed.

The ability to be able to prove the isolation via a bleed valve between the relief device(s) and the isolation valve is important for this purpose.

If the single valve isolation and / or bleed arrangement is inadequate against HSG 253 the options could be:

1. Do not service the relief valve on-line. Schedule the maintenance in a scheduled turnaround when the hazard which the relief valve is protecting against is no longer present or otherwise, shutdown the process to allow the relief maintenance to take place.

or...

2. Risk assess the activity. For example, if the single 3 way isolation valve can be demonstrated to be sound then it may be acceptable under risk assessment to remove the relief valve and immediately blank the off-line relief leg. This would allow the relief valve to be removed to the maintenance shop for servicing. Re-instatement would be a similar procedure under the RA.

Another option that may be prompted from HSG 253 to facilitate future on-line maintenance is to introduce additional isolation valves between the live process and the relief device.

Whilst the installation of additional isolation valves would facilitate and satisfy the safe isolation requirement for on-line maintenance it would also increase the risk of accidental isolation of the relief system from the process during normal operation. This approach would therefore underline even more the need for a robust management system to ensure that a relief device is always open to the process (and the relief vent).

4.1.1.2 Relief system comprised of a duty standby system with each leg containing a bursting disc and relief valve discharge to a common header

This example is similar to § 4.1.1.1 above, except there is an additional consideration in that the relief discharge is to a common header.

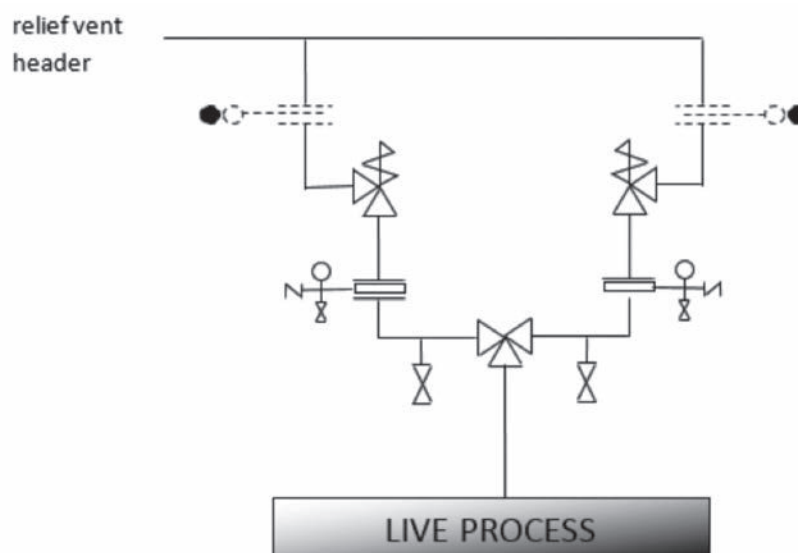


Figure 3: Relief system schematic – Duty standby system with each leg containing a bursting disc and relief valve with discharge to common header