

DEP SPECIFICATION

**DESIGN OF PRESSURE RELIEF, FLARE AND VENT
SYSTEMS**

DEP 80.45.10.10-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of pressure relief, flare and vent systems.

Surge relief valves are excluded from the scope of this DEP.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2012; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Absolutely Dry Gas	Stream contains no liquid and will not condense liquid at ambient temperature range associated with the location.
Balanced PRV	Pressure Relief Valve that incorporates a bellows or other means for minimizing the effect of backpressure on the operational characteristics of the valve
CDTP	Cold differential test pressure
Combination Capacity Factor	The capacity of a PRV in combination with a rupture disk device, where the rupture disk device is located at the valve inlet.
Combustion efficiency	The percentage of the combustible fluid totally oxidized in the burner. In the case of hydrocarbons, combustion efficiency is the weight percent of carbon in the original fluid that oxidizes completely to CO ₂ .
CSO	Car Seal Open
Deflagration	Combustion that propagates through a gas at subsonic speeds, driven by the transfer of heat
Detonation	Sonic Combustion. Detonation results in greater overpressures compared to a similar Deflagration
E&P	Exploration and Production
EHT	Electrical Heat Tracing
Essentially Dry Gas	Liquids in the stream as less than 5 % on a mass basis and the liquids are considered non-fouling / non-solidifying
Flare Burner/Tip	The part of the flare where fuel and air are mixed at velocities, turbulence and concentrations required to establish and to maintain proper ignition and stable combustion
HSE-MS	Health, Safety and Environment Management System
IPF	Instrumented Protective Function
LDT	Lower Design Temperature – Per DEP 01.00.01.30-Gen. The LDT is the lowest temperature to which equipment may be safely subjected at its design pressure with respect to brittle fracture control (see DEP 30.10.02.31-Gen.).
LNG	Liquefied Natural Gas
LO	Locked Open
LODMAT	Lowest One-Day Mean Ambient Temperature
LPG	Liquefied Petroleum Gas
PFD	Probability of Failure on Demand
PORV	Pilot Operated Relief Valve
Process Unit	Subsection of a larger facility as defined by the facility PEFS.
PRV	Pressure Relief Valve
PS	Process Safety
TERV	Thermal Expansion Relief Valve
UDT	Upper Design Temperature – Per DEP 01.00.01.30-Gen. The UDT is the highest temperature to which equipment may be subjected at the upper and/or lower design pressure.

Term	Definition
Unit	See Process Unit
Very Toxic	Substances that are very hazardous for the environment or human health, as specified in DEP 01.00.01.30-Gen. This includes all three sub classifications: acute, chronic and environment.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (12).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2012. The following are the main, non-editorial changes.

Section/Clause	Change
General	Removed ISO references and replaced with API equivalents
1.1	Moved 6 paragraphs into new Section 2, titled General Requirements
1.3.2	Added clarification that the "Very Toxic" category includes all sub classifications
2 through 12	Renumbered all sections after Section 2 and added clause numbering
3.1.1 item 9	Changed wording so the area of the PRV inlet is used as opposed to using the nominal size.
3.1.3 item 3	Reduced port valves no longer allowed
4.1.1 item 1	Removed wording that allowed disposal of operational waste streams without a suitable outlet.
4.1.4 item 2	Defined an open drain
4.1.5.1g	Remove a SHALL [PS] that required a risk assessment since it is part of Managing Risk.
4.2.1 item 1	Added clarification for analysis on multi-unit facilities
4.2.1 item 5	Added Shell Flare Bundle Method as an analysis method
4.2.1 item 5	Added example of where a reduction in flare loading is appropriate
4.2.1 item 7	Added wording on when the usage of a dynamic methodology is acceptable
4.2.2 item 1	Removed reference to LNG and generalized for multi unit relief.
4.2.3 item 4	Added caution on using the Shell Flare IPF methodology
4.2.4 (new)	Added a high level description of Flare Bundle Method
4.2.4 item 1	Removed wording that the Bundle Method builds upon IPF
4.2.4 item 5	Added wording to describe the need for independency of instrumentation in the long term
4.2.4 item 7	Added clarity that the Bundle method requires commitments from several parties to maintain instrumentation barrier independency
4.3 item 4, 5	Added potential problems due to high Mach numbers

Section/Clause	Change
4.4.1 item 3	Added clarity on welding subheaders into main headers
4.4.2 item 4	Added wording that reaction moments during full relief should be considered
4.7.6	Corrected equations on FIV and AIV
4.7.6	AIV study now required regardless of size or schedule
5.1.1.3	Added a SHALL [PS] that KOD should be designed with considerations for relief fluids' interactions.
5.3.1	Added purge requirements to all sealing systems
5.3.3.1 item 2	Added clarity that an alternative method should be at least as reliable as a liquid seal
5.3.3.3	Removed, since purgeless systems should not be allowed
6.2.2.4b	Added clarification that thermal radiation limits are for emergency scenarios.
6.2.2 row 1 of table	Added startup and shutdown for continuous exposure limit
6.2.2	Note 1 added, Personnel height defined conservatively as 2 m (6.6 ft)
6.2.2 item 6	Added side view radiation considerations for equipment location
6.3.2ab	Added clarification that Pasquill-Gifford Stability Categories are used.
6.3 item 1	Added wind speeds for dispersion calculations
8.1 item 1	Added a SHALL [PS] for purge requirements
8.1 item 1	Added equipment needed at purge station
Appendix 1	Changed spectacle blinds to optional (Figure not numbered)
Appendix 7	Added note that purge rate for elevated flares may not be same for ground flares
Appendix 7	Added graph for purge rated in USC units

1.6 COMMENTS ON THIS DEP

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DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL REQUIREMENTS

1. The relieving facilities for pressure vessels shall be in accordance with the following standards (if applicable), as clarified, amended or supplemented by this DEP:
 - a. Pressure Vessel Code(s):
 - i. ASME VIII, Division 1 or 2;
 - ii. PD 5500;
 - iii. EN 13445;
 - iv. GB150;
 - b. API RP 520, Part I and Part II;
 - c. API Std 521);
 - d. API Std 2000).
2. The prevention of and protection against overpressure and underpressure shall be in accordance with DEP 80.45.10.11-Gen.
3. Emergency depressuring and sectionalizing shall be in accordance with DEP 80.45.10.12-Gen.
4. Flare and vent tips shall be in accordance with DEP 80.45.11.12-Gen., Section 4.5 through 4.10.
5. Flare pilot and ignition systems shall be in accordance with DEP 80.45.11.12-Gen., Sections 4.7 through 4.9.
6. Flare derrick structural support design shall be in accordance with DEP 80.45.11.12-Gen., Section 5.10.

3. PRESSURE RELIEF DEVICES

3.1 RELIEF DEVICE LOCATION, MOUNTING POSITION, INSTALLATION AND ARRANGEMENT

3.1.1 General

1. The objectives of relief devices, their installation and arrangement shall be as follows:
 - a. The pressure equipment in operation shall always be protected against overpressure by a relief device for applicable scenarios;
 - b. The design shall permit maintenance of the relief device.
2. Relief devices in vapour- liquid systems shall be connected to the protected equipment in the vapour space above any contained liquid or to piping connected to the vapour space. This means that the relief device is preferably connected to the highest point of the vessel.
 - a. An exception may be made if the vessel is fitted with internal restrictions (e.g., demister mat, coalescing pads). In this case the relief connection shall be upstream of the mat. The relief valve may be installed downstream of the demister mat if the relief flow is not greater than the operating flow.
3. The relief device location shall be such that the integrity of the relief path is maintained; taking into account the potential for hydraulic restrictions that could compromise the relief valve function or capacity due to undetected fouling or damage.
4. Relief valves shall be installed in the upright position. Relief devices discharging to closed relief systems shall be sufficiently elevated to drain to the downstream header.
5. Relief valves connected to a vapour space shall have an inlet line that is self draining into the vapour space. Alternatives such as drain systems or heat tracing shall only be implemented where there are minimal liquid reliefs and by approval of the Principal.

6. TERVs may be installed with pocketed inlet and outlet lines provided plugging and freezing within the inlet or outlet lines will not occur or is prevented from occurring.
7. For installation requiring heat tracing, refer to (3.2.3).
8. Relief valve bypasses may be installed to depressure equipment during shutdowns. The sizing of the bypass shall be within the flare system capacity as this could lead to a flare sizing basis.
9. The opening through all pipe, fittings, and nonreclosing pressure relief devices (if installed) between the protected equipment and its pressure relief valve shall have at least the area of the pressure relief valve inlet
10. Rupture disks come in forward acting and reverse buckling designs. Therefore, the rupture disk shall be installed per the flow direction shown on the rupture disk tag for proper orientation.

3.1.2 Inlet piping pressure losses

1. Hydraulic calculations shall be performed for all non-recoverable inlet line losses at each relevant allowable accumulation. All relief devices, except directly mounted tank pressure vacuum vents and TERVs (where heat gain is via the environment and not via the process), require inlet loss calculations.
2. Based on the rated relief valve capacity at the allowable overpressure, the pressure drop in the inlet piping and fittings for new facilities shall not exceed 3 % of the valve set pressure. Exceptions to this requirement are allowed in the case of a pilot-operated relief valve (PORV) with a suitably arranged remote pilot sensing connection close to the source of overpressure. Refer to DEP 80.36.00.30-Gen. and API 520 Part I for more details on use and applicability of PORV.
3. For systems containing pressure relief valves in combination with rupture disks, the pressure drop across the rupture disk shall be ignored if the inlet losses are based on the PRV's capacity adjusted with the certified Combination Capacity Factor. However, if inlet loss assessment involves rigorously calculating the inlet pressure of the PRV, the effects of the rupture disk shall be taken into account.

3.1.3 Spare relief devices and isolation philosophy

1. The asset or project shall have a spare relief and isolation philosophy agreed with the Principal. If a specific isolation philosophy is not written, the default philosophy shall be to have installed spare relief capacity with isolation valves to facilitate maintenance. For philosophies without installed spare capacity, the philosophy shall state whether inlet and outlet isolation valves are required.
2. If the normal operating pressure is atmospheric pressure (e.g., in an atmospheric storage tank), no inlet isolation valve is required.
3. The port size of the inlet and discharge isolation valves shall be in accordance with ASME VIII so that the flow area shall be no smaller than the inlet and outlet of the relief device and shall be consistent with the port size assumptions used in the hydraulic calculations. Ensuring full-port valves for valves smaller than DN 80 (NPS 3) requires special attention (noting that valves to ISO 15761/API 602 are normally reduced port for these sizes, which are not allowed in this application).
4. The facility isolation philosophy and design shall ensure adequate isolation between the process systems to be isolated and the flare or other closed system to which relief valves discharge.
5. Inlet and outlet piping for PRVs shall not have check valves since their failure may result in a blocked relief path.
6. For pipeline TERVs (which may be removed while the system is in operation), a single relief valve with upstream and downstream isolation valves may be provided. Strict procedural controls should ensure that the line is not shut in while the relief valve is out of service.

7. Typical relief valve isolation is shown in (Appendix 1).

3.1.4 Isolation valve operation control

1. The method for managing the valve positions SHALL [PS] be consistent with the site HSE-MS and agreed with the Principal. The preferred method for controlling this is to use valve interlocking systems on block valves used on the inlet and outlet of relief valves, their spares and their open spool pieces in accordance with DEP 80.46.30.11-Gen.
2. Alternatively, valve locks or car seals may be employed with the agreement of the Principal provided there are strict administrative controls in place. To confirm the proper operation of the upstream block valve, a vent connection shall be provided between the upstream block valve and the relief valve.
3. Butterfly valves shall not be used in relief device inlet and outlet piping, but are allowed downstream in the flare header per (4.4.1).
4. Isolation gate valves in the relief system SHALL [PS] have their stems in the horizontal position. This requirement applies to all isolation gate valves for relief devices, flare laterals, flare headers, and KO vessels. This is not a requirement for PRV bypass gate valves.
5. Isolation gate valves for emergency depressuring valves shall have their valve stem in the horizontal position, unless otherwise approved by the Principal.

3.1.5 Balanced PRV bonnet venting

1. Balanced PRVs in very toxic service or balanced PRVs that discharge into a closed system containing very toxic substances shall have the bonnet vent discharge to a safe location. The amount of toxic gas leakage shall be estimated assuming complete failure of the bellows with the flow limited by the annular area between the disk holder and the guide, vent hole in the valve guide plate (if the vent hole is present), and vent opening in the valve bonnet.
2. It shall be demonstrated by dispersion analysis that the toxic gas levels that may flow from the bonnet vent or associated vent tubing are acceptable where personnel may be located. If the vent tubing is installed it shall be designed to prevent ingress of rain and shall have no pockets. If this is not practical, another type of relief device shall be used.

3.2 PREVENTION OF MALFUNCTIONING OF RELIEF VALVES

3.2.1 Relief valves affected by hydrates and freezing

1. The Joule-Thomson effect, which occurs across the relief valve when relieving, may lower the temperature to within the hydrate or ice formation region. Due to the high velocities, there will likely be no problem of relief valve blockage at relieving conditions. For additional details, see (4.5).
2. Valve blockages due to small leaks across the relief valve seat resulting in hydrate formation and freezing could occur. To prevent this blockage, install a bursting disk upstream of the relief valve or add heat tracing/insulation around the relief valves that can be affected by the hydrates and freezing.
3. If a relief device and/or its inlet/outlet piping requires heat tracing to ensure an open relief path, then:
 - a. Steam tracing system shall have dual circuits (i.e., dual supply, tracers, and traps).
 - b. Electric tracing system may use diagnostic alarms instead of dual tracing circuits. These alarms shall be segregated from non-critical heat tracing alarms and appropriately classified by the alarm management work process.

4. The integrity of the heat tracing shall be ensured by proper instrumentation including low temperature alarm on the valve/piping itself. In addition, the injection of hydrate inhibitor may be considered.
5. Removable insulation covers shall be used on relief devices if insulation is required.

3.2.2 Relief valves affected by corrosive process fluids

1. Corrosive fluid may attack the internals of the relief valve. Proper material selection and associated maintenance philosophy is required to guarantee the suitability of the relief valve. Furthermore, a relief valve cannot be assumed to be fully leak-tight and corrosive fluid may then enter the flare/relief system.
2. To prevent the fluid from corroding and/or passing through the relief valve, one of the following preventive actions shall be taken:
 - a. purging or flushing of the inlet piping with a clean fluid which can be accommodated by the process.
 - b. installation of a bursting disk upstream of the relief valve.

3.2.3 Relief valves affected by solidifying process fluids

1. Although relief valves are installed at the highest point of the vessel, which normally contains vapour, it shall be assumed that liquid may reach the relief valve. This could be by condensation or by liquid entrainment during emergency relief action.
2. This liquid could solidify (e.g., high pour point liquid) or form coke and affect the operation of the relief valve and downstream piping. If this can be the case, either or both of the following preventive actions shall be carried out:
 - a. Provision of heat tracing at the relief valve and along its inlet and outlet piping where heat tracing is known to eliminate the solidification of the specific products. Some coking materials may not be removed or may even be formed by heat tracing.
 - b. Purging or flushing of the inlet and outlet piping with a clean fluid that can be accommodated by the receiving system.

4. FLARE AND VENT SYSTEMS

4.1 SELECTION OF DISPOSAL SYSTEMS

4.1.1 General

1. Streams requiring disposal:
 - a. relief vapour and/or liquids;
 - b. depressuring vapours;
 - c. waste streams associated with maintenance, start-up or shutdown activities.
2. Disposal streams shall be collected in a closed system and directed preferentially to a flare, unless they meet the requirements of this section for atmospheric venting or they can be sent back into the process or stored.
3. Continuous sources of hydrocarbon shall not be vented or routed to flare for disposal, unless specifically permitted under the HSSE Control Framework, within the Continuous Flaring and Venting Manual.
4. To limit flaring, flare gas recovery may be required by the HSSE Control Framework.

4.1.2 Disposal back into process or storage

1. Disposal back into the process or storage has the advantage of minimizing the product releases; the pressure in the receiving system into which the relief valve discharges generally varies between certain values. The maximum value of this pressure shall be

taken as the constant superimposed backpressure (typically, the set pressure of the downstream system) for the determination of:

- a. relief device capacities;
 - b. the maximum allowed Cold Differential Test Pressure (CDTP) for conventional relief valves.
2. If the discharge of the higher-pressure relief valve is handled by the relief valves of the lower pressure system, it shall be checked that these are adequate for the additional load.
 3. If the relief valve is of a conventional type, it shall be checked that the lowest pressure of the process system into which the relief is discharged does not cause inadvertent discharge of the relief valve with its spring setting (CDTP) determined on the basis of the highest constant superimposed backpressure. For this check, the lowest pressure of the process system under all foreseen process conditions (including start-up and shut down) shall be used.
 4. Two-phase releases that discharge back to process shall be evaluated for slug flow; see (4.7.3).

4.1.3 Segregated flare systems

1. The need to segregate flare systems shall be analysed.
2. Streams containing highly corrosive or very toxic vapours shall be neutralised before being discharged into the flare system. For disposal of hydrogen sulphide gas, see (4.1.6).
3. When the requirement for a high and low pressure disposal system is considered, the relief valve set pressures present in the system shall be taken into account.

4.1.4 Disposal of TERV discharge

1. TERVs shall discharge back into the process, the storage system, or a plant disposal system;
2. TERVs shall not discharge to an open drain unless all of the following are met. An open drain is any drain open to the atmosphere prior to the drain reservoir (sump):
 - a. Discharged liquid cannot be accepted back into the process, storage or plant disposal system,
 - b. It is acceptable per local regulations,
 - c. The environmental impacts are deemed to be acceptable,
 - d. Any contained light hydrocarbon discharge is at a location where it will safely disperse,
 - e. The stream does not contain any fluids defined as very toxic,
 - f. Agreement by the Principal.
3. Liquids containing components that impair gravity separation like emulsifying agents or spent chemicals that tend to flocculate upon dilution shall not be discharged into the oily open drainage.
4. Liquids containing components that impair biological activity shall not be discharged into open drainage systems leading to a biological waste treatment unit.
5. Line-up details are shown in (Appendix 2).

4.1.5 Atmospheric discharge

4.1.5.1 Direct venting

1. Disposal of combustible, flammable, toxic, noxious or corrosive materials by venting directly from relief devices to atmosphere for facilities other than storage shall only be allowed with approval of the Principal where all of the following criteria are met.

- a. Disposal by venting is allowed by local regulations.
- b. The vapours are such that the condensation of flammable, corrosive or toxic substances cannot occur. This shall be calculated through a dispersion analysis, or reviewing the phase envelope of the relief stream. The LODMAT value shall be used in this calculation;
- c. The release of flammable vapours occurs only in an emergency situation.
- d. The vapours are lighter than air. Dispersion analysis; based on the full range of possible flows through any individual modulating pressure relief device directly venting shows that the limits of flammability satisfy the criteria outlined in (6.3). Calculations of effluent emissions shall be submitted for the approval of the Principal.
- e. In the event of accidental ignition of the vent, flames shall not impinge upon adjacent equipment and the thermal radiation to equipment or personnel shall be within the limits of (6.2.2).
- f. The (hot) vented stream cannot self-ignite; the systems being protected by relief devices or piping discharging cannot contain any hydrocarbon liquid that will be above flash point if released.
- g. Discharge piping shall have no pockets, shall discharge vertically, and shall be above the tallest plant structure within a horizontal radius of 15 m (50 ft).

4.1.5.2 Disposal through common vent stack

1. A common vent stack may be used to combine a group of direct venting individual reliefs where the use of a flare is not practical. Where this is done, it shall be assured that the disposal streams do not contain products which, when mixed with other relief streams, may endanger the operation of the vent system through exothermic reactions or the formation of deposits, freezing, solidification, etc.
2. The requirements in (4.1.5.1) shall also apply to designs involving multiple relief valves discharging through common vent system.
3. The vent system is provided with a KO drum, see (5), to prevent the release of any toxic or combustible liquids.
4. Dispersion analysis, based on the full range of possible flows including $\frac{1}{4}$ of the flow through any individual pop action pressure relief device connected to the vent, shall show that the limits of flammability satisfy the criteria outlined in (6.3).
5. Disposal of LNG and LPG storage facilities to atmosphere shall not be allowed through common vent system. See also DEP 30.06.10.12-Gen.

4.1.6 Disposal of hydrogen sulphide gas

1. Streams which are rich in hydrogen sulphide (contain more than 1 % H_2S), such as relief streams from sulphur recovery plants, shall not be discharged into a common HC flare or vent system unless it has been designed for this purpose. An increase in purge gas flow may be required when H_2S rich gas is relieved through a common HC flare or vent system.
2. H_2S -rich streams shall have a separate line-up, preferably a separate flare stack with the installation of gas assist flare burner tips or equipped with a tip of the air pre-mix ("Bunsen") type.
3. If a hydrogen sulphide flare relief system is used, this shall be heat-traced up to 4 m (13 ft) below the top of the stack. No liquid seal drum shall be applied. Header materials shall be carbon steel, except for the top 4 m (13 ft) of the hydrogen sulphide stack, which shall be of type 310S stainless steel.
4. The KO drum for the hydrogen sulphide flare system SHALL [PS] conform to the requirements of (5.1.1).

5. Facilities for injection of assist gas in the flare for adequate combustion and plume buoyancy shall be provided.

4.1.7 Discharge of oxygen-containing gas

1. Streams that contain oxygen (or air) shall not be discharged into a common flare or vent system on a continuous basis, unless this system is free from H₂S and no flammable mixtures are created.
2. Flammable mixtures of gas and oxygen (air) shall not be permitted in a common flare or vent system due to the risk of a detonation blast wave inside the header piping.
3. If an oxygen-containing stream is considered for intermittent routing to the flare system such as a relief event, for example on trip of a waste gas burner, a sufficient fixed purge of fuel gas or nitrogen shall be added and an oxygen analyzer/trip shall be provided. An alarm shall also be provided on the source of the oxygen containing stream to alert operations, rather than wait for the analyzer in the discharge system to alarm.
4. Relief devices in oxygen service shall meet the requirements of DEP 31.10.11.31-Gen., Section 4.4.3, Relief valves.

4.1.8 Process equipment in the discharge system

1. Process equipment (e.g., neutralizers, scrubbers etc) designed to treat the material in the discharge streams shall be designed for the largest required relief load(s). The relief devices upstream of the process equipment shall be identified in order to determine the design load scenario.
2. The backpressures and fluid changes of state (gathering of liquid leading to two phase flashing flow in the discharge system) caused by proper operation of this equipment shall be included in the relief system design.

NOTE: The design load scenario for sizing the process equipment may differ from the scenario for sizing the flare or flare lateral.

3. Where the processing equipment has internals that could foul, freeze, or plug (either from ambient conditions or process interactions), there SHALL [PS] be an emergency bypass consisting of a bursting disk or a buckling pin device sized to pass the entire discharge flow.
4. In order to avoid the use of emergency bypass:
 - a. Where there is the possibility that liquid could freeze from ambient conditions, heat tracing should be used.
 - b. Where there is the possibility that liquid could freeze due to process interactions (e.g., a large LPG release), the inlet nozzle shall either be above the liquid level or have an internal heater device with temperature control and alarm.

4.1.9 Atmospheric and low pressure tank vents

1. For the pressure relief and venting of low-pressure storage tanks, including refrigerated storage tanks, refer to DEP 34.51.01.31-Gen. Annex L, (Normative) Requirements for venting system.

4.2 FLARE/VENT SYSTEM ANALYSIS METHODS

4.2.1 General

1. In order to size the main headers, the maximum load that can be expected at any one time SHALL [PS] be ascertained in accordance with methodologies described in this section.
2. The facility wide impact of total or partial utility failure SHALL [PS] be ascertained. The Principal shall approve the methodology used and the results.

3. Latent or undetected failures in combination with a relieving scenario shall not be assumed to be double jeopardy.
4. The main flare header SHALL [PS] be sized for both individual relief system flare loads as well as simultaneous flare loads during common mode failures.
5. While some flare systems are designed for 100 % of the flare load, there are some applications, such as multi-unit facilities, where a reduction in flare loading is appropriate.
6. The normal method used to analyse a conservative reduction in flare loads is the 100-50-50 approach; see (4.2.2). An alternative to the 100-50-50 approach is to use the Shell Flare IPF methodology or Shell Flare Bundle Method; see (4.2.3 and 4.2.4). 100:50:50 approaches shall not be combined with the other approaches to analyze the same common mode scenario.
7. Dynamic methodology shall not be utilized in the analysis of the flare header hydraulics. However, dynamic analysis to determine relief loads from a pressure systems is allowed, The resulting relief load shall be entered in the flare hydraulic analysis as a steady state load.
8. Flare loads from systems with depressuring valves shall include the larger of:
 - a. the required relief flow for the scenario;
 - b. the peak depressuring valve flow for the scenario.
9. Depressuring valve flows shall be considered only for scenarios in which the use of the depressuring valve is expected or procedurally required (e.g., fire case, scenarios which could lead to reactor over temperature conditions). For some facilities, including offshore facilities, the entire facility may be depressured automatically on confirmed fire or gas detection and shall be included in the flare analysis.
10. The design should also ensure that if two or more depressuring valves in any process system are opened simultaneously, flow from the high pressure system will not back up into the low pressure system (where applicable) sufficiently to overpressure it or hinder its operation.
11. The standard design basis for flare header hydraulics for the fire scenario SHALL [PS] assume that all emergency depressuring systems that protect equipment within a common fire circle are activated. However, the emergency depressuring valves intended for other scenarios (e.g., power failure) may also be operated.
 - a. The effect of opening additional emergency depressuring valves within the unit shall be evaluated.
 - b. The risk shall be reviewed and any flare system design modifications agreed to with the Principal.
12. Equipment that is protected by only a vent line to the flare (i.e., no PRV) introduces fire relief loads that shall be taken into account.
13. Flare loads from systems with PCVs shall be the larger of:
 - a. the required relief flow for the scenario;
 - b. the maximum control valve flow (100 % open with system at relieving conditions).

NOTE: If the control valve flow is determined to be higher than the relief flow, the system will never reach the assumed full relieving pressure. If this is the case and the control valve flow is a significant flare load, it may be cost effective to evaluate the system at pressures at which the vapour generation rate equals the control valve's capacity.

14. Routine operational vents shall be assumed to exist as a background flare load unless it can be shown that such loads would be redundant.
15. To determine the backpressure at the relief valves the required relief flow rates may be used.

4.2.2 Use of 100-50-50 approach for flare load mitigation

1. The impact on the common discharge system design produced by relief flows from connected process units as the result of a utility failure may be calculated by taking 100 % of the quantities established for the relief and depressuring load for each unit in turn, together with 50 % thereof for the other units.
2. If it is determined that multiple trains will discharge simultaneously, the relief loads from those trains should be taken at 100 % (e.g., parallel trains that would simultaneously relieve / depressure during a utility failure).
3. The individual relief valve backpressure shall be taken as the highest value from any one of the above combinations.

4.2.3 Use of Shell Flare IPF methodology for flare load mitigation

1. To reduce the total load on the common relief system, the use may be considered of IPFs consisting of one or more initiators, a Logic Solver, and one or more Final Elements on a pressure system to eliminate the cause of overpressure (e.g., close the heat input and thus prevent the individual relief case).
2. There are two criteria in the Shell Flare IPF Methodology and both shall be met:
 - a. The system shall meet the tolerability requirements with any single IPF failing (not working as designed).
 - b. The combination of up to three concurrent individual or partial IPF failures resulting in total flare loads exceeding the acceptance criteria [for example, thermal radiation acceptance criteria would be the limits found in (6.2.2)] shall be designed to the appropriate SIL level to meet the appropriate acceptance criteria.
3. The following items of the Flare IPF design shall be covered by the flare design documentation:
 - a. A list of all relief valves with their assumptions, the mitigated (by an individual IPF) and unmitigated loads and the associated individual and partial IPFs;
 - b. The rationale, assumptions and calculations demonstrating the claimed mitigated and unmitigated loads;
 - c. Assumed failure rates, test intervals, test and diagnostic coverage factors for IPF components;
 - d. Individual and partial IPF architectures and description of the locations in the process and their resulting PFDs (Probability of Failure on Demand);
 - e. Mapping between individual IPFs and logic solvers;
 - f. Listing of all combinations of failing logic solvers, individual and partial IPFs that would result in exceeding the acceptance criteria for the limit being analysed (for example, backpressure), including the average PFD for each combination;
 - g. Overall resulting PFD;
 - h. Hydraulic flare models for all scenario combinations considered, including the relief capacity calculations if backpressures can limit the individual relief system's capacity.
4. The Principal shall approve this application of this method.
5. The Shell Flare IPF methodology approach may create safety critical elements that require appropriate managing. Therefore, this method shall only be applied with the support of the location management.