



Document No.	GP 44-25
Applicability	Group
Date	DRAFT 3 January 2007

Guidance on Practice for Depressurisation

GP 44-25

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 44-25. This Guidance on Practice (GP) is based on parts of heritage documents from the merged BP companies as follows:

BP

RP 44-4	Guide to Depressurisation.
CP 37	BP Engineering Code of Practice CP 37 – Guide to Depressurisation.

Uncontrolled Copy

Copyright © 2007, BP Group. All rights reserved. The information contained in this document is subject to the terms and conditions of the agreement or contract under which the document was supplied to the recipient's organization. None of the information contained in this document shall be disclosed outside the recipient's own organization without the prior written permission of BP Group, unless the terms of such agreement or contract expressly allow.



Table of Contents

	Page
Foreword	2
Introduction	6
1. Scope	7
1.1. General	7
1.2. Objective	7
1.3. General requirements	7
1.4. Calculation methods	8
2. Normative references	8
3. Terms and definitions	9
3.1. Terms	9
3.2. Definitions	9
4. Symbols and abbreviations	10
5. General	10
6. Operational vapour depressurisation	11
6.1. General	11
6.2. Plant and equipment	11
6.3. Pipelines	11
7. Emergency vapour depressurisation	12
7.1. General	12
7.2. Vessels, aboveground pipework, and valves	12
7.3. Compressors	12
8. Depressurisation requirements	13
8.1. General	13
8.2. Emergency shutdown system	13
8.3. Emergency shutdown valves	14
8.4. Emergency depressuring (EDP) system	15
8.5. Emergency depressuring valves	16
9. Application of depressurisation systems	16
9.1. General	16
9.2. Manned production platforms and floating production facilities	17
9.3. Unmanned production platforms	17
9.4. Onshore gas/condensate plants	17
9.5. Hydrotreating/hydrocracking reactors	18
10. Time for depressurisation	18
10.1. Fire case	18
10.2. Non-fire case	19
10.3. Stopping depressurisation	19



11. Methods of depressurisation	19
11.1. Uncontrolled depressurisation	19
11.2. Depressurisation by zone	19
11.3. Controlled depressurisation	20
11.4. Depressurisation flow rates	20
11.5. Draindown	20
12. Effects of depressurisation	21
12.1. Auto-refrigeration	21
12.2. Hydrates and ice	22
13. Repressurisation	22
Annex A (Normative) Background to the selected depressurisation time	23
A.1. Depressurisation purpose	23
A.2. Depressurisation systems designed for pool fire exposure	23
A.3. Depressurisation systems designed to minimize leak size	26
A.4. Calculation of depressurisation mass flow rates	26
A.5. API 521 guidelines	27
Annex B (Normative) Methods for estimating the minimum wall temperature of depressurised vessels and pipework	33
B.1 Proposed methods	33
B.2 General assumptions	33
B.3 Vessel contents	33
B.4 Method 1	33
B.5 Method 2	33
B.6 Method 3	33
B.7 Method 4	33
Bibliography	33

List of Tables

Table A1 - High temperature tensile properties for typical carbon steel (1)	30
Table A2 - High temperature tensile properties for 18-8 stainless steel (1)	32

List of Figures

Figure A1 - API RP 521 figure on average rate of heating steel plates exposed to open gasoline fire on one side	28
Figure A2 - API RP 521 figure on effect of overheating steel (ASTM A515 grade 70)	29
Figure A3 - Typical carbon steel (SA-515, grade 70) rupture stress versus time to rupture (bibliographical reference [1], Page 20)	29
Figure A4 - Typical carbon steel (SA-515, grade 70) tensile strength and yield stress versus temperature (bibliographical reference [1], Page 16)	30



Figure A5 - Typical carbon steel (SA-515, grade 70) internal pressure versus pool fire exposure time to minimize potential for vessel rupture	31
Figure A6 – 18-8 grade stainless steel (304, 304L) rupture stress versus time to rupture (bibliographical reference [1], Page 20).....	31
Figure A7 – 18-8 stainless steel (304; 304L) tensile strength and yield stress versus temperature (bibliographical reference [1], Page 140).....	32
Figure A8 – 18-8 stainless steel (304; 304L) internal pressure versus pool fire exposure time to minimize potential for vessel rupture	33
Figure A9 - Effect of depressurisation on reduction of distance to overpressure effects (e.g., side-on overpressure).....	33



Introduction

This Guidance on Practice (GP) provides guidance on depressurising systems that are within its stated scope and is for use in determining the need for, and design of, specific depressurising systems.

This GP refers to National and International Standards that are widely accepted. Codes and Standards of the country where the equipment is manufactured and/or operated should be considered and may be accepted if they can be used to achieve an equivalent, safe, technical result. In any case, statutory and local regulations must be complied with.

The value of this GP to its users is significantly enhanced by their regular participation in its improvement and updating. For this reason, users are urged to inform BP of their experiences in all aspects of its application using the “shared learning” folder on the ETP website.



1. Scope

1.1. General

- a. This GP provides guidance on depressurisation as it relates to system design and selection of process equipment and piping. This GP is applicable to new, above ground plant and facilities and may also be used to assess possible hazards in existing systems.
- b. This GP generally covers the depressurisation of connected systems, typically consisting of one or more pressure vessels, heat exchangers, rotating equipment and other equipment items interconnected by pipework as described herein. During depressurisation of these systems:
 1. Fluid flow may pass through any or all equipment and pipework in the system being considered.
 2. Fluid may reverse flow direction to its expected flow path during either normal or abnormal operation.
 3. Depressurising flow through centrifugal compressors and other rotating equipment may result in “windmilling” of the equipment, which in turn could impact the temperature reached by the fluid (and could cause damage to the rotating equipment).
- c. This document describes and provides guidelines for the Emergency Depressuring (EDP) system and the Emergency Shutdown (ESD) system as it relates to the EDP along with briefly discussing depressurisation as it relates to maintenance. The EDP and ESD systems are integral parts of the overall operations and safety systems provided for a facility.

1.2. Objective

- a. Early detection and isolation of hazardous releases and reduction of certain hazardous inventories can substantially limit the consequences from an emergency situation such as a major release of flammable materials, hydrocarbons or a fire. An emergency Shutdown (ESD) and emergency vapour space depressurisation system shall be provided in situations where rapid isolation of uncontrolled releases is desirable; to shut off secondary fuel sources that could feed a fire or vapour cloud, and to minimize releases through the use of rapid depressurisation. Coupled with a fire and gas detection system, strategically located and properly designed ESD and EDP valves can significantly reduce exposure from fire and vapour clouds.
- b. These systems do not replace any requirement for providing pressure safety valves (PSV) as required by regulation, and are supplemental to plant pressure relief protection systems.

1.3. General requirements

- a. This GP specifies BP general requirements for vapour depressurising systems as applied to all sectors: Exploration and Production; Refining and Marketing; Gas, Renewables, Supply and Trading. However, additional sector factors may have to be taken into account and reference should be made to any sector specific GP(s) in the ETP library.
- b. Plants, systems, and facilities covered by this GP require some form of operational depressurisation. Depressurisation can also be required for emergency situations. Clause 9 provides the information necessary to select a depressuring system and means of disposal applicable to a particular facility.
- c. Contractors are to develop designs and apply their services in accordance with the principles of this GP as amplified or modified by any accompanying supplementary specification(s). Proposed depressurisation designs, services, calculation methodologies, and the final depressurisation system design shall be subject to general discussion with and written approval by BP.



1.4. Calculation methods

This GP provides guidance on calculation methods to be used for determining:

- a. Depressurisation loads.
- b. The effects of depressurisation on the temperature of plant piping.
- c. The effects of depressurisation on the minimum design temperature of vessels.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. The latest edition of the following normative documents apply.

BP

GP 24-03	Guidance on Practice for Concept Selection for Inherently Safer Design.
GP 24-10	Guidance on Practice for Fire Protection – Onshore.
GP 24-20	Guidance on Practice for Fire and Explosion Hazard Management of Offshore Facilities.
GP 24-24	Offshore Passive Fire Protection.
GP 30-35	Guidance on Practice for Control Valves and Pressure Regulators.
GP 30-45	Guidance on Practice for Human Machine Interface for Process Control.
GP 30-76	Guidance on Practice for SIS – Development of the Process Requirement Specification.
GP 30-80	Guidance on Practice for SIS – Implementation of the Process Requirements Specification.
GP 30-85	Guidance on Practice for Fire and Gas Detection.
GP 43-54	Guidance on Practice for Depressurisation of Pipelines.
GP 44-70	Guidance on Practice for Overpressure Protection Systems.
GP 44-80	Guidance on Practice for Relief Disposal Systems.
GP 62-01	Guidance on Practice for Valves.
PSS 10	BP Refining Process Safety Standard No. 10.0 - Hydrotreating/Hydrocracking.
gHSEr	BP's Getting HSE Right.

American Petroleum Institute (API)

API RP 521	Guide for Pressure-Relieving and Depressuring Systems.
------------	--

American Society of Mechanical Engineers (ASME)

ASME VIII	Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels.
-----------	--

American Society for Testing and Materials (ASTM)

ASTM A515	Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher-Temperature Service.
-----------	--

British Standards Institute (BSI)

BSI PD 5500	Unfired Fusion Welded Pressure Vessels.
-------------	---



Energy Institute (Previously known at the Institute of Petroleum)

IP 9 Model Code of Safe Practice in the Petroleum Industry, Part 9 - Liquefied Petroleum Gas.

National Fire Protection Association (NFPA)

NFPA 59A Standard for the Production, Storage, and Handling of Liquid Natural Gas.

Other

BLOWDOWN™ Software developed by Imperial College in London.

Note The contact for information on this program is Dr. Stephen Richardson, Department of Chemical Engineering, Imperial College, London United Kingdom SW7 2BY.

3. Terms and definitions**3.1. Terms**

- a. In this GP the term 'approve', as applied to BP, is used if BP does not wish a design to proceed unless certain features have been agreed in writing with a contractor or supplier. This does not imply that all details in a written document have been considered by BP and does not affect the design responsibilities of the contractor or supplier.
- b. Throughout this document, the words 'should', 'shall' and 'must', when used in the context of actions by BP or others, have specific meanings. For the purposes of this GP, the following terms and definitions apply:
 1. "Should" - is used if a provision is preferred.
 2. "Shall" - used if a provision is mandatory.
 3. "Must" - is used only if a provision is a statutory requirement.

3.2. Definitions**Blowdown**

Can be used interchangeably with 'depressurisation' but more commonly taken to mean a rapid relieving of all system pressure down to atmospheric or low pressure levels.

BP

BP p.l.c. and their associates.

Controlled Depressurisation

An instrument controlled depressurisation generally giving a lower maximum flow rate over a longer period of time than uncontrolled depressurisation.

Depressurise or Depressurisation

To reduce the internal pressure of process equipment.

Draindown

Draining of liquid from vessels or storage to remove the source of flashing liquid that may feed a fire.

Emergency Depressurisation

The ability to rapidly depressurise, by release of gas, a plant or part of a plant in an emergency.



Operational Depressurisation

The ability to depressurise equipment, by release of gas, to permit decommissioning and maintenance operations.

Yellow Shutdown

On an offshore production facility, the production process from wellhead valves to export lines is shutdown and isolated. Other systems remain in operation. This type of shutdown normally includes controlled depressurisation of the production facilities.

4. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

EDP	Emergency Depressuring
EDPV	Emergency Depressuring Valve
ESD	Emergency shut-down
ESDV	Emergency shut-down valve
LPG	Liquefied petroleum gas
MCR	Main Control Room
PAS	Process Automation System
PSD	Process shut-down (i.e. not ESD)
SI	Système International d'Unités
SIL	Safety Integrity Level
SIS	Safety Instrumented System

5. General

A depressurisation system is a means of reducing the pressure in a process plant or pipeline below the normal operating pressure. The main reasons for this are:

- *For maintenance and inspection.*
- *To reduce the failure potential of pressure containment equipment for scenarios involving over-temperature from a fire or exothermic/runaway process reactions.*
- *To minimise release of fuel that may be feeding a fire or could be ignited.*
- *To minimise the uncontrolled release of hazardous gases.*
- *To mitigate the effect (i.e. size and/or duration) of a jet fire.*

Like pressure relief, depressurisation is generally to a flare or remote vent. It is normal to be able to utilise part or all of the relief system for depressurisation.

- a. Disposal is normally to a flare, but an atmospheric vent may be pursued for emergency discharge in rare instances when the project can demonstrate flaring is not an option and GP 44-80 conditions for venting with the required management approvals are obtained.



Vents must also follow applicable local regulations, discharge to a safe location (refer to API 521, Section 5), and have appropriate dispersion analysis conducted.

- b. Depressurisation systems may be installed to cover operational and/or emergency situations and may be automatically or manually initiated.
- c. Depressurisation systems shall be developed in accordance with the strategy and associated performance standards for managing major hazard events in GP 24-03 and either GP 24-10 (for onshore facilities) or GP 24-20 (for offshore facilities) as appropriate.
- d. GP 44-70 and GP 44-80 contain further guidance on both system design and required process components for depressurisation systems.

Dependent upon the nature of the contained fluid, depressurisation can cause low temperatures (auto-refrigeration) which can form large volumes of liquid condensate, plugging of the depressurisation system due to solids being formed (freezing) or the need for more expensive materials to avoid brittle fracture issues.

6. Operational vapour depressurisation

6.1. General

Operational depressurisation is often required for the shutdown of machinery and as preparation for plant inspection and maintenance.

The maximum rate of depressurisation is influenced by:

- *The reduction in temperature due to auto-refrigeration (see clause 12.1),*
- *The disposal system (e.g., flare) capacity, and*
- *The pressure rating of the depressuring system and connected equipment.*

The addition of supplemental fuel gas to the flared gas may be required to maintain the minimum heating value required for proper flare operation when depressuring vessels containing inert gas or other gas with a low heating value.

6.2. Plant and equipment

- a. Sections of plant or individual plant items containing hydrocarbon gas and/or liquid should normally be isolated, depressurised, drained, and purged to allow access for inspection and maintenance.
- b. Offshore, operational depressurisation should use the same valve as emergency depressurisation, if installed, to minimise weight, minimise leakage to flare, and provide a means of testing the valve. For manual depressurising the valve auto position should be overridden by local key lock to prevent the depressurisation logic becoming over complex.
- c. In onshore applications, the system may be the same as offshore; although a dedicated operational depressurisation valve is often used.

6.3. Pipelines

Pipeline depressurisation is not covered within this GP; refer to GP 43-54 for pipeline depressurisation guidelines.

Occasionally depressurisation of pipelines may be required to allow for inspection or repair. Generally, pipeline depressurising times are extensive, measured in days rather than minutes, making the pipeline unavailable for transportation; which may be particularly important when more than a single operator is reliant on the pipeline availability.



7. Emergency vapour depressurisation

7.1. General

Emergency vapour depressurisation is generally used to avoid incident escalation, thereby reducing risk to personnel and limiting property or environmental damage. Examples are:

- a. Reducing the failure potential of pressure containment equipment for scenarios involving over temperature from a fire, exothermic or runaway process reaction.
- b. Minimising the release of fuel that may be feeding a fire or could be ignited.
- c. Minimising the potential uncontrolled release of hydrocarbons or hazardous gas.
- d. Mitigating the effect (i.e., size, impact, and/or duration) of a jet fire.

7.2. Vessels, aboveground pipework, and valves

Vessels and aboveground pipework are normally protected from overpressure in the fire case by relief valves. However during a fire, high pressure vessels or systems can heat-up rapidly and rupture at pressures below vessel design pressure or relief valve set pressure.

The rate of temperature increase and hence the decrease of vessel strength is more rapid for gas filled systems since the rate of heat transfer and thermal capacity for a gas are less than a liquid. The same applies to the gas space of vessels that could be subject to flame impingement.

- a. Provision may be made to insulate the vessel vapour space, or apply external water for cooling, or to depressurise the vessel by means of a vapour depressurising system. When dealing with vapour, the objective of a depressurising system should be to keep the internal pressure of the exposed vessels and piping below the rupture pressure as the yield stress of the wall reduces due to overheating.
- b. Depressurisation may also be used to minimise uncontrolled release from a vessel or pipework resulting from a leak such as a blown gasket or leaking valve.

Detection of the gas followed by depressurisation minimises the possibility of ignition. If ignition has already occurred, depressurisation on fire detection limits fuel supply to the fire.

- c. The platform topsides section of a subsea pipeline, including the pig launcher/receiver and downstream pipework to the pipeline ESDV at the riser/topsides interface, should be depressurised through the normal platform system. The platform design shall ensure that the ESDV and downstream pipeline are fire protected, so the pipeline inventory can be maintained.
- d. Deluge systems are designed to minimise the temperature rise of equipment in and surrounding a fire. Passive fire protection may be considered for vessels particularly at risk in a fire, in addition to or instead of deluge systems. Refer to fire protection GP category 24 for more specific information and GP 30-85 on fire and gas detection.

7.3. Compressors

- a. Blocking in and depressurisation of centrifugal compressors is required on seal oil failure. Depressurisation is required within the hold-up time of the seal oil overhead tank to prevent gas escape via the seals.
- b. For compressors with seals not relying on a seal oil system to contain the gas, the compressor may be considered as part of the depressurisation system.

